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Synthesis of 1,4-dihydroquinoline derivatives under transition-metal-free conditions and their diverse applications†

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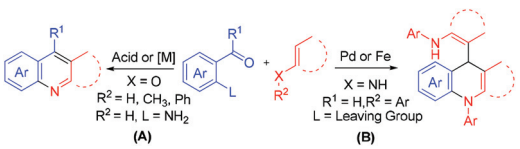
A transition-metal-free process for the synthesis of 1,4-dihydroquinoline derivatives starting from simple enaminones with aldehydes *via* intermolecular cascade cyclization in a one-pot protocol is developed. This methodology affords a variety of products in moderate to good yields. Particularly, the use of the enaminone fragment in 1,4-dihydroquinoline derivatives 3 as a leaving group for further diverse applications with *C*-nucleophiles is proved to be feasible.

The transition-metal (TM)-catalyzed cross-coupling reactions are direct and powerful strategies for the construction of new C–N bonds, which are featured in the synthesis of various pharmaceuticals and biologically active molecules.[1] Although some success has been achieved with Pd (Buchwald–Hartwig amination),[2] Cu (Ullmann or Goldberg-type reaction),[3] Fe,[4] or Ni[5] catalysts for this transformation in the past few decades, they still suffer from a number of drawbacks: (i) use of expensive catalysts, ligands or additives; (ii) need harsh conditions (*e.g.*, under inert gas protection); (iii) limited starting materials (organometallic reagents for C_{aryl}–N coupling);[6] (iv) trace-metal contamination (especially in production of APIs).[7] Hence, developing a cheaper, less toxic, and eco-friendly methodology is highly desirable, and in this context, TM-free processes aroused extensive attention.[8–15] For instance, Tu,[10] Bolm,[11] and others[12,14] described the base-promoted amination of aryl halides with *N*-nucleophiles. Considerable efforts have been directed towards the formation of heterocycles,[13] especially through intra or intermolecular N-arylation.[11c–f,14]

Quinoline, as a privileged skeleton, is a core element of many pharmaceutically relevant compounds and natural products.[15] Quinoline derivatives have been widely used in the manufacture of dyes and the discovery of experimental drug candidates.[16] Among them, 1,4-dihydroquinolines have attracted special research interest,[17] because of their potential utilities as calcium channel modulators (1,4-DHPs),[17a–c] brain delivery carriers,[17d] antiurease compounds,[17e] HIV-1 inhibitors,[17f] the M_1 muscarinic receptor modulators,[17g] and organic optoelectronic materials.[17h] Traditional strategies for the assembly of the quinoline ring system involve an initial intermolecular reaction of an aniline with a carbonyl compound or its precursor, which suffered from a lack of readily available starting materials (*o*-aminobenzaldehydes) and harsh reaction conditions (*e.g.* Scheme 1, **A**).[18] Recently, transition-metal-catalyzed syntheses of quinoline derivatives have also been developed. Palladium, rhodium, ruthenium, and iron salts or complexes are used as catalysts in combination with strong bases.[19] Our goal is to seek for an efficient method for the synthesis of quinoline derivatives by transition-metal-free intermolecular cyclization from simple and readily accessible substrates.



Scheme 1 Acid or transition-metal catalyzed synthesis of quinoline derivatives.

Considering our previous findings (Scheme 1, **B**),[19a,g] we designed **A** as a building block, which could be generated *via* the Baylis–Hillman reaction[20] from β-enaminone and benzaldehyde, and then under basic conditions, the *ortho*-substituent of the aldehyde serving as a leaving group leads to the final ring-closed product, the 1,4-dihydroquinoline derivative (Scheme 2).[11c–f]

To carry out our trials, β-enaminone **2a** (easily prepared from the corresponding amine with diketone) and *o*-bromobenzaldehyde were selected as model substrates. To our delight, the desired product 1,4-dihydroquinoline **3aa** could be obtained in 33% LC-yield without the involvement of any

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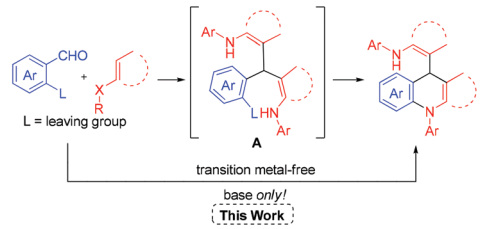
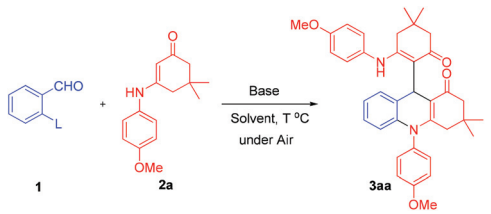


Scheme 2 TM-free synthesis of 1,4-dihydroquinoline derivatives.

Table 1 Optimization of the reaction conditions[a]



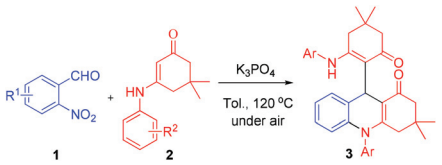
Entry	L	Base	Solvent (2 ml)	Temp. (°C)	Time (h)	LC yield[b] (%)
1	Br	Cs_2CO_3	Toluene	110	12	33
2	Cl	Cs_2CO_3	Toluene	110	12	<10
3	NO_2	Cs_2CO_3	Toluene	110	12	60(52[c])
4	NO_2	K_2CO_3	Toluene	110	24	59
5	NO_2	*t*-BuOK	Toluene	110	12	41
6	NO_2	NaOAc	Toluene	110	24	39
7	NO_2	—	Toluene	110	24	39
8	NO_2	KOH	Toluene	110	12	Trace
9	NO_2	DABCO[d]	Toluene	110	24	43
10	NO_2	K_3PO_4	Toluene	110	12	65(54[c])
11[e]	NO_2	K_3PO_4	Toluene	120	12	79(70[c])
12[e]	NO_2	K_3PO_4	MeCN	Reflux	12	(30[c])
13[e]	NO_2	K_3PO_4	EtOH	Reflux	12	Trace
14[e]	NO_2	K_3PO_4	DMF	120	12	(23[c])
15[e]	NO_2	K_3PO_4	DMSO	120	12	Trace

[a] Reaction conditions: **1a** (0.25 mmol), **2a** (0.5 mmol), solvent (2 mL), and base (2 equiv.). [b] Yields were determined by LC with an internal standard (biphenyl) as the ratio between the formed products and the initial amount of the limiting reactant. [c] Isolated yield. [d] DABCO = triethylenediamine. [e] 0.3 mmol **1a** was used.

transition-metal catalyst (Table 1, entry 1). When the bromo-substituent of **1a** was changed to a chloro group, a lower yield was obtained (Table 1, entry 2). Interestingly, the reaction employing 2-nitrobenzaldehyde performed better leading to **3aa** in 60% LC-yield (Table 1, entry 3). Further optimization studies revealed that the product formation was dramatically affected by the base (*e.g.*, Cs_2CO_3, *t*-BuOK, NaOAc, KOH, DABCO and K_3PO_4) (Table 1, entries 3–10). Among the bases screened, K_3PO_4 turned out to be the best choice, leading to remarkable improvement of the product yield (70% isolated yield) by increasing the temperature to 120 °C (oil bath temperature) in toluene under air (Table 1, entry 11). Moreover, the feasibility of the solvents was also investigated and no better results were observed in these cases (Table 1, entries 12–15).

