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Construction of Dispirocyclopentanebisoxindoles via Self-Domino Michael-Aldol Reactions of 3-Phenacylideneoxindoles

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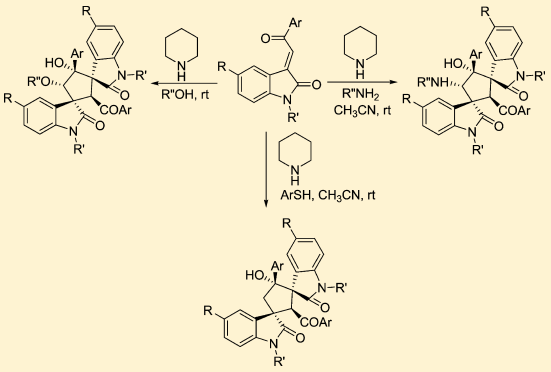
Supporting Information

ABSTRACT: A simple protocol for the construction of novel dispirocyclopentanebisoxindoles is accomplished by the base promoted domino reactions between two molecules of 3-phenacylideneoxindoles with the participation of solvents, alcohol, or other added nucleophiles such as amines or thiophenols. Significantly, this domino reaction results in the complex dispiro compounds with high yields and diastereoselectivity, which would allow construction of dispirocyclopentanebisoxindole with four and five diastereoisomeric centers using simple materials.



INTRODUCTION

The spirooxindole framework represents an important structural motif that is embodied in a number of bioactive natural products.[1,2] The unique structural array and the highly pronounced pharmacological activity displayed by this class of spirooxindoles have made them attractive synthetic targets.[3,4] The intense investigations on the isatin chemistry have led to the successful design and synthesis of diverse types of heterocyclic and carbocyclic spirooxindoles.[5] Although the synthetic approaches to heterocyclic spirooxindoles have been widely investigated, the biological properties and syntheses of the carbocyclic oxindoles are now attracting more and more attention.[6,7] Spirocyclopentaneoxindole moieties are found in natural alkaloids such as cirinalins, notoamides, citrinadins, and cyclopiamines (Scheme 1).[8] Spirocyclopentaneoxindoles have also been recognized as compounds with a wide spectrum of biological activity, such as insecticidal, cytotoxic, anthelmintic, and antibacterial. Therefore, substantial effort has focused on both the synthetic and the biosynthetic aspects of this unique ring system.[9] As a consequence, a number of methods have been developed for the efficient preparation of spirocyclopentaneoxindole derivatives. A $TiCl_4$-mediated reaction of 1,1-diarylethylenes and isatins gave spiroindeneoxindoles through the tandem Prins and intramolecular Friedel–Crafts reactions.[10a] An In(III)-catalyzed reductive cyclization of isatylidene malononitriles by using the Hantzsch ester afforded the novel bis-spirocyclopentenebisoxindoles.[10b] The intramolecular Wittig reaction of isatin-derived phosphorus ylide also led to a facile synthesis of spirocyclopenteneoxindoles.[11] Shi and coworkers have reported the diastereoselective synthesis of spirocyclopenteneoxindoles via annulations of isatylidene malononitrile with the Morita–Baylis–Hillman (MBH) carbonates and isatin-derived electron-deficient alkenes with allenoates in the presence of phosphines.[12] The three-component [2+2+1]-cycloaddition reactions of isocyanides, activated alkynes, and isatylidene malononitriles provided a new approach to spirocyclopentaneoxindole.[13] Several efficient metal or organocatalyzed enantioselective syntheses of spirocyclopentaneoxindoles were also successfully explored by Marinetti,[14] Trost,[15] Barbas III,[16] Shao,[17] and Chen.[18] Encouraged by these achievements and with the aim of expanding our previous studies on the synthesis of spirooxindoles,[19,20] here we report the facile construction of novel bis-spirocyclopentenebisoxindoles by domino reaction between two molecules of 3-phenacylideneoxindoles in basic solution.

RESULTS AND DISCUSSION

In the synthesis of the dispirooxindole-fused heterocycles via domino reactions of in situ generated Huisgen 1,4-dipoles with 3-phenacylideneoxindole,[19] we found that 3-phenacylideneoxindole could produce an unexpected dispirocyclopentanebisoxindole (**2q**) in 42% yield in the presence of 4-dimethylaminopyridine (DMAP). This surprising result is of value to us because we were unable to find a published method for such a convenient synthesis of this kind of product. A literature survey showed that 3-phenacylideneoxindoles have long been used as active electron-deficient alkenes in many synthetic procedures such as 1,3-dipolar cycloaddition, Diels–Alder reaction, Michael addition, and versatile multicomponent reactions for the design of the fused cyclic and spirocyclic frameworks.[8,21,22] However, there are no reports of effective 1,3-dipoles cycloaddition or dimerization with those reagents. On the other hand, there are very few examples of the synthesis of a

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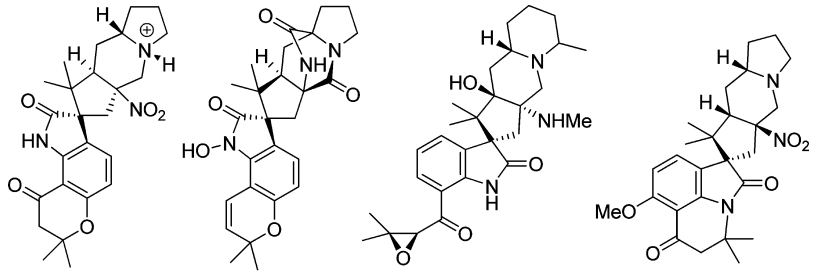
Scheme 1. Typical Natural Products Containing Spirocyclopentaneoxindole Scaffold

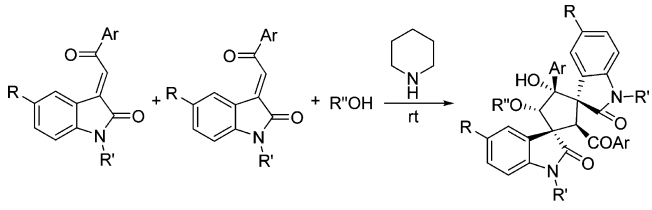


Cirinalins A Notoamide A Citrinadin B Cyclopiamine B

complex dispirocyclopentanebisoxindole system.[10,11b] Barbas III reported the efficient synthesis of dispirocyclopentanebisoxindoles with four chiral centers by organocatalyzed domino asymmetric reactions of 3-substituted oxindoles with methylenindolinones.[16b] Encouraged by this interesting result, we decided to optimize the reaction conditions, which included the choice of a base, solvent, temperature, and molar ratio of the substrates (**SPI**, Table s1, Supporting Information). The best result was obtained by stirring the methanolic solution of 3-phenacylideneoxindole in the presence of piperidine at room temperature for 5 h, which gave the desired dispirocyclopentanebisoxindole **2q** in 80% yield. Upon optimization of reaction conditions, various 3-phenacylideneoxindoles with different kinds of substituents in the oxindole and phenacyl moieties were introduced into the transformation. We were satisfied to find that the corresponding methoxy-substituted dispirocyclopentanebisoxindoles **2a**–**2r** were obtained in 80–98% yields (Table 1, entries 1–18). Similarly, the reactions in ethanol afforded the ethoxy-substituted dispirocyclopentanebisoxindoles **2s**–**2w** in satisfactory yields (Table 1, entries 19–23). These results showed that a base promoted unprecedented domino reaction for the facile synthesis of dispirocyclopentanebisoxindoles had been successfully established.

The methoxy and ethoxy groups in the above-obtained dispirocyclopentanebisoxindoles obviously arise from the nucleophilic substitution of methanol and ethanol. We envisioned that if some stronger nucleophiles existed in the reaction system, other nucleophilic-substituted products would be formed. Thus, stronger nucleophiles such as aniline, *p*-toluidine, *p*-chloroaniline, *n*-butylamine, or benzylamine were added to acetonitrile solution of 3-phenacylideneoxindoles with piperidine as a catalyst. To our delight, the reactions proceeded smoothly to afford the expected amino-substituted dispirocyclopentanebisoxindoles (**3a**–**3g**) in satisfactory yields (Table 2, entries 1–7). Furthermore, if no other nucleophile was added to the reaction system, the acetonitrile solution of 3-phenacylideneoxindoles in the presence of piperidine yielded piperidino-substituted dispirocyclopentanebisoxindoles (**3h**–**3i**) in good yields (Table 2, entries 8 and 9). Clearly, piperidine acted as both base catalyst and nucleophile in the reaction. We used morpholine and dimethylamine to replace piperdine in similar reactions, and the corresponding morpholino- and dimethylamine-substituted dispiro compounds (**3j** and **3k**) were also obtained in 85% and 50% yields, respectively. These results not only provided a convenient procedure for the preparation of versatile dispirocyclopentanebisoxindoles but also shed more light on the reaction mechanism of this domino reaction.

Table 1. Synthesis of Dispirocyclopentanebisoxindoles 2a–2w[a]



1 1 2

entry	compound	R	R′	Ar	R″	yield[b,c] (%)
1	**2a**	H	Bn	*p*-$CH_3OC_6H_4$	Me	85
2	**2b**	H	Bn	*p*-ClC_6H_4	Me	83
3	**2c**	CH_3	n-Bu	C_6H_5	Me	96 (14:1)
4	**2d**	CH_3	n-Bu	*p*-$CH_3C_6H_4$	Me	80
5	**2e**	F	n-Bu	C_6H_5	Me	96
6	**2f**	F	n-Bu	*p*-$CH_3C_6H_4$	Me	98
7	**2g**	F	n-Bu	*p*-$CH_3OC_6H_4$	Me	97
8	**2h**	F	Bn	C_6H_5	Me	82 (5:1)
9	**2i**	F	Bn	*p*-$CH_3C_6H_4$	Me	83
10	**2j**	F	Bn	*p*-$CH_3OC_6H_4$	Me	89
11	**2k**	F	Bn	*m*-$CH_3OC_6H_4$	Me	90
12	**2l**	Cl	H	C_6H_5	Me	93
13	**2m**	Cl	H	*p*-$CH_3C_6H_4$	Me	92
14	**2n**	Cl	n-Bu	*p*- $CH_3C_6H_4$	Me	87
15	**2o**	Cl	n-Bu	*p*-ClC_6H_4	Me	90 (1:1)
16	**2p**	Cl	Bn	C_6H_5	Me	87 (7:1)
17	**2q**	Cl	Bn	*p*-$CH_3C_6H_4$	Me	80
18	**2r**	Cl	Bn	*p*-ClC_6H_4	Me	96
19	**2s**	F	n-Bu	*p*-$CH_3C_6H_4$	Et	83
20	**2t**	F	n-Bu	*p*-ClC_6H_4	Et	78 (12:1)
21	**2u**	Cl	n-Bu	*p*-$CH_3OC_6H_4$	Et	97
22	**2v**	Cl	Bn	*p*-$CH_3C_6H_4$	Et	85
23	**2w**	Cl	Bn	*p*-ClC_6H_4	Et	80 (7:1)

[a]Reaction conditions: 3-phenacylideneoxindole (1.0 mmol) and piperidine (0.5 mmol) in methanol or ethanol (10 mL) at rt for 4-5 hours. [b]Isolated yield. [c]Ratio of diastereoisomers.

The structures of the prepared dispirocyclopentanebisoxindoles **2a**–**2w** and **3a**–**3k** were fully characterized by the spectroscopic methods. Because there are five diastereoisomeric carbon atoms in the newly formed cyclopentyl moiety in the prepared dispirocyclopentanebisoxindoles **2a**–**2w** and **3a**–**3k**, many diastereoisomers could exist for each product. To determine the diastereochemistry of these complex dispiro compounds, six crystal structures were successfully determined by single-crystal X-ray diffraction studies performed on compounds **2j**, **2l**, **2q**, **2s**, **3a**, and **3j** (**SPI**, Figures s1–s6,

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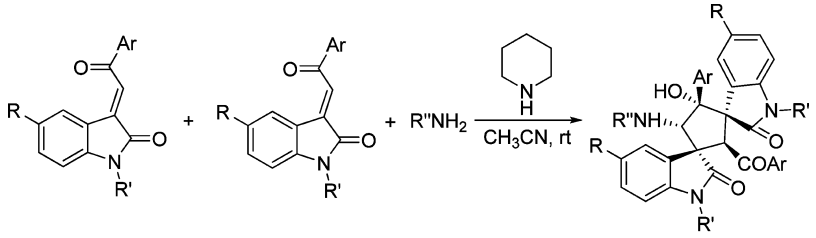
Table 2. Synthesis of Dispirocyclopentanebisoxindoles 3a−3j[a]

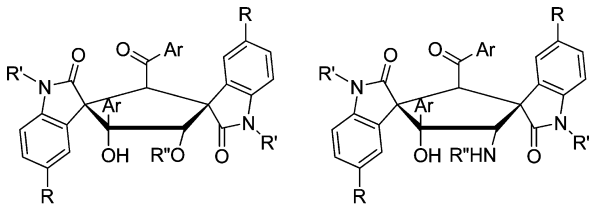


entry	compound	R	R′	Ar	R″	yield[b] (%)
1	**3a**	Cl	n-Bu	p-$CH_3C_6H_4$	p-$CH_3C_6H_4$	80
2	**3b**	Cl	n-Bu	p-ClC_6H_4	p-$CH_3C_6H_4$	83
3	**3c**	F	Bn	p-$CH_3C_6H_4$	p-$CH_3C_6H_4$	78
4	**3d**	Cl	Bn	p-$CH_3C_6H_4$	C_6H_5	76
5	**3e**	Cl	Bn	p-$CH_3C_6H_4$	p-ClC_6H_5	86
6	**3f**	Cl	Bn	p-$CH_3C_6H_4$	$CH_2C_6H_5$	80
7	**3g**	Cl	Bn	p-$CH_3C_6H_4$	n-C_4H_9	74
8	**3h**	Cl	Bn	p-$CH_3C_6H_4$	$(CH_2)_5$[c]	84
9	**3i**	F	Bn	p-$CH_3C_6H_4$	$(CH_2)_5$[c]	70
10	**3j**	Cl	Bn	p-$CH_3C_6H_4$	$(CH_2CH_2)_2O$[d]	85 (5:1)[e]
11	**3k**	Cl	Bn	p-$CH_3C_6H_4$	$(CH_3)_2$[d]	50

[a]Reaction conditions: 3-phenacylideneoxindole (1.0 mmol), amine (2.0 mmol), and piperidine (0.5 mmol) in CH_3CN (10 mL) at rt for 12 h. [b]Isolated yield. [c]Piperidine (2.0 mmol), no other amine was added. [d]Morpholine or dimethylamine (2.0 mmol) to replace piperidine and no other amine was added. [e]Ratio of diastereoisomers.

Supporting Information). ^1H and ^{13}C NMR spectra clearly showed that one diastereoisomer usually existed in most of the prepared samples. In a few cases, another minor diastereoisomer could be observed (Table 1, entries 3, 8, 15, 16, 20, and 23; Table 2, entry 10) with the ratio of diastereoisomer in **2c** being 14:1 and the ratio of diastereoisomers in **2h** being 5:1. Only in the spiro compound **2o** was the ratio of two diastereoisomers equal. In the amino-substituted dispiro compounds **3a−3k**, two diastereoisomer with a ratio of 5:1 could be observed only in compound **3j**. The molecular structures of all six single crystals indicated that the following major diastereoisomer occurs (Scheme 2) in which the two

Scheme 2. Illustration of the Obtained Diastereoisomer of Dispiro Compounds 2 and 3



oxindole moieties at 1,3-positions are in trans orientation, while the 2-benzoyl group and the 5-aryl group are in cis orientation. It is known that the benzoyl group and the aryl group of the oxindole moiety exist in the cis position in the starting 3-phenacylideneoxindoles.[23] This fact displayed that a multistep reaction process was involved in this reaction, and the most thermodynamically stable diastereoisomer was preferentially formed in this domino reaction.

