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I_2/O_2-Promoted Domino Reactions of Isatins or 3-Hydroxyindolin-2-one Derivatives with Enaminones

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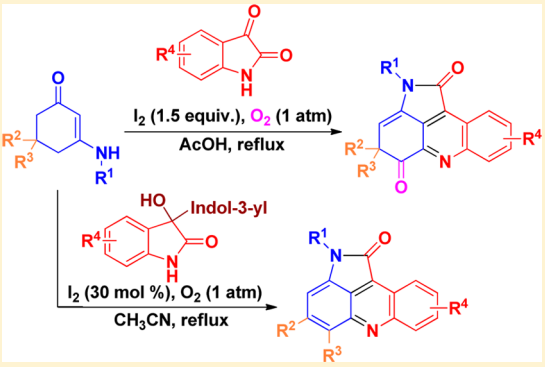
Supporting Information

ABSTRACT: I_2-promoted domino reactions of isatins or 3-hydroxyindolin-2-one derivatives with enaminones under O_2 conditions have been established. The reactions of isatins with enaminones afforded functionalized tetracyclic pyrrolo[2,3,4-*kl*]acridine derivatives in moderate to good yields through domino cyclization and C−H oxidation. The reactions of 3-hydroxyindolin-2-one derivatives with enaminones proceeded well to give functionalized pyrrolo[2,3,4-*kl*]acridine derivatives via tandem ring-opening/recyclization/methyl migration sequences with two C−C bonds cleaved.



INTRODUCTION

Among *N*-heterocycle skeletons, a unique fused acridine parent, being the core structural unit in unnaturally and naturally occurring products, exhibit a broad range of significant biological activities including antiparasitic,[1] antibacterial,[2] and antitumor activity.[3] Acridine alkaloids such as dercitin[4] and plakinidines A, B, and C (Figure 1) commonly exist in nature,

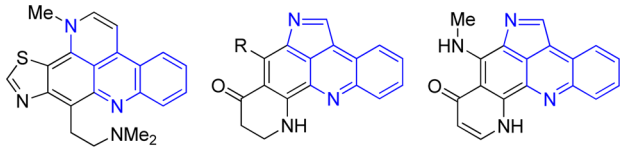


Figure 1. Several natural products containing acridine skeleton.

which show a broad range of biological activities. Thus, the construction of such molecules and their structural analogues has been considered as a major research topic in our group.

Although many studies on the preparation of fused acridine derivatives have been developed,[5−7] these methods involve multistep syntheses. Very recently, the one-pot synthesis of fused acridines using enaminones and isatin as substrates has been disclosed by Shi and Tu independently.[8] When 5,5-disubstitued enaminones were employed in this domino reaction, fused dihydroacridine derivatives were obtained (Scheme 1).

Traditional C−H oxidation is usually accomplished by the use of transition metal catalysts under harsh conditions (high temperature and high pressure), thereby suffering from poor conversion and selectivity.[10] On the other hand, there has been urgent demand in the design of green and sustainable transformations since the transition metals involved in these procedures are generally thought to be environmentally unfriendly. Therefore, the development of an efficient and broadly applicable C−H oxidation without the use of metal catalysts is more desirable.[11] To the best of our knowledge, the utilization of domino strategy combined with C−H oxidation under oxygen conditions for the construction of tetracyclic pyrrole-fused acridine skeleton through C−N and C−H bonds cleavage has not been documented so far.

Recently, our group[12] and others[13,14] have developed several domino reactions[13] for the synthesis of polyfunctionalized ring structures of chemical and pharmaceutical interest. As a part of our continuous efforts on the development of useful domino reactions,[12] we now report a novel I_2/O_2-promoted domino reaction of *N*-substituted 3-aminocyclohex-2-enones **1** and isatins **2** or 3-hydroxyindolin-2-ones **4** (Scheme 2). The former reaction showed unique characteristics, including that (1) the ring-opening/recyclization/C−H oxidation process occurs unexpectedly at the rings of indolin-2-ones and cyclohex-2-enones, and (2) new pyrrolo[2,3,4-*kl*]acridine derivatives **3**, which are normally difficult to prepare in a single step, are obtained in a straightforward manner. Similar to the former, the metal-free methyl migration of in situ generated pyrrolo[2,3,4-*kl*]acridine ring was easily realized in domino fashion for the second reaction.

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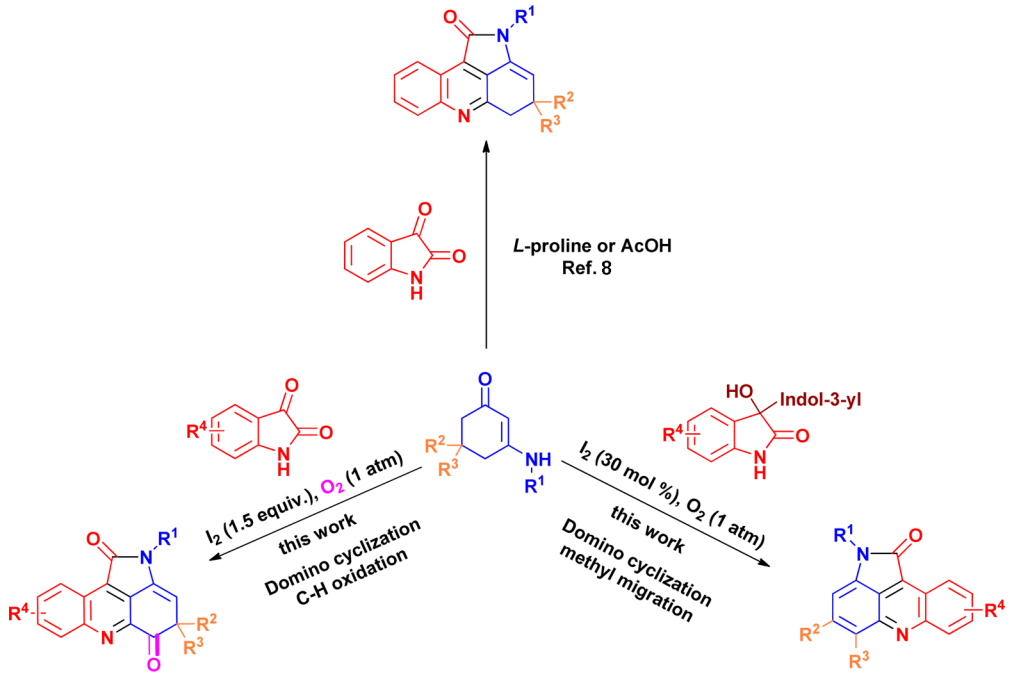
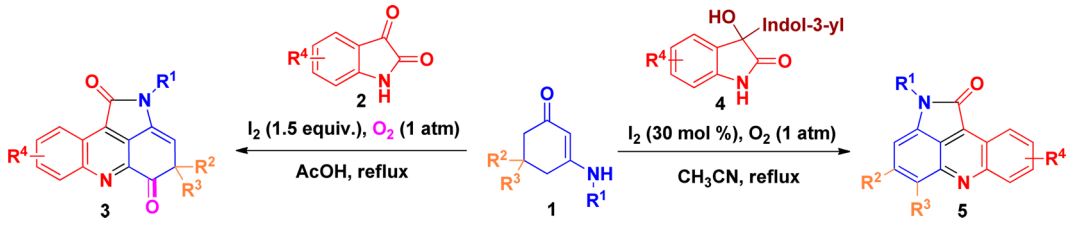
Scheme 1. Domino Synthesis of Fused Acridines



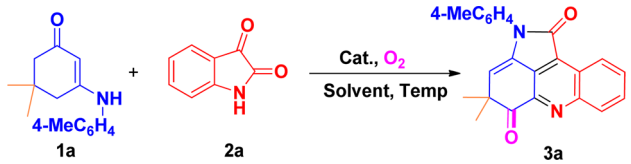
Scheme 2. Domino Synthesis of Fused Acridines



RESULTS AND DISCUSSION

Our studies were initiated by evaluating the domino reaction of 5,5-dimethyl-3-(*p*-tolylamino)cyclohex-2-enone **1a** and isatin **2a**. The reaction was tested under a variety of different conditions. The results are summarized in Table 1. It was found that the reaction could not proceed in many solvents including DMF, DMSO, CH_3CN, EtOH, and THF under oxygen conditions without any catalyst (Table S1, entries 1−5, see Supporting Information on page S2). Further solvent screening revealed that the use of AcOH led to the desired product **3a** albeit in a low yield of 12% (Table 1, entry 1). When 0.1 equiv of I_2 was added into reaction mixture in AcOH under reflux conditions (Table 1, entry 2), the expected product **3a** was obtained in 35% yield, which suggested that iodine played an important role in the reaction. Next, we investigated the amount of iodine required for this domino reaction. The results indicated that increasing the amount of I_2 from 0.1 to 1.5 equiv led to an increased yield from 35 to 78% (Table 1, entries 2−6). The addition of larger amounts of I_2 did not improve the yields at all (Table 1, entry 7). The decrease of reaction temperature gave relatively low yield of product **3a** (Table 1, entry 8). Gratifyingly, this I_2-promoted reaction worked more efficiently under refluxing AcOH conditions when substrates **1a** and **2a** were used in a ratio of 1.3:1, affording the corresponding product **3a** in 82% yield (Table 1, entry 9). In contrast, the identical reaction performed under an argon atmosphere produced much lower yield (11%) of product **3a** (Table 1, entry 10), which indicated that oxygen was an essential oxidant for this C−H oxidation reaction.

Table 1. Optimization of Reaction Conditions for the Domino Reaction



entry	cat (equiv)	solvent	temp (°C)	yield (%)[a,b]
1	–	AcOH	reflux	12
2	I_2 (0.1)	AcOH	reflux	35
3	I_2 (0.4)	AcOH	reflux	52
4	I_2 (0.8)	AcOH	reflux	68
5	I_2 (1.0)	AcOH	reflux	72
6	I_2 (1.5)	AcOH	reflux	78
7	I_2 (2.0)	AcOH	reflux	73
8	I_2 (1.5)	AcOH	100	70
9[c]	I_2 (1.5)	AcOH	reflux	82
10[d]	I_2 (1.5)	AcOH	reflux	11

[a]Ratio, **1a**:**2a** = 1:1. [b]Yields were determined by LC−MS analysis using biphenyl as internal standard. [c]Ratio, **1a**:**2a** = 1.3:1. [d]Argon atmosphere.

With the optimal conditions in hand, we then proceeded to examine the substrate scope of this I_2/O_2-promoted domino