Under the optimized reaction conditions, the scope of this intermolecular cyclization reaction was examined using

Table 2 Synthesis of 1,4-dihydroquinoline derivatives[a]



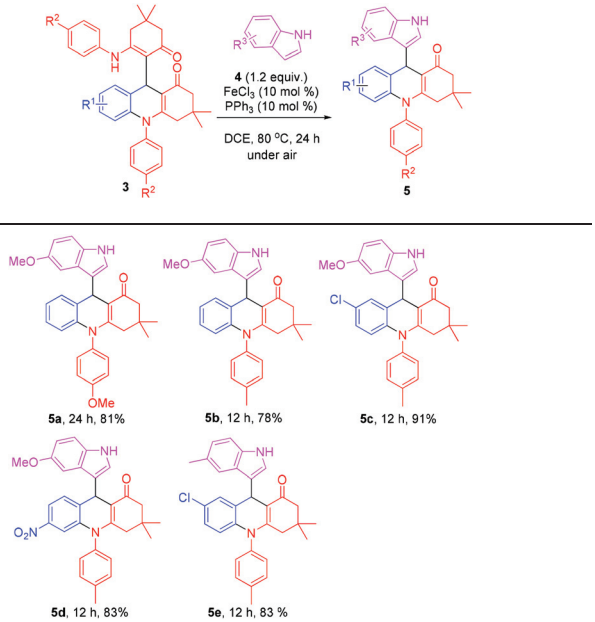
Entry	R^1	R^2	Time (h)	Product	Yield[b] (%)
1	H	4-OMe	12	**3aa**	70
2	H	4-OCF_3	12	**3ab**	68
3	H	3,4-Methylenedioxy	14	**3ac**	68
4	H	4-Me	16	**3ad**	75
5	H	3-Me	16	**3ae**	61
6	H	2-Me	17	**3af**	22
7	H	H	17	**3ag**	73
8	H	4-Cl	21	**3ah**	75
9	H	3-Cl	20	**3ai**	72
10	H	4-Br	18	**3aj**	75
11	H	4-I	18	**3ak**	68
12	H	4-CN	24	**3al**	Trace
13	4-NO_2	4-OMe	10	**3ba**	75
14	5-Cl	4-OMe	10	**3ca**	74
15	5-F	4-OMe	12	**3da**	66
16	5-OTs	4-OMe	11	**3ea**	54
17	5-OBn	4-OMe	18	**3fa**	50

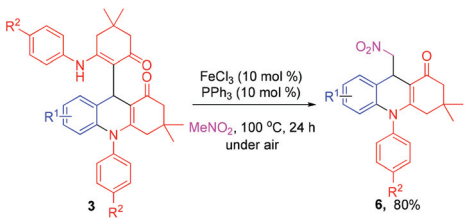
[a] Reaction conditions: **1** (0.3 mmol), **2** (0.5 mmol) and K_3PO_4 (0.6 mmol) in 2 mL toluene. [b] Isolated yield.

various substituted enaminones with *o*-nitrobenzaldehydes, as shown in Table 2. The 3-aryl enaminones bearing functional groups such as methoxy (**2a**), trifluoromethoxy (**2b**), 3,4-methylenedioxy (**2c**), methyl (**2d–e**), as well as halogens (**2h–k**) were equally efficient, giving the desired 1,4-dihydroquinoline derivatives **3** in very similar good yields (61–75%) (Table 2, entries 1–5 and 8–11). It was found that the reaction of **1a** and **2f** with *ortho* steric hindrance could also lead to the product **3af**, albeit in 22% yield (Table 2, entry 6). Enaminones **2g** reacting with **1a** furnished the corresponding products **3ag** in 73% yield (Table 2, entry 7). However, substrate **2l** with a strong electron-withdrawing group had dramatic detrimental effects on the transformation, likely due to the low nucleophilicity of the resulting anion for further cyclization (Table 2, entry 12). In addition, nitro (**1b**), halogens (**1c–d**), OTs (**1e**), and OBn (**1f**) substituents on the 2-nitrobenzaldehyde were also found to be suitable for the present cascade reactions to afford the expected products **3ba**, **3ca**, **3da**, **3ea**, and **3fa** in 75%, 74%, 66%, 54%, and 50% yields, respectively (Table 2, entries 13–17).

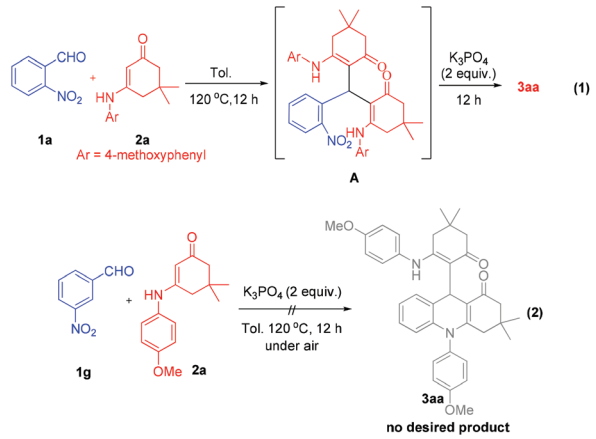
Recently, the use of the 1,3-dicarbonyl fragment as a leaving group through C–C bond cleavage has emerged as an attractive alternative in organic synthesis.[21] We envisioned that we could apply a similar β-enaminone unit as a leaving group through C–C bond cleavage. Therefore, the diverse applications of 1,4-dihydroquinoline derivatives **3** were subsequently investigated by performing the reaction of **3** with indoles **4**. The assembly of these important heterocyclic cores becomes highly desirable, which might be useful for developing libraries of medicinal scaffolds. It was found that the

Table 3 Reaction of **3** with indoles **4**

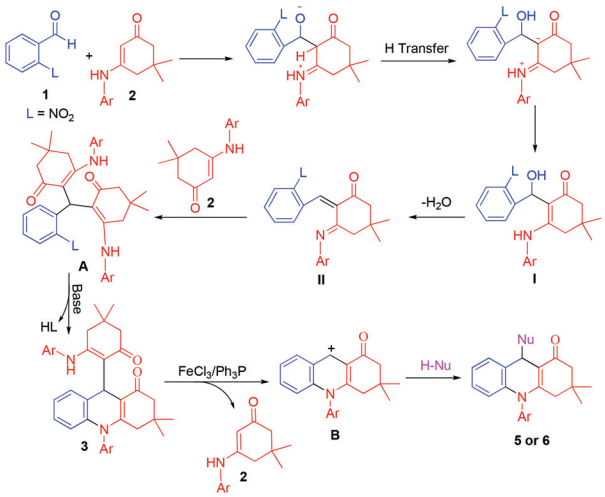




Scheme 3 Reaction of **3** with nitromethane.



Scheme 4 Control experiment.