To explain the formation of dispirocyclopentanebisoxindoles, a plausible reaction mechanism is proposed in Scheme 3. First, a 1,4-conjugated addition of secondary amine to the exocyclic carbon atom of one molecular 3-phenacylideneoxindole **1** gives an adduct intermediate (**A**). Second, Michael addition of the carbanion in intermediate (**A**) to another molecular 3-phenacylideneoxindole **1** yields a new intermediate (**B**). Third, the intramolecular aldol condensation of carbanion with carbonyl group yields the cyclized intermediate (**C**). Finally, the nucleophilic substitution of alcohol or amine to the ammonium cation produces the final dispirocyclopentanebisoxindoles **2** or **3**. If no other of nucleophile was added, the excess secondary amine in the solution acted as the nucleophile to finish substitution reaction and to afford the dispirocyclopentanebisoxindoles **3**.

To probe the credibility of our proposed mechanistic scheme and shed more light on the formation of dispirocyclopentanebisoxindole, further experiments were carried out. First, the stronger nucleophilic thiophenols were used as nucleophiles in the base promoted self-domino reactions of 3-phenacylideneoxindoles. A solution of equivalent molar 3-phenacylideneoxindole and thiophenol in acetonitrile in the presence of piperidine was stirred at room temperature. The reactions could be finished in about 3−4 h, which is much faster than the reactions in alcohol and in the presence of amine. After workup, it is very surprising to find that the reactions afforded dispirocyclopentanebisoxindoles without a phenylsulfanyl group (**4a−4n**) in moderate to good yields. The results were summarized in Table 3. The reactions of 3-phenacylideneoxindoles without N-substituents and 3-acetonylideneoxindole also proceeded smoothly to give the expected spiro compounds in moderate yields (Table 3, entries 10−14). The structures of prepared dispirocyclopentanebisoxindoles **4a−4n** were fully characterized by ^1H and ^{13}C NMR, HRMS, and IR spectra, and their structures were confirmed by single-crystal X-ray diffraction studies of **4a**, **4g**, **4i**, **4k**, and **4m** (**SPI**, Figures s7−s11, Supporting Information). ^1H NMR spectra and the single crystal structure clearly indicated that the dispirocyclopentanebisoxindoles **4a−4n** existed in a diastereoisomer similar

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Scheme 3. Proposed Formation Mechanism of Dispirocyclopentanebisoxindoles 2 and 3

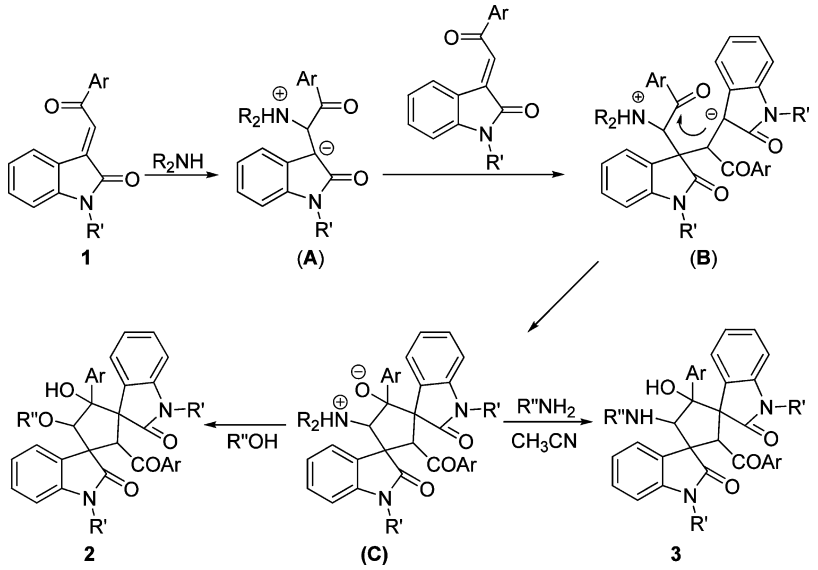
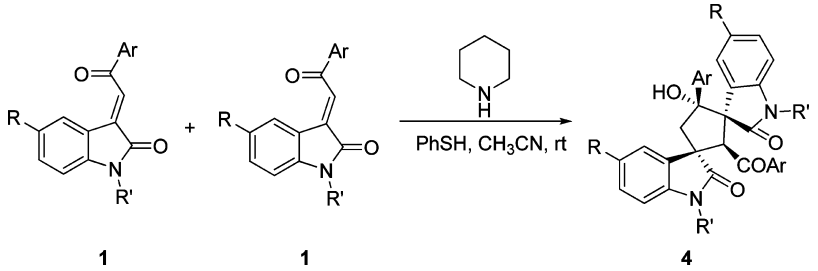


Table 3. Synthesis of Dispirocyclopentanebisoxindoles 4a–4n[a]



entry	compound	R	R′	Ar (R″)	yield[b] (%)
1	**4a**	H	Bn	*p*-$CH_3C_6H_4$	75
2	**4b**	H	Bn	*p*-ClC_6H_4	68
3	**4c**	CH_3	Bn	*p*-$CH_3C_6H_4$	88
4	**4d**	F	Bn	*p*-ClC_6H_4	66
5	**4e**	Cl	Bn	*p*-$CH_3OC_6H_4$	79
6	**4f**	Cl	Bn	C_6H_5	82
7	**4g**	Cl	Bn	*p*-ClC_6H_4	80
8	**4h**	F	n-Bu	*p*-$CH_3C_6H_4$	76
9	**4i**	Cl	n-Bu	*p*-$CH_3C_6H_4$	91[c]
10	**4j**	Cl	H	C_6H_5	73[c]
11	**4k**	Cl	H	*p*-$CH_3C_6H_4$	55[c]
12	**4l**	Cl	H	*p*-$CH_3OC_6H_4$	48[c]
13	**4m**	CH_3	H	CH_3	55[c]
14	**4n**	F	H	CH_3	62[c]

[a]Reaction conditions: 3-phenacyloxindole (0.5 mmol), thiophenol (0.5 mmol), and piperidine (0.5 mmol) in acetonitrile (10.0 mL) at rt for 3–4 h. [b]Isolated yield. [c]*p*-Chlorothiophenol was used as reactant.

to that of the above dispirocyclopentanebisoxindoles **2** and **3**, in which the two oxindole moieties at the 1,3-positions are in trans orientation, while the 2-benzoyl group and the 5-aryl group are in cis orientation. Thus this reaction is also a highly diastereoselective reaction.

The most unusual feature of compounds **4a–4n** is that no expected phenylsulfanyl group or other nucleophilic substituents were introduced into the newly formed cyclopentyl ring. There is one CH_2 unit in the newly formed cyclopentane moiety. This kind of dispirocyclopentanebisoxindole with different substituents has recently been prepared by the organocatalytic domino reaction between 3-substituted oxindole and methyleneindolinones.[16b] Their results were very helpful for us to understand the reaction mechanism of this self-domino reaction. Thus, one molecule of 3-phenacylideneoxindole was reduced by thiophenol to give the 3-phenacyloxindole in the reaction. There are several reports about the reduction of 3-phenacylideneoxindoles to give the 3-phenacyloxindoles by reducing reagents such as Zn, PMe_3, $Na_2S_2O_4$, and $NaHSO_3$.[24] Thus, in the presence of thiophenol, the above proposed reaction mechanism (Scheme 3) is slightly adjusted to Scheme 4. At first, the nucleophilic 1,4-addition of thiophenol to 3-phenacylideneoxindole afforded a phenylsulfanyl-substituted adduct (**D**), which in turn transformed to

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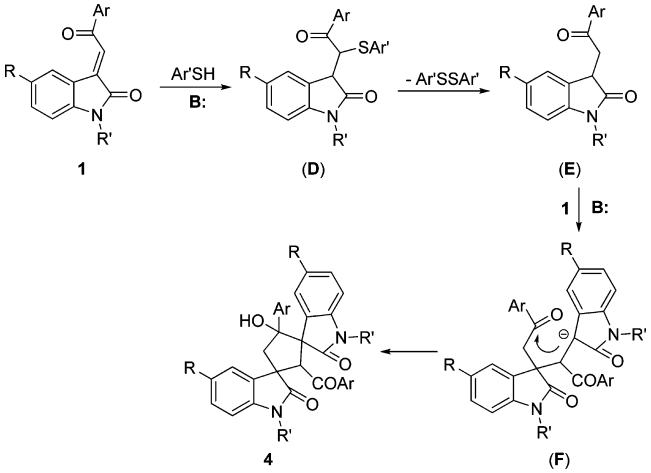
Scheme 4. Proposed Formation Mechanism of Dispirocyclopentanebisoxindoles 4



3-phenacylindolinone (**E**). Then, Michael addition of the carbanion of 3-phenacylindolinone (**E**) to another molecular 3-phenacylideneoxindole **1** yielded a new intermediate (**F**). Finally, the intramolecular aldol condensation of carbanion with carbonyl group in intermediate (**F**) produced the finally product **4**. Thus, this reaction provided an efficient procedure for in situ generation of 3-phenacylindolinones and its sequential reactions.

To support the proposed mechanism, separation of the reaction intermediates were attempted. (Scheme 5). In the absence of piperidine, the reactions of 3-phenacylideneoxindoles with thiophenol or *p*-chlorothiophenol in acetonitrile at room temperature gave the phenylsulfanyl or 4-chlorophenylsulfanyl adducts **D1** and **D2** in 77% and 84% yields, respectively. On the other hand, the reaction of 3-phenacylideneoxindole with 2-mercaptoethanol in the presence of piperidine resulted in the 3-phenacyloxindole (**E**) in 91% yield. The mechanism proposed in Scheme 4 is strongly supported by the isolation of these two key intermediates. Now we can conclude that the 3-phenacyloxindole is generated in situ by the reduction of 3-phenacylideneoxindole with thiophenol (**E**), which in turn undergo further sequential reactions similar to the reaction described by Barbas III and coworkers.[16b]

CONCLUSION

In summary, we have developed a highly efficient protocol for the synthesis of a novel dispirocyclopentanebisoxindole system from the base catalyzed domino reaction between two molecules of 3-phenacylideneoxindoles. Significantly, this domino reaction has high diastereoselectivity, which would allow the construction of dispirocyclopentanebisoxindole with four and five stereogenic centers. The reaction mechanism is believed to involve domino Michael addition, aldol condensation, and nucleophilic substitution as well as the reduction reaction. The advantages of the reactions are using readily available starting materials, mild reaction conditions, operational simplicity, and a wide variety of substrates. This reaction provides a convenient synthetic procedure for the preparation of the complex dispirooxindole system. The potential uses of the reaction in synthetic and medicinal chemistry may be significant.

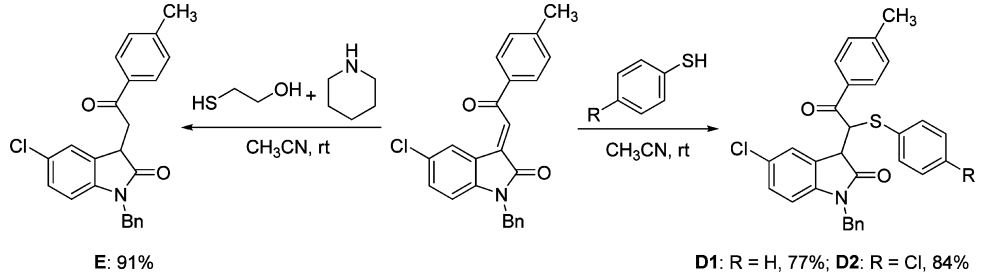
EXPERIMENTAL SECTION

1. General Procedure for the Preparation of Methoxy- and Ethoxy-Substituted Dispirocyclopentanebisoxindoles (2a–2w). A solution of 3-phenacylideneoxindoles (1.0 mmol) and piperidine (0.5 mmol, 0.042 g) in 10.0 mL of methanol or ethanol was stirred at room temperature for about 4–5 h. Then, the resulting precipitates were collected by filtration and washed with a little cold ethanol to give the pure products **2a–2w** for analysis.

2a: white solid, 0.326 g, 85%, mp 236–238 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.16 (d, J = 7.8 Hz, 1H), 7.98 (d, J = 7.2 Hz, 1H), 7.40 (d, J = 7.8 Hz, 2H), 7.32–7.30 (m, 2H), 7.27–7.26 (m, 2H), 7.24 (s, 1H), 7.17–7.09 (m, 6H), 7.07–7.05 (m, 1H), 7.02–7.00 (m, 1H), 6.97–6.95 (m, 1H), 6.81 (s, 1H), 6.66 (d, J = 8.4 Hz, 2H), 6.54 (d, J = 8.4 Hz, 4H), 6.39 (d, J = 7.8 Hz, 1H), 6.37 (d, J = 7.8 Hz, 1H), 6.12 (s, 1H), 5.43 (d, J = 15.2 Hz, 1H), 5.35 (s, 1H), 5.27 (d, J = 16.1 Hz, 1H), 4.46 (d, J = 16.1 Hz, 1H), 4.25 (d, J = 15.2 Hz, 1H), 3.74 (s, 3H), 3.73 (s, 3H), 3.02 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.3, 180.2, 177.3, 163.0, 159.1, 143.8, 142.0, 135.6, 135.2, 130.6, 129.9, 129.6, 128.8, 128.7, 128.4, 128.3, 128.0, 127.9, 127.0, 126.8, 126.5, 126.0, 124.1, 122.0, 113.1, 113.0, 108.7, 108.4, 89.9, 84.5, 64.5, 62.0, 60.6, 58.9, 55.5, 55.0, 44.6, 43.8; IR (KBr) υ 3668, 3288, 3057, 2932, 2835, 1697, 1676, 1610, 1599, 1514, 1490, 1467, 1440, 1386, 1367, 1346, 1304, 1257, 1216, 1170, 1153, 1114, 1096, 1028, 982, 963, 922, 842, 805, 753 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{49}H_{42}N_2NaO_7$ ([M + Na]$^+$) 793.2884, found 793.2882.

2b: white solid, 0.322 g, 83%, mp 224–226 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.15–8.14 (m, 1H), 7.97 (d, J = 7.2 Hz, 1H), 7.41 (d, J = 7.2 Hz, 2H), 7.35–7.32 (m, 2H), 7.31–7.29 (m, 1H), 7.23–7.20 (m, 3H), 7.17 (d, J = 9.0 Hz, 2H), 7.13–7.08 (m, 6H), 7.03–7.00 (m, 2H), 6.96 (d, J = 8.4 Hz, 2H), 6.87 (s, 1H), 6.61 (d, J = 6.6 Hz, 2H), 6.44–6.41 (m, 2H), 6.08 (s, 1H), 5.35 (d, J = 15.0 Hz, 1H), 5.31 (s, 1H), 5.20 (d, J = 16.2 Hz, 1H), 4.49 (d, J = 16.2 Hz, 1H), 4.30 (d, J = 15.0 Hz, 1H), 3.00 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.9, 179.8, 176.8, 143.6, 142.0, 138.8, 135.8, 135.4, 135.2, 134.8, 133.8, 130.1, 129.0, 128.9, 128.7, 128.6, 128.5, 128.2, 128.1, 127.8, 127.2, 126.4, 126.1, 126.0, 124.2, 122.2, 108.9, 108.6, 89.7, 84.2, 64.3, 62.3, 60.6, 58.4, 44.7, 43.9; IR (KBr) υ 3676, 3341, 3063, 2933, 1700, 1610, 1592, 1491, 1468, 1434, 1386, 1370, 1300, 1240, 1215, 1181, 1157, 1092, 1005, 986, 963, 849, 809, 790, 756 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{47}H_{36}Cl_2N_2NaO_5$ ([M + Na]$^+$) 801.1893, found 801.1887.

