Pergamon

Tetrahedron 56 (2000) 5893–5903

TETRAHEDRON

Synthesis of 1,3-Di[alkoxy(aryloxy)carbonyl]-2-oxo-2,3-dihydroindoles

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Received 14 March 2000; revised 8 May 2000; accepted 25 May 2000

Abstract—Two protocols have been developed for the synthesis of 1,3-di[alkoxy(aryloxy)carbonyl]-2-oxo-2,3-dihydroindoles starting from the corresponding *N*,*O*-diacyl derivatives obtained by treatment of 2-oxindoles with chloroformic acid esters and triethylamine. The first is rearrangement of *N*,*O*-diacylated compounds in the presence of 4-dimethylaminopyridine to give *N*,*C*(3)-diacylated products with identical acyl groups in the two positions. The second involves *O*-deacylation of the *N*,*O*-diacylated compounds, followed by *O*-acylation and rearrangement resulting *N*,*C*(3)-diacylated 2-oxindoles with different acyl groups in the two positions.

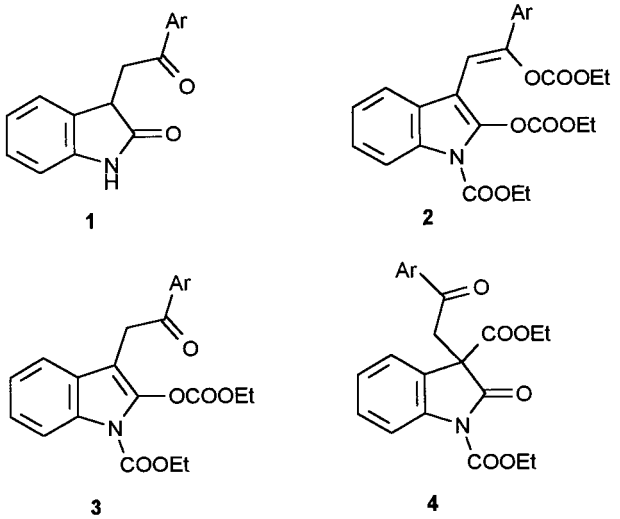
Introduction

As a part of our program in medicinal chemistry we required 1,3-di[alkoxy(aryloxy)carbonyl]-2-oxo-2,3-dihydroindoles (exemplified by compounds **11** and **12**, Scheme 2) as starting material, containing identical or different alkoxy(aryloxy)-carbonyl groups in the two positions.

Several papers dealt with the reactions of 3-substituted-2-oxindole derivatives and alkyl chloroformates under various conditions, encountering the formation of product mixtures and low yield of the required regioisomer.[1–5] In the most instructive paper in this field, Beccalli and Marchesini described the reactions of 3-aroylmethyl-2-oxo-2,3-dihydro-indoles (**1**) with ethyl chloroformate.[6] When compounds **1** were treated with excess of ethyl chloroformate and triethyl-amine in dichloromethane at 0°C, in addition to the expected product **2**, derivatives **3** and **4** were formed in some cases (Scheme 1). If the acylation reaction of **1** (Ar=Ph) was carried out by refluxing after the ethyl chloroformate addition, compound **4** (Ar=Ph) was obtained as the single product. Treatment of type **3** *N*,*O*-diacylated compounds with ethyl chloroformate and triethylamine resulted in the formation of **2** and **4** in some cases. The results were rationalized as follows: attack of ethyl chloroformate at the nitrogen atom is followed by acylation of the oxygen at *C*(2). Acylation at the oxygen of the side chain carbonyl leads to compounds **2**. Derivatives **4** arise from compounds **3** by *O*–*C*(3) acyl migration.

O–*C*(3) Acyl migrations were carried out in quantitative yields by heating **3** (Ar: 2-thienyl, and 1-carbethoxy-2-indolyl) in dichloromethane in the presence of a catalytic amount of 4-dimethylaminopyridine (DMAP).

There are very few examples in the literature for the acylation of 2-oxindoles unsubstituted in the 3-position. Treatment of 2-oxindole with sodium hydride and ethyl chloroformate in THF gave the *N*-acylated derivative in 20% yield.[7] In a patent application[8] we described *N*,*O*-diacylation of 5-chloro-2-oxindole with alkyl- and aryl-chloroformates and the conversion of the *N*,*O*-diacylated compounds to *N*-acylated ones.



Scheme 1.

Keywords: acylation; indolinones; rearrangements; regio control; tautomerism.

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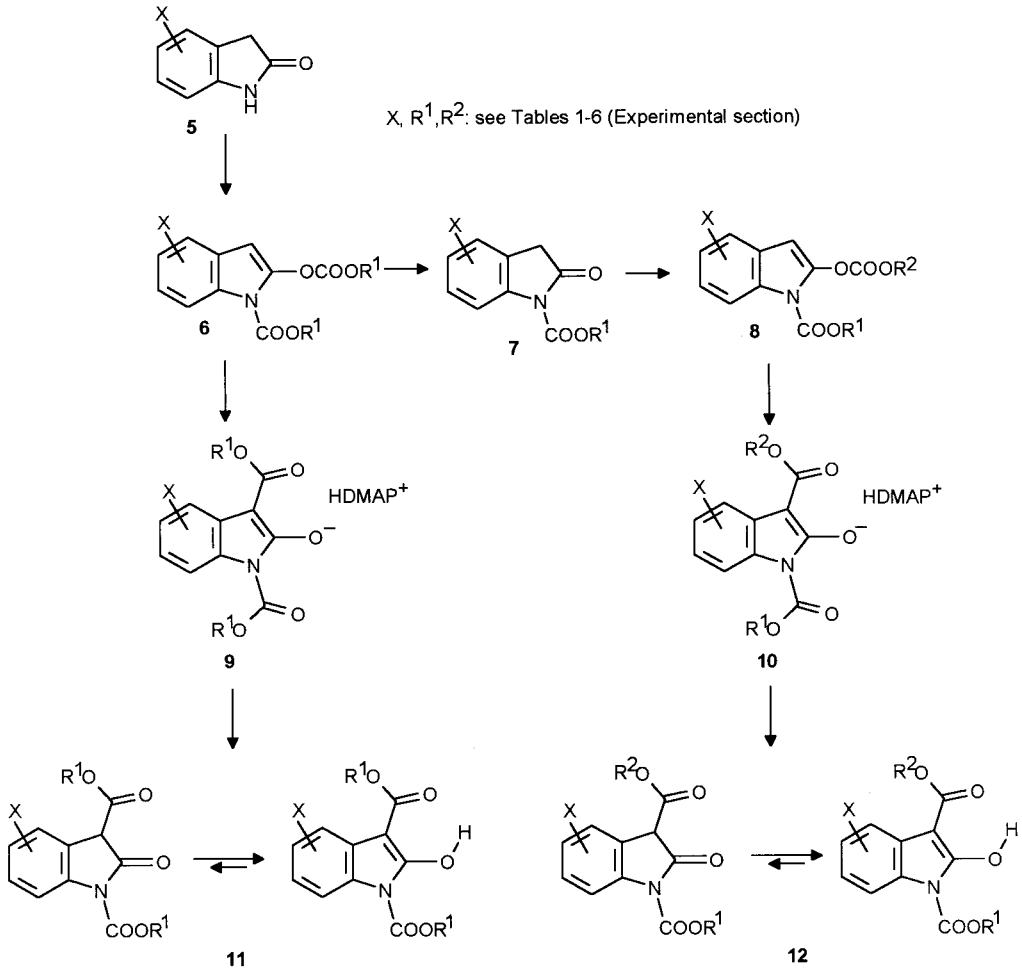
PII: S0040-4020(00)00477-4



Scheme 2.