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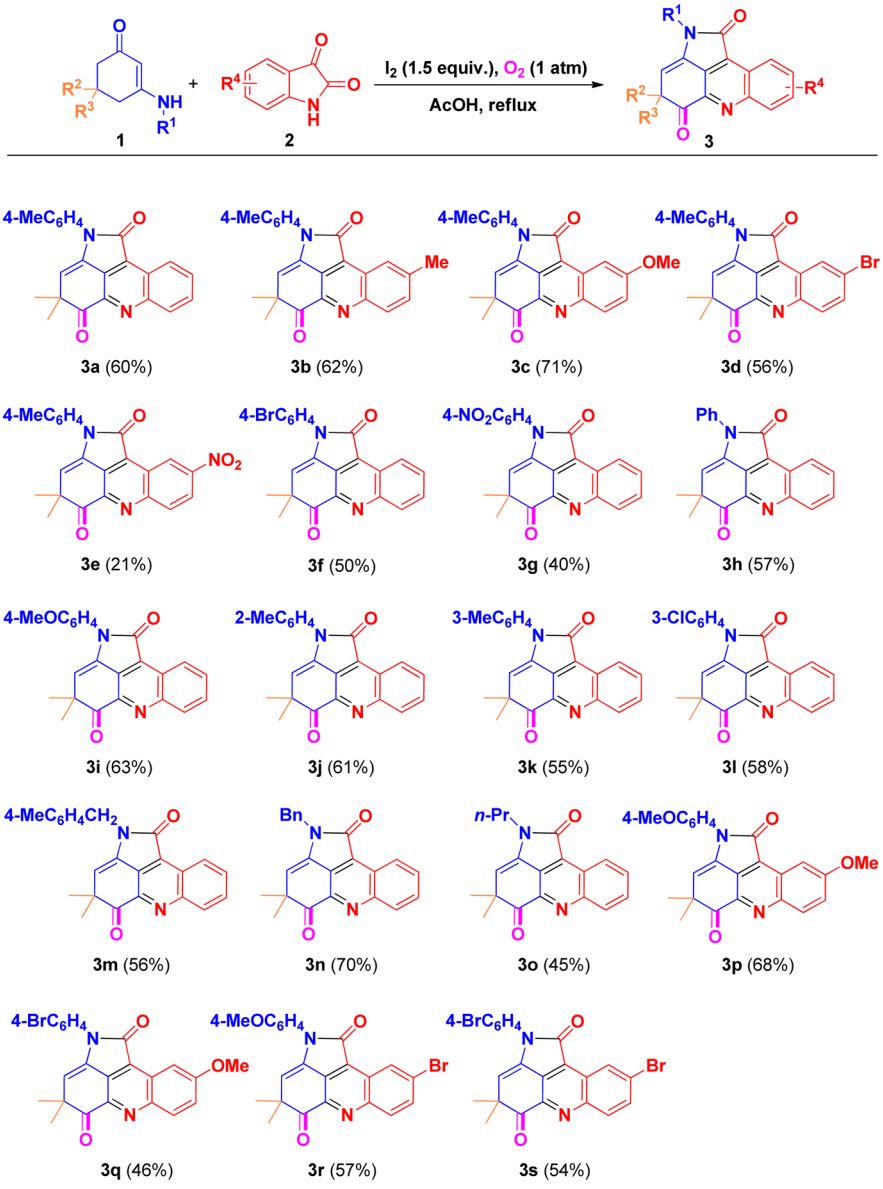
Table 2. Domino Synthesis of Pyrrolo[2,3,4-*kl*]acridines[a]



[a]Isolated yield.

reaction of *N*-substituted 5,5-dimethyl-3-aminocyclohex-2-enones **1** and isatins **2**, and the results are shown in Table 2. At the beginning, the scope of isatin was investigated, by using enaminone **1a** and isatins **2** as model substrates (Table 2, **3a**−**3d**), and the results indicated that isatins **2** bearing methyl (**2b**), methoxy (**2c**), or bromo (**2d**) group in its 5-position were suitable candidates for the synthesis of compound **3**. The 5-NO_2-substituted isatin **2e** was converted into the corresponding pyrrolo[2,3,4-*kl*]acridines **3e** in 21% yield, because of its strong electron-withdrawing effect. However, 4-chloroindoline-2,3-dione **2f** failed to yield the desired pyrrolo[2,3,4-*kl*]-acridines, presumably as a result of steric hindrance. Subsequently, the enaminone scope of this interesting transformation was investigated (Table 2). Several different *N*-aryl substituents were compared, and substituents bearing electron-withdrawing (4-Br **1b**, 4-NO_2 **1c**, 3-Cl **1h**) or electron-donating (4-MeO **1e**, 2-Me **1f**, 3-Me **1g**) groups were found to be suitable for this domino reaction. In addition, the variation of *N*-alkyl substituents on the enaminone unit **1** including 4-methylbenzyl, benzyl, or *n*-propyl groups all furnished the unreported pyrrolo[2,3,4-*kl*]acridines **3m**−**3o** in 45−70% yields through domino C−H oxidation. Furthermore, using various isatins together with different *N*-substituted enaminones **1b** and **1e** resulted in the domino cyclization as well, leading to the corresponding substituted pyrrolo[2,3,4-*kl*]-acridines **3p**−**3s** smoothly. The results demonstrate the scope and generality of this novel domino C−H oxidation in view of the fact that a range of structurally varied enaminone and isatin substrates can be used.

After the above reaction was achieved, we then turned our attention to the metal-free methyl migration of in situ generated pyrrolo[2,3,4-*kl*]acridine ring, using 3-hydroxyindolin-2-ones **4** to replace isatins **2**. The domino reaction of 5,5-dimethyl-3-(*p*-tolylamino)cyclohex-2-enone **1a** and 3-hydroxy-3-(1*H*-indol-3-yl)indolin-2-one **4a** in AcOH was evaluated under air conditions with the use of 1.5 equiv of iodine as a

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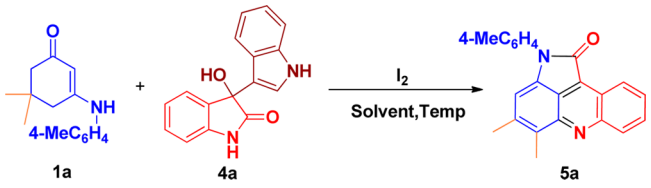
promoter. Impressively, the reaction gave the desired product **5a**, albeit in a low yield of 13% (Table 3, entry 1). Next, the

Table 3. Optimization of Reaction Conditions for the Domino Reaction



1a **4a** **5a**

entry	solvent	cat (mol %)	temp (°C)	yield (%)[a]
1	AcOH	I_2 (150)	80	13
2	AcOH	I_2 (10)	80	19
3	CH_3CN	I_2 (10)	reflux	34
4	EtOH	I_2 (10)	reflux	8
5	toluene	I_2 (10)	80	32
6	CH_3CN	I_2 (30)	reflux	66
7	CH_3CN	I_2 (30)-O_2	reflux	77
8	CH_3CN	I_2 (30)-Ar	reflux	58

[a]Yields were determined by HPLC−MS analysis.

reaction conditions were optimized by screening the dosage of iodine and solvents. The results are summarized in Table 3. When 10 mol % of I_2 was used in AcOH at 80 °C, a slightly improved yield of the expected product **5a** was obtained (Table 3, entry 2). Subsequently, different solvents were surveyed using 10 mol % of I_2 as a promoter, and it was observed that the reaction proceeded more efficiently in CH_3CN than in AcOH, EtOH, and toluene (Table 3, entries 2−5). Next, the dosage of iodine was investigated for this domino reaction. The results indicated that increasing the amount of I_2 from 10 to 30 mol % led to an increased yield from 34 to 66% (Table 3, entries 3 and 6). The addition of larger amounts of I_2 did not improve the yields. Under oxygen atmosphere, the use of 30 mol % I_2 in CH_3CN was more effective in pushing this reaction forward, giving rise to product **5a** in 77% yield (Table 3, entry 7). In comparison, the reaction involving **1a** and **4a** gave relatively low yield under argon atmosphere (Table 3, entry 8).

Under the optimized reaction conditions, the scope of *N*-substituted 5,5-dimethyl-3-aminocyclohex-2-enones in the direct methyl migration of 3-hydroxy-3-(1*H*-indol-3-yl)-indolin-2-ones **4** with a variety of *N*-substituted 5,5-dimethyl-3-aminocyclohex-2-enones **1** was investigated. It was found that all the reactions proceeded efficiently to furnish the desired products in moderate to good yields. The results are presented in Table 4. The substituents on the aromatic ring of enaminones **1** did not hamper the reaction process. Reactions of methylphenyl-, bromophenyl-, or iodophenyl-substituted enaminones **1** with **4a** all worked well to afford the desired products **5a−5d** in moderate to good yields. *N*-Benzyl enaminones bearing electron-rich groups were converted into the corresponding 4,5-dimethylpyrrolo[2,3,4-*kl*]acridin-1(2*H*)-ones **5f** and **5g** in 46−68% yields. Furthermore, the same reaction employing *N*-butyl counterparts led to **5h** in 63% yield. Other substituted 3-hydroxyindolin-2-ones instead of **4a** reacted equally well with *N*-benzyl or *N*-butyl enaminones. Substrates **4** bearing substituents on the different positions of isatin ring all successfully participated in this reaction, leading to the final products with moderate to good yields (**5i−5t**). During our investigation on enaminone substrates **1**, *N*-substituted 5-aryl-3-aminocyclohex-2-enones were subjected to the reaction with 3-hydroxyindolin-2-ones **4** in CH_3CN under oxygen conditions using 30 mol % I_2 as reaction promoter. We found that *N*-substituted 5-aryl-3-aminocyclohex-2-enones with methoxy group at the *para* position of C5 phenyl ring also efficiently participated in this reaction, and the corresponding 4-aryl-substituted tetracyclic fused acridines **5u−5x** were isolated in 71−82% yields.

The structures of the products were determined from their IR, ^{1}H NMR, ^{13}C NMR, and HRMS spectra. The structures of compounds **3a** and **5d** were unequivocally confirmed by X-ray diffractional analysis (see Supporting Information).

To understand this domino process, 3-hydroxy-indolin-2-one derivatives **6a** and **6b** were subjected to the reaction with **1a** in the presence of 30 mol % I_2 in CH_3CN under oxygen atmosphere and reflux conditions. However, no desired product **5a** was found (determined by LC−MS analysis, Scheme 3, eq 1 and eq 2). And when a reaction using preformed 4,4-dimethyl-2-(*p*-tolyl)-4,5-dihydropyrrolo[2,3,4-*kl*]acridin-1(2*H*)-one **7**, prepared by the method of Tu and co-workers,[8b] was carried out under the same reaction conditions, only a trace amount of **5a** was detected by LC−MS analysis, along with the formation of a C−H oxidation product **3a** in 46% yield (Scheme 3, eq 3). These experimental results reveal that indole substituent on 3-hydroxyindolin-2-one ring plays a key role in this methyl migration process, which might serve as a leaving group. Next, we hypothesized that the elimination of indole substituent is very likely to take place after the methyl migration step. To prove this, a reaction between the preformed pyrrolo[2,3,4-*kl*]acridin-1(2*H*)-one **7** and indole was performed under above reaction conditions. The expected product **5a** was scarcely detected by LC−MS analysis, and similar yield of oxidation product **3a** was generated (Scheme 3, eq 4). This result implied that the elimination of the indole group occurred after methyl migration, and the intermediate **7** was generated in oxidation process not in methyl migration. Therefore, we believe that this unique domino proceeds in a way that is different than that reported in literature.[8]

On the basis of above experimental results and the literature reports,[8,9] reasonable mechanisms for this domino reaction are postulated in Schemes 4 and 5. The former reaction undergoes domino [3 + 2]/[4 + 2] bis-cyclizations to yield pyrrolo[2,3,4-*kl*]acridin-1(2*H*)-one **7**. Then, a single-electron oxidation of intermediate **7**, mediated by I_2, proceeded to give the corresponding radical cation **8**, which is in resonance with radical cation **9**. With the release of HI, a radical intermediate **10** is formed, and subsequently isomerized to **11**. Then, peroxide radical intermediate **12** is formed by the reaction of **11** with oxygen. Finally, the intermediate **12** is further oxidized to generate the corresponding C−H oxidation product **3**.