Scheme 5. Preparation of the Reaction Intermediates D and E



E: 91%

D1: R = H, 77%; **D2**: R = Cl, 84%

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2c: white solid, 0.322 g, 96%, mp 234−236 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ major 7.98 (s, 1H), 7.72 (s, 1H), 7.23 (t, J = 7.2 Hz, 1H), 7.15 (d, J = 7.8 Hz, 2H), 7.12−7.09 (m, 4H), 7.07−7.04 (m, 4H), 6.85 (s, 1H), 6.81 (d, J = 7.8 Hz, 1H), 6.51 (d, J = 7.8 Hz, 1H), 6.24 (d, J = 7.8 Hz, 1H), 6.09 (s, 1H), 5.24 (s, 1H), 3.96−3.91 (m, 1H), 3.82−3.78 (m, 1H), 3.27−3.22 (m, 1H), 3.20−3.16 (m, 1H), 3.09 (s, 3H), 2.40 (s, 3H), 2.33 (s, 3H), 1.65−1.62 (m, 1H), 1.59−1.56 (m, 1H), 1.45−1.39 (m, 2H), 1.11−1.05 (m, 1H), 1.00−0.95 (m, 5H), 0.91−0.86 (m, 1H), 0.79 (t, J = 7.2 Hz, 3H), δ minor 8.00 (s, 1H), 7.69 (s, 1H), 6.54 (d, J = 7.8 Hz, 1H), 5.22 (s, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 196.3, 179.7, 176.5, 141.7, 140.0, 137.4, 133.5, 132.0, 131.0, 130.8, 129.0, 128.6, 127.7, 127.4, 127.2, 127.1, 126.8, 126.4, 107.5, 107.3, 89.1, 84.7, 64.2, 61.7, 60.1, 58.5, 40.4, 39.8, 29.5, 29.0, 21.3, 20.1, 13.9, 13.7; IR (KBr) υ 3285, 3059, 2955, 2929, 2867, 1698, 1618, 1599, 1495, 1446, 1382, 1355, 1287, 1259, 1206, 1175, 1154, 1114, 1072, 1039, 991, 944, 900, 846, 805, 774, 756 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{43}H_{46}N_2NaO_5$ ([M + Na]$^+$) 693.3299, found 693.3298.

2d: white solid, 0.278 g, 80%, mp 246−248 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.97 (s, 1H), 7.70 (s, 1H), 7.07 (d, J = 8.4 Hz, 2H), 7.03 (d, J = 7.8 Hz, 1H), 6.96 (d, J = 8.4 Hz, 2H), 6.90 (d, J = 7.8 Hz, 2H), 6.85 (d, J = 7.8 Hz, 2H), 6.82 (d, J = 7.8 Hz, 1H), 6.76 (s, 1H), 6.50 (d, J = 7.8 Hz, 1H), 6.27 (d, J = 7.8 Hz, 1H), 6.06 (s, 1H), 5.21 (s, 1H), 3.93−3.88 (m, 1H), 3.87−3.82 (m, 1H), 3.33−3.29 (m, 1H), 3.18−3.14 (m, 1H), 3.08 (s, 3H), 2.38 (s, 3H), 2.33 (s, 3H), 2.22 (s, 3H), 2.20 (s, 3H), 1.64−1.61 (m, 1H), 1.57−1.55 (m, 1H), 1.45−1.39 (m, 2H), 1.08−1.03 (m, 1H), 1.00−0.96 (m, 5H), 0.87−0.83 (m, 1H), 0.79 (t, J = 7.2 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.8, 179.8, 176.6, 142.7, 141.7, 140.0, 136.8, 134.8, 134.3, 133.4, 130.9, 128.8, 128.5, 128.4, 127.9, 127.3, 127.2, 126.9, 126.8, 126.3, 107.4, 107.2, 89.2, 84.6, 64.3, 61.5, 60.1, 58.6, 40.5, 39.8, 29.5, 29.1, 21.4, 21.3, 21.0, 20.2, 20.1, 14.0, 13.8; IR (KBr) υ 3679, 3654, 3342, 3035, 2958, 2928, 2809, 2348, 1696, 1604, 1496, 1440, 1361, 1288, 1260, 1201, 1146, 1113, 999, 934, 902, 809 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{45}H_{50}N_2NaO_5$ ([M + Na]$^+$) 721.3612, found 721.3613.

2e: white solid, 0.326 g, 96%, mp 206−208 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.06 (dd, J = 8.4, 2.6 Hz, 1H), 7.68 (dd, J = 8.4, 2.6 Hz, 1H), 7.29 (d, J = 7.2 Hz, 1H), 7.21 (d, J = 7.2 Hz, 2H), 7.16−7.13 (m, 3H), 7.12−7.09 (m, 4H), 6.95 (td, J = 8.8, 2.6 Hz, 1H), 6.74 (td, J = 8.6, 2.6 Hz, 1H), 6.70 (s, 1H), 6.52 (dd, J = 8.5, 4.1 Hz, 1H), 6.30 (dd, J = 8.5, 4.1 Hz, 1H), 6.03 (s, 1H), 5.20 (s, 1H), 3.98 (m, 1H), 3.78−3.74 (m, 1H), 3.25−3.21 (m, 2H), 3.09 (s, 3H), 1.64−1.61 (m, 1H), 1.58−1.53 (m, 1H), 1.45−1.39 (m, 2H), 1.18−1.14 (m, 1H), 1.04−1.00 (m, 3H), 0.96 (t, J = 7.2 Hz, 3H), 0.82 (t, J = 7.2 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.8, 179.3, 176.3, 160.0 (d, J = 181.2 Hz), 158.4 (d, J = 178.2 Hz), 140.0, 138.4, 136.9, 136.6, 132.5, 132.3 (d, J = 8.9 Hz), 128.2, 128.0, 127.7, 127.4, 127.2, 126.3, 115.0, 114.9, 114.8, 114.7, 114.6, 114.1, 114.0, 108.3 (d, J = 8.0 Hz), 108.0 (d, J = 8.0 Hz), 89.1, 84.6, 64.6, 61.8, 60.2, 58.7, 40.6, 40.0, 29.4, 28.9, 20.0, 13.9, 13.7; IR (KBr) υ 3271, 3068, 2961, 2935, 2872, 1691, 1620, 1580, 1490, 1452, 1377, 1348, 1271, 1219, 1197, 1150, 1123, 1074, 1003, 983, 944, 904, 855, 817, 775, 757 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{41}H_{40}F_2N_2NaO_5$ ([M + Na]$^+$) 701.2797, found 701.2795.

2f: white solid, 0.346 g, 98%, mp 216−218 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.05 (dd, J = 8.4, 2.6 Hz, 1H), 7.66 (dd, J = 8.4, 2.6 Hz, 1H), 7.12 (d, J = 8.4 Hz, 2H), 7.02 (d, J = 8.4 Hz, 2H), 6.95−6.89 (m, 5H), 6.75 (td, J = 8.6, 2.6 Hz, 1H), 6.60 (s, 1H), 6.52 (dd, J = 8.5, 4.1 Hz, 1H), 6.32 (dd, J = 8.5, 4.1 Hz, 1H), 6.00 (s, 1H), 5.17 (s, 1H), 3.95−3.90 (m, 1H), 3.83−3.79 (m, 1H), 3.32−3.27 (m, 1H), 3.23−3.18 (m, 1H), 3.08 (s, 3H), 2.24 (s, 3H), 2.21 (s, 3H), 1.65−1.61 (m, 1H), 1.57−1.53 (m, 1H), 1.45−1.39 (m, 2H), 1.16−1.10 (m, 1H), 1.02−0.95 (m, 6H), 0.81 (t, J = 7.2 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.3, 179.4, 176.5, 159.9 (d, J = 180.3 Hz), 158.3 (d, J = 177.5 Hz), 143.3, 140.1, 138.4, 137.2, 134.3, 133.7, 132.4 (d, J = 8.7 Hz), 128.7, 128.4, 128.0, 127.3, 126.2, 114.9, 114.8, 114.7, 114.1, 113.9, 108.2 (d, J = 8.1 Hz), 107.9 (d, J = 8.0 Hz), 89.3, 84.5, 64.6, 61.6, 60.2, 58.9, 40.6, 40.0, 29.4, 29.0, 21.5, 20.9, 20.1, 13.9, 13.7; IR (KBr) υ 3844, 3679, 3655, 3328, 3072, 2957, 2932, 2872, 2349, 1696, 1608, 1489, 1453, 1352, 1268, 1193, 1120, 987, 910, 839, 811 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{43}H_{44}F_2N_2NaO_5$ ([M + Na]$^+$) 729.3111, found 729.3111.

2g: white solid, 0.358 g, 97%, mp 204−206 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.03 (dd, J = 8.4, 2.6 Hz, 1H), 7.65 (dd, J = 8.4, 2.6 Hz, 1H), 7.23 (d, J = 9.0 Hz, 2H), 7.06 (d, J = 9.0 Hz, 2H), 6.94 (td, J = 8.8, 2.6 Hz, 1H), 6.76 (td, J = 8.6, 2.6 Hz, 1H), 6.63 (d, J = 9.0 Hz, 2H), 6.60 (d, J = 5.4 Hz, 2H), 6.58 (s, 1H), 6.53 (dd, J = 8.5, 4.1 Hz, 1H), 6.37 (dd, J = 8.5, 4.1 Hz, 1H), 6.00 (s, 1H), 5.14 (s, 1H), 3.97−3.94 (m, 1H), 3.83−3.78 (m, 1H), 3.74 (s, 3H), 3.70 (s, 3H), 3.34−3.30 (m, 1H), 3.26−3.21 (m, 1H), 3.09 (s, 3H), 1.67−1.60 (m, 2H), 1.46−1.41 (m, 2H), 1.21−1.15 (m, 1H), 1.07−1.01 (m, 3H), 0.98 (t, J = 7.2 Hz, 3H), 0.82 (t, J = 7.2 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 193.9, 179.4, 176.6, 163.1, 159.9 (d, J = 182.0 Hz), 159.1, 158.3 (d, J = 178.7 Hz), 140.0, 138.4, 132.4 (d, J = 8.7 Hz), 129.7, 129.5, 129.0, 128.4, 127.5, 114.8, 114.7, 114.1, 113.9, 113.2, 112.6, 108.3 (d, J = 8.3 Hz), 108.0 (d, J = 8.0 Hz), 107.9, 89.3, 84.3, 64.7, 61.3, 60.2, 59.0, 55.4, 55.0, 40.6, 40.0, 29.4, 29.1, 20.1, 13.8, 13.7; IR (KBr) υ 3679, 3362, 3067, 2959, 2935, 2872, 2838, 1695, 1676, 1602, 1574, 1514, 1491, 1454, 1377, 1359, 1270, 1248, 1176, 1151, 1117, 1094, 1035, 1011, 983, 945, 910, 845, 815, 751 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{43}H_{44}F_2N_2NaO_7$ ([M + Na]$^+$) 761.3009, found 761.3007.

2h: white solid, 0.306 g, 82%, mp 218−220 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ major 8.07 (dd, J = 8.7, 2.4 Hz, 1H), 7.77 (dd, J = 8.4, 2.4 Hz, 1H), 7.36−7.34 (m, 2H), 7.33−7.31 (m, 2H), 7.30−7.27 (m, 5H), 7.26 (br, 1H), 7.22−7.14 (m, 5H), 7.13−7.10 (m, 3H), 6.81 (td, J = 8.7, 3.0 Hz, 1H), 6.78 (s, 1H), 6.68−6.64 (m, 1H), 6.55 (d, J = 7.2 Hz, 2H), 6.25 (dd, J = 8.4, 4.2 Hz, 1H), 6.22 (dd, J = 8.4, 4.2 Hz, 1H), 6.10 (s, 1H), 5.45 (d, J = 15.0 Hz, 1H), 5.34 (s, 1H), 5.16−5.12 (m, 1H), 4.50 (d, J = 16.2 Hz, 1H), 4.08 (d, J = 15.0 Hz, 1H), 3.04 (s, 3H), δ minor 8.58 (s, 1H), 7.63 (dd, J = 7.8, 2.4 Hz, 1H), 7.53 (d, J = 7.2 Hz, 2H), 7.46 (dd, J = 8.4, 2.4 Hz, 1H), 7.23−7.21 (m, 3H), 7.00 (t, J = 7.8 Hz, 2H), 6.92 (td, J = 8.4, 2.4 Hz, 1H), 6.59−6.56 (m, 1H), 6.50 (d, J = 7.2 Hz, 2H), 5.98 (dd, J = 9.0, 4.2 Hz, 1H), 5.53 (d, J = 15.6 Hz, 1H), 5.38 (s, 1H), 4.88 (d, J = 16.2 Hz, 1H), 4.72 (d, J = 16.2 Hz, 1H), 3.76 (d, J = 15.6 Hz, 1H), 3.10 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.9, 179.7, 176.8, 160.2 (d, J = 170.1 Hz), 158.6 (d, J = 167.2 Hz), 139.7, 138.1, 136.9, 135.2, 134.7, 132.7, 132.1 (d, J = 8.8 Hz), 128.9, 128.6, 128.2, 128.0, 127.9, 127.8, 127.7, 127.6, 127.4, 127.3, 127.1, 126.6, 126.5, 126.4, 115.2, 115.0, 114.9, 114.7, 114.5, 114.2, 114.0, 109.3 (d, J = 7.9 Hz), 109.1 (d, J = 8.4 Hz), 89.6, 84.6, 64.9, 62.6, 60.7, 59.0, 44.8, 44.0; IR (KBr) υ 3340, 3068, 3036, 2984, 2932, 2834, 1958, 1707, 1618, 1492, 1452, 1368, 1344, 1265, 1218, 1179, 1146, 1129, 1111, 1076, 1029, 1003, 981, 944, 897, 853, 808, 777 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{47}H_{36}F_2N_2NaO_5$ ([M + Na]$^+$) 769.2484, found 769.2484.

2i: white solid, 0.320 g, 83%, mp 214−216 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.05 (dd, J = 8.5, 2.5 Hz, 1H), 7.75 (dd, J = 8.5, 2.5 Hz, 1H), 7.37 (d, J = 7.2 Hz, 2H), 7.33−7.29 (m, 3H), 7.17 (t, J = 7.8 Hz, 5H), 7.12 (t, J = 7.8 Hz, 2H), 6.98 (d, J = 8.4 Hz, 2H), 6.87 (d, J = 7.8 Hz, 2H), 6.79 (td, J = 8.8, 2.6 Hz, 1H), 6.68 (s, 1H), 6.67−6.65 (m, 1H), 6.56 (d, J = 7.2 Hz, 2H), 6.26 (td, J = 8.3, 4.1 Hz, 2H), 6.06 (s, 1H), 5.40 (d, J = 15.6 Hz, 1H), 5.30 (s, 1H), 5.23 (d, J = 16.2 Hz, 1H), 4.45 (d, J = 16.2 Hz, 1H), 4.17 (d, J = 15.6 Hz, 1H), 3.04 (s, 3H), 2.33 (s, 3H), 2.27 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.4, 179.7, 177.0, 160.1 (d, J = 168.3 Hz), 158.5 (d, J = 165.6 Hz), 143.6, 139.8, 138.1, 137.4, 135.3, 134.8, 134.2, 134.1, 132.2 (d, J = 9.0 Hz), 128.9, 128.7, 128.6, 128.5, 128.4, 128.3, 128.1, 127.9, 127.5, 127.4, 127.1, 126.6, 126.5, 115.0, 114.9, 114.8, 114.6, 114.2, 114.0, 109.2 (d, J = 8.0 Hz), 109.0 (d, J = 8.1 Hz), 89.9, 84.5, 64.9, 62.4, 60.7, 59.1, 44.8, 44.1, 21.6, 21.3; IR (KBr) υ 3653, 3306, 3065, 2920, 2834, 1689, 1607, 1490, 1454, 1372, 1347, 1268, 1224, 1178, 1145, 1112, 1095, 1031, 1006, 980, 942, 903, 860, 842, 809, 762 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{49}H_{40}F_2N_2NaO_5$ ([M + Na]$^+$) 797.2797, found 797.2796.

2j: white solid, 0.358 g, 89%, mp 218−220 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.03 (dd, J = 8.5, 2.5 Hz, 1H), 7.74 (dd, J = 8.4, 2.5 Hz, 1H), 7.38 (d, J = 7.2 Hz, 2H), 7.33−7.31 (m, 2H), 7.30−7.27 (m, 3H), 7.19−7.16 (m, 3H), 7.14−7.12 (m, 2H), 6.80 (td, J = 8.8, 2.6 Hz, 1H), 6.70 (s, 1H), 6.68−6.66 (m, 3H), 6.58 (d, J = 8.4 Hz, 2H), 6.53

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(d, J = 7.2 Hz, 2H), 6.32 (dd, J = 8.6, 4.1 Hz, 1H), 6.27 (dd, J = 8.6, 4.2 Hz, 1H), 6.06 (s, 1H), 5.43 (d, J = 15.6 Hz, 1H), 5.27−5.24 (m, 2H), 4.45 (d, J = 16.2 Hz, 1H), 4.22 (d, J = 15.0 Hz, 1H), 3.77 (s, 3H), 3.76 (s, 3H), 3.04 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.0, 179.8, 177.1, 163.3, 160.1 (d, J = 170.7 Hz), 159.3, 158.5 (d, J = 168.0 Hz), 139.8, 138.1, 135.3, 134.8, 132.3 (d, J = 9.0 Hz), 129.6, 129.2, 128.9, 128.5, 128.4, 127.9, 127.1, 126.5, 115.1, 114.9, 114.8, 114.7, 114.6, 114.2, 114.0, 113.3, 113.1, 109.2, 109.1, 89.8, 84.4, 65.0, 60.7, 59.2, 55.5, 55.1, 44.8, 44.0; IR (KBr) υ 3356, 3069, 2938, 2836, 1712, 1690, 1603, 1577, 1513, 1490, 1453, 1374, 1349, 1295, 1250, 1180, 1144, 1114, 1031, 981, 945, 902, 866, 845, 808, 765 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{49}H_{40}F_2N_2NaO_7$ ([M + Na]$^+$) 829.2696, found 829.2695.