In a recent communication[9] 2-oxindole and 3-methyl-2-oxindole were shown to have different reactivities in acylation reactions under similar conditions. Treatment of 2-oxindole with benzyl chloroformate and triethylamine in THF gave only the *N*,*O*-diacylated derivative. 3-Methyl-2-oxindole did not react under the same conditions, however, its treatment with benzyl chloroformate and DMAP gave *N*,*C*(3)-diacylated derivative in moderate yield.[10] We are unaware, however, of any examples of *N*,*C*(3)-diacylation of 2-oxindoles unsubstituted in the 3-position.

After consideration of the information provided by the literature we reasoned that *N*,*O*-diacylated compounds **6** and **8** could serve as the appropriate precursors of the desired *N*,*C*(3)-diacylated products **11** and **12** (Scheme 2). In this paper we describe the reaction conditions where the required rearrangement proceeds smoothly and the products are obtained in high yield. Recently, we have reported the application of a similar strategy in our synthesis of anti-rheumatic drug tenidap. [8,11]

Results and Discussion

Treatment of 2-oxindoles **5** with 2.2 equiv. of chloroformic acid esters and triethylamin in THF afforded *N*,*O*-diacylated derivatives **6**.[8,9,11] The *O*-acyl moiety was removed by reaction with ammonium carbonate in DMF to give *N*-[alkoxy(aryloxy)carbonyl]-2-oxo-2,3-dihydroindoles **7** with good yields.[8,11] The reaction of *N*-acylated derivatives **7** with 1.1 equiv. of chloroformic acid esters and triethylamine in THF afforded mixed *N*,*O*-diacylated derivatives **8**.

Attempts to rearrange compounds **6a** and **8a** to **11a** and **12a** using catalytic amounts of triethylamine or DMAP as well as equivalent amount of triethylamine afforded product mixtures. Treatment of **6a** with 1 equiv. of DMAP followed by acidic work-up resulted in the formation of **11a** in good yield. Derivatives **11** and **12** with aryl- or benzyloxycarbonyl group in the 3-position were unstable towards the acidic work-up. However, 4-dimethylaminopyridinium salts of **11** and **12**, namely enolates **9** and **10** were easily accessible by addition of water to the reaction mixture in DMF. The structures of enolates **9** and **10** shown in Scheme 2 are assigned on the bases of single crystal X-ray analysis of **9d** (Fig. 1).

The formation of salts **9** and **10** points to the different role played by DMAP in the rearrangement of 3-substituted and 3-unsubstituted *N*,*O*-diacylated 2-oxindoles. Rearranged products obtained from 3-substituted *N*,*O*-diacylated 2-oxindoles using a catalytic amount of DMAP do not exhibit an acidic hydrogen in the 3-position.[6] However, in the case of the corresponding 3-unsubstituted derivatives

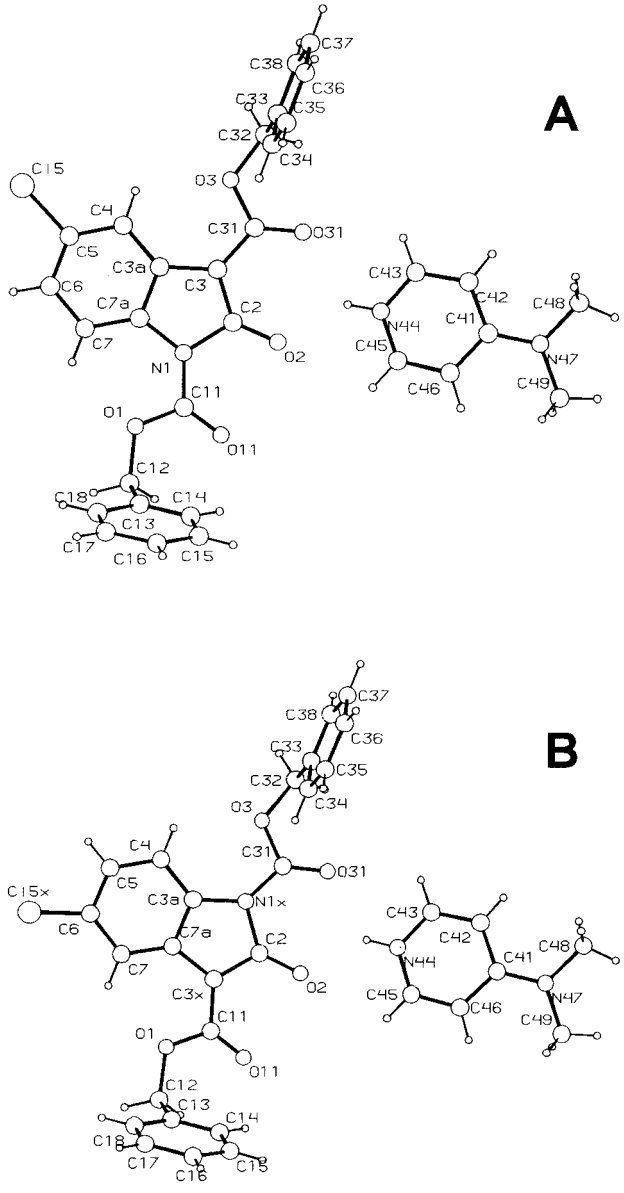


Figure 1. Perspective view of **9d** showing atomic numbering. The positional disorder of *N*(1) vs. *C*(3) and *Cl*(5) with 82:18 (A:B) ratio are labelled (×) in structure B.

the reaction is accomplished by the formation of enolates **9** and **10** with the equivalent amount of DMAP present (Scheme 2).

As mentioned above, addition of aqueous hydrogen chloride solution to the reaction mixture containing **9** and **10** enolates in DMF did not afford conjugate acids **11** and **12** in all cases with preparatively useful yields. On treatment with aqueous acid, 3-aryl- and 3-benzyloxycarbonyl groups underwent hydrolysis and decarboxylation. However, selected type **11** and **12** compounds containing 3-alkyloxycarbonyl group were isolated in good yield (Table 7). The ^{1}H NMR spectra of **11** and **12** indicated an equilibrium between the keto and enol forms in solution, while single crystal X-ray analysis has shown that **11b** exhibits enol form in crystalline state (Fig. 2).

Enolates **9** and **10** are useful synthetic intermediates in

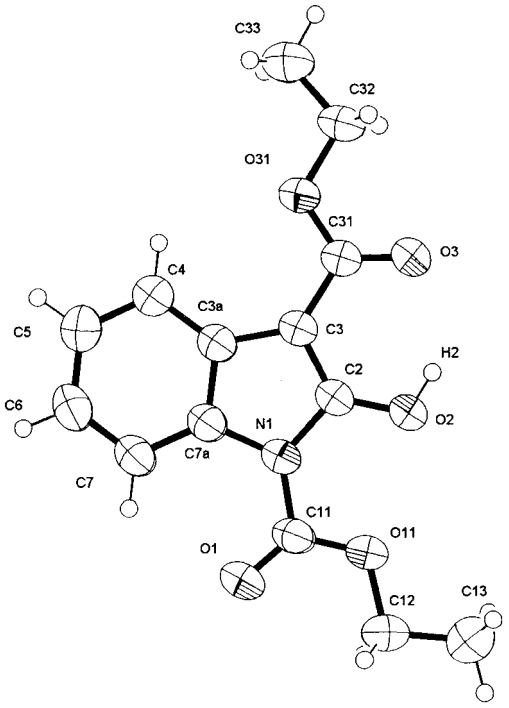


Figure 2. ORTEP drawing of **11b**. Displacement ellipsoids correspond to 50% probability.

medicinal chemistry for the preparation of various 1- and 3-carboxamide derivatives of 2-oxindoles.