Scheme 5 Plausible reaction pathway.

densely functionalized 1,4-dihydroquinoline derivatives **5** were obtained in 78–91% yields with 10 mol% $FeCl_3$ and 10 mol% PPh_3 (Table 3). Scheme 3 shows that nitromethane could react smoothly with 1,4-dihydroquinoline derivatives **3** as another carbon-based nucleophile.

To gain a deeper mechanistic understanding, we tried **1a** with **2a** in the absence of potassium phosphate in toluene under air for 12 h. It was found that intermediate **A**, rather than the expected product **3aa**, was formed in the system (determined by LC-MS analysis, Scheme 4, eqn (1)). In the following step, potassium phosphate (2 equiv.) was added to the reaction for another 12 h, only a trace amount of **A** remained, along with the formation of the final ring-closed product **3aa** in 50% yield. These experimental results reveal that intermediate **A** plays a central role in this intermolecular cascade cyclization process. Next, when the aldehyde **1g** bearing a nitro group in the *meta*-position was subjected to the reaction instead of **1a**, no cyclic product **3aa** was observed (Scheme 4, eqn (2)). Although not entirely conclusive, this result indicates that the reaction does not proceed *via* an aryne intermediate.[22]

On the basis of above results, a reasonable pathway for the formation of 1,4-dihydroquinoline derivatives was postulated in Scheme 5. Firstly, the intermediate **I** was generated through a Baylis–Hillman-type reaction[20] from benzaldehydes and enaminones, involving H-transfer and tautomerization of imine back to the enamine process. This intermediate **I** underwent elimination of water to form the corresponding α,β-unsaturated imine/ketone **II**, which were susceptible towards nucleophilic attack of another β-enaminone to give **A**. Under the basic conditions, the nitro-substituent of **A** serving as a leaving group leads to the final product **3**.[14d,23] However, the details regarding nitro group's elimination are not very clear, it seems to proceed through an S_NAr mechanism. The mechanism from **3** to **5**/**6** demonstrated in Table 3 and Scheme 3 might involve the following steps: (i) with the promotion of a catalyst, breaking of a C–C bond of the product **3**, in which a fragment of **2** acts as a leaving group (**2** determined by LC-MS analysis during the reaction), generating thus a carbonium intermediate **B**;[21] (ii) trapping of **B** with another nucleophile,

such as indole or nitromethane, which led to the formation of the product **5** or **6**.

In conclusion, we have developed a transition-metal-free intermolecular cyclization reaction of aldehydes with enaminones. By using this methodology, a variety of 1,4-dihydroquinoline derivatives were synthesized in moderate to good yields. Particularly, the application of a β-enaminone unit as a new and useful leaving group through C–C bond cleavage of 1,4-dihydroquinoline derivatives was attractive.

Experimental

General

Unless otherwise stated, all reagents were purchased from commercial suppliers and used without further purification. All reactions were carried out in air and using an undistilled solvent, without any precautions to exclude air and moisture unless otherwise noted. Melting points were recorded on electrothermal digital melting point apparatus. IR spectra were recorded on a FT-IR spectrophotometer using KBr optics. ^{1}H and ^{13}C NMR spectra were recorded in $CDCl_3$ or DMSO-d_6 on 300 MHz, 400 MHz or 600 MHz spectometers. Tetramethylsilane (TMS) served as the internal standard for ^{1}H NMR and $CDCl_3$ or DMSO-d_6 was used as the internal standard for ^{13}C NMR. High resolution mass spectra were obtained using commercial apparatus (ESI source).

General procedure for intermolecular cascade cyclization of aldehydes with enaminones

o-Nitrobenzaldehyde **1** (0.3 mmol), enaminone **2** (0.5 mmol) and K_3PO_4 (0.6 mmol) in 2 mL toluene were stirred at 120 °C under air for the stipulated time mentioned in Table 2. Upon completion of the reaction (indicated by TLC), the residue was directly purified by flash column chromatography using ethyl acetate and petroleum ether as eluents to afford the pure product **3**.

General procedure for reaction of 1,4-dihydroquinoline derivatives 3 with indoles

1,4-Dihydroquinoline derivative **3** (0.3 mmol), indole **4** (0.36 mmol), $FeCl_3$ (0.03 mmol) and PPh_3 (0.03 mmol) in 2 mL DCE (1,2-dichloroethane) were stirred at 80 °C under air for the stipulated time mentioned in Table 3. Upon completion of the reaction (indicated by TLC), the residue was directly purified by flash column chromatography using ethyl acetate and petroleum ether as eluents to afford the pure product **5**.

General procedure for reaction of 1,4-dihydroquinoline derivatives 3 with nitromethane

1,4-Dihydroquinoline derivative **3** (0.3 mmol), $FeCl_3$ (0.03 mmol) and PPh_3 (0.03 mmol) in 2 mL nitromethane were stirred at 80 °C under air for 24 h. Upon completion of the reaction (indicated by TLC), the residue was directly purified by flash column chromatography using ethyl acetate and petroleum ether as eluents to afford the pure product **6**.

10-(4-Methoxyphenyl)-9-(2-(4-methoxyphenylamino)-4,4-dimethyl-6-oxocyclohex-1-enyl)-3,3-dimethyl-3,4,9,10-tetrahydroacridin-1(2*H*)-one (3aa). Yellow solid. Mp = 218–220 °C. IR (KBr) ν = 3218, 3063, 2955, 2871, 1613, 1589, 1512, 1458, 1389, 833, 756 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.88 (d, J = 8.1 Hz, 6H), 0.98 (s, 6H, $2CH_3$), 2.00–2.31 (m, 7H), 2.69 (d, J = 16.5 Hz, 1H), 3.84 (s, 3H), 3.90 (s, 3H), 5.10 (s, 1H), 6.14–6.17 (m, 1H), 6.85–6.87 (m, 2H), 6.92 (d, J = 8.6 Hz, 2H), 6.99–7.17 (m, 6H), 7.82 (d, J = 8.5, 1H), 10.01 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 196.7, 195.1, 159.5, 157.0, 156.4, 156.1, 141.2, 133.9, 133.1, 131.9, 131.3, 128.7, 127.7, 126.2, 124.8, 123.1, 119.6, 116.0, 115.7, 114.6, 114.5, 107.4, 55.7, 51.8, 49.9, 42.5, 40.5, 32.7, 32.3, 32.1, 30.1, 29.9, 28.3, 28.1, 26.7 ppm. HRMS m/z: calcd for $C_{37}H_{40}N_2O_4$ $[M]^+$ 576.2988, found: 576.3008.