2k: white solid, 0.362 g, 90%, mp 220−222 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.07 (dd, J = 8.5, 2.6 Hz, 1H), 7.78 (dd, J = 8.4, 2.6 Hz, 1H), 7.35 (d, J = 7.2 Hz, 2H), 7.30 (t, J = 7.8 Hz, 2H), 7.28 (d, J = 7.2 Hz, 1H), 7.19−7.15 (m, 3H), 7.11 (t, J = 7.8 Hz, 1H), 7.02 (t, J = 7.8 Hz, 1H), 6.93−6.91 (m, 2H), 6.87 (dd, J = 8.2, 2.5 Hz, 1H), 6.84−6.81 (m, 3H), 6.72 (s, 1H), 6.69−6.66 (m, 2H), 6.60 (d, J = 7.2 Hz, 2H), 6.28−6.24 (m, 2H), 6.04 (s, 1H), 5.48 (d, J = 15.3 Hz, 1H), 5.30 (s, 1H), 5.16 (d, J = 16.2 Hz, 1H), 4.50 (d, J = 16.2 Hz, 1H), 4.06 (d, J = 15.3 Hz, 1H), 3.67 (s, 3H), 3.48 (s, 3H), 3.05 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 196.0, 179.7, 176.7, 160.2 (d, J = 171.6 Hz), 159.5, 159.3, 158.6 (d, J = 169.1 Hz), 139.9, 138.4, 138.3, 138.2, 135.3, 134.8, 132.2 (d, J = 8.9 Hz), 128.9, 128.8, 128.7, 128.6, 128.3, 128.2, 127.8, 127.2, 126.4, 120.0, 119.5, 118.5, 115.1, 115.0, 114.9, 114.8, 114.7, 114.6, 114.1, 113.9, 111.7, 110.9, 109.3 (d, J = 7.8 Hz), 109.2 (d, J = 8.1 Hz), 89.5, 84.6, 64.9, 62.8, 60.7, 59.0, 55.3, 55.1, 44.7, 44.1; IR (KBr) υ 3330, 3068, 2939, 2835, 1694, 1606, 1583, 1489, 1453, 1373, 1346, 1293, 1266, 1181, 1146, 1104, 1052, 994, 958, 897, 837, 808, 783 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{49}H_{40}F_2N_2NaO_7$ ([M + Na]$^+$) 829.2696, found 829.2696.

2l: white solid, 0.278 g, 93%, mp 242−244 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.26 (br, 1H), 8.16 (s, 1H), 7.89 (s, 1H), 7.45 (br, 1H), 7.32 (d, J = 7.2 Hz, 3H), 7.24 (d, J = 7.8 Hz, 2H), 7.21−7.15 (m, 6H), 6.99 (d, J = 8.4 Hz, 1H), 6.60 (d, J = 8.4 Hz, 1H), 6.37 (d, J = 8.4 Hz, 1H), 6.33 (br, 1H), 5.97 (s, 1H), 5.26 (s, 1H), 3.15 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 197.0, 181.0, 178.3, 142.2, 140.9, 137.5, 136.9, 133.7, 133.2, 129.4, 128.8, 128.6, 127.9, 127.6, 127.5, 127.1, 126.8, 126.6, 125.9, 125.2, 111.3, 110.2, 89.1, 84.3, 65.2, 61.4, 59.9, 58.8; IR (KBr) υ 3478, 3360, 3058, 2935, 2839, 1722, 1703, 1621, 1476, 1444, 1347, 1303, 1249, 1219, 1190, 1158, 1106, 1076, 1037, 1006, 976, 956, 897, 814, 754 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{33}H_{24}Cl_2N_2NaO_5$ ([M + Na]$^+$) 621.0954, found 621.0953.

2m: white solid, 0.288 g, 92%, mp 216−218 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.15 (s, 1H), 7.96 (s, 1H), 7.87 (s, 1H), 7.28 (br, 1H), 7.24 (d, J = 7.8 Hz, 2H), 7.17 (d, J = 8.4 Hz, 1H), 7.11 (d, J = 7.8 Hz, 2H), 6.98 (d, J = 7.8 Hz, 3H), 6.95 (d, J = 8.4 Hz, 2H), 6.58 (d, J = 8.4 Hz, 1H), 6.35 (d, J = 7.8 Hz, 1H), 6.22 (s, 1H), 5.92 (s, 1H), 5.22 (s, 1H), 3.14 (s, 3H), 2.25 (s, 6H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 196.2, 181.1, 178.3, 143.5, 142.2, 140.9, 136.9, 134.7, 134.4, 133.7, 129.6, 129.1, 128.8, 128.2, 127.6, 127.0, 126.6, 126.5, 126.0, 125.1, 111.2, 110.2, 89.3, 84.2, 65.2, 61.3, 59.9, 58.9, 21.5, 21.0; IR (KBr) υ 3426, 2929, 2025, 1707, 1618, 1515, 1475, 1438, 1340, 1302, 1249, 1186, 1158, 1109, 1046, 1008, 976, 953, 899, 812, 779 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{35}H_{28}Cl_2N_2NaO_5$ ([M + Na]$^+$) 649.1267, found 649.1267.

2n: white solid, 0.320 g, 87%, mp 228−230 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.02 (s, 1H), 7.87 (s, 1H), 7.21 (d, J = 8.4 Hz, 1H), 7.10 (d, J = 7.8 Hz, 2H), 7.04−7.01 (m, 3H), 6.91 (d, J = 7.8 Hz, 3H), 6.90 (s, 1H), 6.52 (d, J = 6.0 Hz, 2H), 6.31 (d, J = 8.4 Hz, 1H), 5.98 (s, 1H), 5.16 (s, 1H), 3.95−3.90 (m, 1H), 3.86−3.81 (m, 1H), 3.31−3.26 (m, 1H), 3.21−3.16 (m, 1H), 3.08 (s, 3H), 2.24 (s, 3H), 2.22 (s, 3H), 1.64−1.60 (m, 1H), 1.54−1.52 (m, 1H), 1.43−1.40 (m, 2H), 1.11−1.08 (m, 1H), 1.02−0.96 (m, 5H), 0.95−0.91 (m, 1H), 0.80 (t, J = 7.2 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.4, 179.3, 176.3, 143.3, 142.7, 141.0, 137.3, 134.4, 133.7, 132.4, 129.2, 128.7, 128.6, 128.5, 128.1, 127.3, 126.9, 126.8, 126.2, 108.6, 108.5, 89.1, 84.4, 64.5, 61.6, 60.3, 58.7, 40.6, 40.0, 29.4, 29.0, 21.5, 21.0, 20.1, 14.0, 13.7; IR (KBr) υ 3680, 3318, 3069, 2958, 2930, 2870, 2351, 1702, 1608, 1484, 1430, 1355, 1268, 1230, 1202, 1156, 1113, 984, 886, 839, 811 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{43}H_{44}Cl_2N_2NaO_5$ ([M + Na]$^+$) 761.2519, found 761.2516.

2o: white solid, 0.350 g, 90%, mp 208−210 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ major 8.17 (d, J = 7.8 Hz, 1H), 7.85 (d, J = 8.4 Hz, 1H), 7.23 (dd, J = 8.1, 2.4 Hz, 1H), 7.14−7.10 (m, 4H), 7.08 (dd, J = 7.8, 1.8 Hz, 2H), 7.04−7.02 (m, 2H), 7.01−6.99 (m, 1H), 6.60 (s, 1H), 6.56 (d, J = 8.4 Hz, 1H), 6.38 (d, J = 8.4 Hz, 1H), 5.95 (s, 1H), 5.11 (s, 1H), 3.97−3.92 (m, 1H), 3.82−3.77 (m, 1H), 3.33−3.28 (m, 1H), 3.26−3.23 (m, 1H), 3.07 (s, 3H), 1.65−1.59 (m, 2H), 1.54−1.49 (m, 2H), 1.23−1.18 (m, 1H), 1.08−1.03 (m, 3H), 1.02−0.97 (m, 3H), 0.88−0.83 (m, 3H), δ minor 8.48 (br, 1H), 7.78 (d, J = 7.8 Hz, 1H), 7.51 (d, J = 7.8 Hz, 1H), 7.33 (dd, J = 8.4, 2.4 Hz, 1H), 6.87 (d, J = 8.4 Hz, 1H), 6.23 (d, J = 7.8 Hz, 1H), 5.22 (s, 1H), 4.89 (s, 1H), 4.07−4.02 (m, 1H), 3.88−3.83 (m, 1H), 3.46−3.41 (m, 1H), 3.09 (s, 3H), 2.81−2.77 (m, 1H), 1.89−1.84 (m, 1H), 1.83−1.78 (m, 1H), 1.45−1.39 (m, 3H), 0.80−0.76 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.6, 194.4, 179.0, 178.8, 178.1, 176.0, 142.6, 142.1, 141.7, 141.0, 139.0, 138.8, 137.5, 135.4, 135.2, 133.9, 131.9, 129.4, 129.3, 129.2, 129.0, 128.8, 128.6, 128.5, 128.3, 128.2, 127.9, 127.8, 127.6, 127.5, 127.2, 126.8, 126.7, 126.2, 122.6, 110.1, 108.9, 108.8, 108.3, 89.1, 87.9, 85.7, 84.1, 65.8, 64.4, 61.8, 61.6, 60.4, 59.3, 58.4, 40.9, 40.7, 40.1, 29.4, 29.2, 29.1, 29.0, 20.1, 20.0, 13.9, 13.8, 13.7; IR (KBr) υ 3679, 3069, 2959, 2932, 2872, 1701, 1608, 1591, 1484, 1431, 1400, 1350, 1263, 1195, 1159, 1113, 1094, 1011, 984, 891, 848, 810 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{41}H_{38}Cl_4N_2NaO_5$ ([M + Na]$^+$) 801.1427, found 801.1422.

2p: white solid, 0.338 g, 87%, mp 222−224 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ major 8.23 (d, J = 2.4 Hz, 1H), 7.99 (d, J = 2.4 Hz, 1H), 7.35−7.34 (m, 2H), 7.33−7.28 (m, 7H), 7.25−7.23 (m, 2H), 7.20−7.19 (m, 2H), 7.17 (d, J = 9.6 Hz, 1H), 7.10−7.14 (m, 1H), 7.12−7.09 (m, 3H), 7.08 (dd, J = 8.4, 2.4 Hz, 1H), 6.93 (dd, J = 8.4, 1.8 Hz, 1H), 6.69 (s, 1H), 6.51−6.50 (m, 2H), 6.26 (d, J = 8.4 Hz, 1H), 6.22 (d, J = 8.4 Hz, 1H), 6.09 (s, 1H), 5.44 (d, J = 15.6 Hz, 1H), 5.32 (s, 1H), 5.19 (d, J = 16.2 Hz, 1H), 4.47 (d, J = 16.2 Hz, 1H), 4.08 (d, J = 15.6 Hz, 1H), 3.04 (s, 3H), δ minor 8.51 (br, 1H), 7.85 (d, J = 1.8 Hz, 1H), 7.60 (d, J = 1.8 Hz, 1H), 7.52 (d, J = 7.2 Hz, 2H), 6.99 (t, J = 7.8 Hz, 2H), 6.84 (dd, J = 8.4, 1.8 Hz, 1H), 6.67 (d, J = 8.4 Hz, 1H), 5.98 (d, J = 8.4 Hz, 1H), 5.55 (d, J = 15.6 Hz, 1H), 5.39 (s, 1H), 5.11 (s, 1H), 4.87 (d, J = 15.6 Hz, 1H), 4.69 (d, J = 15.6 Hz, 1H), 3.79 (d, J = 15.6 Hz, 1H), 3.10 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 196.0, 179.5, 176.6, 142.4, 140.6, 136.9, 136.8, 135.1, 134.6, 132.6, 132.1, 129.5, 128.9, 128.8, 128.7, 128.6, 128.2, 128.0, 127.9, 127.8, 127.4, 127.3, 127.1, 126.7, 126.6, 126.3, 109.8, 109.4, 89.6, 84.5, 64.8, 62.6, 60.7, 58.8, 44.7, 44.0; IR (KBr) υ 3678, 3286, 3065, 2934, 1707, 1690, 1608, 1484, 1452, 1431, 1347, 1262, 1238, 1211, 1177, 1159, 1106, 1078, 1029, 972, 944, 879, 813, 753 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{47}H_{36}Cl_2N_2NaO_5$ ([M + Na]$^+$) 801.1893, found 801.1893.

2q: white solid, 0.322 g, 80%, mp 216−218 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.21 (s, 1H), 7.97 (s, 1H), 7.37 (d, J = 7.2 Hz, 2H), 7.33−7.29 (m, 3H), 7.17−7.14 (m, 5H), 7.12−7.10 (m, 2H), 7.06 (dd, J = 8.2, 1.6 Hz, 1H), 6.98 (d, J = 7.8 Hz, 2H), 6.94 (dd, J = 8.2, 1.6 Hz, 1H), 6.86 (d, J = 7.8 Hz, 2H), 6.60 (s, 1H), 6.53 (d, J = 7.8 Hz, 2H), 6.26 (d, J = 9.0 Hz, 1H), 6.25 (d, J = 8.4 Hz, 1H), 6.05 (s, 1H), 5.40 (d, J = 15.0 Hz, 1H), 5.28−5.26 (m, 2H), 4.43 (d, J = 15.0 Hz, 1H), 4.17 (d, J = 15.0 Hz, 1H), 3.04 (s, 3H), 2.34 (s, 3H), 2.26 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.4, 179.5, 176.8, 143.5, 142.4, 140.6, 137.4, 135.1, 134.6, 134.2, 134.0, 132.2, 129.5, 128.9, 128.7, 128.5, 128.4, 127.9, 127.4, 127.3, 127.0, 126.7, 126.5, 126.3, 109.7, 109.3, 89.8, 84.4, 64.8, 62.5, 60.7, 58.9, 44.7, 44.1, 21.6, 21.3; IR (KBr) υ 3678, 3299, 3034, 2927, 1707, 1683, 1608, 1484, 1454, 1431, 1345, 1262, 1236, 1204, 1180, 1160, 1113, 1080, 1130, 994, 971, 940, 877, 840, 811, 787 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{49}H_{40}Cl_2N_2NaO_5$ ([M + Na]$^+$) 829.2206, found 829.2202.

2r: white solid, 0.405 g, 96%, mp 234−236 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.17 (d, J = 1.8 Hz, 1H), 7.94 (d, J = 1.8 Hz, 1H), 7.38 (d, J = 7.2 Hz, 2H), 7.36 (d, J = 6.6 Hz, 2H), 7.34−7.32 (m, 1H), 7.23−7.22 (m, 5H), 7.16−7.14 (m, 4H), 7.10 (dd, J = 8.3, 2.1 Hz, 1H), 7.02−6.99 (m, 3H), 6.66 (s, 1H), 6.58−6.57 (m, 2H), 6.36 (d, J

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= 8.4 Hz, 1H), 6.32 (d, *J* = 8.4 Hz, 1H), 6.00 (s, 1H), 5.33 (d, *J* = 15.0 Hz, 1H), 5.24−5.22 (m, 2H), 4.47 (d, *J* = 16.2 Hz, 1H), 4.28 (d, *J* = 15.0 Hz, 1H), 3.02 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.6, 179.2, 176.4, 142.3, 140.6, 139.1, 135.4, 135.0, 134.8, 134.3, 134.1, 131.7, 129.7, 129.0, 128.8, 128.7, 128.6, 128.3, 128.1, 128.0, 127.7, 127.6, 127.4, 126.7, 126.3, 109.9, 109.6, 89.7, 84.0, 64.6, 62.4, 60.7, 58.6, 44.8, 44.1; IR (KBr) υ 3319, 3068, 2932, 2834, 1705, 1691, 1609, 1591, 1484, 1454, 1430, 1401, 1367, 1342, 1264, 1236, 1211, 1180, 1160, 1094, 1031, 1003, 968, 939, 889, 848, 812, 794, 775 cm^{-1}; MS (*m*/*z*) HRMS (ESI-TOF) calcd for $C_{47}H_{34}Cl_4N_2NaO_5$ ([M + Na]$^+$) 869.1114, found 869.1111.