Crystal structures

The 1,3-di(ethoxycarbonyl) derivative **11b**—apart from the chemically non-equivalent *N*(1) and *C*(3) positions of the indole moiety—theoretically has C_s or C_2 molecular symmetry. In the crystal lattice this pseudosymmetry is further diminished by the asymmetric orientation of the central OH group closing an intramolecular OH···O hydrogen bond with the carbonyl group bound to *C*(3). This defines the final asymmetric stretching of the molecule (Fig. 2).

The 1,3-di(benzyloxycarbonyl) derivative **9d** is chlorinated on *C*(5) and forms a salt with DMAP. The proton of the cation is bifurcated and donates two almost symmetrical NH···O bonds to the charged central oxygen and one of the neighbouring carbonyl oxygens (geometry parameters in Å and °) (Table 1).

The above described pseudosymmetry of **11b** retained in **9d** enables the anion to assume a stretched array between the terminal *C*(16) and *C*(36) phenyl carbons in such a way that *N*(1) and *C*(3) are swapped with a probability 0.82:0.18. This gives also rise to a positional disorder of the chlorine atom (Fig. 1).

Table 1. Hydrogen bond parameters for compound **9d**

D–H	A	H···A (Å)	D···A (Å)	DHA (°)
N44–H44	O2	2.00	2.710(2)	139.4
N44–H44	O31	2.16	2.816(2)	132.4

Table 2. *N*,*O*-Diacylated 2-oxindoles **6**

	X	R^1	Yield (%)	mp (°C)[a]	Molecular formula	Elemental analyses		^{1}H NMR ($CDCl_3$)
						Calcd	Found	
a	5-Cl	Et	94	76–77 (hexane)	$C_{14}H_{14}ClNO_5$	C, 53.94,H, 4.53, Cl,11.37, N, 4.49.	C, 53.72, H, 4.54, Cl,11.12, N, 4.38.	8.0 (1H, d, *J*=8.8 Hz), 7.47 (1H, d, *J*=2.1 Hz), 7.25 (1H, dd, *J*=8.8 Hz, *J*=2.1 Hz), 6.26 (1H, s), 4.86 (2H, q, *J*=6.9 Hz), 4.37 (2H, q, *J*=7.1 Hz), 1.43 (6H, m);
b	5-Cl	Me	87	97–98 (ethyl acetate)	$C_{12}H_{10}ClNO_5$	C, 50.80, H, 3.55, Cl,12.50, N, 4.94.	C, 50.47, H, 3.52, Cl,12.31, N, 4.89.	7.97 (1H, d, *J*=8.9 Hz), 7.48 (1H, d, *J*=2.1 Hz), 7.26 (1H, dd, *J*=8.9 Hz, *J*=2.1 Hz), 6.28 (1H, s), 4.03 (3H, s), 3.98 (3H, s);
c	5-Cl	Ph	98	130–132 (ethanol)	$C_{22}H_{14}ClNO_5$	C, 64.79, H, 3.46, Cl, 8.68, N, 3.43.	C, 65.08, H, 3.47, Cl, 8.53, N, 3.49.	8.10 (1H, d, *J*=8.9 Hz), 7.55 (1H, d, *J*=2.1 Hz), 7.38–7.25 (9H, m), 7.10 (2H, m), 6.46 (1H, s);
d	5-Cl	Bn	89.5	108–109 (ethyl acetate)	$C_{24}H_{18}ClNO_5$	C, 66.14, H, 4.16, Cl, 8.13, N, 3.21.	C, 66.18, H, 4.18, Cl, 8.01, N, 3.26.	8.00 (1H, d, *J*=8.4Hz), 7.46 (1H, d, *J*=2.1 Hz), 7.44–7.35 (10H, m), 7.24 (1H, dd, *J*=8.2 Hz, *J*=2.1 Hz), 6.25 (1H, s), 5.30 (2H, s), 5.06 (2H, s);
e	5-Cl	Bu	92	57–58 (ethyl acetate)	$C_{18}H_{22}ClNO_5$	C, 58.78, H, 6.03, Cl, 9.64, N, 3.81.	C, 58.61, H, 5.90, Cl, 9.59, N, 3.76.	8.00 (1H, d, *J*=8.9 Hz), 7.47 (1H, d, *J*=2.1 Hz), 7.27 (1H, dd, *J*=8.9Hz, *J*=2.2 Hz), 6.29 (1H, s), 4.420 (2H, t, *J*=6.6 Hz), 4.30 (2H, t, *J*=6.6 Hz), 1.78 (4H, m), 1.48 (4H, m), 1.00 (6H, m);
f	H	Et	82	57–58 (hexane)	$C_{14}H_{15}NO_5$	C, 60.64, H, 5.45, N, 5.05.	C, 60.49, H, 5.47, N, 5.04.	8.08 (1H, dd, *J*=7.4 Hz, *J*=1.0 Hz), 7.50 (1H, ddd, *J*=7.5 Hz, *J*=0.9 Hz, *J*=1.3 Hz,), 7.33 (1H, ddd, *J*=7.3 Hz, *J*=7.5 Hz, *J*=1.3 Hz), 7.25 (1H, ddd, *J*=7.3 Hz, *J*=7.5 Hz, *J*=1.3 Hz), 6.3 (1H, s) 4.47 (2H, q, *J*=7.8 Hz), 4.37 (2H, q, *J*=7.8 Hz), 1.43 (6H, m);
g	H	Ph	95	117–118 (ethyl acetate/hexane)	$C_{22}H_{15}NO_5$	C, 70.77, H, 4.05, N, 3.75.	C, 70.83, H, 4.14, N, 3.73.	8.17 (1H, d, *J*=8.2 Hz), 7.55 (1H, d, *J*=7.5 Hz), 7.45 (2H, m), 7.38–7.28 (8H, m), 7.11 (2H, d, *J*=7.9 Hz), 6.50 (1H, s);
h	H	Bn	60	86–88[b] (ethanol)	$C_{24}H_{19}NO_5$	C, 71.81, H, 4.77, N, 3.49.	C, 71.36, H, 4.76, N, 3.54.	8.05 (1H, m), 7.50–7.10 (13H, m), 6.29 (1H, s), 5.29 (2H, s), 5.05 (2H, s);
i	6-Cl	Ph	92	126–127 (ethyl acetate/hexane)	$C_{22}H_{14}ClNO_5$	C, 64.79, H, 3.46, Cl, 8.69, N, 3.43.	C, 64.51, H, 3.56, Cl, 8.71, N, 3.48.	8.2 (1H, d, *J*=1.8 Hz), 7.51–7.45 (3H, m), 7.39–7.25 (7H, m), 7.10 (2H, m), 6.47 (1H, s);
j	5-NO_2	Ph	93	144–145 (ethyl acetate)	$C_{22}H_{14}N_2O_7$	C, 63.16, H, 3.37, N, 6.70.	C, 62.75, H, 3.30, N, 6.53.	8.49 (1H, d, *J*=2.1 Hz), 8.32 (1H, d, *J*=9.3 Hz), 8.26 (1H, dd, *J*=2.2 Hz, *J*=9.3 Hz), 7.48 (2H, m), 7.37–7.25 (6H, m), 7.10 (2H, m), 6.66 (1H, s);

[a] Compounds **6a**–**j**: colourless crystals.
[b] Lit.[9]: 86–88°C.