9-(4,4-Dimethyl-6-oxo-2-(4-(trifluoromethoxy)phenylamino)-cyclohex-1-enyl)-3,3-dimethyl-10-(4-(trifluoromethoxy)phenyl)-3,4,9,10-tetrahydroacridin-1(2*H*)-one (3ab). Yellow solid. Mp = 125.5–126.5 °C. IR (KBr) ν = 2959, 2870, 1591, 1558, 1507, 1490, 1392, 1253, 1200, 1156, 1017, 747, 631 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.89 (s, 6H), 1.01 (d, J = 7.2 Hz, 6H), 2.34–1.92 (m, 7H), 2.80 (d, J = 16.3 Hz, 1H), 5.09 (s, 1H), 6.12–6.04 (m, 1H), 6.93–6.85 (m, 2H), 6.98 (dd, J = 9.3, 4.5 Hz, 1H), 7.24–7.16 (m, 4H), 7.33 (d, J = 7.1 Hz, 1H), 7.46–7.38 (m, 2H), 8.03 (d, J = 7.0 Hz, 1H), 10.30 (s, 1H) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 197.0, 195.6, 155.3, 155.2, 149.1, 144.6, 140.7, 139.8, 138.7, 132.7, 131.9, 128.7, 127.2, 126.3, 123.4, 122.9, 122.1, 121.9 121.7, 121.3, 119.3, 119.2, 115.5, 107.6, 51.9, 49.8, 42.5, 40.5, 33.1, 32.3, 32.0, 29.9, 28.5, 27.4, 26.4 ppm. HRMS m/z: calcd for $C_{37}H_{35}F_6N_2O_4$ $[M + H]^+$ 685.2501, found 685.2498.

10-(Benzo[*d*][1,3]dioxol-5-yl)-9-(2-(benzo[*d*][1,3]dioxol-5-ylamino)-4,4-dimethyl-6-oxocyclohex-1-enyl)-3,3-dimethyl-3,4,9,10-tetrahydroacridin-1(2*H*)-one (3ac). Yellow solid. Mp = 215.9–217.5 °C. IR (KBr) ν = 2953, 2868, 1616, 1587, 1482, 1457, 1390, 1270, 1229, 929, 808, 756, 746, 669 cm^{-1}. ^{1}H NMR (600 MHz, $CDCl_3$): δ = 0.89 (d, J = 14.0 Hz, 6H), 0.99 (d, J = 11.8 Hz, 6H), 2.10–2.30 (m, 7H), 2.70 (d, J = 16.5 Hz, 1H), 5.06 (s, 1H), 6.01–5.98 (m, 2H), 6.06–6.12 (m, 2H), 6.24 (t, J = 6.4 Hz, 1H), 6.69 (d, J = 7.9 Hz, 1H), 6.76–6.71 (m, 2H), 6.81 (d, J = 8.1 Hz, 1H), 7.00–6.86 (m, 4H), 7.44 (d, J = 10.1 Hz, 1H), 10.02 (s, 1H). ^{13}C NMR (150 MHz, $CDCl_3$): δ = 196.9, 195.2, 156.9, 156.0, 149.7, 148.3, 148.0, 144.4, 141.2, 135.3, 134.2, 128.8, 127.7, 126.3, 124.5, 123.7, 123.2, 120.0, 116.5, 115.7, 111.6, 111.0, 110.1, 108.5, 107.6, 105.4, 102.1, 101.5, 51.8, 50.0, 42.5, 40.7, 32.8, 32.3, 32.2, 30.1, 30.0, 28.3, 28.2, 26.9 ppm. HRMS m/z: calcd for $C_{37}H_{37}N_2O_6$ $[M + H]^+$ 605.2652, found 605.2663.

9-(4,4-Dimethyl-6-oxo-2-(*p*-tolylamino)cyclohex-1-enyl)-3,3-dimethyl-10-*p*-tolyl-3,4,9,10-tetrahydroacridin-1(2*H*)-one (3ad). Yellow solid. Mp = 246–248 °C. IR (KBr) ν = 3147, 3029, 2954, 2871, 1634, 1589, 1512, 1458, 1389, 810, 756 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.88 (d, J = 5.7 Hz, 6H, $2CH_3$), 0.99 (d, J = 8.4 Hz, 6H, $2CH_3$), 1.98–2.32 (m, 7H), 2.36 (s, 3H, CH_3), 2.46 (s, 3H, CH_3), 2.80 (d, J = 16.6 Hz, 1H), 5.11 (s, 1H, CH), 6.10–6.14 (m, 1H, ArH), 6.84–7.19 (m, 8H, ArH), 7.32 (d, J = 7.8 Hz, 1H, ArH), 7.38 (d, J = 8.0 Hz, 1H, ArH), 7.77 (d, J =

7.3 Hz, 1H, ArH), 10.15 (s, 1H, NH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 196.7, 195.4, 156.4, 155.9, 141.1, 138.7, 138.5, 137.8, 133.0, 131.8, 130.6, 130.1, 130.0, 129.9, 128.8, 127.6, 126.2, 123.1, 122.8, 120.5, 115.8, 107.4, 52.0, 50.0, 42.6, 40.7, 33.0, 32.5, 32.2, 30.1, 28.5, 27.9, 26.8, 21.5, 21.1 ppm. HRMS *m*/*z*: calcd for $C_{37}H_{40}N_2O_2$ $[M]^+$ 544.3090, found: 544.3078.

9-(4,4-Dimethyl-6-oxo-2-(*m*-tolylamino)cyclohex-1-enyl)-3,3-dimethyl-10-*m*-tolyl-3,4,9,10-tetrahydroacridin-1(2*H*)-one (3ae). Yellow solid. Mp = 242–244 °C. IR(KBr) ν = 3129, 3063, 3013, 2954, 2867, 1636, 1584, 1558, 1495, 1457, 1394, 889, 750, 727 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.90 (d, *J* = 6.4 Hz, 6H, $2CH_3$), 1.00 (d, *J* = 12.3 Hz, 6H, $2CH_3$), 2.00–2.33 (m, 7H), 2.39 (s, 3H, CH_3), 2.46 (s, 3H, CH_3), 2.86 (d, *J* = 15.2 Hz, 1H), 5.12 (s, 1H, CH), 6.08–6.13 (m, 1H, ArH), 6.85–6.87 (m, 2H, ArH), 6.92 (d, *J* = 7.6 Hz, 1H, ArH), 6.98–7.24 (m, 5H, ArH), 7.27–7.31 (m, 1H, ArH), 7.40–7.50 (m, 1H, ArH), 7.68–7.72 (m, 1H, ArH), 10.21 (s, 1H, NH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 196.9, 195.8, 156.2, 155.9, 141.5, 141.1, 140.4, 140.3, 139.6, 139.4, 131.1, 129.8, 129.4, 129.1, 128.8, 127.6, 127.4, 126.3, 124.0, 123.3, 121.2, 119.5, 115.8, 107.3, 52.1, 50.1, 42.6, 40.8, 33.2, 32.6, 32.3, 32.2, 30.2, 28.6, 27.8, 26.9, 21.7 ppm. HRMS *m*/*z*: calcd for $C_{37}H_{40}N_2O_2$ $[M]^+$ 544.3090, found: 544.3099.

