JOC The Journal of Organic Chemistry

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# Visible Light Mediated Organocatalytic Activation of Ethyl Bromofluoroacetate: Coupling with Indoles and Anilines

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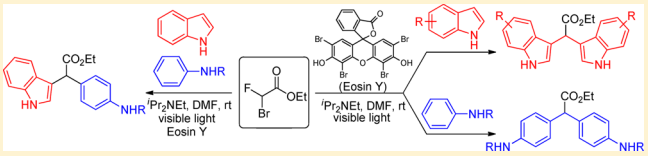
Supporting Information

**ABSTRACT:** The activation of ethyl bromofluoroacetate employing a visible light mediated, Eosin Y catalyzed photoredox transformation is reported. Using indoles and anilines as nucleophiles, the reaction leads to the formation of two $C_{sp^2}$–$C_{sp^3}$ bonds resulting in an efficient synthesis of bisindolyl and bisanilinoyl acetate derivatives. Application of this method to the direct synthesis of unsymmetrical diarylacetates featuring indoles and *N*-substituted anilines was also demonstrated.



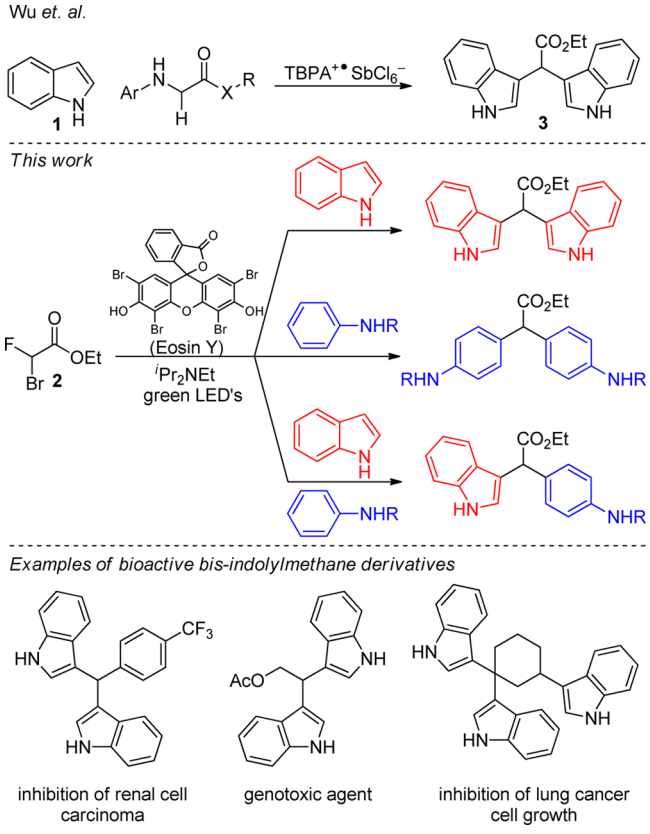

## INTRODUCTION

The formation of carbon–carbon bonds is a process of fundamental importance in organic synthesis. There exists a wide array of elegant transformations that result in the formation of C–C bonds, but the quest continues for newer methods that offer advantages of improved selectivity, milder conditions, environmental sustainability, and convenient access to starting materials. One of the current challenges in this area is the development of catalytic processes, especially those which do not rely on metals. Herein, we report the activation of C–Br and C–F bonds in ethyl bromofluoroacetate initiated by an organo-photocatalytic manifold employing visible light as the energy source.[1] This strategy represents a mild route toward bisindolylmethane derivatives which are of interest due to their biological activities (Scheme 1)[2] and also provides a convenient synthesis for bisanilinoyl acetate derivatives that are otherwise difficult to access.[3] Wu and co-workers have recently published an elegant double Fridel–Crafts alkylation of glycine derivatives for the synthesis of bisindolylacetates employing C–N and C–H activation (Scheme 1).[4] Our strategy utilizes the commercially available and inexpensive ethylbromofluoroacetate to construct $C_{sp^2}$–$C_{sp^3}$ bonds, via the activation of the C–Br and C–F bonds.