Table 3. *N*-Acylated 2-oxindoles **7**

	X	R^1	Yield (%)	mp (°C)[a]	Molecular formula	Elemental analyses		^{1}H NMR ($CDCl_3$)
						Calcd	Found	
a	5-Cl	Et	89	101–102 (hexane)	$C_{11}H_{10}ClNO_3$	C, 55.13, H, 4.21, Cl,14.79, N, 5.84.	C, 55.52, H, 4.20 Cl,14.68, N, 5.82.	7.81 (1H, d, *J*=8.8 Hz), 7.31 (1H, dd, *J*=8.8 Hz, *J*=2.2 Hz), 7.26 (1H, d, *J*=2.2 Hz), 4.48 (2H, q, *J*=7.4 Hz), 3.67 (2H, s), 1.49 (3H, t, *J*=7.4 Hz);
b	5-Cl	Me	88	129–130 (ethyl acetate)	$C_{10}H_8ClNO_3$	C, 53.23, H, 3.57, Cl,15.72, N, 6.21.	C, 53.01, H, 3.59, Cl,15.64, N, 6.24.	7.81 (1H, d, *J*=8.7 Hz), 7.27 (1H, dd, *J*=8.7 Hz, *J*=2.2 Hz), 7.24 (1H, d, *J*=2.2 Hz), 4.01 (3H, s), 3.67 (2H, s);
c	5-Cl	Ph	94	175–176 (ethyl acetate)	$C_{15}H_{10}ClNO_3$	C, 62.62, H, 3.50, Cl,12.32, N, 4.87.	C, 62.79, H, 3.57, Cl,12.35, N, 4.79.	7.90 (1H, d, *J*=8.6 Hz), 7.45 (2H, m), 7.30 (5H, m), 3.75 (2H, s);
d	5-Cl	Bn	95	130–131 (ethyl acetate)	$C_{16}H_{12}ClNO_3$	C, 63.69, H, 4.01, Cl,11.75, N, 4.64.	C, 63.81, H, 4.05, Cl,11.57, N, 4.61.	7.81 (1H, d, *J*=8.7 Hz), 7.45 (2H, m), 7.35 (3H, m), 7.25 (2H, m), 5.44 (2H, s), 3.67 (2H, s);
e	5-Cl	Bu	89	67–68 (ethyl acetate/hexane)	$C_{13}H_{14}ClNO_3$	C, 58.33, H, 5.27, Cl,13.24, N, 5.23.	C, 58.48, H, 5.25, Cl,13.11, N, 5.18.	7.81 (1H, d, *J*=8.7 Hz), 7.30 (1H, dd, *J*=8.7 Hz, *J*=2.2 Hz), 7.25 (1H, bs), 4.40 (2H, t, *J*=6.6 Hz), 3.67 (2H, s), 1.80 (2H, m), 1.50 (2H, m), 1.00 (3H t, *J*=6.6 Hz);
f	H	Et	53	79–80 (hexane)	$C_{11}H_{11}NO_3$	C, 64.38, H, 5.40, N, 6.83.	C, 64.26, H, 5.44, N, 6.91.	7.87 (1H, d, *J*=8.1 Hz), 7.32 (1H, t, *J*=8.5 Hz), 7.25 (1H, d, *J*=7.2 Hz), 7.15 (1H, m), 4.48 (2H, q, *J*=7.2 Hz), 3.68 (2H, s), 1.45 (3H, t, *J*=7.2 Hz);
g	H	Ph	74	95–96 (ethyl acetate/hexane)	$C_{15}H_{11}NO_3$	C, 71.14, H, 4.38, N, 5.53.	C, 70.88, H, 4.33, N, 5.52.	7.94 (1H, d, *J*=8.2 Hz), 7.46 (2H, m), 7.33–7.26 (5H, m), 7.20 (1H, m), 3.76 (2H, s);
h	H	Bn	95	108–109 (ethyl acetate/hexane)[b]	$C_{16}H_{13}NO_3$	C, 71.90, H, 4.90, N, 5.24.	C, 71.57, H, 4.92, N, 5.18.	7.87 (1H, d, *J*=8.1 Hz), 7.52 (2H, dd, *J*=7.6 Hz, *J*=1.9 Hz), 7.42–7.22 (5H, m), 7.17 (1H, m), 5.46 (2H, s), 3.69 (2H, s);
i	6-Cl	Ph	97	138–139 (ethyl acetate/hexane)	$C_{15}H_{10}ClNO_3$	C, 62.62, H, 3.50, Cl,12.32, N, 4.87.	C, 62.45, H, 3.57, Cl,12.19, N, 4.91.	8.00 (1H, d, *J*=1.4 Hz), 7.45 (2H, m), 7.34–7.25 (3H, m), 7.20–7.18 (2H, m), 3.74 (2H, s);
j	5-NO_2	Ph	87	182–183 (ethyl acetate)	$C_{15}H_{10}N_2O_3$	C, 60.40, H, 3.38, N, 9.39.	C, 59.99, H, 3.40, N, 9.32.	8.29 (1H, dd, *J*=9.0 Hz, *J*=1.8 Hz), 8.22 (1H, bs), 8.13 (1H, d, *J*=9.0 Hz), 7.46 (2H, m), 7.35–7.26 (3H, m), 3.88 (2H, s);

[a] Compounds **7a–i**: colourless crystals; compound **7j**: yellow crystals.
[b] Lit.[9]: 109–110°C.