2s: white solid, 0.298 g, 83%, mp 214−216 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.05 (dd, *J* = 8.7, 2.3 Hz, 1H), 7.67 (dd, *J* = 8.4, 2.3 Hz, 1H), 7.12 (d, *J* = 7.8 Hz, 2H), 7.04 (d, *J* = 8.4 Hz, 2H), 6.93 (dd, *J* = 8.8, 2.3 Hz, 1H), 6.90 (d, *J* = 7.8 Hz, 4H), 6.74 (td, *J* = 8.6, 2.3 Hz, 1H), 6.54 (s, 1H), 6.51 (dd, *J* = 8.4, 4.1 Hz, 1H), 6.31 (dd, *J* = 8.4, 4.0 Hz, 1H), 6.07 (s, 1H), 5.18 (s, 1H), 3.91−3.86 (m, 1H), 3.83−3.78 (m, 1H), 3.35−3.30 (m, 1H), 3.29−3.24 (m, 1H), 3.23−3.19 (m, 1H), 3.13−3.08 (m, 1H), 2.24 (s, 3H), 2.21 (s, 3H), 1.64−1.62 (m, 1H), 1.58−1.53 (m, 1H), 1.45−1.40 (m, 2H), 1.15−1.11 (m, 1H), 1.03−0.96 (m, 6H), 0.84−0.80 (m, 6H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.5, 179.4, 176.5, 159.9 (d, *J* = 173.9 Hz), 158.3 (d, *J* = 170.7 Hz), 143.2, 140.0, 138.6, 137.1, 134.4, 133.9, 132.3 (d, *J* = 8.7 Hz), 128.6, 128.5, 127.9, 127.4, 126.2, 114.9, 114.8, 114.7, 114.6, 114.1, 114.0, 108.0 (d, *J* = 8.3 Hz), 107.9 (d, *J* = 7.8 Hz), 87.8, 84.5, 68.1, 64.7, 61.6, 59.1, 40.7, 40.0, 29.5, 29.0, 21.5, 21.0, 20.6, 20.2, 20.1, 15.2, 13.9, 13.7; IR (KBr) υ 3317, 3066, 2959, 2932, 2870, 1697, 1608, 1573, 1488, 1454, 1357, 1269, 1223, 1183, 1146, 1122, 1022, 987, 936, 900, 837, 814, 792 cm^{-1}; MS (*m*/*z*) HRMS (ESI-TOF) calcd for $C_{44}H_{46}F_2N_2NaO_5$ ([M + Na]$^+$) 743.3267, found 743.3270.

2t: white solid, 0.296 g, 78%, mp 218−220 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ major 8.03 (dd, *J* = 8.4, 2.5 Hz, 1H), 7.65 (dd, *J* = 8.3, 2.5 Hz, 1H), 7.15−7.08 (m, 8H), 6.95 (td, *J* = 8.7, 2.5 Hz, 1H), 6.80 (td, *J* = 8.6, 2.5 Hz, 1H), 6.60 (s, 1H), 6.55 (dd, *J* = 8.5, 4.1 Hz, 1H), 6.37 (dd, *J* = 8.5, 4.0 Hz, 1H), 6.03 (s, 1H), 5.13 (s, 1H), 3.94−3.89 (m, 1H), 3.79−3.74 (m, 1H), 3.31−3.25 (m, 3H), 3.12−3.07 (m, 1H), 1.66−1.62 (m, 1H), 1.59−1.53 (m, 1H), 1.48−1.39 (m, 2H), 1.26−1.21 (m, 1H), 1.11−1.05 (m, 3H), 0.98 (t, *J* = 7.2 Hz, 3H), 0.87 (t, *J* = 7.2 Hz, 3H), 0.84 (t, *J* = 7.2 Hz, 3H), δ minor 7.96 (d, *J* = 8.2 Hz, 1H), 7.62 (d, *J* = 2.4 Hz, 1H), 6.76 (dd, *J* = 8.8, 2.3 Hz, 1H), 6.51 (dd, *J* = 8.5, 4.1 Hz, 1H), 6.35−6.34 (m, 1H), 5.59 (s, 1H), 5.06 (s, 1H), 3.37−3.35 (m, 1H), 2.65−2.64 (m, 2H), 1.97−1.96 (m, 2H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.7, 179.2, 176.2, 160.0 (d, *J* = 173.6 Hz), 158.4 (d, *J* = 171.2 Hz), 139.9, 138.9, 138.5, 135.4, 135.2, 133.7, 131.9 (d, *J* = 8.9 Hz), 128.6, 128.5, 128.2, 127.9, 127.8, 127.7, 127.5, 127.1, 115.2, 115.1, 115.0, 114.8, 114.6, 114.2, 114.0, 108.4 (d, *J* = 8.1 Hz), 108.2 (d, *J* = 8.1 Hz), 87.7, 84.1, 68.2, 64.6, 61.8, 58.9, 40.7, 40.1, 29.5, 29.1, 21.2, 15.2, 13.9, 13.7; IR (KBr) υ 3332, 3068, 2958, 2933, 2873, 1698, 1681, 1619, 1591, 1490, 1457, 1363, 1270, 1218, 1194, 1144, 1113, 1091, 1048, 1013, 985, 937, 907, 837, 814, 778, 752 cm^{-1}; MS (*m*/*z*) HRMS (ESI-TOF) calcd for $C_{42}H_{40}Cl_2F_2N_2NaO_5$ ([M + Na]$^+$) 783.2175, found 783.2172.

2u: white solid, 0.380 g, 97%, mp 204−206 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.18 (d, *J* = 1.8 Hz, 1H), 7.87 (d, *J* = 1.8 Hz, 1H), 7.22−7.19 (m, 3H), 7.07 (d, *J* = 9.0 Hz, 2H), 7.02 (dd, *J* = 8.3, 2.1 Hz, 1H), 6.63 (d, *J* = 9.0 Hz, 2H), 6.59 (d, *J* = 9.0 Hz, 2H), 6.53 (d, *J* = 7.8 Hz, 1H), 6.45 (s, 1H), 6.35 (d, *J* = 8.4 Hz, 1H), 6.04 (s, 1H), 5.13 (s, 1H), 3.95−3.90 (m, 1H), 3.84−3.80 (m, 1H), 3.74 (s, 3H), 3.70(s, 3H), 3.36−3.32 (m, 1H), 3.31−3.26 (m, 1H), 3.24−3.19 (m, 1H), 3.14−3.09 (m, 1H), 1.66−1.63 (m, 1H), 1.57−1.55 (m, 1H), 1.46−1.41 (m, 2H), 1.19−1.13 (m, 1H), 1.07−1.02 (m, 3H), 0.98 (t, *J* = 7.2 Hz, 3H), 0.85−0.80 (m, 6H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.1, 179.4, 176.5, 163.0, 159.0, 142.7, 141.1, 132.3, 129.8, 129.5, 129.1, 128.6, 128.5, 128.4, 127.6, 126.8, 126.3, 113.2, 112.6, 108.5, 87.8, 84.2, 68.1, 64.7, 61.5, 58.0, 55.4, 55.0, 40.6, 40.0, 29.5, 29.1, 20.2, 15.3, 13.8, 13.7; IR (KBr) υ 3679, 3270, 3068, 2961, 2933, 2873, 2378, 2348, 2313, 1691, 1604, 1576, 1513, 1485, 1432, 1355, 1256, 1178, 1159, 1114, 1031, 982, 848, 808 cm^{-1}; MS (*m*/*z*) HRMS (ESI-TOF) calcd for $C_{44}H_{46}Cl_2N_2NaO_7$ ([M + Na]$^+$) 807.2574, found 807.2574.

2v: white solid, 0.348 g, 85%, mp 234−236 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.24 (d, *J* = 1.8 Hz, 1H), 7.97 (d, *J* = 1.8 Hz, 1H), 7.36−7.35 (m, 2H), 7.33−7.29 (m, 3H), 7.19−7.16 (m, 3H), 7.14−7.10 (m, 4H), 7.05 (dd, *J* = 8.3, 1.9 Hz, 1H), 6.97 (d, *J* = 7.8 Hz, 2H), 6.94 (dd, *J* = 8.3, 1.9 Hz, 1H), 6.86 (d, *J* = 7.8 Hz, 2H), 6.54 (d, *J* = 7.2 Hz, 2H), 6.48 (s, 1H), 6.23 (d, *J* = 8.4 Hz, 2H), 6.12 (s, 1H), 5.32 (d, *J* = 15.0 Hz, 1H), 5.28−5.25 (m, 2H), 4.44 (d, *J* = 16.2 Hz, 1H), 4.16 (d, *J* = 15.0 Hz, 1H), 3.32−3.27 (m, 1H), 3.11−3.06 (m, 1H), 2.33 (s, 3H), 2.26 (s, 3H), 0.80 (t, *J* = 6.6 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.6, 179.6, 176.9, 143.4, 142.4, 140.9, 137.3, 135.2, 134.7, 134.4, 134.3, 132.1, 129.3, 128.9, 128.7, 128.5, 128.4, 128.1, 127.9, 127.4, 127.3, 127.1, 126.8, 126.6, 126.5, 126.3, 109.7, 109.2, 88.3, 84.3, 68.3, 65.0, 62.7, 59.1, 44.8, 44.1, 21.6, 21.3, 15.3; IR (KBr) υ 3291, 3074, 3029, 2977, 2924, 1704, 1682, 1609, 1514, 1482, 1454, 1431, 1379, 1359, 1341, 1265, 1238, 1205, 1178, 1159, 1097, 1080, 1027, 976, 940, 898, 875, 839, 809, 786 cm^{-1}; MS (*m*/*z*) HRMS (ESI-TOF) calcd for $C_{50}H_{42}Cl_2N_2NaO_5$ ([M + Na]$^+$) 843.2363, found 843.2357.

2w: white solid, 0.344 g, 80%, mp 230−232 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ major 8.19 (d, *J* = 1.8 Hz, 1H), 7.94 (d, *J* = 1.2 Hz, 1H), 7.38−7.31 (m, 5H), 7.26−7.22 (m, 7H), 7.13 (dd, *J* = 8.4, 2.4 Hz, 4H), 6.99 (d, *J* = 8.4 Hz, 2H), 6.59−6.58 (m, 2H), 6.53 (s, 1H), 6.34 (d, *J* = 8.4 Hz, 1H), 6.31 (d, *J* = 8.4 Hz, 1H), 6.07 (s, 1H), 5.27 (d, *J* = 15.0 Hz, 1H), 5.34−5.21 (m, 2H), 4.48 (d, *J* = 16.2 Hz, 1H), 4.26 (d, *J* = 15.0 Hz, 1H), 3.27−3.23 (m, 1H), 3.09−3.04 (m, 1H), 0.80 (t, *J* = 7.2 Hz, 3H), δ minor 8.10 (br, 1H), 7.92 (br, 1H), 7.47 (d, *J* = 7.2 Hz, 3H), 7.42−7.41 (m, 3H), 6.82 (d, *J* = 8.4 Hz, 2H), 6.44 (d, *J* = 7.8 Hz, 1H), 6.27 (d, *J* = 8.4 Hz, 1H), 5.69 (s, 1H), 5.14 (s, 1H), 4.95 (d, *J* = 15.0 Hz, 1H), 4.62 (d, *J* = 15.0 Hz, 1H), 2.71 (br, 1H), 1.98 (br, 1H), 1.15−1.04 (m, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.8, 179.2, 176.5, 142.3, 140.8, 139.0, 135.7, 135.1, 134.9, 134.4, 133.9, 131.7, 129.5, 129.0, 128.8, 128.7, 128.6, 128.3, 128.2, 128.0, 127.9, 127.8, 127.5, 127.3, 126.7, 126.3, 109.9, 109.4, 88.2, 83.9, 68.5, 64.8, 62.6, 58.8, 44.1, 15.2; IR (KBr) υ 3326, 3068, 2931, 2351, 1706, 1691, 1609, 1591, 1483, 1454, 1430, 1400, 1348, 1264, 1234, 1206, 1178, 1157, 1093, 1031, 970, 881, 847, 810, 794, 771 cm^{-1}; MS (*m*/*z*) HRMS (ESI-TOF) calcd for $C_{48}H_{36}Cl_4N_2NaO_5$ ([M + Na]$^+$) 883.1271, found 883.1262.

2. General Procedure for the Preparation of the Amino-Substituted Dispirocyclopentanebisoxindoles (3a−3k). A solution of 3-phenacylideneoxindoles (1.0 mmol), amine (2.0 mmol), and piperidine (0.5 mmol, 0.042 g) in 10.0 mL of acetonitrile was stirred at room temperature for about 12 h. Then, the resulting precipitates were collected by filtration and washed with a little cold ethanol to give the pure products **3a−3k** for analysis.

3a: white solid, 0.324 g, 80%, mp 228−230 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.12 (br, 1H), 7.98 (br, 1H), 7.34 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.13 (d, *J* = 7.8 Hz, 2H), 7.08 (d, *J* = 8.4 Hz, 1H), 6.99 (d, *J* = 8.4 Hz, 2H), 6.87 (d, *J* = 8.4 Hz, 1H), 6.81 (d, *J* = 7.8 Hz, 2H), 6.60 (d, *J* = 7.8 Hz, 2H), 6.57−6.55 (m, 3H), 6.47 (d, *J* = 8.4 Hz, 1H), 6.16 (d, *J* = 9.6 Hz, 1H), 6.09 (d, *J* = 8.4 Hz, 2H), 5.40 (s, 1H), 5.32 (d, *J* = 9.6 Hz, 1H), 3.69−3.64 (m, 1H), 3.62−3.58 (m, 1H), 3.25−3.19 (m, 2H), 2.19 (s, 3H), 2.11 (s, 3H), 1.99 (s, 3H), 1.25−1.15 (m, 2H), 1.07−1.01 (m, 2H), 0.90−0.85 (m, 3H), 0.74−0.70 (m, 6H), 0.67−0.63 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.1, 180.5, 176.0, 143.4, 143.3, 142.8, 141.3, 137.6, 134.3, 132.7, 132.1, 129.3, 128.7, 128.6, 128.2, 128.1, 127.3, 126.9, 126.6, 126.5, 126.3, 125.8, 113.2, 109.0, 108.7, 86.2, 65.6, 64.1, 61.2, 60.0, 40.7, 40.0, 29.2, 28.9, 21.5, 21.0, 20.2, 20.1, 14.0, 13.7; IR (KBr) υ 3454, 3034, 2979, 2948, 2025, 1739, 1709, 1651, 1609, 1480, 1459, 1433, 1369, 1346, 1313, 1284, 1234, 1183, 1139, 1117, 1024, 952, 918, 900, 875, 845, 812, 775 cm^{-1}; MS (*m*/*z*) HRMS (ESI-TOF) calcd for $C_{49}H_{49}Cl_2N_3NaO_4$ ([M + Na]$^+$) 836.2992, found 836.2986.