For the reaction of 3-hydroxyindolin-2-one derivatives with enaminones, first, an S_N2-type reaction between the 3-hydroxyindolin-2-ones **4** and enaminones **1** in the presence of I_2 occurs, affording intermediate **14** which undergoes imine-enamine tautomerization to give bis-indoles **15**. The intermediate **15** further reacts through an intramolecular cyclization/ring-opening/recyclization sequence to give compound **18**, as observed by LC−MS analysis. The reaction of compound **18** with molecular I_2 (30 mol %) and oxygen generates an iminium iodide **20** through a radical intermediate **19**, and the iminium iodide **20** thus generated will undergo methyl migration process to furnish cation intermediate **21** and regenerate I_2 by reacting with molecular O_2 (Scheme 5).[15]

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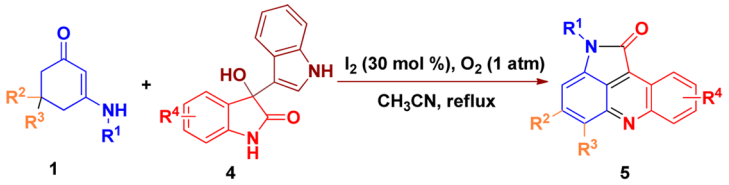
Table 4. Domino Synthesis of Pyrrolo[2,3,4-*kl*]acridines[a]



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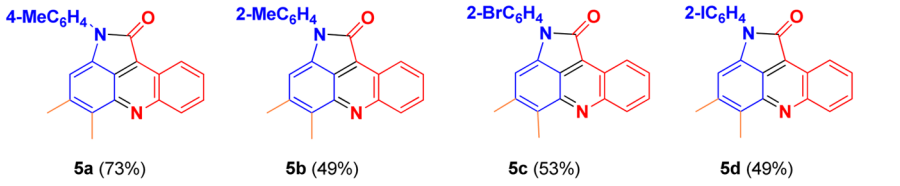
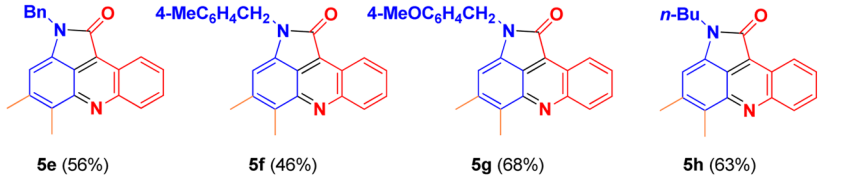
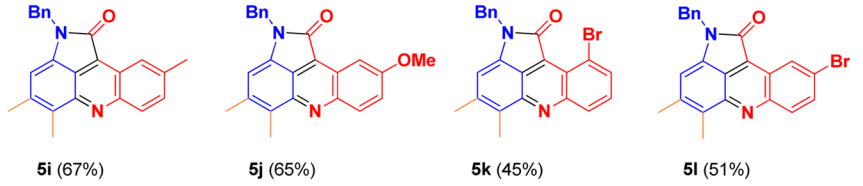


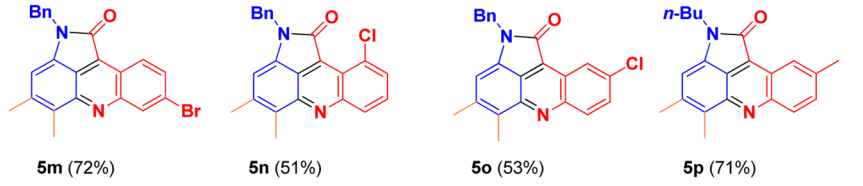
5a (73%) 5b (49%) 5c (53%) 5d (49%)



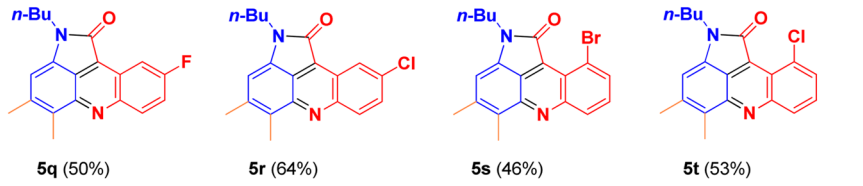
5e (56%) 5f (46%) 5g (68%) 5h (63%)



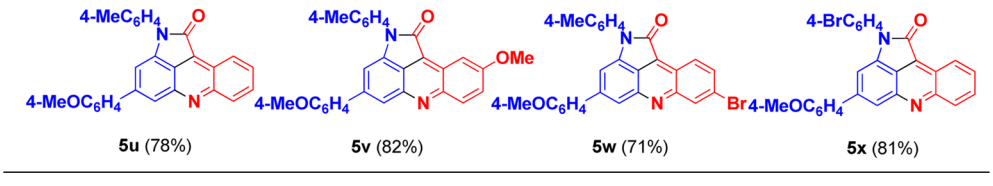
5i (67%) 5j (65%) 5k (45%) 5l (51%)



5m (72%) 5n (51%) 5o (53%) 5p (71%)



5q (50%) 5r (64%) 5s (46%) 5t (53%)



5u (78%) 5v (82%) 5w (71%) 5x (81%)

[a]Isolated yield.

Subsequent tautomerization and elimination of indole took place to generate the thermodynamically stable product **5**.

Biological Testing. We tested the pyrrolo[2,3,4-*kl*]acridine derivatives **3a**−**3s** for the antitumor activity against lung adenocarcinoma NSCLC (A549) because of their potential biological activity. Five of the analogues (**3b**, **3e**, **3k**, **3l**, and **3m**) were found to be very active with IC_{50} values 0.16, 0.046, 0.08, 0.07, and 0.11 μM, respectively (Table 5). More significantly, compound **3e** showed quite good anticancer activity, which is equipotent with Gefitinib. They could be considered as new lead compounds for further development.

CONCLUSION

In conclusion, we have described a novel I_2/O_2-promoted domino reaction that provides a general and efficient strategy for the selective construction of pyrrolo[2,3,4-*kl*]acridine skeletons with complete regioselectivity in a one-pot manner. The former reaction simultaneously installs C−N and C−O bonds through an I_2-promoted domino cyclization and C−H oxidation, showing that the synthetic route allows us to access blocks of pyrrolo[2,3,4-*kl*]acridine derivatives with a wide diversity of substituents. The latter employs readily available 3-

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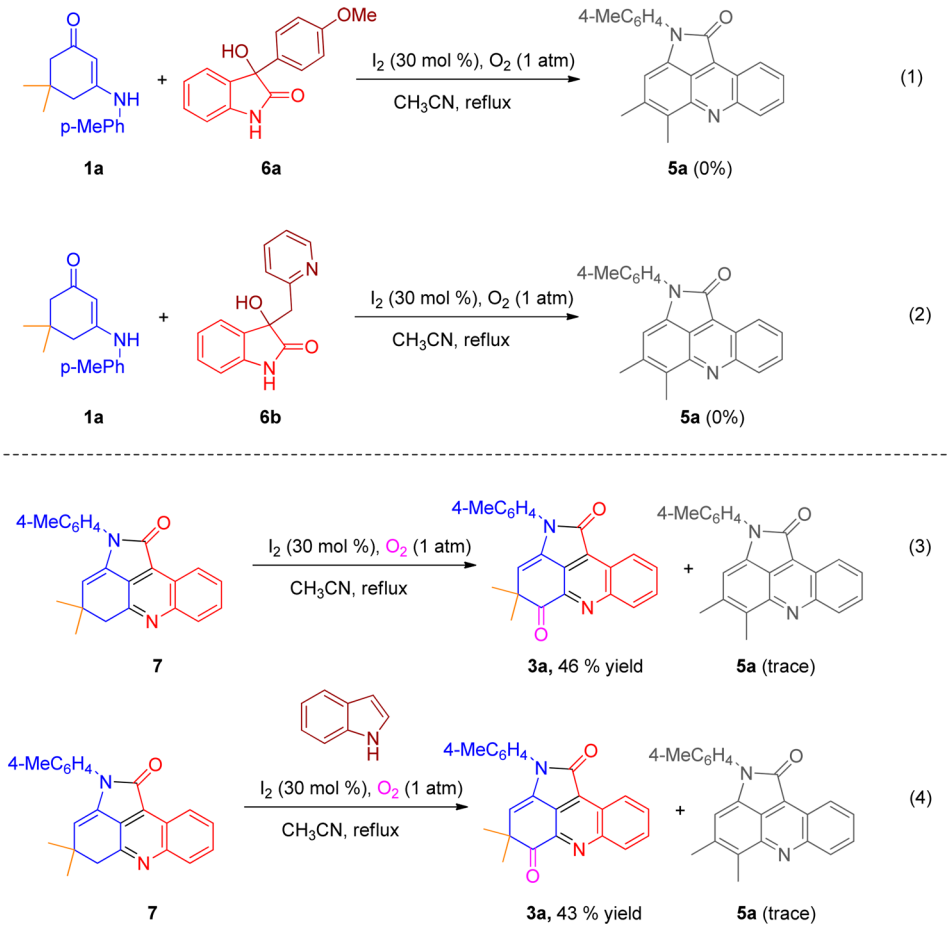
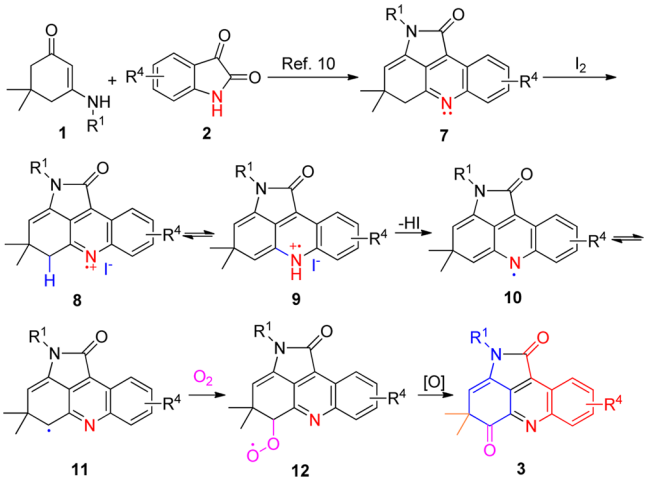
Scheme 3. Control Experiments



Scheme 4. Proposed Mechanism for Forming Product 3



hydroxyindolin-2-one derivatives and enaminones as starting materials and involves tandem ring-opening/recyclization/methyl migration sequences. As examples for demonstrating its potential, this strategy was used to access the compact core of Plakinidines. In addition, compound **3e** showed quite good antcancer activity, which is equipotent with Gefitinib. Further understanding of the mechanisms, exploration of this domino strategy, and their applications in the preparation of several closely related natural products are currently in progress.

EXPERIMENTAL SECTION

General Experimental Information. All the solvents for routine isolation of products and chromatography were reagent grade. Flash chromatography was performed using silica gel (300−400 mesh) with the indicated solvents. Melting points were recorded on an electrothermal digital melting point apparatus and were uncorrected. IR spectra were recorded on a spectrophotometer using KBr optics. ^{1}H NMR and ^{13}C NMR spectra were recorded on a 300 or 400 MHz (^{1}H NMR) and 75 or 100 MHz (^{13}C NMR) spectrometer using $CDCl_3$ as solvent and TMS as internal standard. The ^{1}H NMR data are reported as the chemical shift in parts per million, multiplicity (s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet), coupling constant in hertz, and number of protons. High resolution mass spectra were obtained using a high resolution ESI-TOF mass spectrometer.

General Procedure for the Synthesis of Pyrrolo[2,3,4-*kl*]acridines 3 and 5. A mixture of *N*-substituted 5,5-dimethyl-3-aminocyclohex-2-enones **1** (1.3 mmol) and isatins **2** (1 mmol), iodine (1.5 equiv) and AcOH (4 mL) were added into a Schlenk tube under oxygen atmosphere. Then the mixture was vigorously stirred at refluxing temperature until isatins was completely consumed as indicated by TLC analysis. After the reaction finished, the reaction mixture was cooled to room temperature and quenched by the addition of a saturated solution of $Na_2S_2O_3$ (3 mL). The mixture was extracted with ethyl acetate (3 × 10 mL), the combined organic phases were dried over anhydrous Na_2SO_4, and the solvent was evaporated under a vacuum. After removing the solvents in vacuo, the residue was purified by flash column chromatography on silica gel (ethyl acetate/petroleum ether) to yield the corresponding products **3**.