9-(4,4-Dimethyl-6-oxo-2-(*o*-tolylamino)cyclohex-1-enyl)-3,3-dimethyl-10-*o*-tolyl-3,4,9,10-tetrahydroacridin-1(2*H*)-one (3af). Yellow solid. Mp = 236–238 °C. IR(KBr) ν = 3142, 3014, 2957, 2867, 1640, 1592, 1559, 1486, 1393, 750, 709 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.91 (d, *J* = 10.1 Hz, 6H, $2CH_3$), 0.98 (d, *J* = 3.0 Hz, 6H, $2CH_3$), 2.03–2.12 (m, 4H), 2.19 (s, 3H, CH_3), 2.26 (s, 3H, CH_3), 2.53–2.62 (m, 4H), 5.20 (s, 1H, CH), 5.99–6.01 (m, 1H, ArH), 6.86–6.88 (m, 2H, ArH), 7.01–7.10 (m, 1H, ArH), 7.13 (d, *J* = 7.1 Hz, 2H, ArH), 7.23 (d, *J* = 7.3 Hz, 1H, ArH), 7.28 (d, *J* = 7.3 Hz, 1H, ArH), 7.34–7.43 (m, 3H, ArH), 7.85–7.87 (m, 1H, ArH), 9.63 (s, 1H, NH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 196.5, 195.5, 157.2, 155.4, 139.7, 139.6, 139.4, 137.6, 132.7, 131.9, 131.1, 130.2, 129.1, 128.9, 128.8, 127.6, 126.7, 126.6, 124.8, 124.6, 123.1, 121.2, 114.9, 107.4, 51.8, 50.2, 41.4, 40.9, 32.6, 32.5, 32.2, 32.0, 29.3, 27.8, 27.3, 18.6, 17.7 ppm. HRMS *m*/*z*: calcd for $C_{37}H_{40}N_2O_2$ $[M]^+$ 544.3090, found: 544.3089.

9-(4,4-Dimethyl-6-oxo-2-(phenylamino)cyclohex-1-enyl)-3,3-dimethyl-10-phenyl-3,4,9,10-tetrahydroacridin-1(2*H*)-one (3ag). Yellow solid. Mp = 152–154 °C. IR (KBr) ν = 3148, 3033, 2955, 2871, 1736, 1589, 1559, 1489, 1458, 1389, 748, 702cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.89 (s, 6H, $2CH_3$), 0.98 (s, 3H, CH_3), 1.02 (s, 3H, CH_3), 1.96–2.33 (m, 7H), 2.85 (d, *J* = 16.4 Hz, 1H), 5.14 (s, 1H, CH), 6.09–6.11 (m, 1H, ArH), 6.85–7.00 (m, 3H, ArH), 7.10 (t, *J* = 7.0 Hz, 1H, ArH), 7.20–7.62 (m, 8H, ArH), 7.93 (d, *J* = 7.3 Hz, 1H, ArH), 10.26 (s, 1H, NH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 196.8, 195.6, 155.9, 155.7, 141.1, 140.4, 131.2, 130.9, 130.4, 129.4, 129.3, 128.8, 127.4, 126.3, 123.2, 123.0, 122.3, 121.1, 115.7, 107.3, 60.54, 52.0, 49.9, 42.6, 40.6, 33.1, 32.5, 32.1, 30.0, 27.8, 26.5 ppm. HRMS *m*/*z*: calcd for $C_{35}H_{36}N_2O_2$ $[M]^+$ 516.2777, found: 516.2752.

10-(4-Chlorophenyl)-9-(2-(4-chlorophenylamino)-4,4-dimethyl-6-oxocyclohex-1-enyl)-3,3-dimethyl-3,4,9,10-tetrahydroacridin-1(2*H*)-one (3ah). Yellow solid. Mp = 234–236 °C. IR (KBr) ν = 3156, 3040, 2955, 2871, 1620, 1589, 1559, 1489, 1389, 825, 756 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.88 (s, 6H, $2CH_3$), 1.00 (d, *J* = 5.4 Hz, 6H, $2CH_3$), 1.94–2.33 (m, 7H), 2.78 (d, *J* = 16.3 Hz, 1H), 5.09 (s, 1H, CH), 6.09–6.12 (m, 1H, ArH), 6.87–7.24 (m, 6H, ArH), 7.33 (d, *J* = 8.5 Hz, 2H, ArH), 7.52–7.58 (m, 2H, ArH), 7.90 (d, *J* = 6.4 Hz, 1H, ArH), 10.27 (s, 1H, NH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 197.3, 196.0, 155.8, 155.7, 141.0, 140.0, 139.2, 135.1, 132.7, 132.1, 131.8, 130.1, 129.6, 129.1, 128.5, 127.6, 126.7, 123.7, 121.5, 115.9, 107.9, 52.3, 50.2, 42.9, 40.9, 33.5, 32.7, 32.4, 30.4, 29.0, 27.8, 26.7 ppm. HRMS *m*/*z*: calcd for $C_{35}H_{34}Cl_2N_2O_2$ $[M]^+$ 584.1997, found: 584.1967.

10-(3-Chlorophenyl)-9-(2-(3-chlorophenylamino)-4,4-dimethyl-6-oxocyclohex-1-enyl)-3,3-dimethyl-3,4,9,10-tetrahydroacridin-1(2*H*)-one (3ai). Yellow solid. Mp = 202–204 °C. IR (KBr) ν = 3156, 3063, 2955, 2871, 1628, 1582, 1489, 1389, 887, 748, 725 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.89 (s, 6H, $2CH_3$), 1.02 (d, *J* = 8.3 Hz, 6H, $2CH_3$), 1.94–2.34 (m, 7H), 2.84 (d, *J* = 16.4 Hz, 1H), 5.08 (s, 1H, CH), 6.01 (s, 1H, ArH), 6.89–7.07 (m, 5H, ArH), 7.19–7.98 (m, 6H, ArH), 10.33 (s, 1H, NH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 197.1, 195.9, 155.3, 155.0, 142.6, 141.7, 140.6, 136.7, 135.0, 132.2, 131.2, 130.7, 130.3, 129.5, 129.4, 128.9, 127.2, 126.5, 123.5, 122.8, 121.8, 120.0, 115.6, 107.7, 52.2, 50.0, 42.6, 40.8, 33.4, 32.6, 32.2, 30.2, 28.9, 27.5, 26.5 ppm. HRMS *m*/*z*: calcd for $C_{35}H_{34}Cl_2N_2O_2$ $[M]^+$ 584.1997, found: 584.1968.

10-(4-Bromophenyl)-9-(2-(4-bromophenylamino)-4,4-dimethyl-6-oxocyclohex-1-enyl)-3,3-dimethyl-3,4,9,10-tetrahydroacridin-1(2*H*)-one (3aj). Yellow solid. Mp = 241–243 °C. IR (KBr) ν = 3156, 3056, 2955, 2871, 1613, 1589, 1566, 1489, 1389, 825, 756 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.88 (s, 6H, $2CH_3$), 1.00 (d, *J* = 5.2 Hz, 6H, $2CH_3$), 1.94–2.33 (m, 7H), 2.79 (d, *J* = 16.3 Hz, 1H), 5.08 (s, 1H, CH), 6.09–6.11 (m, 1H, ArH), 6.87–6.98 (m, 3H, ArH), 7.07 (d, *J* = 8.4 Hz, 2H, ArH), 7.17 (d, *J* = 6.6 Hz, 1H, ArH), 7.47 (d, *J* = 8.5 Hz, 2H, ArH), 7.71–7.85 (m, 3H, ArH), 10.27 (s, 1H, NH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 197.0, 195.7, 155.3, 140.6, 140.4, 140.2, 139.5, 134.4, 133.5, 132.8, 132.3, 129.0, 128.8, 127.3, 126.8, 126.4, 123.9, 123.7, 123.4, 122.9, 121.4, 115.7, 111.6, 107.6, 60.5, 52.0, 49.9, 42.6, 41.7, 40.6, 36.5, 33.2, 32.1, 28.7, 27.5 ppm. HRMS *m*/*z*: calcd for $C_{35}H_{34}Br_2N_2O_2$ $[M]^+$ 674.0967, found: 674.0970.