3b: white solid, 0.354 g, 83%, mp 248−250 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.19 (d, *J* = 1.8 Hz, 1H), 7.82 (d, *J* = 1.2 Hz, 1H), 7.28 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.15 (d, *J* = 8.4 Hz, 2H), 7.08 (d, *J* = 8.4 Hz, 3H), 7.03 (dd, *J* = 8.3, 1.7 Hz, 1H), 6.98 (d, *J* = 8.4 Hz, 2H), 6.83−6.81 (m, 3H), 6.64−6.60 (m, 3H), 6.33 (s, 1H), 6.21 (d, *J* = 8.4 Hz, 1H), 6.03 (d, *J* = 8.4 Hz, 2H), 5.07 (s, 1H), 3.84−3.79 (m, 1H), 3.69−3.64 (m, 1H), 3.26−3.21 (m, 2H), 2.07 (s, 3H), 1.32−1.26 (m, 2H), 1.18−1.11 (m, 3H), 1.05−1.01 (m, 2H), 0.92−0.90 (m, 1H),

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0.85−0.80 (m, 6H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.3, 180.3, 175.7, 143.0, 142.7, 141.2, 139.0, 135.2, 134.1, 131.7, 129.5, 129.1, 128.6, 128.5, 128.4, 128.0, 127.9, 127.6, 127.2, 127.1, 126.4, 125.8, 113.2, 109.4, 109.0, 85.9, 65.7, 64.0, 61.3, 59.6, 40.8, 40.1, 29.2, 29.0, 20.2, 20.1, 20.0, 13.9, 13.7; IR (KBr) υ 3425, 2959, 2930, 2870, 2025, 1702, 1680, 1611, 1520, 1484, 1431, 1379, 1356, 1294, 1231, 1186, 1115, 976, 813 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{47}H_{43}Cl_4N_3NaO_4$ ([M + Na]$^+$) 876.1900, found 876.1899.

3c: white solid, 0.330 g, 78%, mp 249−251 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.12 (dd, J = 8.4, 2.4 Hz, 1H), 7.71 (dd, J = 8.3, 2.3 Hz, 1H), 7.19−7.14 (m, 4H), 7.10 (t, J = 7.8 Hz, 2H), 7.01 (t, J = 7.8 Hz, 2H), 6.88−6.84 (m, 10H), 6.69 (d, J = 7.8 Hz, 2H), 6.61 (td, J = 8.6, 2.4 Hz, 1H), 6.52 (d, J = 7.2 Hz, 2H), 6.48 (s, 1H), 6.33 (dd, J = 8.5, 4.1 Hz, 1H), 6.09 (d, J = 8.4 Hz, 2H), 5.96 (dd, J = 8.5, 4.2 Hz, 1H), 5.27−5.24 (m, 2H), 5.18 (d, J = 16.2 Hz, 1H), 4.42 (d, J = 16.2 Hz, 1H), 4.20 (d, J = 16.2 Hz, 1H), 2.28 (s, 3H), 2.24 (s, 3H), 2.11 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.1, 181.2, 176.8, 160.2 (d, J = 185.6 Hz), 158.6 (d, J = 183.0 Hz), 143.6, 143.5, 139.9, 138.4, 137.6, 135.3, 134.1, 133.7, 133.0, 131.8 (d, J = 8.8 Hz), 128.8, 128.7, 128.6, 128.5, 127.6, 127.4, 127.0, 126.8, 126.7, 126.6, 126.5, 115.2, 115.1, 114.9, 114.7, 114.6, 114.4, 113.7, 113.6, 113.2, 109.8 (d, J = 8.2 Hz), 109.4 (d, J = 8.0 Hz), 86.3, 66.4, 64.4, 62.4, 60.5, 44.4, 21.4, 20.3; IR (KBr) υ 3424, 3071, 2956, 2931, 2868, 2026, 1711, 1675, 1611, 1520, 1483, 1431, 1379, 1354, 1294, 1251, 1224, 1190, 1095, 1013, 968, 847, 808 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{55}H_{45}F_2N_3NaO_4$ ([M + Na]$^+$) 872.3270, found 872.3270.

3d: white solid, 0.330 g, 76%, mp 264−266 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.29 (s, 1H), 7.93 (s, 1H), 7.17−7.11 (m, 5H), 7.09 (t, J = 7.8 Hz, 2H), 7.02 (t, J = 7.2 Hz, 2H), 6.91−6.88 (m, 9H), 6.84−6.82 (m, 3H), 6.55 (t, J = 7.2 Hz, 1H), 6.51 (s, 1H), 6.48 (d, J = 7.8 Hz, 2H), 6.34 (d, J = 8.4 Hz, 1H), 6.20 (d, J = 8.4 Hz, 2H), 5.96 (d, J = 8.4 Hz, 1H), 5.31 (d, J = 16.2 Hz, 1H), 5.26 (s, 1H), 5.16 (d, J = 15.6 Hz, 1H), 4.42 (d, J = 16.2 Hz, 1H), 4.21 (d, J = 16.2 Hz, 1H), 2.28 (s, 3H), 2.23 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.0, 181.1, 176.6, 145.7, 143.6, 142.6, 140.9, 137.8, 135.1, 134.2, 133.5, 132.9, 131.7, 129.7, 129.2, 128.9, 128.8, 128.6, 128.5, 127.7, 127.4, 127.1, 126.8, 126.6, 126.5, 125.8, 117.9, 113.2, 110.1, 86.2, 66.1, 64.2, 62.5, 60.2, 44.6, 44.2, 21.6, 21.3; IR (KBr) υ 3396, 3279, 3072, 2918, 1806, 1712, 1682, 1607, 1513, 1486, 1432, 1378, 1356, 1312, 1255, 1235, 1181, 1144, 1078, 1034, 971, 896, 873, 836, 812, 787 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{54}H_{43}Cl_2N_3NaO_4$ ([M + Na]$^+$) 890.2523, found 890.2519.

3e: white solid, 0.388 g, 86%, mp 257−259 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.27 (s, 1H), 7.92 (s, 1H), 7.19−7.15 (m, 4H), 7.13 (d, J = 7.8 Hz, 1H), 7.11−7.05 (m, 4H), 6.92−6.83 (m, 11H), 6.78 (s, 1H), 6.48 (d, J = 7.2 Hz, 2H), 6.44 (d, J = 8.4 Hz, 1H), 6.34 (d, J = 7.8 Hz, 1H), 6.11 (d, J = 8.4 Hz, 2H), 6.00 (d, J = 8.4 Hz, 1H), 5.30 (d, J = 16.2 Hz, 1H), 5.24 (s, 1H), 5.20 (d, J = 16.2 Hz, 1H), 4.63 (d, J = 8.4 Hz, 1H), 4.42 (d, J = 15.6 Hz, 1H), 4.19 (d, J = 16.2 Hz, 1H), 2.30 (s, 3H), 2.24 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.9, 180.9, 176.5, 144.4, 143.7, 142.5, 140.8, 137.9, 135.0, 134.1, 133.4, 132.7, 131.5, 129.8, 129.0, 128.9, 128.8, 128.7, 128.4, 128.3, 127.8, 127.4, 127.3, 127.1, 126.7, 126.5, 126.4, 125.8, 122.4, 114.2, 110.2, 110.0, 86.1, 66.0, 64.1, 62.4, 60.0, 44.6, 44.2, 21.6, 21.2; IR (KBr) υ 3448, 3071, 2921, 2026, 1710, 1683, 1608, 1486, 1431, 1376, 1348, 1234, 1180, 1095, 1034, 973, 813, 788 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{54}H_{42}Cl_3N_3NaO_4$ ([M + Na]$^+$) 924.2133, found 924.2123.

3f: white solid, 0.352 g, 80%, mp 242−246 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.04 (d, J = 1.8 Hz, 1H), 7.90 (d, J = 1.2 Hz, 1H), 7.36 (d, J = 7.8 Hz, 2H), 7.29−7.27 (m, 1H), 7.25−7.23 (m, 2H), 7.17−7.15 (m, 1H), 7.11−7.03 (m, 10H), 6.96 (d, J = 8.4 Hz, 2H), 6.92 (dd, J = 7.8, 1.8 Hz, 1H), 6.78−6.74 (m, 5H), 6.50 (d, J = 7.8 Hz, 2H), 6.22 (d, J = 3.0 Hz, 1H), 6.20 (d, J = 3.0 Hz, 1H), 5.62 (s, 1H), 5.22 (d, J = 16.2 Hz, 1H), 5.17−5.14 (m, 2H), 4.40 (d, J = 16.2 Hz, 1H), 4.32 (d, J = 15.0 Hz, 1H), 3.45 (d, J = 13.8 Hz, 1H), 3.37 (d, J = 13.2 Hz, 1H), 2.35 (s, 3H), 2.23 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.5, 181.6, 176.6, 143.2, 142.4, 140.9, 139.3, 137.5, 135.2, 134.5, 134.4, 133.6, 132.4, 129.5, 129.0, 128.7, 128.6, 128.5, 128.4, 128.1, 128.0, 127.3, 127.1, 127.0, 126.8, 126.4, 126.0, 109.7, 109.3, 85.9, 70.8, 65.2, 63.0, 60.6, 52.8, 45.1, 44.0, 21.6, 21.3; IR (KBr) υ 3450, 3368, 3280, 3065, 3028, 2918, 2848, 2025, 1712, 1671, 1608, 1483, 1451, 1431, 1376, 1348, 1233, 1176, 1117, 1079, 1030, 952, 839, 811, 788 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{55}H_{45}Cl_2N_3NaO_4$ ([M + Na]$^+$) 904.2679, found 904.2666.

3g: white solid, 0.314 g, 74%, mp 242−246 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.18 (s, 1H), 7.90 (s, 1H), 7.38−7.37 (m, 2H), 7.33−7.32 (m, 3H), 7.18−7.16 (m, 1H), 7.13−7.10 (m, 6H), 7.05 (d, J = 8.4 Hz, 1H), 6.98 (d, J = 7.8 Hz, 2H), 6.93 (d, J = 8.4 Hz, 1H), 6.78 (d, J = 7.8 Hz, 2H), 6.71 (s, 1H), 6.53 (d, J = 7.2 Hz, 2H), 6.24 (t, J = 8.4 Hz, 2H), 5.62 (s, 1H), 5.25 (d, J = 16.2 Hz, 1H), 5.20 (d, J = 15.6 Hz, 1H), 5.15 (s, 1H), 4.43 (d, J = 16.2 Hz, 1H), 4.33 (d, J = 15.6 Hz, 1H), 2.40−2.37 (m, 1H), 2.34 (s, 3H), 2.23 (s, 3H), 2.14−2.10 (m, 1H), 1.03−0.99 (m, 2H), 0.94−0.88 (m, 2H), 0.60 (t, J = 7.8 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.6, 181.6, 176.7, 143.2, 142.3, 140.9, 137.4, 135.2, 134.5, 134.3, 133.7, 129.4, 128.8, 128.7, 128.6, 128.5, 128.4, 128.0, 127.3, 127.1, 127.0, 126.9, 126.5, 126.4, 126.0, 109.7, 109.2, 85.9, 72.2, 65.1, 62.8, 60.6, 49.5, 44.9, 44.0, 32.3, 21.5, 21.3, 19.8, 13.7; IR (KBr) υ 3451, 3292, 3069, 2925, 2861, 2025, 1706, 1683, 1609, 1485, 1403, 1377, 1354, 1264, 1236, 1181, 1124, 1081, 1034, 977, 816, 789 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{52}H_{47}N_3Cl_2O_4$ ([M + H]$^+$) 848.3016, found 848.3017.

3h: white solid, 0.360 g, 84%, mp 224−226 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.14 (s, 1H), 7.95 (s, 1H), 7.45 (d, J = 7.2 Hz, 2H), 7.38−7.34 (m, 4H), 7.18−7.16 (m, 1H), 7.14−7.11 (m, 4H), 7.08 (d, J = 7.8 Hz, 2H), 7.03 (d, J = 7.8 Hz, 1H), 6.96−6.95 (m, 3H), 6.73 (d, J = 7.2 Hz, 2H), 6.55 (d, J = 7.8 Hz, 2H), 6.32 (d, J = 8.4 Hz, 1H), 6.20 (d, J = 8.4 Hz, 1H), 5.73 (s, 1H), 5.23−5.21 (m, 2H), 5.01 (d, J = 15.0 Hz, 1H), 4.52 (d, J = 14.4 Hz, 1H), 4.43 (d, J = 16.2 Hz, 1H), 2.78 (s, 2H), 2.34 (s, 3H), 2.21 (s, 3H), 1.98 (br, 2H), 1.13−1.04 (m, 6H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 193.8, 180.4, 174.9, 141.3, 140.5, 139.3, 135.1, 133.4, 133.3, 132.8, 132.5, 131.0, 127.3, 127.0, 126.0, 126.8, 126.7, 126.5, 126.3, 126.2, 125.3, 125.1, 124.6, 124.5, 107.7, 107.2, 83.8, 64.1, 60.9, 58.3, 51.7, 43.4, 42.2, 24.9, 22.2, 19.6, 19.4; IR (KBr) υ 3449, 3065, 3033, 2931, 2851, 2815, 2763, 2026, 1708, 1678, 1606, 1516, 1483, 1432, 1377, 1342, 1271, 1239, 1177, 1118, 1081, 1033, 1004, 970, 898, 843, 810, 789 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{53}H_{47}Cl_2N_3NaO_4$ ([M + Na]$^+$) 882.2836, found 882.2833.

3i: white solid, 0.290 g, 70%, mp 226−228 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.98 (d, J = 8.4 Hz, 1H), 7.72 (d, J = 8.4 Hz, 1H), 7.44 (d, J = 7.2 Hz, 2H), 7.36−7.33 (m, 4H), 7.17−7.10 (m, 7H), 6.94 (d, J = 7.8 Hz, 2H), 6.77−6.74 (m, 3H), 6.67 (t, J = 8.4 Hz, 1H), 6.60 (d, J = 7.2 Hz, 2H), 6.31 (dd, J = 8.4, 3.6 Hz, 1H), 6.19 (dd, J = 8.4, 4.2 Hz, 1H), 5.75 (s, 1H), 5.22 (s, 1H), 5.16 (d, J = 16.2 Hz, 1H), 5.01 (d, J = 15.0 Hz, 1H), 4.52 (d, J = 15.0 Hz, 1H), 4.45 (d, J = 16.2 Hz, 1H), 2.78 (br, 2H), 2.33 (s, 3H), 2.22 (s, 3H), 1.98 (br, 2H), 1.13−1.03 (m, 6H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.7, 182.4, 177.0, 160.0 (d, J = 181.6 Hz), 158.4 (d, J = 178.4 Hz), 143.3, 139.7, 138.7, 137.0, 135.5, 135.4, 134.9, 134.4, 133.0 (d, J = 8.7 Hz), 128.9, 128.7, 128.6, 128.5, 128.1, 127.3, 127.0, 126.6, 126.4, 114.8, 114.6, 114.5, 114.4, 114.3, 114.2, 109.0 (d, J = 7.4 Hz), 108.8 (d, J = 8.1 Hz), 85.5, 66.2, 62.7, 60.5, 53.6, 45.4, 44.2, 26.9, 24.2, 21.6, 21.3; IR (KBr) υ 3449, 3279, 3087, 3033, 2929, 2850, 2807, 2764, 1679, 1606, 1487, 1448, 1380, 1344, 1264, 1225, 1170, 1137, 1081, 1011, 977, 903, 863, 813, 793, 760 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{53}H_{47}F_2N_3NaO_4$ ([M + Na]$^+$) 850.3427, found 850.3424.