A mixture of *N*-substituted 5,5-dimethyl-3-aminocyclohex-2-enones **1** (1 mmol) and 3-hydroxy-3-(1*H*-indol-3-yl)indolin-2-ones **4** (1.1

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Scheme 5. Proposed Mechanism for Forming Product 5

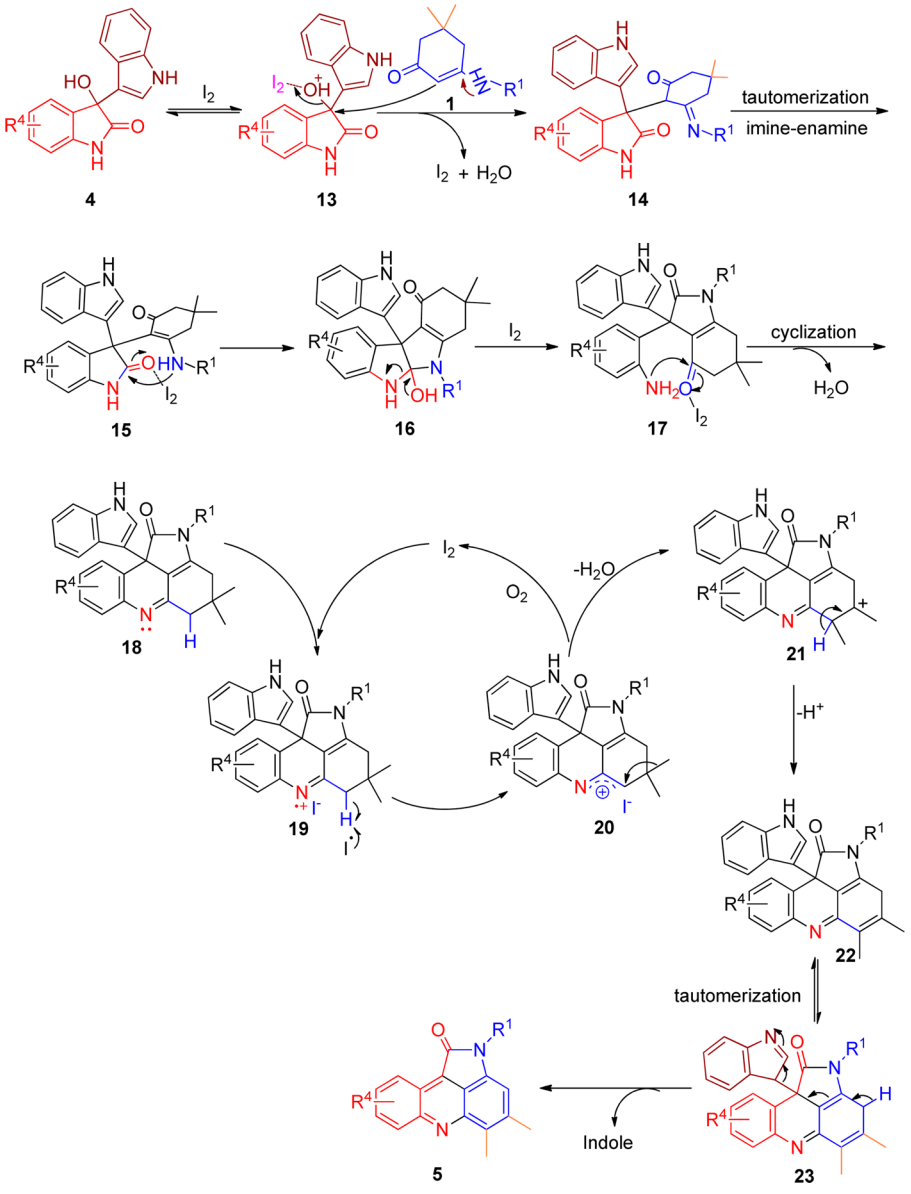

Table 5. Biological Activities of Compounds against Cultured NSCLC (A549)[a]

compd	A549 IC_{50}, μM
Gefitinib[b]	0.04
3b	0.16
3e	0.046
3j	0.08
3k	0.07
3l	0.11

[a]All values are the mean of four independent experiments. [b]Gefitinib, an anticancer agent used as a positive control.

mmol), iodine (0.3 mmol, 30 mol %) and CH_3CN (4 mL) were added into a Schlenk tube under oxygen atmosphere. Then the mixture was vigorously stirred at refluxing temperature until *N*-substituted 5,5-dimethyl-3-aminocyclohex-2-enones were completely consumed as indicated by TLC analysis. The solvent was evaporated under reduced pressure and the residue was purified by column chromatography on silica gel (acetone/petroleum ether) to yield the corresponding products **5**.

Cytotoxicity Assay. The cell viability was determined using the 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay. Exponentially growing cells (A549 Cell line) (5 × 104 cells/99 μL/well) were incubated with test compounds for 48 h. The test compounds were added at 2-fold dilutions up to 7 points in complete medium starting from 0.4 μM concentration and were incubated at 37 °C in a humidified mixture of CO_2 and 95% air in an incubator. Gefitinib was used as a reference drug, and control wells containing dimethyl sulfoxide (DMSO) without compounds were also included in the experiment. Stock solutions of compounds were initially dissolved in DMSO and further diluted with fresh complete medium. After incubation, 10 μL of MTT reagent (5 mg/mL) in phosphate belanced solution (PBS) medium, followed by syringe filtration, was added to each well and incubated at 37 °C for 4 h. At the end of the incubation period, sodium dodecyl sulfate (SDS) solution (100 μL) was added to each well and incubated at 37 °C in a humidified mixture of CO_2 and 95% air in an incubator for 12 h. The readings were recorded as absorbance at 570 nm on a microplate reader. The cytotoxic effect were expressed as 50% lethal dose, i.e., as the concentration of a compound that provoked a 50% reduction in cell viability compared to cells in culture medium alone. IC_{50} values were estimated as described.

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*4,4-Dimethyl-2-(p-tolyl)pyrrolo[2,3,4-kl]acridine-1,5(2H,4H)-dione (**3a**).* Yellow solid, 212 mg, 60% yield: mp 222−223 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.87 (d, J = 7.6 Hz, 1H, ArH), 8.53 (d, J = 7.6 Hz, 1H, ArH), 7.91−7.87 (m, 2H, ArH), 7.40 (s, 4H, ArH), 5.82 (s, 1H, =CH), 2.46 (s, 3H, CH_3), 1.52 (s, 6H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) 199.4, 165.3, 149.9, 142.5, 137.8, 132.1, 131.3, 130.9, 130.8, 130.5, 130.0, 127.8, 126.1, 124.6, 123.8, 117.3, 48.6, 27.5, 21.0; IR (KBr, ν, cm^{-1}) 3036, 2968, 2920, 2866, 1700, 1659, 1513, 1465, 1360, 1334, 1215, 1120, 1033, 829, 770, 739, 626; HRMS Calcd For $C_{23}H_{18}N_2NaO_2^+$, (ESI, M + Na$^+$) 377.1260, found 377.1253.

*4,4,9-Trimethyl-2-(p-tolyl)pyrrolo[2,3,4-kl]acridine-1,5(2H,4H)-dione (**3b**).* Yellow solid, 228 mg, 62% yield: mp 210−212 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.63 (s, 1H, ArH), 8.41 (d, J = 8.8 Hz, 1H, ArH), 7.72 (d, J = 8.4 Hz, 1H, ArH), 7.42−7.37 (m, 4H, ArH), 5.79 (s, 1H, =CH), 2.65 (s, 3H, CH_3), 2.46 (s, 3H, CH_3), 1.51 (s, 6H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 199.6, 165.8, 148.9, 142.5, 141.8, 137.9, 133.1, 131.9, 131.6, 131.5, 131.1, 130.1, 127.1, 126.3, 124.9, 122.8, 117.3, 48.7, 27.6, 22.2, 21.2; IR (KBr, ν, cm^{-1}) 3032, 2966, 2919, 2851, 1699, 1658, 1511, 1456, 1338, 1287, 1219, 1157, 1125, 1028, 824, 790, 747, 675, 627; HRMS Calcd For $C_{24}H_{21}N_2O_2^+$, (ESI, M + H$^+$) 369.1598, found 369.1603.

*9-Methoxy-4,4-dimethyl-2-(p-tolyl)pyrrolo[2,3,4-kl]acridine-1,5-(2H,4H)-dione (**3c**).* Yellow solid, 273 mg, 71% yield: mp 239−240 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.39 (d, J = 9.6 Hz, 1H, ArH), 8.12 (d, J = 2.4 Hz, 1H, ArH), 7.51 (dd, J_1 = 9.4 Hz, J_2 = 2.5 Hz, 1H, ArH), 7.42−7.37 (m, 4H, ArH), 5.80 (s, 1H, =CH), 4.04 (s, 3H, OCH_3), 2.46 (s, 3H, CH_3), 1.50 (s, 6H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 199.5, 166.0, 161.8, 146.5, 139.9, 137.9, 133.7, 132.1, 131.5, 131.0, 130.1, 126.9, 126.2, 126.0, 124.2, 117.6, 101.3, 56.0, 48.7, 27.6, 21.2; IR (KBr, ν, cm^{-1}) 3030, 2976, 2920, 2855, 1714, 1697, 1667, 1516, 1467, 1342, 1260, 1175, 1036, 871, 834, 787; HRMS Calcd For $C_{24}H_{21}N_2O_3^+$, (ESI, M + H$^+$) 385.1547, found 385.1552.

*9-Bromo-4,4-dimethyl-2-(p-tolyl)pyrrolo[2,3,4-kl]acridine-1,5-(2H,4H)-dione (**3d**).* Yellow solid, 242 mg, 56% yield: mp 224−226 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 9.03 (d, J = 2.0 Hz, 1H, ArH), 8.37 (d, J = 9.2 Hz, 1H, ArH), 7.96 (dd, J_1 = 9.1 Hz, J_2 = 1.8 Hz, 1H, ArH), 7.39 (s, 4H, ArH), 5.84 (s, 1H, =CH), 2.46 (s, 3H, CH_3), 1.52 (s, 6H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) 199.2, 165.0, 148.5, 142.8, 138.1, 134.4, 133.5, 132.0, 131.2, 130.7, 130.1, 127.1, 126.5, 126.3, 126.2, 125.5, 118.2, 48.8, 27.6, 21.2.; IR (KBr, ν, cm^{-1}) 3041, 2960, 2919, 2851, 1703, 1661, 1514, 1442, 1331, 1281, 1213, 1126, 1025, 983, 853, 823, 775, 701; HRMS Calcd For $C_{23}H_{18}BrN_2O_2^+$, (ESI, M + H$^+$) 433.0546, found 433.0552.

*4,4-Dimethyl-9-nitro-2-(p-tolyl)pyrrolo[2,3,4-kl]acridine-1,5-(2H,4H)-dione (**3e**).* Yellow solid, 84 mg, 21% yield: mp 262−264 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 9.71 (d, J = 2.4 Hz, 1H, ArH), 8.68 (d, J = 9.2 Hz, 1H, ArH), 8.63 (dd, J_1 = 9.4 Hz, J_2 = 2.5 Hz, 1H, ArH), 7.40 (s, 4H, ArH), 5.92 (s, 1H, =CH), 2.47 (s, 3H, CH_3), 1.55 (s, 6H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) 198.9, 164.4, 151.6, 148.1, 145.3, 138.5, 133.9, 132.4, 130.9, 130.6, 130.3, 130.3, 126.2, 124.0, 123.9, 120.4, 119.1, 109.8, 49.1, 27.6, 21.2; IR (KBr, ν, cm^{-1}) 3043, 2921, 2851, 1703, 1659, 1546, 1509, 1452, 1338, 1211, 1082, 909, 817, 776, 758, 709; HRMS Calcd For $C_{23}H_{18}N_3O_4^+$, (ESI, M + H$^+$) 400.1292, found 400.1297.

*2-(4-Bromophenyl)-4,4-dimethylpyrrolo[2,3,4-kl]acridine-1,5-(2H,4H)-dione (**3f**).* Yellow solid, 209 mg, 50% yield: mp 236−238 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.86−8.83 (m, 1H, ArH), 8.55−8.52 (m, 1H, ArH), 7.93−7.85 (m, 2H, ArH), 7.73−7.72 (m, 1H, ArH), 7.71−7.70 (m, 1H, ArH), 7.44−7.43 (m, 1H, ArH), 7.42−7.41 (m, 1H, ArH), 5.83 (s, 1H, =CH), 1.53 (s, 6H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) 199.2, 165.2, 150.1, 142.6, 133.1, 132.7, 132.3, 131.3, 130.8, 130.4, 127.9, 127.7, 124.6, 123.8, 121.6, 117.6, 48.8, 27.5; IR (KBr, ν, cm^{-1}) 3039, 2924, 2854, 1719, 1696, 1657, 1489, 1466, 1328, 1214, 1117, 1031, 826, 805, 767, 737; HRMS Calcd For $C_{22}H_{16}BrN_2O_2^+$, (ESI, M + H$^+$) 419.0390, found 419.0395.