10-(4-Iodophenyl)-9-(2-(4-iodophenylamino)-4,4-dimethyl-6-oxocyclohex-1-enyl)-3,3-dimethyl-3,4,9,10-tetrahydroacridin-1(2*H*)-one (3ak). Yellow solid. Mp = 264–266 °C. IR (KBr) ν = 3143, 3058, 2953, 2864, 1609, 1583, 1566, 1483, 1389, 824, 750 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.87 (s, 6H, $2CH_3$), 1.00 (d, *J* = 4.8 Hz, 6H, $2CH_3$), 1.94–2.32 (m, 7H), 2.80 (d, *J* = 16.7 Hz, 1H), 5.07 (s, 1H, CH), 6.09–6.11 (m, 1H, ArH), 6.87–6.89 (m, 2H, ArH), 6.95 (d, *J* = 7.6 Hz, 4H, ArH), 7.02–7.04 (m, 1H, ArH), 7.75 (d, *J* = 7.7 Hz, 2H, ArH), 7.89–7.93(m, 2H, ArH), 10.29 (s, 1H, NH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 197.1, 195.9, 155.4, 155.2, 143.5, 141.1, 140.8, 140.7, 140.3, 138.9, 138.3, 133.1, 132.5, 128.9, 128.5, 127.7, 127.5, 127.3, 126.5, 124.0, 123.6, 121.7, 115.8, 107.7, 52.2, 50.0, 42.8, 41.9, 40.8, 40.3, 33.4, 32.2, 30.2, 28.9, 26.6 ppm. HRMS *m*/*z*: calcd for $C_{35}H_{34}I_2N_2O_2$ $[M]^+$ 768.0710, found: 768.0721.

10-(4-Methoxyphenyl)-9-(2-(4-methoxyphenylamino)-4,4-dimethyl-6-oxocyclohex-1-enyl)-3,3-dimethyl-6-nitro-3,4,9,10-tetrahydroacridin-1(2*H*)-one (3ba). Yellow solid. Mp = 231.2–232.6 °C. IR (KBr) ν = 2960, 2929, 1608, 1578, 1509, 1387, 1324, 1262, 1241, 1179, 1033, 830, 802, 761, 735 cm^{-1}. ^1H NMR (600 MHz, $CDCl_3$): δ = 0.89 (d, J = 12.1 Hz, 6H), 0.99 (d, J = 12.5 Hz, 6H), 2.00–2.32 (m, 7H), 2.67 (d, J = 16.6 Hz, 1H), 3.85 (s, 3H), 3.93 (s, 3H), 5.08 (s, 1H), 6.94 (d, J = 8.6 Hz, 2H), 7.03 (d, J = 1.8 Hz, 1H), 7.13–7.07 (m, 3H), 7.16–7.22 (m, 3H), 7.69–7.72 (m, 1H), 7.80 (d, J = 7.8 Hz, 1H), 10.02 (s, 1H) ppm. ^{13}C NMR (150 MHz, $CDCl_3$): δ = 197.4, 194.9, 158.3, 156.9, 155.8, 146.6, 142.3, 135.2, 133.3, 131.0, 129.2, 125.3, 118.6, 117.8, 116.6, 115.3, 114.7, 110.5, 107.7, 55.8, 51.6, 49.9, 42.5, 40.7, 32.7, 32.5, 32.1, 30.1, 28.3, 28.1, 26.7 ppm. HRMS m/z: calcd for $C_{37}H_{40}N_3O_6$ $[M + H]^+$ 622.2917, found 622.2912.

7-Chloro-10-(4-methoxyphenyl)-9-(2-(4-methoxyphenylamino)-4,4-dimethyl-6-oxocyclohex-1-enyl)-3,3-dimethyl-3,4,9,10-tetrahydroacridin-1(2*H*)-one (3ca). Yellow solid. Mp = 216.1–217.9 °C. IR (KBr) ν = 2953, 1598, 1581, 1555, 1481, 1386, 1365, 1270, 1241, 1184, 1027, 833, 811, 607 cm^{-1}. ^1H NMR (600 MHz, $CDCl_3$): δ = 0.88 (d, J = 9.3 Hz, 6H), 0.99 (d, J = 11.9 Hz, 6H), 2.05–1.98 (m, 2H), 2.13 (t, J = 16.6 Hz, 3H), 2.25 (dd, J = 37.4, 16.3 Hz, 2H), 2.70 (d, J = 16.4 Hz, 1H), 3.84 (s, 3H), 3.90 (s, 3H), 5.02 (s, 1H), 6.07 (d, J = 8.8 Hz, 1H), 6.78–6.82 (m, 1H), 6.91–6.96 (m, 3H), 7.03 (dd, J = 8.5, 2.8 Hz, 1H), 7.08 (dd, J = 8.6, 2.6 Hz, 1H), 7.20–7.13 (m, 3H), 7.80 (d, J = 8.5, 1H), 10.04 (s, 1H) ppm. ^{13}C NMR (150 MHz, $CDCl_3$): δ = 196.8, 195.1, 159.7, 157.7, 156.6, 155.8, 140.2, 133.7, 132.8, 131.9, 131.1, 129.6, 128.3, 127.9, 126.1, 125.0, 118.9, 116.9, 116.2, 114.8, 114.6, 107.4, 55.8, 55.7, 51.8, 49.9, 42.5, 40.8, 32.9, 32.3, 32.1, 30.2, 28.6, 27.9, 26.7 ppm. HRMS m/z: calcd for $C_{37}H_{40}ClN_2O_4$ $[M + H]^+$ 611.2677, found 611.2671.

7-Fluoro-10-(4-methoxyphenyl)-9-(2-(4-methoxyphenylamino)-4,4-dimethyl-6-oxocyclohex-1-enyl)-3,3-dimethyl-3,4,9,10-tetrahydroacridin-1(2*H*)-one (3da). Yellow solid. Mp = 219.9–221.8 °C. IR (KBr) ν = 2956, 2866, 1608, 1569, 1508, 1490, 1386, 1366, 1243, 1231, 1149, 1032, 825, 808, 779, 605 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ = 0.88 (d, J = 5.2 Hz, 6H), 0.99 (d, J = 6.2 Hz, 6H), 2.05–2.00 (m, 2H), 2.17–2.07 (m, 3H), 2.18–2.32 (m, 2H), 2.68 (d, J = 16.5 Hz, 1H), 3.84 (s, 3H), 3.90 (s, 3H), 5.06 (s, 1H), 6.10 (dd, J = 9.0, 4.9 Hz, 1H), 6.55 (td, J = 8.6, 2.9 Hz, 1H), 6.71 (dd, J = 8.8, 2.5 Hz, 1H), 6.93 (d, J = 8.8 Hz, 2H), 7.03 (dd, J = 8.6, 2.7 Hz, 1H), 7.08 (dd, J = 8.6, 2.5 Hz, 1H), 7.17 (d, J = 8.6 Hz, 3H), 7.80 (d, J = 7.3 Hz, 1H), 10.03 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 196.7, 195.1, 159.7, 157.6, 156.6, 156.0, 137.9, 133.8, 133.1, 132.0, 131.2, 130.0, 125.0, 119.0, 116.9, 116.8, 116.2, 114.8, 114.6, 112.8, 112.6, 106.6, 55.8, 55.7, 51.8, 50.0, 42.6, 40.1, 32.8, 32.6, 32.1, 30.1, 28.5, 28.1, 26.7 ppm. HRMS m/z: calcd for $C_{37}H_{40}FN_2O_4$ $[M + H]^+$ 595.2972, Found 595.2960.