3j: white solid, 0.362 g, 85%, mp 224−226 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ major 8.18 (s, 1H), 7.92 (s, 1H), 7.45−7.44 (m, 2H), 7.40−7.36 (m, 3H), 7.30 (s, 1H), 7.20−7.11 (m, 6H), 7.07 (d, J = 7.8 Hz, 2H), 7.03 (d, J = 8.4 Hz, 1H), 6.99−6.95 (m, 3H), 6.77−6.74 (m, 2H), 6.58 (d, J = 7.2 Hz, 2H), 6.33 (d, J = 8.4 Hz, 1H), 6.20 (d, J = 8.4 Hz, 1H), 5.68 (s, 1H), 5.20 (s, 1H), 5.05 (d, J = 15.0 Hz, 1H), 4.46 (d, J = 3.6 Hz, 1H), 4.44 (br, 1H), 3.23−3.20 (m, 2H), 3.12−3.09 (m, 2H), 2.81−2.78 (m, 2H), 2.33 (s, 3H), 2.23 (s, 3H), 1.98 (t, J = 8.4 Hz, 2H), δ minor 8.90 (s, 1H), 7.82 (s, 1H), 7.60 (d, J = 7.2 Hz, 2H), 7.52 (s, 1H), 6.83 (d, J = 7.8 Hz, 1H), 6.71 (d, J = 7.8 Hz, 1H), 5.97 (d, J = 7.8 Hz, 1H), 5.25 (d, J = 15.6 Hz, 1H), 5.17−5.14 (m, 3H), 4.87 (s, 1H), 4.61 (d, J = 15.6 Hz, 1H), 3.86 (d, J = 15.6 Hz, 1H), 2.31 (s, 3H), 2.16 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.5, 182.0, 176.7, 143.3, 142.4, 141.1, 137.3, 135.2, 134.9, 134.7, 134.4, 132.8,

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129.5, 129.1, 129.0, 128.7, 128.6, 128.5, 128.4, 128.3, 128.0, 127.4, 127.2, 127.1, 126.6, 126.5, 126.4, 126.3, 109.7, 109.2, 85.5, 76.0, 67.3, 66.1, 63.0, 60.2, 52.9, 45.3, 44.1, 21.6, 21.3; IR (KBr) υ 3449, 3066, 3033, 2954, 2915, 2850, 2026, 1705, 1680, 1608, 1483, 1452, 1431, 1347, 1264, 1234, 1179, 1118, 1080, 1029, 976, 868, 815, 789 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{52}H_{45}Cl_2N_3NaO_5$ ([M + Na]$^+$) 884.2628, found 884.2626.

3k: white solid, 0.304 g, 50%, mp 228−230 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.03 (d, J = 7.8 Hz, 2H), 7.42 (d, J = 7.2 Hz, 3H), 7.35 (d, J = 4.8 Hz, 3H), 7.29 (br, 2H), 7.20−7.18 (m, 1H), 7.17−7.16 (m, 1H), 7.15 (br, 1H), 7.12 (d, J = 7.2 Hz, 2H), 7.08 (d, J = 8.4 Hz, 1H), 7.00 (d, J = 7.8 Hz, 2H), 6.96−6.93 (m, 3H), 6.71 (d, J = 7.2 Hz, 2H), 6.56 (d, J = 8.4 Hz, 1H), 6.39 (d, J = 8.4 Hz, 1H), 5.52 (s, 1H), 5.36 (s, 1H), 5.25 (d, J = 15.6 Hz, 1H), 4.94 (d, J = 16.2 Hz, 1H), 4.55 (d, J = 16.2 Hz, 1H), 4.46 (d, J = 15.7 Hz, 1H), 2.27 (s, 3H), 2.24 (s, 3H), 1.96 (s, 6H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.7, 181.0, 176.3, 143.2, 142.2, 141.2, 136.6, 135.4, 135.0, 134.9, 133.8, 132.8, 128.7, 128.5, 128.2, 128.1, 127.8, 127.7, 127.6, 127.5, 127.2, 127.0, 126.9, 126.6, 126.5, 125.9, 125.6, 110.2, 109.5, 85.2, 75.8, 65.7, 61.9, 59.3, 44.6, 43.8, 43.2, 21.0, 20.7; IR (KBr) υ 3453, 3065, 3030, 2955, 2906, 2841, 2797, 2372, 2025, 1704, 1688, 1608, 1482, 1454, 1430, 1345, 1268, 1236, 1178, 1114, 1081, 1037, 975, 936, 906, 878, 843, 813, 791 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{50}H_{44}Cl_2N_3O_4$ ([M + H]$^+$) 820.2703, found 820.2717.

3. General Procedure for the Preparation of Dispirocyclopentanebisoxindoles (4a−4n) from the Domino Reaction of 3-Phenacylideneoxindoles. A solution of 3-phenacylideneoxindoles (0.5 mmol), thiophenol (0.5 mmol) and piperidine (0.5 mmol, 0.042 g) in 10.0 mL of acetonitrile was stirred at room temperature for about 3−4 h. Then, the resulting precipitates were collected by filtration and washed with a little cold ethanol to give the pure products **4a−4n** for analysis.

4a: white solid, 0.133 g, 75%, mp 227−229 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.20 (d, J = 7.8 Hz, 1H), 7.95 (d, J = 7.2 Hz, 1H), 7.35−7.30 (m, 5H), 7.16−7.14 (m, 1H), 7.11−7.01 (m, 9H), 6.97−6.93 (m, 4H), 6.75 (d, J = 7.8 Hz, 2H), 6.56 (d, J = 7.8 Hz, 2H), 6.40 (d, J = 7.2 Hz, 1H), 6.35 (d, J = 7.8 Hz, 1H), 5.35 (s, 1H), 5.25 (d, J = 16.0 Hz, 1H), 5.17 (d, J = 15.3 Hz, 1H), 4.48 (d, J = 13.9 Hz, 1H), 4.43 (d, J = 16.1 Hz, 1H), 4.38 (d, J = 15.3 Hz, 1H), 2.53 (d, J = 13.9 Hz, 1H), 2.32 (s, 3H), 2.22 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 196.0, 184.0, 177.1, 143.9, 143.1, 141.7, 137.2, 135.9, 135.6, 135.0, 134.5, 130.6, 129.0, 128.6, 128.5, 128.4, 128.3, 128.1, 127.9, 27.3, 127.1, 126.9, 126.6, 126.1, 125.8, 124.2, 121.9, 108.8, 108.5, 84.5, 66.7, 65.2, 54.4, 47.1, 44.7, 43.9, 21.6, 21.4; IR (KBr) υ 3449, 3281, 3059, 3028, 2916, 2858, 1707, 1680, 1611, 1518, 1491, 1467, 1435, 1390, 1350, 1303, 1265, 1233, 1180, 1102, 1077, 1015, 930, 837, 818, 768 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{48}H_{40}N_2NaO_4$ ([M + Na]$^+$) 731.2880, found 731.2865.

4b: white solid, 0.127 g, 68%, mp 235−237 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.15 (d, J = 6.6 Hz, 1H), 7.93 (d, J = 7.2 Hz, 1H), 7.38−7.33 (m, 5H), 7.22−7.20 (m, 3H), 7.16−7.13 (m, 1H), 7.11−7.07 (m, 5H), 7.05−7.02 (m, 5H), 6.84 (d, J = 7.8 Hz, 2H), 6.58 (d, J = 6.6 Hz, 2H), 6.45 (d, J = 7.2 Hz, 2H), 5.27 (s, 1H), 5.22 (d, J = 16.0 Hz, 1H), 5.09 (d, J = 15.2 Hz, 1H), 4.50 (d, J = 15.2 Hz, 1H), 4.47−4.42 (m, 2H), 2.54 (d, J = 13.8 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.2, 183.7, 176.7, 143.8, 141.6, 138.8, 136.9, 135.5, 135.3, 134.8, 133.9, 130.1, 129.2, 129.0, 128.7, 128.6, 128.4, 128.3, 128.2, 127.9, 127.8, 127.2, 127.0, 126.4, 126.2, 125.8, 124.4, 122.1, 108.9, 108.7, 84.1, 66.7, 65.1, 54.2, 46.8, 44.8, 43.9; IR (KBr) υ 3449, 3286, 3065, 3028, 2913, 1708, 1686, 1613, 1591, 1491, 1467, 1435, 1391, 1352, 1300, 1263, 1206, 1181, 1094, 1013, 959, 930, 909, 845, 827, 781 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{46}H_{34}Cl_2N_2NaO_4$ ([M + Na]$^+$) 771.1788, found 771.1773.

4c: white solid, 0.162 g, 88%, mp 233−235 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.00 (s, 1H), 7.76 (s, 1H), 7.34−7.30 (m, 5H), 7.15−7.12 (m, 1H), 7.09−7.05 (m, 6H), 7.00 (s, 1H), 6.96 (d, J = 7.8 Hz, 2H), 6.91 (d, J = 7.8 Hz, 1H), 6.75 (d, J = 7.8 Hz, 3H), 6.49 (d, J = 7.2 Hz, 2H), 6.29 (d, J = 7.8 Hz, 1H), 6.22 (d, J = 7.8 Hz, 1H), 5.34−5.30 (m, 2H), 5.17 (d, J = 15.3 Hz, 1H), 4.48 (d, J = 13.9 Hz, 1H), 4.39−4.33 (m, 2H), 2.52 (d, J = 13.9 Hz, 1H), 2.36 (s, 3H), 2.33 (s, 3H), 2.29 (s, 3H), 2.22 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 196.1, 183.9, 177.0, 142.9, 141.6, 139.3, 137.2, 136.0, 135.8, 135.1, 134.7, 133.9, 131.2, 130.6, 129.0, 128.5, 128.3, 128.0, 127.9, 127.6, 127.2, 127.0, 126.8, 126.6, 126.5, 126.1, 108.4, 108.2, 84.4, 66.7, 65.3, 54.5, 47.2, 44.7, 44.0, 21.6, 21.4; IR (KBr) υ 3450, 3031, 2908, 2025, 1705, 1681, 1608, 1495, 1431, 1370, 1349, 1292, 1258, 1236, 1199, 1157, 1101, 1032, 1006, 933, 909, 812, 772 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{50}H_{44}N_2NaO_4$ ([M + Na]$^+$) 759.3193, found 759.3202.

4d: white solid, 0.129 g, 66%, mp 206−208 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.02 (d, J = 8.4 Hz, 1H), 7.69 (d, J = 7.8 Hz, 1H), 7.41−7.37 (m, 3H), 7.33 (d, J = 7.8 Hz, 2H), 7.23−7.22 (m, 3H), 7.13 (s, 4H), 7.10 (d, J = 7.8 Hz, 2H), 6.95 (s, 1H), 6.88−6.83 (m, 3H), 6.73 (t, J = 8.4 Hz, 1H), 6.56 (d, J = 7.2 Hz, 2H), 6.39 (dd, J = 8.4, 3.6 Hz, 1H), 6.35 (dd, J = 8.4, 3.6 Hz, 1H), 5.23−5.19 (m, 2H), 5.08 (d, J = 15.2 Hz, 1H), 4.49 (d, J = 15.2 Hz, 1H), 4.44 (d, J = 16.0 Hz, 1H), 4.38 (d, J = 14.0 Hz, 1H), 2.53 (d, J = 14.0 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.8, 183.3, 176.4, 160.2 (J = 199.2 Hz), 158.6 (J = 197.2 Hz), 139.7, 139.1, 137.6, 136.4, 135.1, 135.0, 134.4, 134.1, 131.7 (J = 8.7 Hz), 129.3, 128.7, 128.5, 128.4, 128.3, 128.1, 128.0, 127.6, 127.3, 126.4, 115.4, 115.3, 115.2, 114.0, 113.8, 109.4 (J = 8.0 Hz), 84.0, 67.0, 65.1, 54.4, 46.7, 45.0, 44.1; IR (KBr) υ 3449, 2025, 1681, 1624, 1488, 1451, 1381, 1346, 1260, 1181, 1093, 1005, 929, 904, 830, 809, 758 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{46}H_{32}Cl_2F_2N_2NaO_4$ ([M + Na]$^+$) 807.1599, found 807.1604.

4e: white solid, 0.160 g, 79%, mp 204−206 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.20 (s, 1H), 7.92 (s, 1H), 7.37−7.32 (m, 3H), 7.29 (d, J = 7.8 Hz, 2H), 7.21 (d, J = 7.8 Hz, 2H), 7.17−7.15 (m, 1H), 7.12−7.09 (m, 5H), 6.94 (d, J = 8.4 Hz, 1H), 6.84 (s, 1H), 6.69 (d, J = 7.8 Hz, 2H), 6.50 (d, J = 8.4 Hz, 2H), 6.46 (d, J = 7.8 Hz, 2H), 6.32 (t, J = 7.2 Hz, 2H), 5.32 (d, J = 16.2 Hz, 1H), 5.23−5.19 (m, 2H), 4.43−4.41 (m, 2H), 4.38 (d, J = 6.9 Hz, 1H), 3.76 (s, 3H), 3.73 (s, 3H), 2.53 (d, J = 14.0 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 183.3, 175.8, 167.7, 142.3, 141.1, 137.5, 135.0, 134.6, 133.6, 129.7, 128.9, 128.7, 128.6, 128.5, 128.4, 128.3, 128.1, 127.4, 127.2, 127.0, 126.8, 126.4, 125.9, 110.0, 109.7, 84.6, 67.0, 61.3, 61.0, 54.3, 46.4, 44.6, 43.8, 21.2, 13.1; IR (KBr) υ 3450, 2934, 2839, 2021, 1704, 1680, 1606, 1513, 1481, 1429, 1376, 1345, 1253, 1176, 1106, 1080, 1030, 998, 929, 840, 813 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{48}H_{38}Cl_2N_2NaO_6$ ([M + Na]$^+$) 831.1999, found 831.1998.

4f: white solid, 0.153 g, 82%, mp 221−223 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.24 (s, 1H), 7.95 (s, 1H), 7.36−7.29 (m, 6H), 7.21−7.14 (m, 8H), 7.11 (t, J = 7.8 Hz, 3H), 7.04 (t, J = 7.8 Hz, 2H), 6.94−6.91 (m, 2H), 6.46 (d, J = 7.2 Hz, 2H), 6.30 (d, J = 7.8 Hz, 1H), 6.22 (d, J = 8.4 Hz, 1H), 5.28 (s, 1H), 5.25−5.21 (m, 2H), 4.46−4.42 (m, 2H), 4.24 (d, J = 15.3 Hz, 1H), 2.56 (d, J = 14.0 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 196.1, 183.3, 176.3, 142.4, 140.1, 137.7, 136.9, 135.1, 134.3, 132.5, 131.9, 129.8, 129.1, 128.7, 128.6, 128.4, 128.2, 128.0, 127.9, 127.6, 127.2, 127.0, 126.3, 126.0, 109.8, 109.5, 84.4, 66.8, 65.5, 54.3, 46.5, 44.6, 43.9; IR (KBr) υ 3443, 3069, 2936, 2025, 1691, 1611, 1481, 1429, 1368, 1344, 1273, 1232, 1204, 1181, 1079, 989, 914, 814 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{46}H_{34}Cl_2N_2NaO_4$ ([M + Na]$^+$) 771.1788, found 771.1785.

4g: white solid, 0.163 g, 80%, mp 228−230 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.18 (d, J = 1.8 Hz, 1H), 7.90 (d, J = 1.8 Hz, 1H), 7.42−7.37 (m, 3H), 7.33 (d, J = 7.2 Hz, 2H), 7.22−7.21 (m, 3H), 7.13−7.11 (m, 5H), 7.08 (d, J = 8.4 Hz, 2H), 7.01 (dd, J = 8.3, 1.8 Hz, 1H), 6.90 (s, 1H), 6.86 (d, J = 8.4 Hz, 2H), 6.55−6.54 (m, 2H), 6.39 (d, J = 8.4 Hz, 1H), 6.36 (d, J = 8.4 Hz, 1H), 5.24 (d, J = 16.1 Hz, 1H), 5.17 (s, 1H), 5.06 (d, J = 15.2 Hz, 1H), 4.50 (d, J = 15.2 Hz, 1H), 4.43 (d, J = 16.1 Hz, 1H), 4.37 (d, J = 14.0 Hz, 1H), 2.52 (d, J = 14.0 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.8, 183.2, 176.2, 142.4, 140.2, 139.1, 136.3, 135.0, 134.2, 134.1, 131.7, 129.9, 129.3, 129.0, 128.8, 128.7, 128.5, 128.3, 128.1, 128.0, 127.8, 127.7, 127.4, 127.3, 126.3, 126.1, 109.9, 109.7, 84.0, 66.8, 65.2, 54.2, 46.7, 45.0, 44.0, 29.7; IR (KBr) υ 3449, 2919, 2025, 1711, 1687, 1640, 1481, 1428, 1350, 1235, 1180, 1091, 998, 933, 811 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{46}H_{32}Cl_4N_2NaO_4$ ([M + Na]$^+$) 839.1008, found 839.1002.