## RESULTS AND DISCUSSION

Our initial studies (Table 1a) focused on employing ethylbromofluoroacetate as a radical precursor which would react with nuleophiles such as arenes. Preliminary experiments revealed that Eosin Y as a catalyst provided clean conversion to product (**3**), albeit with low yield.[5] While only one product was being formed, **2** was being completely consumed, and hence we reasoned that the radical generated from **2** might be getting reduced by the amine ($^i$Pr$_2$NEt)[6] and the amount of ethyl bromofluoroacetate was increased. Under these conditions, **3** was obtained as the sole product in high yield. Dimethylformamide (DMF) was found to be the ideal solvent, and it was observed that dimethyl sulfoxide (DMSO) afforded diminished yields while no product was obtained with acetonitrile ($CH_3CN$).

**Scheme 1. Activation of C–Br and C–F Bonds in Ethyl Bromofluoroacetate**




Under the optimized conditions, only 2.5 mol % of Eosin Y was necessary to afford the product efficiently. A comparative study into the applicability of ethyl dibromoacetate and ethyl chlorofluoroacetate revealed that only ethyl bromofluoroacetate

**Received:** August 1, 2015
**Published:** September 22, 2015

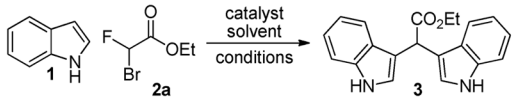




DOI: 10.1021/acs.joc.5b01736
J. Org. Chem. 2015, 80, 10187–10196

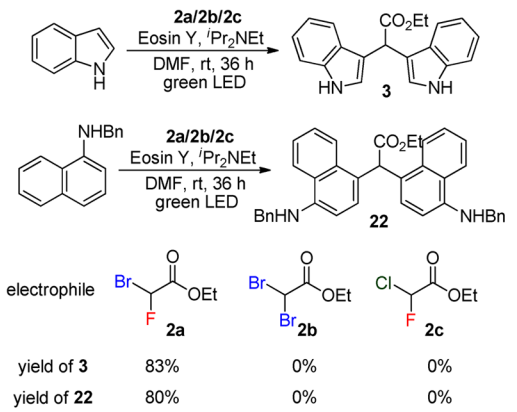
**Table 1. Preliminary Experiments and Reaction Optimization**

a) Optimization of Reaction Conditions




| entry | catalyst | 1 (equiv.) | 2 (equiv.) | $^i$Pr$_2$NEt (equiv.) | solvent | yield[c] (%) |
|---|---|---|---|---|---|---|
| 1[a] | Eosin Y | 2 | 1 | 0.3 | DMF | 31 |
| 2[a] | Eosin Y | 2 | 1 | 1.1 | DMF | 37 |
| 3[a] | Eosin Y | 2 | 1 | 1.5 | DMF | 39 |
| 4[a] | Eosin Y | 2 | 1 | 2.0 | DMF | 42 |
| 5[a] | Eosin Y | 2 | 1 | 2 | DMSO | 18 |
| 6[a] | Eosin Y | 2 | 1 | 2 | MeCN | 00 |
| 7[a] | Eosin Y | 2 | 1 | 2 | DMF | 38 |
| 8[b] | Eosin Y | 1 | 1 | 1.5 | DMF | 67 |
| 9[a] | Eosin Y | 1 | 2 | 2 | DMF | 83 |

b) Evaluation of Ethyl dibromoacetate and Ethyl chlorofluoroacetate

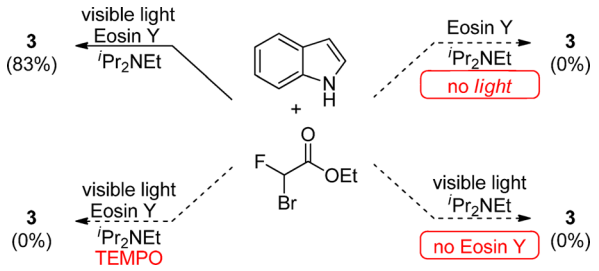



[a]2.5 mol % EOSIN Y. [b]5 mol % EOSIN Y. [c]Isolated yield.

could be activated by photocatalysis (Table 1b). The C3 substitution on indole was established by NMR studies and further confirmed by X-ray diffraction of a single crystal that was obtained for **7**. The C3-alkylation is an interesting contrast to the reported C2 selectivity provided by the malonyl radical.[6]

Key control experiments were performed to establish that both visible light and catalyst are necessary for the reaction and that simply heating indole with **2** did not afford any product (Scheme 2). A test reaction in the presence of (2,2,6,6-tetramethylpiperidin-1-yl)oxidanyl (TEMPO) did not afford any bisindole product, indicating the involvement of a radical mechanism.