10-(4-Methoxyphenyl)-9-(2-(4-methoxyphenylamino)-4,4-dimethyl-6-oxocyclohex-1-enyl)-6,6-dimethyl-8-oxo-5,6,7,8,9,10-hexahydroacridin-2-yl 4-methylbenzenesulfonate (3ea). Yellow solid. Mp = 144.8–146.4 °C. IR (KBr) ν = 2953, 2868, 1569, 1559, 1508, 1488, 1374, 1242, 1177, 1146, 1032, 827, 813, 745, 705, 661 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ = 0.84 (s, 6H), 0.98 (d, J = 2.1 Hz, 6H), 2.04–1.95 (m, 3H), 2.06–2.13 (m, 2H), 2.26–2.18 (m, 2H), 2.32 (s, 3H), 2.62 (d, J = 16.3 Hz, 1H), 3.86 (s, 3H), 3.88 (s, 3H), 4.91 (s, 1H), 6.01 (d, J = 9.0 Hz, 1H), 6.39 (dd, J = 9.0, 2.6 Hz, 1H), 6.58 (d, J = 2.6 Hz, 1H), 6.94 (d, J = 8.8 Hz, 2H), 7.01 (dd, J = 8.5, 2.8 Hz, 1H), 7.06 (dd, J = 8.6, 2.7 Hz, 1H), 7.10–7.15 (m, 3H), 7.23–7.26 (m, 2H), 7.66 (d, J = 8.3 Hz, 2H), 7.77–7.73 (m, 1H), 9.87 (s, 1H) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ = 196.9, 195.0, 159.8, 157.7, 156.7, 155.9, 145.3, 145.2, 140.3, 133.6, 132.8, 131.9, 131.1, 129.8, 129.2, 128.8, 125.0, 122.3, 119.8, 118.8, 116.3, 116.2, 114.8, 114.7, 107.1, 55.8, 55.7, 51.8, 49.9, 42.5, 40.8, 32.8, 32.4, 32.1, 30.1, 28.7, 27.8, 26.7, 21.8 ppm. HRMS m/z: calcd for $C_{44}H_{46}N_2NaO_7S$ $[M + Na]^+$ 769.2923, found 769.2931.

7-(Benzyloxy)-10-(4-methoxyphenyl)-9-(2-(4-methoxyphenylamino)-4,4-dimethyl-6-oxocyclohex-1-enyl)-3,3-dimethyl-3,4,9,10-tetrahydroacridin-1(2*H*)-one (2fa). Yellow solid. Mp = 194.9–196.7 °C. IR (KBr) ν = 2951, 2866, 1574, 1560, 1509, 1492, 1388, 1242, 1219, 1032, 1010, 831, 805, 755 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ = 0.87 (d, J = 10.0 Hz, 6H), 0.97 (s, 6H), 2.06–2.00 (m, 3H), 2.08–2.14 (m, 2H), 2.17–2.31 (m, 2H), 2.61 (d, J = 16.3 Hz, 1H), 3.84 (s, 3H), 3.89 (s, 3H), 4.99–4.91 (m, 2H), 5.05 (s, 1H), 6.08 (d, J = 8.9 Hz, 1H), 6.50 (dd, J = 8.9, 2.9 Hz, 1H), 6.61 (d, J = 2.4 Hz, 1H), 6.92 (d, J = 8.8 Hz, 2H), 7.00–7.18 (m, 5H), 7.38–7.27 (m, 5H), 7.80 (d, J = 7.3 Hz, 1H), 10.07 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 196.4, 195.1, 159.6, 157.2, 156.4, 156.0, 155.0, 137.6, 135.8, 134.1, 133.4, 132.1, 131.2, 129.5, 128.8, 128.0, 127.6, 124.8, 119.3, 116.7, 116.1, 115.3, 114.6, 112.3, 106.5, 70.4, 55.8, 55.7, 51.9, 50.0, 42.6, 40.7, 32.9, 32.7, 32.1, 30.1, 27.9, 26.8 ppm. HRMS m/z: calcd for $C_{44}H_{47}N_2O_5$ $[M + H]^+$ 683.3485, found 683.3479.

9-(5-Methoxy-1*H*-indol-3-yl)-10-(4-methoxyphenyl)-3,3-dimethyl-3,4,9,10-tetrahydroacridin-1(2*H*)-one (5a). Yellow soild. Mp = 225.1–227.8 °C. IR (KBr) ν = 3283, 2962, 2923, 2867, 1596, 1558, 1509, 1484, 1456, 1391, 1268, 1241, 1182, 1023, 850, 749, 634 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ = 0.78 (s, 3H), 0.95 (s, 3H), 2.05–1.94 (m, 1H), 2.13–2.27 (m, 3H), 3.78 (s, 3H), 3.91 (s, 3H), 5.70 (s, 1H), 6.32 (d, J = 7.5 Hz, 1H), 6.75 (d, J = 7.0 Hz, 1H), 6.98–6.90 (m, 3H), 7.07 (d, J = 8.5 Hz, 2H), 7.18–7.11 (m, 2H), 7.22–7.28 (m, 3H), 7.95 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 195.6, 159.6, 153.7, 152.4, 140.4, 132.4, 131.8, 131.3, 130.0, 126.9, 126.5, 126.4, 123.8, 122.9, 122.6, 115.6, 115.4, 111.5, 110.1, 102.4, 56.1, 55.6, 50.3, 42.3, 32.1, 31.4, 29.9, 26.9 ppm. HRMS m/z: calcd for $C_{31}H_{31}N_2O_3$ $[M + H]^+$ 479.2335, found 479.2329.

9-(5-Methoxy-1*H*-indol-3-yl)-3,3-dimethyl-10-*p*-tolyl-3,4,9,10-tetrahydroacridin-1(2*H*)-one (5b). Yellow soild. Mp = 234.9–236.7 °C. IR (KBr) ν = 3312, 2956, 2832, 1597, 1559, 1508, 1487, 1457, 1383, 1362, 1266, 1244, 1171, 1061, 1032, 791, 758, 631, 611 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ = 0.77 (s, 3H), 0.94 (s, 3H), 2.04–1.92 (m, 2H), 2.28–2.13 (m, 3H), 2.48 (s, 3H), 3.78 (s, 3H), 5.70 (s, 1H), 6.32–6.26 (m, 1H), 6.74 (dd, J = 8.7, 2.1 Hz, 1H), 6.95–6.89 (m, 3H), 7.11 (d, J = 8.7 Hz, 1H), 7.21–7.17 (m, 3H), 7.28–7.25 (m, 1H), 7.37 (d, J = 7.9 Hz, 2H), 8.05 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 195.6, 153.6, 152.2, 140.2, 138.9, 137.1, 131.8, 131.0, 130.0, 130.0, 126.9, 126.4, 126.4, 123.8, 122.9, 122.5, 115.7, 111.6, 111.5, 110.0,

102.4, 56.1, 50.3, 42.3, 32.2, 31.5, 29.9, 26.9, 21.3 ppm. HRMS *m*/*z*: calcd for $C_{31}H_{31}N_2O_2$ $[M + H]^+$ 463.2386, found 463.2374.