4h: white solid, 0.128 g, 76%, mp 191−193 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.05 (d, J = 8.4 Hz, 1H), 7.63 (d, J = 8.4 Hz, 1H),

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7.09 (d, J = 7.2 Hz, 2H), 6.97−6.94 (m, 3H), 6.91−6.89 (m, 4H), 6.81 (s, 1H), 6.74 (t, J = 8.4 Hz, 1H), 6.55 (dd, J = 8.2, 3.5 Hz, 1H), 6.30 (dd, J = 8.2, 3.5 Hz, 1H), 5.15 (s, 1H), 4.33 (d, J = 14.0 Hz, 1H), 3.84−3.77 (m, 2H), 3.37−3.33 (m, 1H), 3.21−3.16 (m, 1H), 2.41 (d, J = 14.0 Hz, 1H), 2.25 (s, 3H), 2.22 (s, 3H), 1.63−1.58 (m, 1H), 1.55−1.49 (m, 1H), 1.43−1.34 (m, 2H), 1.11−1.04 (m, 1H), 0.98 (t, J = 7.2 Hz, 5H), 0.91−0.86 (m, 1H), 0.78 (t, J = 7.2 Hz, 3H) ; ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.6, 183.2, 176.2, 160.0 (J = 211.4 Hz), 158.4 (J = 208.1 Hz), 143.3, 132.3 (J = 8.7 Hz), 128.7, 128.5, 128.1, 127.2, 125.7, 115.4, 115.2, 114.8, 114.7, 114.6, 113.9, 113.7, 108.4 (J = 8.2 Hz), 107.9 (J = 8.0 Hz), 84.4, 66.8, 64.2, 54.5, 46.3, 40.7, 40.0, 29.4, 29.0, 21.5, 21.0, 20.2, 20.1, 14.0, 13.8; IR (KBr) υ 3449, 3072, 2957, 2870, 2025, 1704, 1684, 1615, 1489, 1453, 1358, 1261, 1193, 1162, 1133, 1010, 931, 902, 866, 813, 775 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{42}H_{42}F_2N_2NaO_4$ ([M + Na]$^+$) 699.3005, found 699.3000.

4i: white solid, 0.162 g, 91%, mp 217−219 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.20 (s, 1H), 7.84 (s, 1H), 7.23 (d, J = 8.4 Hz, 1H), 7.07 (d, J = 7.8 Hz, 2H), 7.02 (d, J = 8.4 Hz, 1H), 6.94−6.90 (m, 6H), 6.80 (s, 1H), 6.57 (d, J = 8.4 Hz, 1H), 6.30 (d, J = 7.8 Hz, 1H), 5.13 (s, 1H), 4.32 (d, J = 14.0 Hz, 1H), 3.88−3.78 (m, 2H), 3.36−3.32 (m, 1H), 3.19−3.14 (m, 1H), 2.41 (d, J = 14.0 Hz, 1H), 2.25 (s, 3H), 2.22 (s, 3H), 1.62−1.59 (m, 1H), 1.54−1.50 (m, 1H), 1.41−1.35 (m, 2H), 1.03−1.02 (m, 1H), 0.99−0.96 (m, 5H), 0.82−0.81 (m, 1H), 0.77 (t, J = 7.2 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.6, 183.1, 176.0, 143.2, 142.8, 140.5, 137.4, 134.7, 134.5, 132.2, 129.4, 129.3, 128.7, 128.6, 128.5, 128.4, 128.2, 127.4, 127.2, 126.7, 126.0, 125.7, 108.8, 108.5, 84.4, 66.7, 64.4, 54.3, 46.2, 40.7, 39.9, 29.3, 29.0, 21.5, 21.0, 20.2, 20.1, 14.0, 13.7; IR (KBr) υ 3447, 3070, 2957, 2930, 2869, 2025, 1705, 1684, 1608, 1514, 1482, 1429, 1355, 1272, 1233, 1190, 1115, 1009, 929, 907, 840, 813, 778 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{42}H_{42}Cl_2N_2NaO_4$ ([M + Na]$^+$) 731.2414, found 731.2410.

4j: white solid, 0.104 g, 73%, mp 240−242 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 11.14 (br, 1H), 10.23 (s, 1H), 8.00 (s, 1H), 7.89 (s, 1H), 7.40 (t, J = 7.2 Hz, 1H), 7.28−7.27 (m, 2H), 7.23−7.21 (m, 3H), 7.18−7.16 (m, 1H), 7.13−7.11 (m, 2H), 7.01 (d, J = 7.8 Hz, 3H), 6.76 (s, 1H), 6.62 (d, J = 8.4 Hz, 1H), 6.38 (d, J = 7.8 Hz, 1H), 5.31 (s, 1H), 4.03 (d, J = 13.8 Hz, 1H), 2.44 (d, J = 13.8 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.8, 182.9, 176.5, 140.6, 139.0, 137.2, 135.4, 132.0, 131.5, 128.1, 127.1, 126.9, 126.4, 126.0, 125.8, 125.4, 125.1, 124.9, 124.6, 123.5, 109.6, 108.6, 82.4, 65.7, 62.6, 54.9, 52.9, 44.5, 17.4; IR (KBr) υ 3651, 3355, 3207, 3059, 2848, 1721, 1682, 1621, 1596, 1474, 1445, 1345, 1304, 1250, 1213, 1185, 1127, 1076, 1010, 975, 944, 897, 851, 814, 758 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{32}H_{22}Cl_2N_2NaO_4$ ([M + Na]$^+$) 591.0849, found 591.0850.

4k: white solid, 0.082 g, 55%, mp 230−232 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 11.16 (s, 1H), 10.25 (s, 1H), 7.98 (s, 1H), 7.86 (s, 1H), 7.22−7.18 (m, 3H), 7.04−7.02 (m, 3H), 6.92−6.91 (m, 2H), 6.88−6.87 (m, 2H), 6.69 (s, 1H), 6.62 (d, J = 7.8 Hz, 1H), 6.42 (d, J = 8.4 Hz, 1H), 5.26 (s, 1H), 4.00 (d, J = 13.8 Hz, 1H), 2.40 (d, J = 13.8 Hz, 1H), 2.23 (s, 3H), 2.19 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 196.7, 184.6, 178.1, 143.5, 142.2, 140.6, 137.0, 135.9, 134.4, 133.7, 129.9, 129.1, 128.6, 128.5, 128.2, 127.6, 126.9, 126.6, 126.5, 126.1, 125.0, 111.1, 110.2, 83.9, 67.3, 64.1, 56.5, 54.6, 46.3, 21.5, 21.0, 19.0; IR (KBr) υ 3656, 3354, 2925, 1695, 1673, 1619, 1517, 1474, 1438, 1344, 1307, 1252, 1207, 1187, 1124, 1086, 1015, 975, 937, 903, 811, 774 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{34}H_{26}Cl_2N_2NaO_4$ ([M + Na]$^+$) 619.1162, found 619.1153.

4l: white solid, 0.075 g, 48%, mp 174−176 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 11.16 (br, 1H), 10.22 (s, 1H), 7.98 (s, 1H), 7.84 (s, 1H), 7.28 (d, J = 8.4 Hz, 2H), 7.22 (d, J = 8.4 Hz, 1H), 7.03 (d, J = 8.4 Hz, 1H), 6.91 (d, J = 8.4 Hz, 2H), 6.76 (d, J = 8.4 Hz, 2H), 6.67−6.66 (m, 3H), 6.63 (d, J = 7.8 Hz, 1H), 6.47 (d, J = 8.4 Hz, 1H), 5.22 (s, 1H), 3.99 (d, J = 13.8 Hz, 1H), 3.73 (s, 3H), 3.66 (s, 3H), 2.40 (d, J = 13.8 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.2, 184.6, 178.2, 163.2, 158.9, 142.3, 140.6, 133.7, 131.1, 130.0, 129.8, 129.7, 128.6, 128.5, 127.5, 126.9, 126.6, 126.5, 125.0, 113.9, 112.9, 111.1, 110.2, 83.8, 67.3, 64.0, 56.5, 56.0, 55.4, 54.7, 46.4, 19.0; IR (KBr) υ 3680, 3353, 3111, 2918, 2848, 1724, 1680, 1598, 1572, 1514, 1473, 1440, 1349, 1305, 1254, 1213, 1183, 1132, 1090, 1018, 974, 934, 900, 836, 816, 779 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{34}H_{26}Cl_2N_2NaO_6$ ([M + Na]$^+$) 651.1060, found 651.1051.

4m: white solid, 0.056 g, 55%, mp 220−222 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 11.23 (br, 1H), 10.34 (s, 1H), 7.74 (s, 1H), 7.16 (s, 1H), 7.06 (d, J = 7.8 Hz, 1H), 6.97 (d, J = 7.8 Hz, 1H), 6.85 (d, J = 7.8 Hz, 1H), 6.72 (d, J = 7.8 Hz, 1H), 5.96 (s, 1H), 4.24 (s, 1H), 3.13 (d, J = 13.8 Hz, 1H), 2.25 (s, 3H), 2.24 (s, 3H), 2.13 (d, J = 13.8 Hz, 1H), 1.24 (s, 3H), 0.85 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 201.9, 184.9, 179.0, 140.4, 139.1, 132.0, 131.7, 128.9, 128.8, 128.6, 128.1, 127.9, 126.7, 126.4, 109.8, 108.2, 81.3, 68.6, 64.7, 53.9, 48.8, 28.0, 21.0, 20.8, 19.7; IR (KBr) υ 3670, 3543, 3406, 3186, 3059, 2919, 2852, 1729, 1709, 1678, 1623, 1490, 1421, 1394, 1351, 1307, 1234, 1216, 1173, 1124, 1096, 1074, 1043, 998, 944, 872, 806 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{24}H_{24}N_2NaO_4$ ([M + Na]$^+$) 427.1628, found 427.1628.

4n: white solid, 0.064 g, 62%, mp 222−224 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 11.32 (br, 1H), 10.58 (s, 1H), 7.80 (d, J = 8.4 Hz, 1H), 7.20 (d, J = 7.2 Hz, 1H), 7.13−7.10 (m, 1H), 7.04−7.01 (m, 1H), 6.99−6.96 (m, 1H), 6.85−6.83 (m, 1H), 5.90 (s, 1H), 4.42 (s, 1H), 3.10 (d, J = 13.8 Hz, 1H), 2.24 (d, J = 13.8 Hz, 1H), 1.32 (s, 3H), 0.88 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 200.9, 183.3, 178.0, 157.5 (J = 207.3 Hz), 155.9 (J = 204.9 Hz), 137.8, 136.8, 132.5 (J = 8.8 Hz), 128.4, 128.3, 128.1, 114.1, 114.0, 113.1, 113.0, 112.6, 112.4, 112.3, 109.9 (J = 8.3 Hz), 108.0 (J = 8.1 Hz), 80.3, 67.1, 64.1, 53.1, 47.5, 26.8, 18.6; IR (KBr) υ 3398, 3313, 3218, 3079, 2991, 2935, 2890, 1721, 1697, 1632, 1605, 1483, 1433, 1337, 1311, 1258, 1237, 1199, 1177, 1131, 1089, 1038, 1011, 944, 901, 882, 866, 820, 790, 760 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{22}H_{18}F_2N_2NaO_4$ ([M + Na]$^+$) 435.1127, found 435.1117.

4. General Procedure for the Reaction of 3-Phenacylideneoxindoles with Thiophenol. A solution of 1-benzyl-5-chloro-3-(2-oxo-2-*p*-tolylethylidene)-1,3-dihydroindol-2-one (0.5 mmol) and thiophenol or *p*-chlorothiophenol (0.5 mmol) in 10.0 mL of acetonitrile was stirred at room temperature for about 3−4 h. Then, solvent was evaporated under reduced pressure. The residue was triturated with ethanol to give the pure product **D1** and **D2** for analysis.

D1: white solid, 0.191 g, 77%, mp 106−108 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.71 (s, 1H), 7.68 (d, J = 7.8 Hz, 2H), 7.36 (d, J = 6.6 Hz, 2H), 7.24−7.22 (m, 4H), 7.15−7.14 (m, 3H), 7.12 (d, J = 7.8 Hz, 4H), 6.62 (d, J = 7.8 Hz, 1H), 5.40 (s, 1H), 5.15 (d, J = 15.9 Hz, 1H), 4.84 (d, J = 15.9 Hz, 1H), 4.30 (s, 1H), 2.38 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.4, 176.1, 144.3, 142.9, 135.1, 133.2, 133.1, 132.6, 129.3, 129.2, 129.1, 128.8, 128.5, 128.4, 128.2, 127.7, 127.5, 127.1, 109.9, 54.3, 48.0, 44.2, 21.7; IR (KBr) υ 3670, 3052, 2939, 1709, 1672, 1606, 1479, 1454, 1431, 1354, 1318, 1296, 1262, 1221, 1206, 1181, 1167, 1121, 1071, 1023, 978, 926, 908, 847, 818, 789 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{30}H_{25}ClNO_2S$ ([M + H]$^+$) 498.1295, found 498.1316.

D2: white solid, 0.223 g, 84%, mp 102−104 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.71 (d, J = 7.8 Hz, 2H), 7.67 (s, 1H), 7.36 (d, J = 7.2 Hz, 2H), 7.28−7.27 (m, 1H), 7.24−7.23 (m, 2H), 7.17 (t, J = 7.8 Hz, 3H), 7.09 (d, J = 7.8 Hz, 2H), 6.98 (d, J = 7.8 Hz, 2H), 6.63 (d, J = 8.4 Hz, 1H), 5.36 (s, 1H), 5.15 (d, J = 15.8 Hz, 1H), 4.83 (d, J = 15.8 Hz, 1H), 4.28 (s, 1H), 2.41 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.2, 176.0, 144.6, 142.8, 135.1, 134.8, 134.7, 132.6, 131.4, 129.3, 129.2, 128.8, 128.5, 128.3, 128.2, 127.8, 127.2, 109.9, 54.3, 473.9, 44.2, 21.7; IR (KBr) υ 3669, 3061, 1708, 1674, 1607, 1479, 1453, 1430, 1355, 1318, 1296, 1261, 1222, 1207, 1181, 1167, 1121, 1096, 1076, 1012, 980, 926, 908, 837, 818, 788 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{30}H_{23}Cl_2NNaO_2S$ ([M + Na]$^+$) 554.0719, found 554.0713.

5. General Procedure for the Reaction of 3-Phenacylideneoxindoles with 2-Mercaptoethanol. A solution of 1-benzyl-5-chloro-3-(2-oxo-2-*p*-tolylethylidene)-1,3-dihydroindol-2-one (0.5 mmol) and 2-mercaptoethanol (0.5 mmol) in 10.0 mL of acetonitrile was stirred at room temperature for about 1 h. Then solvent was evaporated under reduced pressure. The residue was triturated with ethanol to give the pure product **E**: white solid, 0.177 g, 91%, mp 176−178 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.90 (d, J = 7.8 Hz, 2H),

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7.36−7.33 (m, 4H), 7.28 (d, J = 7.2 Hz, 3H), 7.24 (s, 1H), 7.11 (d, J = 8.4 Hz, 1H), 6.63 (d, J = 8.4 Hz, 1H), 4.96 (s, 2H), 4.13 (d, J = 8.4 Hz, 1H), 3.88 (d, J = 18.2 Hz, 1H), 3.50−3.45 (m, 1H), 2.43 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 196.1, 177.4, 144.6, 142.0, 135.5, 133.6, 130.8, 129.4, 128.9, 128.3, 127.9, 127.8, 127.3, 124.9, 109.9, 44.1, 41.3, 39.8, 21.7; IR (KBr) υ 3670, 3062, 2913, 1712, 1685, 1608, 1488, 1453, 1432, 1399, 1355, 1291, 1227, 1209, 1183, 1077, 1023, 974, 908, 851, 812 cm^{-1}; MS (m/z) HRMS (ESI-TOF) calcd for $C_{24}H_{21}ClNO_2$ ([M + H]$^+$) 390.1255, found 390.1269.

■ ASSOCIATED CONTENT

Supporting Information

^{1}H NMR and ^{13}C NMR spectra for all compounds, molecular structures, experimental conditions, and cif file. This material is available free of charge via the Internet at http://pubs.acs.org. Crystallographic data for compounds **2j** (CCDC 905184), **2l** (CCDC 906362), **2q** (CCDC 905183), **2s** (CCDC 905185), **3a** (CCDC 905186), **3j** (CCDC 905187), **4a** (CCDC 933927), **4g** (CCDC 933928), **4i** (CCDC 933929), **4k** (CCDC 933930), and **4m** (CCDC 933931) can be obtained free of charge from the Cambridge Crystallographic Data Centre via www.ccdc.cam.ac.uk/data_request/cif.

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Notes

The authors declare no competing financial interest.

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