**Scheme 2. Control Experiments**




This protocol for generating bis-indolyl acetates represents a milder alternative to the currently known acid[7] and metal[8] mediated methods. Table 2 shows the derivatives that were synthesized using the optimized procedure. Electron-rich aromatics were found to be suitable substrates for this reaction. Various substituted indoles and anilines afforded the corresponding diarylacetate products efficiently. Free indole (*N*-H), *N*-methylindole, and 2-methylindole reacted smoothly, and a variety of substitutions on the carbocyclic ring of indole were tolerated well. It was discovered that 3-substituted indoles did not react under these conditions. *N*-Substituted anilines (mono- and disubstituted) exhibited *C*-alkylation at the 4-position to afford products in good yields. The applicability of precursors with pendant olefin and acetylene as functionalities was also possible (products **15**, **16**, **17**, Table 2). While the *N*,*N*-dimethylaniline derivative **18** was obtained in low yield (probably due to the propensity of such tertiary amines to engage in electron transfer),[9] the fluoro substituted derivative provided the product **20** in good yield. *N*-Benzyl-1-naphthylamine also provided the product in good yield (**22**), but pyrrole afforded the *bis*-compound **23** in only 30% yield (a *tris*-pyrrole product was isolated in 65% yield).[10] While our method works well for *N*-substituted anilines, free anilines do not afford the desired product. Such *bis*-aniline derivatives represent a less explored chemical space, presumably due to the paucity of methods available to synthesize them, and this photocatalytic route fills a key gap in this area by offering a convenient route to these molecules.