*4,4-Dimethyl-2-(4-nitrophenyl)pyrrolo[2,3,4-kl]acridine-1,5-(2H,4H)-dione (**3g**).* Yellow solid, 154 mg, 40% yield: mp 272−274 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.82 (d, J = 7.6 Hz, 1H, ArH), 8.54 (d, J = 8.4 Hz, 1H, ArH), 8.45 (d, J = 8.8 Hz, 2H, ArH), 7.95−7.87 (m, 1H, ArH), 7.79 (d, J = 8.4 Hz, 2H, ArH), 5.98 (s, 1H, =CH), 1.55 (s, 6H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) 198.8, 165.1, 150.1, 146.2, 142.6, 140.0, 132.4, 131.6, 131.4, 131.0, 129.7, 127.2, 126.4, 124.9, 124.5, 123.8, 118.4, 48.8, 27.5; IR (KBr, ν, cm^{-1}) 2987, 2918, 2851, 1722, 1658, 1594, 1520, 1466, 1321, 1288, 1113, 1036, 853, 777, 743; HRMS Calcd For $C_{22}H_{16}N_3O_4^+$, (ESI, M + H$^+$) 386.1135, found 386.1141.

*4,4-Dimethyl-2-phenylpyrrolo[2,3,4-kl]acridine-1,5(2H,4H)-dione (**3h**).* Yellow solid, 194 mg, 57% yield: mp 251−253 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.85 (d, J = 6.8 Hz, 1H, ArH), 8.53 (d, J = 7.2 Hz, 1H, ArH), 7.90−7.86 (m, 2H, ArH), 7.58 (d, J = 6.8 Hz, 2H, ArH), 7.54 (s, 2H, ArH), 7.47−7.44 (m, 1H, ArH), 5.84 (s, 1H, =CH), 2.46 (s, 3H, CH_3), 1.52 (s, 6H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 199.5, 165.5, 150.1, 142.7, 134.1, 132.3, 131.5, 131.2, 130.8, 130.7, 129.6, 128.0, 126.5, 124.8, 123.9, 117.6, 48.8, 27.6; IR (KBr, ν, cm^{-1}) 3038, 2922, 2861, 1702, 1662, 1597, 1498, 1465, 1362, 1335, 1119, 1032, 847, 777, 749, 698; HRMS Calcd For $C_{22}H_{17}N_2O_2^+$, (ESI, M + H$^+$) 341.1285, found 341.1290.

*2-(4-Methoxyphenyl)-4,4-dimethylpyrrolo[2,3,4-kl]acridine-1,5-(2H,4H)-dione (**3i**).* Yellow solid, 233 mg, 63% yield: mp 200−201 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.86 (d, J = 7.6 Hz, 1H, ArH), 8.53 (d, J = 8.4 Hz, 1H, ArH), 7.92−7.84 (m, 2H, ArH), 7.43 (d, J = 8.8 Hz, 2H, ArH), 7.09 (d, J = 8.8 Hz, 2H, ArH), 5.77 (s, 1H, =CH), 3.89 (s, 3H, OCH_3), 1.52 (s, 6H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 199.7, 165.8, 159.2, 150.2, 142.7, 132.3, 131.5, 131.3, 131.2, 130.7, 128.2, 127.9, 126.6, 124.9, 124.1, 117.3, 114.8, 55.6, 48.8, 27.7; IR (KBr, ν, cm^{-1}) 2960, 2922, 2852, 1699, 1665, 1511, 1449, 1363, 1249, 1123, 1031, 834, 786; HRMS Calcd For $C_{23}H_{19}N_2O_3^+$, (ESI, M + H$^+$) 371.1390, found 371.1396.

*4,4-Dimethyl-2-(o-tolyl)pyrrolo[2,3,4-kl]acridine-1,5(2H,4H)-dione (**3j**).* Yellow solid, 216 mg, 61% yield: mp 177−178 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.70 (d, J = 7.6 Hz, 1H, ArH), 8.54 (d, J = 7.6 Hz, 1H, ArH), 7.91−7.87 (m, 2H, ArH), 7.48−7.45 (m, 1H, ArH), 7.35 (s, 1H, ArH), 7.29 (d, J = 6.8 Hz, 2H, ArH), 5.82 (s, 1H, =CH), 2.48 (s, 3H, CH_3), 1.53 (s, 6H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 199.6, 165.6, 150.2, 142.7, 139.7, 134.0, 132.3, 131.5, 131.2, 131.0, 130.7, 129.3, 128.9, 128.1, 127.2, 124.9, 124.0, 123.5, 117.6, 107.9, 48.8, 27.6, 21.5; IR (KBr, ν, cm^{-1}) 2968, 2924, 2864, 1699, 1669, 1587, 1465, 1365, 1330, 1204, 1115, 1033, 874, 771, 741; HRMS Calcd For $C_{23}H_{19}N_2O_2^+$, (ESI, M + H$^+$) 355.1441, found 355.1447.

*4,4-Dimethyl-2-(m-tolyl)pyrrolo[2,3,4-kl]acridine-1,5(2H,4H)-dione (**3k**).* Yellow solid, 195 mg, 55% yield: mp 179−181 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.86 (d, J = 7.6 Hz, 1H, ArH), 8.53 (d, J = 8.0 Hz, 1H, ArH), 7.92−7.85 (m, 2H, ArH), 7.48−7.44 (m, 1H, ArH), 7.35 (s, 1H, ArH), 7.29 (d, J = 8.0 Hz, 2H, ArH), 5.82 (s, 1H, =CH), 2.47 (s, 3H, CH_3), 1.52 (s, 6H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 199.6, 165.6, 150.1, 142.7, 139.7, 134.0, 132.3, 131.5, 131.2, 131.0, 130.7, 129.3, 128.9, 128.0, 127.2, 124.8, 124.0, 123.5, 117.5, 48.8, 27.6, 21.5; IR (KBr, ν, cm^{-1}) 2968, 2922, 2860, 1698, 1668, 1586, 1464, 1365, 1330, 1293, 1204, 1114, 1033, 873, 771, 741; HRMS Calcd For $C_{23}H_{19}N_2O_2^+$, (ESI, M + H$^+$) 355.1441, found 355.1447.

*2-(3-Chlorophenyl)-4,4-dimethylpyrrolo[2,3,4-kl]acridine-1,5-(2H,4H)-dione (**3l**).* Yellow solid, 217 mg, 58% yield: mp 152−154 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.82 (d, J = 8.0 Hz, 1H, ArH), 8.52 (d, J = 8.0 Hz, 1H, ArH), 7.92−7.85 (m, 2H, ArH), 7.55 (d, J = 8.4 Hz, 1H, ArH), 7.51 (d, J = 8.0 Hz, 1H, ArH), 7.43 (d, J = 8.0 Hz, 2H, ArH), 5.86 (s, 1H, =CH), 1.53 (s, 6H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) 199.2, 165.1, 149.9, 142.6, 135.3, 135.0, 132.2, 131.3, 130.8, 130.5, 130.3, 128.0, 127.4, 126.6, 124.5, 124.5, 123.7, 117.8, 48.8, 27.5; IR (KBr, ν, cm^{-1}) 2961, 2921, 2852, 1727, 1709, 1664, 1690, 1467, 1362, 1327, 1133, 1033, 858, 769, 703, 685; HRMS Calcd For $C_{22}H_{16}ClN_2O_2^+$, (ESI, M + H$^+$) 375.0895, found 375.0900.

*4,4-Dimethyl-2-(4-methylbenzyl)pyrrolo[2,3,4-kl]acridine-1,5-(2H,4H)-dione (**3m**).* Yellow solid, 206 mg, 56% yield: mp 178−180 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.88−8.85 (m 1H, ArH), 8.53−8.51 (m, 1H, ArH), 7.92−7.85 (m, 2H, ArH), 7.29 (d, J = 5.6 Hz, 2H, ArH), 7.18 (d, J = 8.0 Hz, 2H, ArH), 5.71 (s, 1H, =CH), 5.08 (s, 2H, CH_2), 2.36 (s, 3H, CH_3), 1.49 (s, 6H, CH_3); ^{13}C NMR

(100 MHz, $CDCl_3$) (δ, ppm) 199.5, 166.2, 149.9, 142.5, 137.4, 133.1, 132.1, 131.6, 130.9, 130.5, 130.2, 129.4, 128.4, 127.3, 124.7, 123.8, 116.9, 48.7, 43.7, 27.6, 21.0; IR (KBr, ν, cm^{-1}) 3023, 2920, 2851, 1704, 1664, 1516, 1467, 1358, 1321, 1210, 1146, 1023, 1005, 849, 807, 770, 738; HRMS Calcd For $C_{24}H_{21}N_2O_2^+$, (ESI, M + H^+) 369.1598, found 369.1603.

*2-Benzyl-4,4-dimethylpyrrolo[2,3,4-kl]acridine-1,5(2H,4H)-dione (**3n**).* Yellow solid, 248 mg, 70% yield: mp 188−189 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.84−8.82 (m 1H, ArH), 8.49 (d, J = 7.6 Hz, 1H, ArH), 7.89−7.82 (m, 2H, ArH), 7.35 (s, 2H, ArH), 7.34 (s, 2H, ArH), 7.31−7.27 (m, 1H, ArH), 5.66 (s, 1H, ═CH), 5.09 (s, 2H, CH_2), 1.45 (s, 6H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) 199.2, 165.9, 149.6, 142.3, 135.9, 131.8, 131.3, 130.7, 130.2, 129.9, 128.5, 128.1, 127.5, 127.2, 124.3, 123.5, 116.8, 48.5, 43.7, 27.3; IR (KBr, ν, cm^{-1}) 3045, 2967, 2920, 2851, 1707, 1692, 1671, 1467, 1360, 1320, 1293, 1210, 1143, 1022, 1002, 865, 772, 701; HRMS Calcd For $C_{23}H_{19}N_2O_2^+$, (ESI, M + H^+) 355.1441, found 355.1447.

*4,4-Dimethyl-2-propylpyrrolo[2,3,4-kl]acridine-1,5(2H,4H)-dione (**3o**).* Yellow solid, 138 mg, 45% yield: mp 218−220 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.83−8.80 (m 1H, ArH), 8.50−8.48 (m, 1H, ArH), 7.89−7.81 (m, 2H, ArH), 5.76 (s, 1H, ═CH), 3.86 (t, J = 7.3 Hz, 2H, CH_2), 1.87−1.77 (m, 2H, CH_2), 1.54 (s, 6H, CH_3), 1.03 (t, J = 7.4 Hz, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) 199.7, 166.3, 150.1, 142.5, 132.2, 131.5, 130.9, 130.7, 130.5, 128.8, 124.8, 124.0, 115.9, 48.7, 41.9, 29.6, 27.8, 22.2, 11.5; IR (KBr, ν, cm^{-1}) 3032, 2964, 2919, 2850, 1963, 1668, 1517, 1468, 1359, 1326, 1226, 1186, 1027, 1003, 879, 775, 743; HRMS Calcd For $C_{19}H_{19}N_2O_2^+$, (ESI, M + H^+) 307.1441, found 307.1447.

*9-Methoxy-2-(4-methoxyphenyl)-4,4-dimethylpyrrolo[2,3,4-kl]-acridine-1,5(2H,4H)-dione (**3p**).* Yellow solid, 272 mg, 68% yield: mp 226−227 °C; ^{1}H NMR (300 MHz, $CDCl_3$) (δ, ppm) 8.39 (d, J = 9.3 Hz, 1H, ArH), 8.11 (d, J = 2.1 Hz, 1H, ArH), 7.51 (dd, J_1 = 9.1 Hz, J_2 = 1.9 Hz, 1H, ArH), 7.43 (d, J = 8.7 Hz, 2H, ArH), 7.09 (d, J = 8.7 Hz, 2H, ArH), 5.76 (s, 1H, ═CH), 4.04 (s, 3H, OCH_3), 3.89 (s, 3H, OCH_3), 1.50 (s, 6H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 199.6, 166.3, 161.9, 159.1, 146.6, 139.9, 133.8, 132.1, 131.3, 127.8, 127.0, 126.7, 126.1, 124.3, 117.5, 114.8, 101.3, 56.1, 55.6, 48.8, 27.6; IR (KBr, ν, cm^{-1}) 2976, 2919, 2850, 1696, 1668, 1620, 1516, 1467, 1285, 1253, 1204, 1175, 1157, 1035, 868, 834, 789; HRMS Calcd For $C_{24}H_{21}N_2O_4^+$, (ESI, M + H^+) 401.1496, found 401.1501.