Table 4. *N*,*O*-Diacylated 2-oxindoles **8**

	X	R^1	R^2	mp (°C)[a]	Yield (%)	Molecular formula	Elemental analyses		^{1}H NMR (DMSO-d_6)
							Calcd	Found	
a	5-Cl	Ph	Et	87–88 (ethanol)	98	$C_{18}H_{14}ClNO_5$	C, 60.09, H, 3.92, Cl, 9.86, N, 3.89.	C, 60.10, H, 3.96, Cl, 9.66, N, 3.83.	8.08 (1H, d, *J*=9.0 Hz), 7.52 (1H, d, *J*=2.2 Hz), 7.46 (2H, m), 7.30 (4H, m), 6.36 (1H, s), 4.30 (2H, q, *J*=7.1 Hz), 1.27 (3H, t, *J*=7.1 Hz);
b	5-Cl	Ph	Me	110–111 (ethanol)	99	$C_{17}H_{12}ClNO_5$	C, 59.06, H, 3.50, Cl,10.26, N, 4.05.	C, 59.17, H, 3.49, Cl,10.04, N, 4.07.	8.08 (1H, d, *J*=8.8 Hz), 7.52 (1H, d, *J*=2.2 Hz), 7.46 (2H, m), 7.33 (4H, m), 6.36 (1H, s), 3.88 (3H, s);
c	5-Cl	Ph	Bn	139–140 (acetonitrile)	83	$C_{23}H_{16}ClNO_5$	C, 65.49, H, 3.82, Cl, 8.41, N, 3.32.	C, 65.92, H, 3.95, Cl, 8.18, N, 3.42.	8.08 (1H, d, *J*=8.8 Hz), 7.50 (1H, d, *J*=1.8 Hz), 7.46 -7.17 (11H, m), 6.35 (1H, s), 5.22 (2H, s);
d	5-Cl	Et	Bn	98–99 (hexane)	94	$C_{19}H_{16}ClNO_5$	C, 61.05, H, 4.31, Cl, 9.49, N, 3.75.	C, 60.86, H, 4.29, Cl, 9.55, N, 3.66.	8.02 (1H, d, *J*=8.8 Hz), 7.47 (1H, d, *J*=2.2 Hz), 7.43 -7.37 (5H, m), 7.28 (1H, dd, *J*=8.8 Hz, *J*=2.2 Hz), 6.27 (1H, s), 5.32 (2H, s), 4.34 (2H, q, *J*=7.1 Hz), 1.33 (3H, t, *J*=7.1 Hz);
e	5-Cl	Et	Ph	69–71 (ethanol)	98	$C_{18}H_{14}ClNO_5$	C, 60.09, H, 3.92, Cl, 9.86, N, 3.89.	C, 59.76, H, 4.05, Cl, 9.77, N, 3.86.	8.00 (1H, d, *J*=8.8 Hz), 7.51 (1H, d, *J*=2.2 Hz), 7.43 (2H, m), 7.30 (4H, m), 6.37 (1H, s), 4.54 (2H, q, *J*=7.1 Hz), 1.48 (3H, t, *J*=7.1 Hz);
f	5-Cl	Me	Ph	80–81 (ethanol)	81	$C_{17}H_{12}ClNO_5$	C, 59.06, H, 3.50, Cl,10.26, N, 4.05.	C, 58.66, H, 3.53, Cl, 9.99, N, 3.99.	7.98 (1H, d, *J*=8.8 Hz), 7.51 (1H, d, *J*=2.2 Hz), 7.43 (2H, m), 7.31 (4H, m), 6.39 (1H, s), 4.09 (3H, s);
g	5-Cl	Bn	Et	108–109 (ethanol)	97	$C_{19}H_{16}ClNO_5$	C, 61.05, H, 4.31, Cl, 9.49, N, 3.75.	C, 61.10, H, 4.33, Cl, 9.36, N, 3.71.	8.00 (1H, d, *J*=9.2 Hz), 7.47 (1H, d, *J*=2.2 Hz), 7.43 (5H, m), 7.26 (1H, dd, *J*=9.2 Hz, *J*=2.2 Hz), 6.26 (1H, s), 5.42 (2H, s), 4.10 (2H, q, *J*=7.1 Hz), 1.30 (3H, t, *J*=7.1 Hz);
h	5-Cl	Bn	Ph	138–140 (ethanol)	97	$C_{23}H_{16}ClNO_5$	C, 65.49, H, 3.82, Cl, 8.41, N, 3.32.	C, 65.10, H, 3.81, Cl, 8.31, N, 3.24.	7.97 (1H, d, *J*=8.8 Hz), 7.52 -7.30 (10H, m), 7.25 (1H, dd, *J*=8.8 Hz, *J*=2.2 Hz), 7.12 (1H, m), 6.37 (1H, s), 5.49 (2H, s);
i	H	Ph	Et	88–89 (ethanol)	94	$C_{18}H_{15}NO_5$	C, 66.46, H, 4.65, N, 4.30.	C, 66.30, H, 4.68, N, 4.27.	8.15 (1H, d, *J*=9.1 Hz), 7.57–7.26 (8H, m), 6.41 (1H, s), 4.30 (2H, q, *J*=7.1 Hz), 1.28 (3H, t, *J*=7.1 Hz);
j	6-Cl	Ph	Et	74–75 (ethanol)	83	$C_{18}H_{14}ClNO_5$	C, 60.09, H, 3.92, Cl, 9.86, N, 3.89.	C, 59.99, H, 3.89, Cl, 9.77, N, 3.87.	8.19 (1H, d, *J*=1.5 Hz), 7.46 (3H, m), 7.30 (4H, m), 6.38 (1H, s), 4.30 (2H, q, *J*=7.1 Hz), 1.32 (3H, t, *J*=7.1 Hz);
k	5-NO_2	Ph	Et	113–115 (ethanol)	87	$C_{18}H_{14}N_2O_5$	C, 63.90, H, 4.17, N, 8.28.	C, 63.55, H, 4.19, N, 8.09.	8.47 (1H, d, *J*=1.8 Hz), 8.33 (1H, s), 8.26 (1H, d, *J*=2.2 Hz), 7.49 (2H, m), 7.39 (1H, m), 7.29 (2H, dd, *J*=1.4 Hz, *J*=9.5 Hz), 6.56 (1H, s), 4.32 (2H, q, *J*=7.1 Hz), 1.29 (3H, t, *J*=7.1 Hz);

[a] Compounds **8a–k**: colourless crystals.