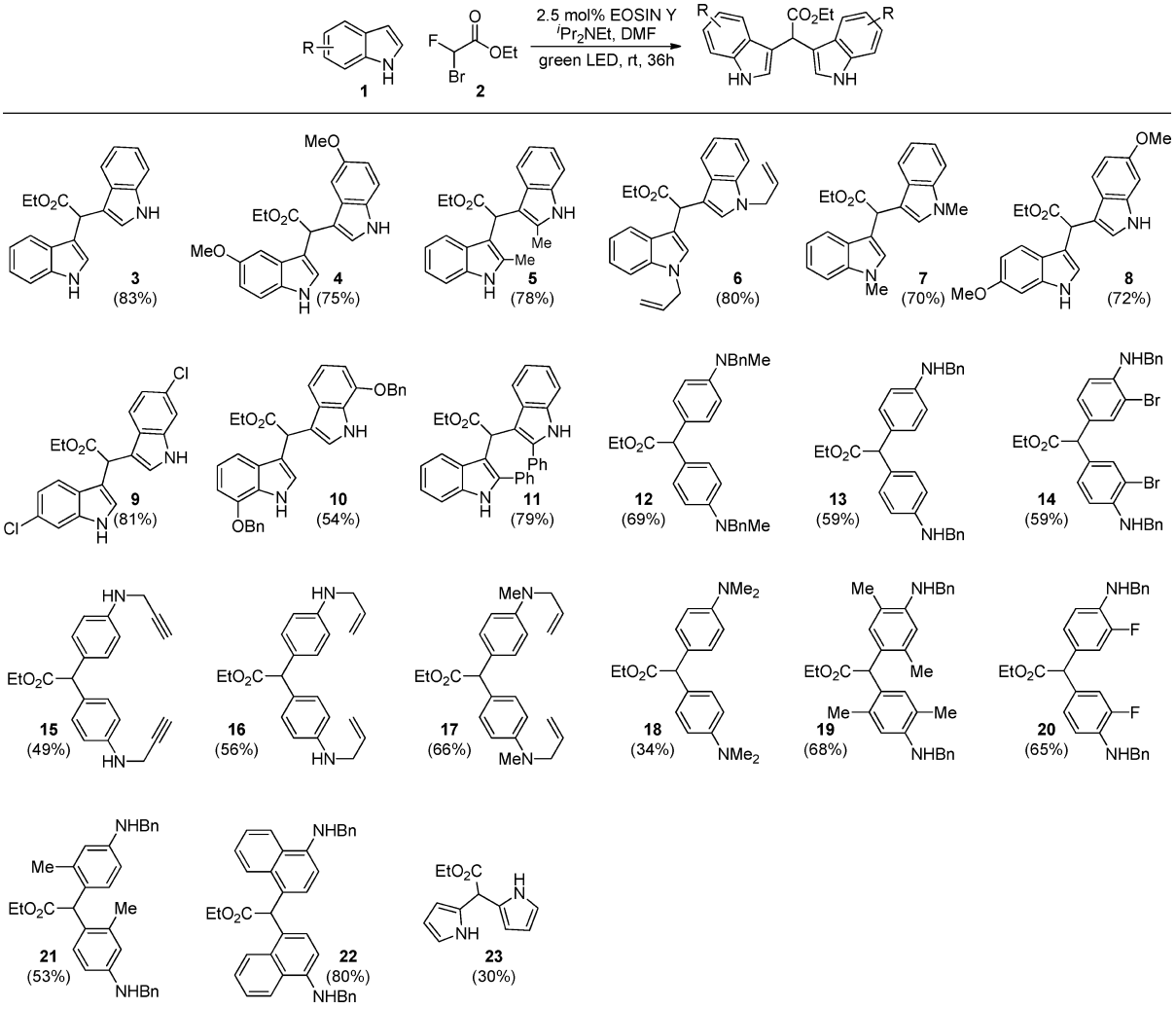
Mechanistic possibilities for this reaction are outlined in Scheme 3, and although we have not obtained direct evidence to support the existence of key intermediates, the analysis is based on the products formed and related information available in the literature.[11] We propose that the reaction proceeds via the generation of the ethyl $\alpha$-fluoroacetate radical which is formed by a single electron transfer from the Eosin Y radical anion to **2**. The intermediacy of the Eosin Y radical anion has been postulated previously for reactions that contain an electron-rich species, including amines.[5,9,12] The fluoroacetate radical is then intercepted by the indole motif via the C3 carbon, leading to the formation of **24** which on subsequent oxidation will provide the $\alpha$-fluoroindole derivative **25**. This oxidation can be brought about by the diisopropylethylamine radical cation, Eosin Y*, or by **2** in a radical-chain propagating manner.[13] While compound **25** is not known in the literature, the instability of analogous bromo derivatives[14] and a related difluoro compound[15] indicate that C−X bonds benzylic to the indole motif are very reactive (and the reactivity is expected to increase if an additional electron-withdrawing group is present at the $\alpha$-carbon). Hence, we postulate that the C−F bond in compound **25** is weakened (compared to other Ar−F and R−F bonds) due to the presence of the ester and indole moieties at the $\alpha$-carbon. In this scenario, **25** can react either by generating the intermediate **26** via a base-mediated extrusion of fluoride or by generating the radical intermediate **27** via photocatalysis. Both **26** and **27** can lead to the observed products, and in the absence of any additional proof, it is not possible to ascertain which pathway is operative for the second arylation.

The installation of two different aryl groups using this reaction would be desirable because accessing such unsymmetrical diarylated compounds without employing prefunctionalized substrates is a significant synthetic challenge.[3,16] As shown in Table 3, this method can be used to synthesize unsymmetrical diarylacetates featuring indoles and anilines, albeit in moderate



DOI: 10.1021/acs.joc.5b01736
J. Org. Chem. 2015, 80, 10187−10196

**Table 2. Scope of the Reaction**[a]




[a]Isolated yields.

yields owing to the inherent limitation on selectivity. While unsymmetrical *bis*-indole derivatives **29**, **31**, and **32** were obtained in low yields, subtle reactivity differences increase the yield of the unsymmetrical diaryl product, as observed for compound **30**. It was discovered that the unsymmetrical indole-aniline diaryl derivatives **33**−**40** could be accessed in improved yields (43−74%). A variety of *N*-substituted anilines underwent the reaction smoothly, and as observed before, the alkynyl (compound **33**, Table 3) and allyl substituents (products **39** and **40**) were tolerated well. Free anilines are not compatible in this reaction, but the applicability of *N*-benzylanilines (products **34** and **38**) can provide a route to diarylacetates with a free aniline moeity, if so desired. Although not a high yielding process, this method does offer rapid access to these molecules without the need to prefunctionalize the substrates and can be potentially useful at the discovery stage.