*2-(4-Bromophenyl)-9-methoxy-4,4-dimethylpyrrolo[2,3,4-kl]-acridine-1,5(2H,4H)-dione (**3q**).* Yellow solid, 206 mg, 46% yield: mp 298−299 °C; ^{1}H NMR (300 MHz, $CDCl_3$) (δ, ppm) 8.40 (d, J = 9.3 Hz, 1H, ArH), 8.09 (d, J = 2.7 Hz, 1H, ArH), 7.71 (d, J = 8.7 Hz, 2H, ArH), 7.52 (dd, J_1 = 9.4 Hz, J_2 = 2.7 Hz, 1H, ArH), 7.43 (d, J = 8.7 Hz, 2H, ArH), 5.83 (s, 1H, ═CH), 4.05 (s, 3H, OCH_3), 1.51 (s, 6H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) 199.1, 165.7, 161.9, 146.5, 139.8, 133.8, 133.2, 132.6, 131.9, 130.4, 127.8, 126.8, 125.5, 124.3, 121.5, 117.8, 101.1, 56.0, 48.7, 27.5; IR (KBr, ν, cm^{-1}) 2976, 2919, 2851, 1695, 1669, 1619, 1514, 1467, 1343, 1260, 1205, 1174, 1157, 1036, 872, 834, 800, 774; HRMS Calcd For $C_{23}H_{18}BrN_2O_3^+$, (ESI, M + H^+) 449.0495, found 449.0501.

*9-Bromo-2-(4-methoxyphenyl)-4,4-dimethylpyrrolo[2,3,4-kl]-acridine-1,5(2H,4H)-dione (**3r**).* Yellow solid, 255 mg, 57% yield: mp 225−226 °C; ^{1}H NMR (300 MHz, $CDCl_3$) (δ, ppm) 9.03 (d, J = 1.5 Hz, 1H, ArH), 8.38 (d, J = 9.0 Hz, 1H, ArH), 7.98 (d, J = 8.1 Hz, 1H, ArH), 7.43 (d, J = 8.7 Hz, 2H, ArH), 7.11 (d, J = 8.4 Hz, 2H, ArH), 5.82 (s, 1H, ═CH), 3.91 (s, 3H, OCH_3), 1.53 (s, 6H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 199.3, 165.3, 159.3, 148.7, 142.8, 134.5, 133.6, 132.0, 131.1, 127.8, 127.2, 126.6, 126.4, 125.6, 118.1, 114.9, 107.9, 55.6, 48.9, 27.6; IR (KBr, ν, cm^{-1}) 2976, 2929, 2836, 1700, 1659, 1512, 1443, 1250, 1129, 1022, 852, 834, 777; HRMS Calcd For $C_{23}H_{18}BrN_2O_3^+$, (ESI, M + H^+) 449.0495, found 449.0501.

*9-Bromo-2-(4-bromophenyl)-4,4-dimethylpyrrolo[2,3,4-kl]-acridine-1,5(2H,4H)-dione. (**3s**).* Yellow solid, 268 mg, 54% yield: mp 280−282 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.90 (s, 1H, ArH), 8.29 (d, J = 9.2 Hz, 1H, ArH), 7.91 (d, J = 9.2 Hz, 1H, ArH), 7.68 (d, J = 8.4 Hz, 2H, ArH), 7.39 (d, J = 8.4 Hz, 2H, ArH), 5.87 (s, 1H, ═CH), 1.51 (s, 6H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) 198.8, 164.7, 148.5, 142.7, 134.5, 133.5, 132.9, 132.7, 131.9, 130.2, 127.9, 126.8, 126.7, 126.2, 125.3, 121.8, 118.4, 48.9, 27.5; IR (KBr, ν, cm^{-1}) 3060, 2966, 2919, 2851, 1700, 1669, 1490, 1445, 1336, 1277, 1158, 1130, 1073, 1009, 987, 881, 830, 768; HRMS Calcd For $C_{22}H_{15}Br_2N_2O_2^+$, (ESI, M + H^+) 496.9495, found 496.9500.

*4,5-Dimethyl-2-(p-tolyl)pyrrolo[2,3,4-kl]acridin-1(2H)-one (**5a**).* Red solid, 247 mg, 73% yield: mp 283−285 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.88 (d, J = 8.4 Hz, 1H, ArH), 8.44 (d, J = 8.4 Hz, 1H, ArH), 7.89−7.85 (m, 1H, ArH), 7.77−7.74 (m, 1H, ArH), 7.51 (d, J = 7.2 Hz, 2H, ArH), 7.39 (d, J = 7.6 Hz, 2H, ArH), 6.79 (s, 1H, ArH), 2.80 (s, 3H, CH_3), 2.50 (s, 3H, CH_3), 2.47 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 167.4, 151.2, 146.4, 139.5(1), 139.4(6), 137.4, 137.2(8), 132.2(6), 130.8, 130.1, 128.5, 127.7, 127.5, 125.7, 123.9, 122.3, 118.7, 110.1, 21.6, 21.2, 11.9; IR (KBr, ν, cm^{-1}) 3044, 2927, 2869, 1703, 1633, 1512, 1392, 1324, 1121, 988, 845, 772, 628, 523; HRMS Calcd For $C_{23}H_{19}N_2O^+$, (ESI, M + H^+) 339.1492, found 339.1492.

*4,5-Dimethyl-2-(o-tolyl)pyrrolo[2,3,4-kl]acridin-1(2H)-one (**5b**).* Red solid, 166 mg, 49% yield: mp 251−253 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.90 (d, J = 8.4 Hz, 1H, ArH), 8.51 (d, J = 5.6 Hz, 1H, ArH), 7.92−7.88 (m, 1H, ArH), 7.79−7.76 (m, 1H, ArH), 7.46−7.43 (m, 2H, ArH), 7.40 (s, 2H, ArH), 6.50 (s, 1H, ArH), 2.83 (s, 3H, CH_3), 2.49 (s, 3H, CH_3), 2.28 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 167.1, 151.4, 139.5, 137.8, 136.9, 133.4, 131.5, 130.9, 130.1, 128.5, 127.7, 127.1, 124.0, 122.5, 119.0, 118.4, 116.4, 115.6, 113.0, 109.8, 21.5, 18.2, 11.9; IR (KBr, ν, cm^{-1}) 3045, 2919, 2850, 2772, 1700, 1631, 1492, 1389, 1322, 1116, 1051, 982, 853, 766, 628; HRMS Calcd For $C_{23}H_{19}N_2O^+$, (ESI, M + H^+) 339.1492, found 339.1492.

*2-(2-Bromophenyl)-4,5-dimethylpyrrolo[2,3,4-kl]acridin-1(2H)-one (**5c**).* Red solid, 213 mg, 53% yield: mp 243−245 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.88 (d, J = 8.4 Hz, 1H, ArH), 8.47 (d, J = 8.4 Hz, 1H, ArH), 7.90−7.86 (m, 1H, ArH), 7.83 (d, J = 8.4 Hz, 1H, ArH), 7.78−7.75 (m, 1H, ArH), 7.56−7.52 (m, 2H, ArH), 7.43−7.39 (m, 1H, ArH), 6.49 (s, 1H, ArH), 2.81 (s, 3H, CH_3), 2.49 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 167.1, 151.4, 146.6, 139.4, 136.9, 134.2, 134.0, 131.0, 130.8, 130.5, 130.1, 128.7, 128.6, 127.9, 127.3, 124.0, 123.4, 122.4, 119.0, 110.0, 21.5, 11.9; IR (KBr, ν, cm^{-1}) 3059, 3022, 2917, 2849, 1710, 1636, 1514, 1488, 1394, 1325, 1288, 1168, 1101, 1132, 1068, 985, 881, 858, 781, 777, 751, 669, 636, 624, 555, 510; HRMS Calcd For $C_{22}H_{16}BrN_2O^+$, (ESI, M + H^+) 403.0441, found 403.0444.

*2-(2-Iodophenyl)-4,5-dimethylpyrrolo[2,3,4-kl]acridin-1(2H)-one (**5d**).* Red solid, 221 mg, 49% yield: mp 265−267 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.90 (d, J = 8.4 Hz, 1H, ArH), 8.48 (d, J = 8.8 Hz, 1H, ArH), 8.08 (d, J = 8.0 Hz, 1H, ArH), 7.91−7.87 (m, 1H, ArH), 7.79−7.75 (m, 1H, ArH), 7.59−7.55 (m, 1H, ArH), 7.51 (d, J = 7.2 Hz, 1H, ArH), 7.23 (s, 1H, ArH), 6.47 (s, 1H, ArH), 2.82 (s, 3H, CH_3), 2.49 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 167.0, 151.4, 146.7, 140.3, 139.4, 137.9, 136.9, 131.0, 130.7, 130.3, 130.0, 129.6, 128.6, 128.0, 127.4, 124.1, 122.4, 119.0, 110.1, 99.0, 21.5, 11.9; IR (KBr, ν, cm^{-1}) 3055, 2919, 2850, 1708, 1632, 1482, 1388, 1324, 1263, 1120, 1015, 863, 765; HRMS Calcd For $C_{22}H_{16}IN_2O^+$, (ESI, M + H^+) 451.0302, found 451.0304.

*2-Benzyl-4,5-dimethylpyrrolo[2,3,4-kl]acridin-1(2H)-one (**5e**).* Red solid, 189 mg, 56% yield: mp 240−242 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.88 (d, J = 8.4 Hz, 1H, ArH), 8.46 (d, J = 8.4 Hz, 1H, ArH), 7.87 (t, J = 7.6 Hz, 1H, ArH), 7.76 (t, J = 7.6 Hz, 1H, ArH), 7.40 (d, J = 7.6 Hz, 2H, ArH), 7.36−7.32 (m, 2H, ArH), 7.28 (d, J = 7.6 Hz, 1H, ArH), 6.60 (s, 1H, ArH), 5.15 (s, 2H, CH_2), 2.77 (s, 3H, CH_3), 2.47 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 168.1, 151.2, 146.3, 139.3, 136.7, 130.9, 129.9, 128.8, 128.3, 127.7, 127.5, 123.9, 122.2, 118.7, 109.6, 44.0, 21.5, 11.8; IR (KBr, ν, cm^{-1}) 3064, 3024, 2921, 2854, 1690, 1637, 1514, 1492, 1417, 1380, 1313, 1105, 1069, 963, 850, 773, 749, 701, 624, 569; HRMS Calcd For $C_{23}H_{17}N_2O^-$, (ESI, M − H^+) 337.1346, found 337.1314.

*4,5-Dimethyl-2-(4-methylbenzyl)pyrrolo[2,3,4-kl]acridin-1(2H)-one (**5f**).* Red solid, 162 mg, 46% yield: mp 198−200 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.87 (d, J = 8.4 Hz, 1H, ArH), 8.42 (d, J = 8.8 Hz, 1H, ArH), 7.86 (t, J = 7.6 Hz, 1H, ArH), 7.77−7.73 (m, 1H, ArH), 7.29 (d, J = 7.6 Hz, 2H, ArH), 7.14 (d, J = 7.2 Hz, 2H, ArH),

6.59 (s, 1H, ArH), 5.10 (s, 2H, CH_2), 2.75 (s, 3H, CH_3), 2.46 (s, 3H, CH_3), 2.31 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 168.0, 156.8, 151.1, 146.2, 139.2, 137.3, 136.7, 133.7, 130.9, 129.8, 129.4, 128.2, 127.7, 127.5, 123.9, 122.1, 118.6, 109.5, 43.7, 21.5, 21.1, 11.7; IR (KBr, ν, cm^{-1}) 3060, 3006, 2919, 2853, 1703, 1638, 1515, 1492, 1400, 1322, 1298, 1151, 1102, 1071, 961, 849, 802, 706, 621, 605, 540; HRMS Calcd For $C_{24}H_{21}N_2O^+$, (ESI, M + H^+) 353.1648, found 353.1655.