Table 5. *N*,3-Diacylated 2-oxindole-4-dimethylaminopyridinium salts **9**

	X	R^1	mp (°C)[a]	Yield (%)	Molecular formula	Elemental analyses		^{1}H NMR (DMSO-d_6)
						Calcd	Found.	
a	5-Cl	Et	173.5–175.5 (acetonitrile)	66	$C_{21}H_{24}ClN_3O_5$	C, 58.13, H, 5.58, Cl, 8.17, N, 9.69.	C, 57.75, H, 5.68, Cl, 8.03, N, 9.46.	13.29 (1H, bs), 8.21 (2H, d, *J*=7.7 Hz), 7.52 (1H, d, *J*=8.4 Hz), 7.49 (1H, d, *J*=2.4 Hz), 6.96 (2H, d, *J*=7.7 Hz), 6.63 (1H, dd, *J*=8.4 Hz, *J*=2.4 Hz), 4.28 (2H, q, *J*=7.1Hz), 4.08 (2H, q, *J*=7.1 Hz), 3.16 (6H, s), 1.30 (3H, t, *J*=7.1 Hz), 1.22 (3H, t, *J*=7.1 Hz);
b	5-Cl	Me	170–171 (acetonitrile)	62	$C_{19}H_{20}ClN_3O_5$	C, 56.23, H, 4.97, Cl, 8.74, N,10.35.	C, 56.00, H, 4.98, Cl, 8.67, N,10.18.	13.29 (1H, bs), 8.22 (2H, d, *J*=7.3 Hz), 7.53 (1H, d, *J*=8.3 Hz), 7.49 (1H, d, *J*=2.3 Hz), 6.96 (2H, d, *J*=7.8 Hz), 6.63 (1H, dd, *J*=8.3 Hz, *J*=2.3 Hz), 3.79 (3H, s), 3.56 (3H, s), 3.16 (6H, s);
c	5-Cl	Ph	198–200 –	93	$C_{29}H_{24}ClN_3O_5$	C, 65.72, H, 4.56, Cl, 6.69, N, 7.93.	C, 65.37, H, 4.53, Cl, 6.81, N, 7.92.	13.2 (1H, bs), 8.20 (2H, d, *J*=7.3 Hz), 7.61 (1H, d, *J*=8.3 Hz), 7.58 (1H, d *J*=2.0 Hz), 7.52–7.05 (10H, m), 6.96 (2H, d, *J*=7.3 Hz), 6.76 (1H, dd, *J*=8.3 Hz, *J*=1.9 Hz), 3.17 (6H, s);
d	5-Cl	Bn	157–158 (ethyl acetate)	95	$C_{31}H_{28}ClN_3O_5$	C, 66.72, H, 5.06, Cl, 6.35, N, 7.53.	C, 66.68, H, 5.02, Cl, 6.25, N, 7.73.	13.3 (1H, bs), 8.20 (2H, d, *J*=7.3 Hz), 7.56 (4H, m), 7.36 (8H, m), 6.96 (2H, d, *J*=7.6 Hz), 6.66 (1H, dd, *J*=8.3 Hz, *J*=2.5 Hz), 5.34 (2H, s), 5.16 (2H, s), 3.17 (6H, s);
e	H	Et	144–145 (ethyl acetate)	75	$C_{21}H_{25}N_3O_5$	C, 63.14, H, 6.31, N, 10.52.	C, 62.98, H, 6.30, N, 10.31.	13.5 (1H, bs), 8.21 (2H, d, *J*=7.6 Hz), 7.54 (2H, t, *J*=7.9 Hz, *J*=7.6 Hz), 6.96 (2H, d, *J*=7.6 Hz), 6.84 (1H, t, *J*=7.6 Hz), 6.65 (1H, t, *J*=8.2 Hz), 4.26 (2H, q, *J*=7.1 Hz), 4.05 (2H, q, *J*=7.0 Hz), 3.16 (6H, s), 1.28 (3H,t, *J*=7.1 Hz), 1.22 (3H, t, *J*=7.0 Hz);
f	H	Ph	197–198 (acetonitrile)	96	$C_{29}H_{25}N_3O_5$	C, 70.29, H, 5.09, N, 8.48.	C, 69.88, H, 5.19, N, 8.54.	13.5 (1H, bs), 8.20 (2H, d, *J*=7.6 Hz), 7.65 (1H, d, *J*=7.3 Hz), 7.59 (1H, d, *J*=0.9 Hz), 7.48 (2H, m), 7.30 (4H, m), 7.10 (4H, m), 6.96 (2H, d, *J*=7.6 Hz), 6.90 (1H, d, *J*=1.1 Hz), 6.74 (1H, td, *J*=7.7 Hz, *J*=1.5 Hz), 3.16 (6H, s);
g	H	Bn	133–134 (ethyl acetate)	77	$C_{31}H_{29}N_3O_5$	C, 71.11, H, 5.58, N, 8.03.	C, 70.92, H, 5.64, N, 7.96.	13.47 (1H, bs), 8.20 (2H, d, *J*=7.5 Hz), 7.56 (4H, m), 7.36 (7H, m), 6.96 (2H, d, *J*=7.6 Hz), 6.85 (1H, ddd, *J*=1.1 Hz, *J*=7.4 Hz, *J*=7.6 Hz), 6.66 (1H, ddd, *J*=1.3 Hz, *J*=7.5 Hz, *J*=7.6 Hz), 5.38 (2H, s), 5.16 (2H, m), 3.17 (6H, s);
h	6-Cl	Ph	208–210 (acetonitrile)	97	$C_{29}H_{24}ClN_3O_5$	C, 65.72, H, 4.56, Cl, 6.69, N, 7.93.	C, 66.05, H, 4.80, Cl, 6.87, N, 7.93.	13.2 (1H, bs), 8.20 (2H, d, *J*=7.8 Hz), 7.66 (1H, d, *J*=1.9 Hz), 7.58 (1H, d, *J*=8.3 Hz), 7.46 (2H, m), 7.36 (2H, d, *J*=7.8 Hz), 7.28 (3H, m), 7.12 (3H, m), 6.96 (3H, m), 3.16 (6H, s);
i	5-NO_2	Ph	160–162 –	94	$C_{29}H_{24}N_4O_5$	C, 64.44, H, 4.48, N, 10.36.	C, 64.04, H, 4.49, N, 10.28.	13.2 (1H, bs), 8.40 (1H, d, *J*=2.0 Hz), 8.20 (2H, d, *J*=7.8 Hz), 7.81 (1H, d, *J*=8.8 Hz), 7.67 (1H, dd, *J*=8.8 Hz, *J*=2.5 Hz), 7.60–7.25 (6H, m), 7.15 (4H, m), 6.97 (2H, d, *J*=7.8 Hz), 3.17 (6H, s);

[a] Compounds **9a–h**: colourless crystals; compond **9i**: orange crystals.

Table 6. *N*,3-Diacylated 2-oxindole-4-dimethylaminopyridinium salts **10**

	X	R^1	R^2	mp (°C)[a]	Yield (%)	Molecular formula	Elemental analyses		^{1}H NMR (DMSO-d_6)
							Calcd	Found.	
a	5-Cl	Ph	Et	184–185 –	86	$C_{25}H_{24}ClN_3O_5$	C, 62.30, H, 5.02, Cl, 7.32, N, 8.72.	C, 62.02, H, 5.03, Cl, 7.29, N, 8.56.	13.3 (1H, bs), 8.22 (2H, d, *J*=7.8 Hz), 7.56 (2H, m), 7.46 (2H, m), 7.26 (3H, m), 6.96 (2H, d, *J*=7.8 Hz), 6.66 (1H, dd, *J*=8.3 Hz, *J*=2.4 Hz), 4.15 (2H, q, *J*=7.0 Hz), 3.17 (6H, s), 1.23 (3H, t, *J*=7.0 Hz);
b	5-Cl	Ph	Me	186–192 (acetonitrile)	92	$C_{24}H_{22}ClN_3O_5$	C, 61.60, H, 4.74, Cl, 7.58, N, 8.98.	C, 61.35, H, 4.81, Cl, 7.42, N, 8.96.	13.3 (1H, bs), 8.22 (2H, d, *J*=7.8 Hz), 7.56 (4H, m), 7.26 (3H, m), 6.96 (2H, d, *J*=7.8 Hz), 6.64 (1H, dd, *J*=8.8 Hz, *J*=2.2 Hz), 3.58 (3H, m), 3.17 (6H, s);
c	5-Cl	Ph	Bn	197–198 (acetonitrile)	95	$C_{30}H_{26}ClN_3O_5$	C, 66.23, H, 4.82, Cl, 6.52, N, 7.72.	C, 65.90, H, 5.01, Cl, 6.45, N, 7.80.	13.3 (1H, bs), 8.20 (2H, d, *J*=8.1 Hz), 7.56 (1H, d, *J*=2.2 Hz), 7.55 (1H, d, *J*=8.4 Hz), 7.52–7.20 (10H, m), 6.96 (2H, d, *J*=8.1 Hz), 6.66 (1H, dd, *J*=8.4 Hz, *J*=2.2 Hz), 5.16 (2H, s), 3.17 (6H, s);
d	5-Cl	Et	Bn	163–165 (acetonitrile)	86	$C_{26}H_{26}ClN_3O_5$	C, 62.96, H, 5.28, Cl, 7.15, N, 8.47.	C, 62.78, H, 5.50, Cl, 7.11, N, 8.41.	13.3 (1H, bs), 8.20 (2H, d, *J*=7.7 Hz), 7.54 (1H, d, *J*=8.6 Hz), 7.52 (1H, d, *J*=2.2 Hz), 7.46–7.20 (5H, m), 6.96 (2H, d, *J*=7.7 Hz), 6.65 (1H, dd, *J*=8.4 Hz, *J*=2.3 Hz), 5.15 (2H, s), 4.26 (2H, q, *J*=7.1 Hz), 3.17 (6H, s), 1.30 (3H, t, *J*=7.1 Hz);
e	5-Cl	Et	Ph	158–160 (acetonitrile)	95	$C_{25}H_{24}ClN_3O_5$	C, 62.30, H, 5.02, Cl, 7.32, N, 8.72.	C, 61.96, H, 5.05, Cl, 7.55, N, 8.59.	13.3 (1H, bs), 8.19 (2H, d, *J*=7.8 Hz), 7.58 (1H, d, *J*=8.2 Hz), 7.50 (1H, d, *J*=2.4 Hz), 7.36 (2H, m), 7.10 (3H, m), 6.94 (2H, d, *J*=7.8 Hz), 6.72 (1H, dd, *J*=8.2 Hz, *J*=2.3 Hz), 4.31 (2H, q, *J*=7.0 Hz), 3.17 (6H, s), 1.30 (3H, t, *J*=7.1 Hz);
f	5-Cl	Me	Ph	137–138 (acetonitrile)	88	$C_{24}H_{22}ClN_3O_5$	C, 61.60, H, 4.74, Cl, 7.58, N, 8.98.	C, 61.22, H, 4.82, Cl, 7.83, N, 9.13.	13.3 (1H, bs), 8.19 (2H, d, *J*=7.7 Hz), 7.59 (1H, d, *J*=8.4 Hz), 7.50 (1H, d, *J*=2.1 Hz), 7.36 (2H, m), 7.10 (3H, m), 6.95 (2H, d, *J*=7.7 Hz), 6.72 (1H, dd, *J*=8.4 Hz, *J*=2.3 Hz), 3.82 (3H, s), 3.17 (6H, s);
g	5-Cl	Bn	Et	173–174 (acetonitrile)	91	$C_{26}H_{26}ClN_3O_5$	C, 62.96, H, 5.28, Cl, 7.15, N, 8.47.	C, 62.59, H, 5.33, Cl, 7.36, N, 8.37.	13.3 (1H, bs), 8.19 (2H, d, *J*=7.6 Hz), 7.56 (1H, d, *J*=8.5 Hz), 7.53 (2H, m), 7.51 (1H, d, *J*=2.3 Hz), 7.42–7.30 (3H, m), 6.95 (2H, d, *J*=7.6 Hz), 6.65 (1H, dd, *J*=8.5 Hz, *J*=2.3 Hz), 5.34 (2H, s), 4.08 (2H, q, *J*=7.0 Hz), 3.17 (6H, s), 1.22 (3H, t, *J*=7.0 Hz);