7-Chloro-9-(5-methoxy-1*H*-indol-3-yl)-3,3-dimethyl-10-*p*-tolyl-3,4,9,10-tetrahydroacridin-1(2*H*)-one (5c). Yellow soild. Mp = 232.3–235.1 °C. IR (KBr) ν = 3323, 2956, 2867, 2828, 1622, 1559, 1508, 1477, 1417, 1381, 1264, 1172, 1105, 1059, 1032, 828, 816, 656 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ = 0.77 (s, 3H), 0.94 (s, 3H), 1.95 (d, *J* = 17.2 Hz, 1H), 2.26–2.11 (m, 3H), 2.48 (s, 3H), 3.81 (s, 3H), 5.63 (s, 1H), 6.20 (d, *J* = 8.8 Hz, 1H), 6.77 (dd, *J* = 8.8, 2.4 Hz, 1H), 6.87 (dd, *J* = 8.8, 2.4 Hz, 1H), 6.96 (s, 1H), 7.15 (d, *J* = 8.8 Hz, 1H), 7.19 (d, *J* = 2.3 Hz, 2H), 7.21 (d, *J* = 3.1 Hz, 2H), 7.38 (d, *J* = 8.0 Hz, 2H), 8.03 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 195.7, 153.9, 152.0, 139.4, 139.0, 137.0, 132.0, 131.4, 130.0, 129.9, 128.8, 128.6, 126.5, 126.5, 123.1, 122.2, 117.2, 111.8, 111.7, 109.8, 102.6, 56.4, 50.4, 42.4, 32.4, 31.8, 30.0, 27.0, 21.5 ppm. HRMS *m*/*z*: calcd for $C_{31}H_{29}ClN_2NaO_2$ $[M + Na]^+$ 519.1815, found 519.1781.

9-(5-Methoxy-1*H*-indol-3-yl)-3,3-dimethyl-6-nitro-10-*p*-tolyl-3,4,9,10-tetrahydroacridin-1(2*H*)-one (5d). Yellow soild. Mp = 222.5–223.8 °C. IR (KBr) ν = 3417, 2952, 2869, 1623, 1579, 1520, 1485, 1421, 1376, 1320, 1254, 1219, 1057, 1040, 885, 821, 800, 743, 676, 623 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ = 0.80 (s, 3H), 0.96 (s, 3H), 1.99 (d, *J* = 17.3 Hz, 1H), 2.29–2.14 (m, 3H), 2.52 (s, 3H), 3.83 (s, 3H), 5.72 (s, 1H), 6.78 (dd, *J* = 8.8, 2.4 Hz, 1H), 6.92 (d, *J* = 2.4 Hz, 1H), 7.16 (dd, *J* = 5.5, 3.3 Hz, 2H), 7.22 (d, *J* = 8.3 Hz, 3H), 7.38 (d, *J* = 8.4 Hz, 1H), 7.44 (d, *J* = 8.1 Hz, 2H), 7.74 (dd, *J* = 8.3, 2.2 Hz, 1H), 8.08 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 195.9, 154.1, 152.0, 146.9, 140.9, 140.1, 136.2, 134.0, 132.0, 131.8, 130.9, 129.7, 126.2, 123.1, 121.6, 118.5, 112.0, 111.9, 110.8, 110.1, 102.4, 56.4, 50.4, 42.3, 32.4, 31.9, 30.0, 27.0, 21.6 ppm. HRMS *m*/*z*: calcd for $C_{31}H_{29}N_3NaO_4$ $[M + Na]^+$ 530.2056, found 530.2031.

7-Chloro-3,3-dimethyl-9-(5-methyl-1*H*-indol-3-yl)-10-*p*-tolyl-3,4,9,10-tetrahydroacridin-1(2*H*)-one (5e). Yellow soild. Mp = 257.2–260.9 °C. IR (KBr) ν = 3299, 2950, 2922, 2863, 1598, 1559, 1476, 1383, 1360, 1322, 1265, 1178, 1106, 1036, 811, 796, 654, 617 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ = 0.76 (s, 3H), 0.94 (s, 3H), 2.02–1.95 (m, 1H), 2.25–2.08 (m, 3H), 2.43 (s, 3H), 2.50 (s, 3H), 5.60 (s, 1H), 6.15 (d, *J* = 8.9 Hz, 1H), 6.83 (dd, *J* = 8.8, 2.4 Hz, 1H), 6.92 (dd, *J* = 8.3, 1.0 Hz, 1H), 7.05 (d, *J* = 2.3 Hz, 1H), 7.17 (d, *J* = 7.9 Hz, 2H), 7.25 (d, *J* = 2.8 Hz, 2H), 7.41 (d, *J* = 8.0 Hz, 2H), 7.49 (s, 1H), 8.10 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 195.7, 151.9, 139.4, 138.7, 137.1, 135.2, 131.4, 130.1, 130.0, 128.8, 128.7, 128.1, 126.5, 126.3, 123.2, 122.3, 122.0, 119.5, 117.3, 111.1, 109.5, 50.3, 42.5, 32.4, 32.2, 30.1, 26.9, 21.9, 21.5 ppm. HRMS *m*/*z*: calcd for $C_{31}H_{29}ClN_2NaO$ $[M + H]^+$ 503.1866, Found 503.1846.

3,3-Dimethyl-9-(nitromethyl)-10-(4-nitrophenyl)-3,4,9,10-tetrahydroacridin-1(2*H*)-one (6). Yellow soild. Mp = 240.2–242.9 °C. ^1H NMR (400 MHz, $CDCl_3$): δ = 7.25 (dd, *J* = 6.1, 3.0 Hz, 1H), 7.14 (d, *J* = 8.2 Hz, 2H), 7.08–7.03 (m, 4H), 6.30–6.25 (m, 1H), 4.91 (t, *J* = 4.3 Hz, 1H), 4.74 (dd, *J* = 11.0, 5.0 Hz, 1H), 4.52 (dd, *J* = 11.0, 3.9 Hz, 1H), 3.90 (s, 3H), 2.29 (s, 2H), 2.16–1.95 (m, 2H), 1.03 (s, 3H), 1.00 (s, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 195.4, 159.9, 155.7, 140.9, 131.7, 130.9, 128.9, 128.1, 124.5, 121.9, 116.8, 115.7, 104.0, 81.1, 55.8, 50.2, 42.4, 35.1, 32.4, 30.1, 27.1 ppm. HRMS *m*/*z*: calcd for $C_{23}H_{25}N_2O_4$ $[M + H]^+$ 393.1814, found 393.1814.

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