2-(4-Methoxybenzyl)-4,5-dimethylpyrrolo[2,3,4-kl]acridin-1(2H)-one (**5g**). Red solid, 250 mg, 68% yield: mp 180−182 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.89 (d, J = 8.0 Hz, 1H, ArH), 8.48 (s, 1H, ArH), 7.90−7.87 (m, 1H, ArH), 7.79−7.75 (m, 1H, ArH), 7.35 (d, J = 8.0 Hz, 2H, ArH), 6.87 (d, J = 8.0 Hz, 2H, ArH), 6.63 (s, 1H, ArH), 5.08 (s, 2H, CH_2), 3.78 (s, 3H, OCH_3), 2.78 (s, 3H, CH_3), 2.48 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 167.6, 159.1, 149.2, 146.2, 140.0, 136.7, 134.8, 132.1, 131.2, 128.9, 128.6, 127.4, 127.1, 122.6, 122.2, 119.0, 114.2, 110.3, 55.3, 43.6, 21.6, 11.7; IR (KBr, ν, cm^{-1}) 3040, 3000, 2965, 2857, 2845, 1694, 1637, 1513, 1490, 1384, 1322, 1307, 1248, 1149, 1113, 1074, 1024, 966, 859, 811, 772, 627, 606, 543; HRMS Calcd For $C_{24}H_{21}N_2O_2^+$, (ESI, M + H^+) 369.1598, found 369.1600.

2-Butyl-4,5-dimethylpyrrolo[2,3,4-kl]acridin-1(2H)-one (**5h**). Red solid, 192 mg, 63% yield: mp 160−162 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.79 (d, J = 8.4 Hz, 1H, ArH), 8.37 (d, J = 8.8 Hz, 1H, ArH), 7.84−7.80 (m, 1H, ArH), 7.72−7.69 (m, 1H, ArH), 6.57 (s, 1H, ArH), 3.89 (t, J = 7.2 Hz, 2H, CH_2), 2.71 (s, 3H, CH_3), 2.47 (s, 3H, CH_3), 1.81−1.74 (m, 2H, CH_2), 1.49−1.40 (m, 2H, CH_2), 1.00−0.96 (m, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) 168.3, 151.4, 146.5, 139.4, 137.5, 131.0, 130.0, 128.4, 128.2, 127.4, 124.1, 122.3, 118.8, 109.0, 40.3, 31.2, 21.7, 20.4, 14.0, 11.9; IR (KBr, ν, cm^{-1}) 3042, 2958, 2919, 2873, 2848, 1693, 1636, 1514, 1491, 1418, 1381, 1314, 1286, 1151, 1092, 1045, 957, 847, 775, 626, 599, 553; HRMS Calcd For $C_{20}H_{19}N_2O^-$, (ESI, M − H^+) 303.1503, found 303.1506.

2-Benzyl-4,5,9-trimethylpyrrolo[2,3,4-kl]acridin-1(2H)-one (**5i**). Red solid, 236 mg, 67% yield: mp 242−244 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.63 (s, 1H, ArH), 8.33 (d, J = 8.4 Hz, 1H, ArH), 7.69 (d, J = 8.8 Hz, 1H, ArH), 7.40 (d, J = 6.8 Hz, 2H, ArH), 7.35−7.31 (m, 2H, ArH), 7.29 (s, 1H, ArH), 6.57 (s, 1H, ArH), 5.14 (s, 2H, CH_2), 2.74 (s, 3H, CH_3), 2.65 (s, 3H, CH_3), 2.44 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 168.3, 150.1, 145.5, 139.0, 138.6, 136.8, 136.6, 132.6, 132.3, 130.5, 128.8, 127.6, 127.5, 126.5, 122.3, 118.6, 109.4, 44.0, 22.1, 21.4, 11.8; IR (KBr, ν, cm^{-1}) 3043, 3026, 2920, 2853, 1699, 1635, 1512, 1484, 1393, 1356, 1306, 1146, 1110, 1070, 965, 848, 826, 743, 700, 625, 553; HRMS Calcd For $C_{24}H_{19}N_2O^-$, (ESI, M − H^+) 351.1503, found 351.1492.

2-Benzyl-9-methoxy-4,5-dimethylpyrrolo[2,3,4-kl]acridin-1(2H)-one (**5j**). Red solid, 239 mg, 65% yield: mp 224−226 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.26 (d, J = 6.4 Hz, 1H, ArH), 8.04 (s, 1H, ArH), 7.49 (d, J = 6.0 Hz, 1H, ArH), 7.39 (s, 2H, ArH), 7.33 (s, 3H, ArH), 6.58 (s, 1H, ArH), 5.13 (s, 2H, CH_2), 4.05 (s, 3H, OCH_3), 2.72 (s, 3H, CH_3), 2.43 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 168.3, 159.6, 148.2, 143.9, 137.6, 136.9, 136.1, 132.3, 128.8, 127.6, 127.5, 125.1, 124.6, 123.7, 118.4, 109.5, 99.7, 55.9, 44.0, 21.3, 11.7; IR (KBr, ν, cm^{-1}) 3065, 3024, 3001, 2953, 2857, 1694, 1634, 1520, 1478, 1455, 1314, 1216, 1181, 1141, 1078, 1025, 970, 859, 831, 794, 724, 691, 623, 572; HRMS Calcd For $C_{24}H_{21}N_2O_2^+$, (ESI, M + H^+) 369.1598, found 369.1598.

2-Benzyl-10-bromo-4,5-dimethylpyrrolo[2,3,4-kl]acridin-1(2H)-one (**5k**). Red solid, 187 mg, 45% yield: mp 236−238 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.41 (d, J = 8.0 Hz, 1H, ArH), 8.05 (d, J = 7.6 Hz, 1H, ArH), 7.66−7.62 (m, 1H, ArH), 7.39 (d, J = 7.2 Hz, 2H, ArH), 7.34−7.31 (m, 2H, ArH), 7.28 (s, 1H, ArH), 6.55 (s, 1H, ArH), 5.13 (s, 2H, CH_2), 2.71 (s, 3H, CH_3), 2.44 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 165.5, 152.4, 146.4, 139.9, 136.6, 136.3, 134.8, 131.3, 129.3, 128.8, 127.6, 127.5, 126.8, 124.2, 123.0, 120.4, 116.7, 108.9, 44.4, 21.4, 11.7; IR (KBr, ν, cm^{-1}) 3088, 3046, 2920, 2854, 1713, 1639, 1513, 1497, 1454, 1399, 1305, 1203, 1118, 1064, 1016, 969, 847, 795, 746, 697, 630, 598, 569; HRMS Calcd For $C_{23}H_{18}BrN_2O^+$, (ESI, M + H^+) 417.0597, found 417.0582.

2-Benzyl-9-bromo-4,5-dimethylpyrrolo[2,3,4-kl]acridin-1(2H)-one (**5l**). Red solid, 212 mg, 51% yield: mp 244−246 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 9.03 (s, 1H, ArH), 8.27 (d, J = 7.2 Hz, 1H, ArH), 7.90 (d, J = 7.6 Hz, 1H, ArH), 7.39 (s, 2H, ArH), 7.34 (s, 3H, ArH), 6.60 (s, 1H, ArH), 5.13 (s, 2H, CH_2), 2.73 (s, 3H, CH_3), 2.45 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 166.7, 156.0, 148.5, 145.5, 138.9, 135.7, 135.5, 132.6, 131.3, 127.9, 127.8, 126.7, 126.5, 125.1, 122.4, 121.7, 118.0, 109.3, 43.1, 20.6, 10.7; IR (KBr, ν, cm^{-1}) 3064, 3029, 2920, 2852, 1693, 1638, 1503, 1472, 1454, 1380, 1303, 1149, 1116, 1071, 1038, 964, 885, 838, 738, 698, 654, 622; HRMS Calcd For $C_{23}H_{18}BrN_2O^+$, (ESI, M + H^+) 417.0597, found 417.0580.

2-Benzyl-8-bromo-4,5-dimethylpyrrolo[2,3,4-kl]acridin-1(2H)-one (**5m**). Red solid, 299 mg, 72% yield: mp 260−262 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.63 (d, J = 8.8 Hz, 1H, ArH), 8.53 (s, 1H, ArH), 7.75 (d, J = 8.8 Hz, 1H, ArH), 7.38 (d, J = 6.4 Hz, 2H, ArH), 7.35−7.32 (m, 2H, ArH), 7.29−7.26 (m, 1H, ArH), 6.48 (s, 1H, ArH), 5.09 (s, 2H, CH_2), 2.64 (s, 3H, CH_3), 2.40 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 167.7, 151.3, 146.8, 140.4, 136.9, 136.5, 132.8, 131.8, 128.8, 128.3, 127.8, 127.6, 127.5, 125.0, 124.6, 120.5, 118.8, 110.1, 44.1, 21.6, 11.8; IR (KBr, ν, cm^{-1}) 3064, 3029, 2920, 2852, 1693, 1638, 1503, 1472, 1454, 1398, 1312, 1303, 1116, 1071, 1049, 940, 885, 838, 738, 713, 698, 635, 554; HRMS Calcd For $C_{23}H_{18}BrN_2O^+$, (ESI, M + H^+) 417.0597, found 417.0580.

2-Benzyl-10-chloro-4,5-dimethylpyrrolo[2,3,4-kl]acridin-1(2H)-one (**5n**). Red solid, 190 mg, 51% yield: mp 222−224 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.32 (d, J = 8.4 Hz, 1H, ArH), 7.79−7.76 (m, 1H, ArH), 7.73−7.69 (m, 1H, ArH), 7.39 (s, 2H, ArH), 7.32 (s, 3H, ArH), 6.52 (s, 1H, ArH), 5.12 (s, 2H, CH_2), 2.69 (s, 3H, CH_3), 2.42 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 165.5, 152.2, 146.5, 139.8, 136.6, 136.4, 130.6, 130.1, 129.7, 129.3, 128.8, 128.8, 127.6, 127.5, 126.8, 122.6, 120.2, 108.9, 44.4, 21.4, 11.7; IR (KBr, ν, cm^{-1}) 3057, 2951, 2918, 2861, 1688, 1637, 1486, 1455, 1389, 1302, 1218, 1155, 1114, 1074, 1048, 969, 852, 836, 803, 740, 682, 657, 607; HRMS Calcd For $C_{23}H_{18}ClN_2O^+$, (ESI, M + H^+) 373.1102, found 373.1084.

2-Benzyl-9-chloro-4,5-dimethylpyrrolo[2,3,4-kl]acridin-1(2H)-one (**5o**). Red solid, 197 mg, 53% yield: mp 251−253 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.81 (s, 1H, ArH), 8.30 (d, J = 9.6 Hz, 1H, ArH), 7.75 (d, J = 8.8 Hz, 1H, ArH), 7.39 (d, J = 6.8 Hz, 2H, ArH), 7.36−7.32 (m, 2H, ArH), 7.29 (d, J = 7.2 Hz, 1H, ArH), 6.57 (s, 1H, ArH), 5.12 (s, 2H, CH_2), 2.70 (s, 3H, CH_3), 2.44 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 166.7, 155.8, 148.3, 145.3, 138.7, 135.7, 135.5, 133.8, 131.3, 130.1, 127.8, 126.7, 126.6, 126.5, 125.9, 121.6, 121.2, 109.2, 43.1, 20.5, 10.7; IR (KBr, ν, cm^{-1}) 3064, 2921, 2850, 1692, 1638, 1507, 1475, 1455, 1397, 1313, 1228, 1148, 1117, 1071, 884, 840, 738, 698, 660, 602; HRMS Calcd For $C_{23}H_{18}ClN_2O^+$, (ESI, M + H^+) 373.1102, found 373.1084.

2-Butyl-4,5,9-trimethylpyrrolo[2,3,4-kl]acridin-1(2H)-one (**5p**). Red solid, 226 mg, 71% yield: mp 164−166 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.57 (s, 1H, ArH), 8.27 (d, J = 8.8 Hz, 1H, ArH), 7.66 (d, J = 8.8 Hz, 1H, ArH), 6.63 (s, 1H, ArH), 3.93−3.90 (m, 2H, CH_2), 2.73 (s, 3H, CH_3), 2.63 (s, 3H, CH_3), 2.49 (s, 3H, CH_3), 1.82−1.75 (m, 2H, CH_2), 1.49−1.40 (m, 2H, CH_2), 1.00−0.96 (m, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) 168.4, 150.3, 145.7, 138.9, 138.6, 137.3, 132.6, 130.6, 127.3, 126.9, 122.5, 122.4, 118.6, 108.8, 40.2, 31.2, 22.2, 21.6, 20.4, 14.0, 11.9; IR (KBr, ν, cm^{-1}) 3049, 2957, 2917, 2869, 1696, 1633, 1514, 1486, 1394, 1377, 1315, 1288, 1180, 1143, 1068, 1046, 844, 825, 807, 746, 631, 613, 554; HRMS Calcd For $C_{21}H_{21}N_2O^-$, (ESI, M − H^+) 317.1659, found 317.1652.