Table 6 (*continued*)

	X	R^1	R^2	mp (°C)[a]	Yield (%)	Molecular formula	Elemental analyses		^{1}H NMR (DMSO-d_6)
							Calcd	Found.	
h	5-Cl	Bn	Ph	153–155 (acetonitrile)	94	$C_{30}H_{26}ClN_3O_5$	C, 66.23, H, 4.82, Cl, 6.52, N, 7.72.	C, 65.83, H, 4.96, Cl, 6.76, N, 7.72.	13.3 (1H, bs), 8.17 (2H, d, *J*=7.8 Hz), 7.62 (1H, d, *J*=8.8 Hz), 7.56 (2H, m), 7.52 (1H, d, *J*=2.4 Hz), 7.36 (5H, m), 7.10 (3H, m), 6.94 (2H, d, *J*=7.8 Hz), 6.72 (1H, dd, *J*=8.8 Hz, *J*=2.4 Hz), 5.37 (2H, s), 3.15 (6H, s);
i	H	Ph	Et	148–150 (ethanol)	89	$C_{25}H_{25}ClN_3O_5$	C, 67.10, H, 5.63, N, 9.39.	C, 66.83, H, 5.71, N, 9.25.	13.3 (1H, bs), 8.21 (2H, d, *J*=7.3 Hz), 7.59 (2H, d, *J*=7.8 Hz), 7.46 (2H, m), 7.26 (3H, m), 6.94 (3H, m), 6.71 (1H, m), 4.10 (2H, q, *J*=7.0 Hz), 3.17 (6H, s), 1.23 (3H, t, *J*=7.0 Hz);
j	6-Cl	Ph	Et	175–176 (acetonitrile)	81	$C_{25}H_{24}ClN_3O_5$	C, 62.30, H, 5.02, Cl, 7.36, N, 8.72.	C, 61.97, H, 5.01, Cl, 7.43, N, 8.86.	13.3 (1H, bs), 8.20 (2H, d, *J*=7.5 Hz), 7.59 (1H, d, *J*=2.0 Hz), 7.54 (1H, d, *J*=8.3 Hz), 7.46 (2H, m), 7.28 (3H, m), 6.96 (2H, d, *J*=7.8 Hz), 6.92 (1H, dd, *J*=8.2 Hz, *J*=2.2 Hz), 4.07 (2H, q, *J*=7.0 Hz), 3.16 (6H, s), 1.24 (3H, t, *J*=7.0 Hz);
k	5-NO_2	Ph	Et	189–190 (acetonitrile)	89	$C_{25}H_{24}N_4O_7$	C, 60.97, H, 4.91, N, 11.37.	C, 60.69, H, 5.02, N, 11.07.	13.3 (1H, bs), 8.41 (1H, d, *J*=2.6 Hz), 8.20 (2H, d, *J*=7.8 Hz), 7.73 (1H, d, *J*=8.8 Hz), 7.64 (1H, dd, *J*=8.8 Hz, *J*=2.6 Hz), 7.47 (2H, m), 7.30 (3H, m), 6.94 (2H, d, *J*=7.5 Hz), 4.13 (2H, q, *J*=7.0 Hz), 3.17 (6H, s), 1.23 (3H, t, *J*=7.0 Hz);

[a] Compounds **10a–j**: colourless crystals; compond **10k**: orange crystals.

Table 7. *N*,3-Diacylated 2-oxindoles **11** and **12**

	X	R^1	R^2	mp (°C)[a]	Yield (%)	Molecular formla	Elemental analyses		Enol:keto ratio	^{1}H NMR	
							Calcd	Found		Enol	Keto
11a	5-Cl	Et	–	121–122 (ethanol)	90	$C_{14}H_{14}ClNO_5$	C, 53.94, H, 4.53, Cl,11.37, N, 4.50.	C, 53.71, H, 4.57, Cl,11.36, N, 4.52.	4: 1	7.92 (1H, d, *J*=8.8 Hz), 7.71 (1H, d, *J*=2.2 Hz), 7.15 (1H, dd, *J*=8.8 Hz, *J*=2.2 Hz), 4.55 (2H, q, *J*=7.1 Hz), 4.45 (2H, q, *J*=7.1 Hz), 1.50 (6H, t, *J*=7.1 Hz);	7.85 (1H, d, *J*=8.8 Hz), 7.35 (2H, m), 4.54 (1H, s), 4.45 (2H, q, *J*=7.1 Hz), 4.25 (2H, q, *J*=7.1 Hz), 1.50 (3H, t, *J*=7.1 Hz), 1.30 (3H, t, *J*=7.1 Hz);
11b	H	Et	–	84–85 (hexane)	82	$C_{14}H_{15}NO_5$	C, 60.64, H, 5.45, N, 5.05.	C, 60.46, H, 5.50, N, 5.01.	1: 1	8.05 (1H, d, *J*=7.8 Hz), 7.77 (1H, dd, *J*=7.7 Hz, *J*=0.7 Hz), 7.38 (1H, d, *J*=8.2 Hz), 7.25 (1H, m), 4.57 (2H, q, *J*=7.1 Hz), 4.48 (2H, q, *J*=7.1 Hz), 1.53 (3H, t, *J*=7.1 Hz), 1.47 (3H, t, *J*=7.1 Hz);	7.92 (1H, d, *J*=8.2 Hz), 7.38 (1H d, *J*=8.0 Hz), 7.25 (2H, m), 4.56 (1H, s), 4.46 (2H, q, *J*=7.1 Hz), 4.25 (2H, m), 1.48 (3H, t, *J*=7.1 Hz), 1.28 (3H, t, *J*=7.1 Hz);
12a	Cl	Ph	Et	144–145 (ethanol)	95	$C_{18}H_{14}ClNO_5$	C, 60.09, H, 3.92, Cl, 9.86, N, 3.89.	C, 60.33, H, 3.93, Cl, 9.64, N, 3.94.	3.5:1	8.04 (1H, d, *J*=8.8 Hz), 7.75 (1H, *J*=2.0 Hz), 7.40 (5H, m), 7.22 (1H, dd, *J*=8.8 Hz, *J*=2.0 Hz), 4.50 (2H, q, *J*=7.1 Hz), 1.50 (3H, t, *J*=7.1 Hz);	7.95 (1H, d, *J*=8.4 Hz), 7.40 (7H, m), 4.64 (1H, s), 4.32 (2H, q, *J*=7.1 Hz), 1.34 (3H, t, *J*=7.1 Hz);
12b	Cl	Ph	Me	140–141 (ethyl acetate)	91	$C_{17}H_{12}ClNO_5$	C, 59.06, H, 3.50, Cl,10.26, N, 4.05.	C, 58.82, H, 3.45, Cl,10.24, N, 4.07.	3: 1	8.03 (1H, d, *J*=8.8 Hz), 7.75 (1H, *J*=2.2 Hz), 7.40 (5H, m), 7.22 (1H, dd, *J*=8.8 Hz, *J*=2.2 Hz), 4.04 (3H, s);	7.94 (1H, d, *J*=8.4 Hz), 7.40 (7H, m), 4.65 (1H, s), 3.85 (3H, s);