2-Butyl-9-fluoro-4,5-dimethylpyrrolo[2,3,4-kl]acridin-1(2H)-one (**5q**). Red solid, 161 mg, 50% yield: mp 186−188 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.41−8.37 (m, 2H, ArH), 7.64−7.60 (m, 1H, ArH), 6.69 (s, 1H, ArH), 3.94−3.91 (m, 2H, CH_2), 2.73 (s, 3H, CH_3), 2.52 (s, 3H, CH_3), 1.83−1.76 (m, 2H, CH_2), 1.50−1.41 (m, 2H, CH_2), 1.01−0.97 (m, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) 162.5, 158.1, 154.7, 153.2 (J_{CF} = 253.4 Hz), 143.2, 140.3, 133.9, 131.7, 128.8 (J_{CF} = 2.6 Hz), 122.4 (J_{CF} = 10.5 Hz), 122.0, 117.2 (J_{CF} = 15.1 Hz), 117.2 (J_{CF} = 36.5 Hz), 113.5, 104.1, 101.5 (J_{CF} = 30.6 Hz);

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IR (KBr, ν, cm^{-1}) 3062, 2958, 2925, 2869, 1701, 1637, 1521, 1472, 1381, 1319, 1290, 1179, 1130, 1064, 1046, 911, 848, 832, 796, 746, 628; HRMS Calcd For $C_{20}H_{18}FN_2O^-$, (ESI, M − H^+) 321.1409, found 321.1413.

*2-Butyl-9-chloro-4,5-dimethylpyrrolo[2,3,4-kl]acridin-1(2H)-one (**5r**).* Red solid, 216 mg, 64% yield: mp 139−141 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.71 (s, 1H, ArH), 8.25 (d, J = 9.2 Hz, 1H, ArH), 7.71 (d, J = 9.6 Hz, 1H, ArH), 6.62 (s, 1H, ArH), 3.92−3.88 (m, 2H, CH_2), 2.68 (s, 3H, CH_3), 2.49 (s, 3H, CH_3), 1.82−1.74 (m, 2H, CH_2), 1.49−1.40 (m, 2H, CH_2), 1.00−0.97 (m, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) 167.5, 149.1, 146.1, 139.7, 137.1, 134.5, 132.3, 130.9, 127.3, 126.9, 122.6, 121.9, 118.6, 109.4, 40.2, 31.1, 21.7, 20.4, 14.0, 11.7; IR (KBr, ν, cm^{-1}) 3063, 2957, 2929, 2874, 1696, 1633, 1509, 1472, 1382, 1362, 1320, 1286, 1172, 1145, 1071, 886, 834, 728, 663, 627, 558; HRMS Calcd For $C_{20}H_{18}ClN_2O^-$, (ESI, M − H^+) 337.1113, found 337.1109.

*10-Bromo-2-butyl-4,5-dimethylpyrrolo[2,3,4-kl]acridin-1(2H)-one (**5s**).* Red solid, 176 mg, 46% yield: mp 138−140 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.37 (d, J = 8.4 Hz, 1H, ArH), 8.02 (d, J = 7.2 Hz, 1H, ArH), 7.61 (t, J = 8.0 Hz, 1H, ArH), 6.61 (s, 1H, ArH), 3.92−3.88 (m, 2H, CH_2), 2.70 (s, 3H, CH_3), 2.50 (s, 3H, CH_3), 1.82−1.74 (m, 2H, CH_2), 1.51−1.41 (m, 2H, CH_2), 1.00−0.97 (m, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) (δ, ppm) 160.5, 147.6, 141.5, 135.0, 131.9, 130.0, 126.0, 124.6, 124.4, 121.7, 119.4, 115.3, 112.0, 103.4, 36.0, 26.2, 16.8, 15.8, 9.3, 7.0; IR (KBr, ν, cm^{-1}) 3046, 2957, 2931, 2871, 1705, 1638, 1606, 1511, 1471, 1399, 1376, 1305, 1284, 1200, 1167, 1074, 1060, 902, 846, 823, 797, 745, 705, 656, 623, 596; HRMS Calcd For $C_{20}H_{18}BrN_2O^-$, (ESI, M − H^+) 381.0608, found 381.0616.

*2-Butyl-10-chloro-4,5-dimethylpyrrolo[2,3,4-kl]acridin-1(2H)-one (**5t**).* Red solid, 179 mg, 53% yield: mp 164−166 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.34 (d, J = 8.4 Hz, 1H, ArH), 7.78 (d, J = 7.2 Hz, 1H, ArH), 7.73−7.69 (t, J = 8.0 Hz, 1H, ArH), 6.64 (s, 1H, ArH), 3.94−3.90 (m, 2H, CH_2), 2.73 (s, 3H, CH_3), 2.52 (s, 3H, CH_3), 1.83−1.75 (m, 2H, CH_2), 1.51−1.42 (m, 2H, CH_2), 1.01−0.97 (m, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 165.3, 152.1, 146.3, 139.7, 136.7, 130.5, 129.9, 129.7, 129.5, 128.7, 126.4, 122.4, 119.9, 108.0, 40.5, 30.7, 21.4, 20.3, 13.8, 11.6; IR (KBr, ν, cm^{-1}) 3047, 2958, 2924, 2870, 1706, 1638, 1608, 1517, 1476, 1380, 1360, 1286, 1201, 1174, 1065, 1015, 848, 825, 797, 745, 626, 598; HRMS Calcd For $C_{20}H_{19}ClN_2NaO^+$, (ESI, M + Na^+) 361.1078, found 361.1081.

*4-(4-Methoxyphenyl)-2-(p-tolyl)pyrrolo[2,3,4-kl]acridin-1(2H)-one (**5u**).* Red solid, 325 mg, 78% yield: mp 215−216 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.82 (d, J = 8.0 Hz, 1H, ArH), 8.37 (d, J = 8.8 Hz, 1H, ArH), 7.94 (s, 1H, ArH), 7.89−7.85 (m, 1H, ArH), 7.75−7.71 (m, 1H, ArH), 7.62 (d, J = 8.8 Hz, 2H, ArH), 7.52 (d, J = 8.0 Hz, 2H, ArH), 7.39 (d, J = 8.0 Hz, 2H, ArH), 7.16 (s, 1H, ArH), 6.99 (d, J = 8.4 Hz, 2H, ArH), 3.86 (s, 3H, OCH_3), 2.47 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 167.4, 160.0, 152.1, 146.6, 145.9, 140.4, 137.6, 133.2, 132.1, 130.6, 130.5, 130.2, 128.7, 127.2, 125.9, 124.1, 122.6, 119.1, 118.7, 114.4, 106.4, 55.4, 21.2; IR (KBr, ν, cm^{-1}) 3058, 3033, 2976, 2944, 2846, 1705, 1636, 1600, 1514, 1485, 1463, 1373, 1299, 1282, 1217, 1185, 1132, 1116, 1087, 1036, 857, 823, 797, 768, 741, 653, 640; HRMS Calcd For $C_{28}H_{21}N_2O_2^+$, (ESI, M + H^+) 417.1598, found 417.1593.

*9-Methoxy-4-(4-methoxyphenyl)-2-(p-tolyl)pyrrolo[2,3,4-kl]-acridin-1(2H)-one (**5v**).* Red solid, 366 mg, 82% yield: mp 260−261 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.30 (d, J = 9.6 Hz, 1H, ArH), 8.10 (d, J = 2.8 Hz, 1H, ArH), 8.00 (s, 1H, ArH), 7.65 (d, J = 8.4 Hz, 2H, ArH), 7.58−7.53 (m, 3H, ArH), 7.40 (d, J = 8.0 Hz, 2H, ArH), 7.23 (s, 1H, ArH), 7.02 (d, J = 8.4 Hz, 2H, ArH), 4.06 (s, 3H, OCH_3), 3.88 (s, 3H, OCH_3), 2.48 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 167.6, 160.0, 159.8, 149.1, 144.4, 144.1, 139.6, 137.4, 133.4, 132.2, 131.9, 130.1, 128.7, 125.8, 125.5, 124.6, 124.3, 118.9, 118.7, 114.4, 106.6, 100.0, 55.9, 55.4, 21.2; IR (KBr, ν, cm^{-1}) 3073, 3036, 3017, 2991, 2975, 2934, 2833, 1701, 1636, 1608, 1514, 1480, 1453, 1375, 1283, 1252, 1227, 1206, 1179, 1128, 1081, 1036, 1013, 847, 821, 813, 799, 653; HRMS Calcd For $C_{29}H_{23}N_2O_3^+$, (ESI, M + H^+) 447.1703, found 447.1701.

*8-Bromo-4-(4-methoxyphenyl)-2-(p-tolyl)pyrrolo[2,3,4-kl]acridin-1(2H)-one (**5w**).* Red solid, 351 mg, 71% yield: mp 248−249 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.75 (d, J = 9.0 Hz, 1H, ArH), 8.62 (d, J = 1.6 Hz, 1H, ArH), 7.96 (s, 1H, ArH), 7.84 (m, 1H, ArH), 7.65 (d, J = 8.8 Hz, 2H, ArH), 7.51 (d, J = 8.0 Hz, 2H, ArH), 7.41 (d, J = 8.4 Hz, 2H, ArH), 7.20 (s, 1H, ArH), 7.02 (d, J = 8.4 Hz, 2H, ArH), 3.88 (s, 3H, OCH_3), 2.48 (s, 3H, CH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 167.0, 166.8, 160.4, 140.7, 140.3, 138.0, 133.0, 132.4, 131.8, 130.3, 128.9, 125.9, 125.3, 121.1, 119.3, 118.3, 114.6, 107.0, 55.4, 21.2; IR (KBr, ν, cm^{-1}) 3083, 3031, 2999, 2947, 2923, 2842, 1705, 1634, 1601, 1516, 1481, 1458, 1256, 1185, 1119, 1037, 889, 874, 820, 806, 798, 744; HRMS Calcd For $C_{28}H_{20}BrN_2O_2^+$, (ESI, M + H^+) 495.0703, found 495.0695.

*2-(4-Bromophenyl)-4-(4-methoxyphenyl)pyrrolo[2,3,4-kl]acridin-1(2H)-one (**5x**).* Red solid, 389 mg, 81% yield: mp 232−234 °C; ^{1}H NMR (400 MHz, $CDCl_3$) (δ, ppm) 8.86 (d, J = 8.4 Hz, 1H, ArH), 8.42 (d, J = 8.8 Hz, 1H, ArH), 8.02 (s, 1H, ArH), 7.94−7.90 (m, 1H, ArH), 7.81−7.77 (m, 1H, ArH), 7.73 (d, J = 8.4 Hz, 2H, ArH), 7.66 (d, J = 8.4 Hz, 2H, ArH), 7.56 (d, J = 8.4 Hz, 2H, ArH), 7.22 (s, 1H, ArH), 7.03 (d, J = 8.8 Hz, 2H, ArH), 3.88 (s, 3H, OCH_3); ^{13}C NMR (75 MHz, $CDCl_3$) (δ, ppm) 167.1, 160.2, 152.2, 146.5, 146.0, 139.7, 133.8, 133.0, 132.8, 130.8, 130.5, 129.1, 128.8, 127.5, 127.0, 124.1, 122.6, 121.2, 119.2, 119.0, 114.5, 106.6, 55.4; IR (KBr, ν, cm^{-1}) 3065, 3021, 2920, 2835, 1725, 1635, 1603, 1517, 1493, 1458, 1374, 1282, 1254, 1183, 1113, 1072, 1033, 1007, 871, 820, 769; 551; HRMS Calcd For $C_{27}H_{18}BrN_2O_2^+$, (ESI, M + H^+) 481.0546, found 481.0523.

■ ASSOCIATED CONTENT

Ⓢ Supporting Information

^{1}H and ^{13}C NMR spectra of all pure products and CIF files for **3a** and **5d**. This material is available free of charge via the Internet at http://pubs.acs.org.

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Notes

The authors declare no competing financial interest.

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