[a] Compounds **11a–b** and **12a–b**: colourless crystals.

Experimental

Melting points are uncorrected. ^{1}H NMR spectra were recorded at 200 or 400 MHz. All unspecified reagents were from commercial sources.

Structure determination of 9d and 11b by X-ray crystallography. Intensity data were collected on an Enraf Nonius CAD4 diffractometer. The structures were solved by direct methods.[12]

9d. $C_{31}H_{28}ClN_3O_5$; Mr=558.01, crystallized from ethyl acetate as colourless crystals. The triclinic cell parameters and calculated cell volume are a=10.568(1) Å, b=11.274(1) Å, c=12.151(2) Å, α=93.07(1)°, β=97.60(1)°, γ=106.16(1)°, V=1372.1(2) Å^3. Space group: P-1. Refinement on F^2 values for all non-hydrogen atoms yielded $R1$=0.0438 and $wR2$=0.1287 for 4391 [$I>2\sigma(I)$] observations.

11b. $C_{14}H_{15}NO_5$; Mr=277.27, crystallized from ethanol as colourless crystals. The triclinic cell parameters and calculated cell volume are a=4.993(1) Å, b=9.184(2) Å, c=15.145(1) Å, α=99.78(1)°, β=92.51(1)°, γ=95.51(1)°, V=679.95(16) Å^3. Space group: P-1. Refinement on F^2 values for all non-hydrogen atoms yielded $R1$=0.0414 and $wR2$=0.1284 for 1943 [$I>2\sigma(I)$] observations.

General procedure for the synthesis of *N*,*O*-diacylated 2-oxindoles 6. To a solution of 2-oxindole **5** (0.10 mol) and triethylamine (0.22 mol) in THF (360 mL) was added chloroformic acid ester (0.22 mol) dropwise. The temperature was kept below 30°C during the addition. After stirring for 30 min at room temperature, the solvent was evaporated. Water (100 mL) was added to the residue and the mixture was stirred for 2 h at 0–5°C. The crystalline product was filtered and recrystallized to give **6**. For the yields, mp's, solvents of recrystallization, elemental analyses and ^{1}H NMR data see Table 2.

General procedure for the synthesis of *N*-acylated 2-oxindoles 7. To a solution of **6** (0.1 mol) in DMF (200 mL) was added finely powdered ammonium carbonate (7.80 g, NH_3 content 22%, 0.1 mol) at 0–5°C. The mixture was stirred for 6 h at room temperature then poured into ice-water (400 g). The crude product was filtered, washed with water and recrystallized to give **7**. For the yields, mp's, solvents of recrystallization, elemental analyses and ^{1}H NMR data see Table 3.

General procedure for the synthesis of 'mixed' *N*,*O*-diacylated 2-oxindoles 8. To a solution of **7** (0.10 mol) and triethylamine (0.11 mol) in THF (360 mL) was added chloroformic acid ester **2** (0.11 mol) dropwise. The temperature was kept below 30°C during the addition. After stirring for 30 min at room temperature, the solvent was evaporated. Water (100 mL) was added to the residue and the mixture was stirred for 2 h at 0–5°C. The crystalline product was filtered and recrystallized to give **8**. For the yields, mp's, solvents of recrystallization, elemental analyses and ^{1}H NMR data see Table 4.

General procedure for the synthesis of *N*,3-diacylated 2-oxindole-4-dimethylamino-pyridinium salts 9 and 10. To a solution of **6** or **8** (0.1 mol) in DMF (100 mL) was added a solution of 4-dimethylaminopyridine (0.1 mol) in DMF (100 mL) at 0–2°C. The mixture was stirred for 10 min and ice-water (400 g) was added. The crude product was filtered, washed with water and recrystallized to give **9** or **10**, respectively. For the yields, mp's, solvents of recrystallization, elemental analyses and ^{1}H NMR data see Tables 5 and 6, respectively.

General procedure for the synthesis of *N*,3-diacylated 2-oxindoles 11 and 12. To a solution of **6** or **8** (0.1 mol) in DMF (100 mL) was added a solution of 4-dimethylaminopyridine (0.1 mol) in DMF (100 mL) at 0–2°C. It was stirred for 10 min and a mixture of concentrated HCl (8.2 mL) and ice-water (400 g) was added. The crude product was filtered, washed with water and recrystallized to give **11** or **12**, respectively. For the yields, mp's, solvents of recrystallization, elemental analyses and ^{1}H NMR data see Table 7.

References

1. Beccalli, E. M.; Marchesini, A. *Tetrahedron* **1995**, *51*, 2353.
2. Beccalli, E. M.; Marchesini, A. *Synth. Comm.* **1993**, *23*, 2945.
3. Beccalli, E. M.; Marchesini, A.; Pilati, T. *J. Chem. Soc., Perkin Trans. 1* **1994**, 579.
4. Beccalli, E. M.; Marchesini, A.; Pilati, T. *Tetrahedron* **1994**, *50*, 12697.
5. Beccalli, E. M.; Marchesini, A.; Pilati, T. *Synthesis* **1992**, 891.
6. Beccalli, E. M.; Marchesini, A. *Tetrahedron* **1993**, *49*, 4741.
7. Caramella, P.; Coda Corsico, A.; Corsaro, A.; Del Monte, D.; Marinone Albini, F. *Tetrahedron* **1982**, *38*, 173.
8. Blaskó, G.; Lukács, Gy.; Reiter, J.; Flórián, E.; Porcs-Makkay, M.; Mezei, T.; Simig, Gy. WO 97 36,895 (to Egis Pharmaceuticals Ltd., filed on 3 April 1997), *Chem. Abstr.* **1997**, *127*, 318879z.
9. Rajeswaran, W. G.; Cohen, L. A. *Tetrahedron* **1998**, *54*, 11375.
10. For similar reactions of 3-alkyloxindoles see Beccalli, E. M.; Marchesini, A. *Synthesis* **1992**, 265.
11. Porcs-Makkay, M.; Simig, Gy. *Org. Process Res. Dev.* **2000**, *4*, 10.
12. The authors have deposited atomic coordinates with the Cambridge Crystallographic Data Centre. The coordinates can be obtained, on request, from the Director, Cambridge Crystallographic Data Centre, 12 Union Road, Cambridge, CB2 1EZ, UK. Ref. No. for **9d** CCDC 143819 and for **11b** CCDC 143820.