## CONCLUSION

In summary, we have developed a visible light mediated method for the synthesis of bisindolyl and bisanilinoyl acetate derivatives by activating ethyl bromofluoroacetate using Eosin Y as the photocatalyst. The reaction occurs under mild conditions and represents a convenient and transition-metal-free method to construct $C_{sp^2}$−$C_{sp^3}$ bonds resulting in $\alpha,\alpha$-diarylated acetate derivatives. This method can also be applied to the direct synthesis of unsymmetrical diarylacetates (indole−indole and indole−aniline) in moderate yields. Explorations into employing this method to establish a general route toward unsymmetrical diarylacetates are underway.

## EXPERIMENTAL SECTION

**General Information.** All reactions were carried out under an argon atmosphere with dry solvents under anhydrous conditions. Reagents were purchased at the highest commercial quality and used without further purification, unless otherwise stated. Yields refer to chromatographically pure material. Reactions were monitored by thin-layer chromatography (TLC) carried out on 0.25 mm Merck silica gel plates (60F-254) using UV light as a visualizing agent and *p*-anisaldehyde or $KMnO_4$ stain and heat as developing agents. Merck silica gel (particle size 100−200 and 230−400 mesh) was used for flash column chromatography.

NMR spectra were recorded on 500 ($^1$H: 500 MHz, $^{13}$C: 125 MHz) or 400 ($^1$H: 400 MHz, $^{13}$C: 100 MHz) NMR spectrometers in $CDCl_3$ having TMS 0.03% as an internal standard. Mass spectrometric data were obtained using Q-TOF ESI-MS.

The following abbreviations were used to explain the multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, dd = doublet of doublet, ddd = doublet of a doublet of doublet.

Crystal data for **7** have been deposited at the Cambridge Crystallographic Data Centre with the deposition numbers CCDC-1060893.



DOI: 10.1021/acs.joc.5b01736
J. Org. Chem. 2015, 80, 10187−10196

**Scheme 3. Plausible Reaction Pathways for the Formation of 3**

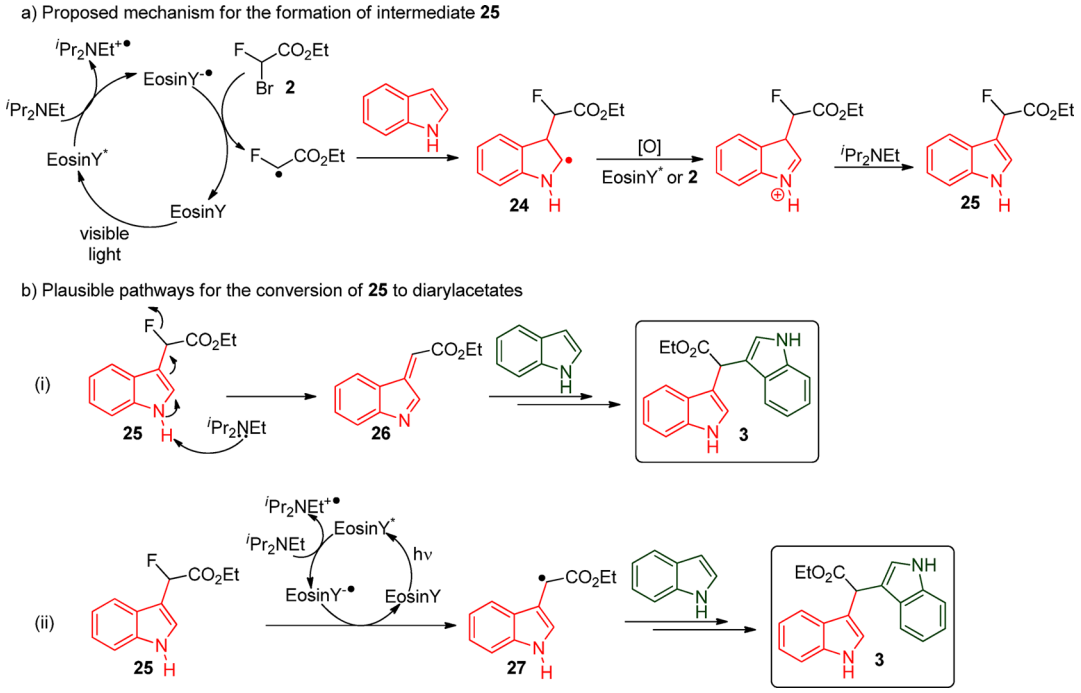
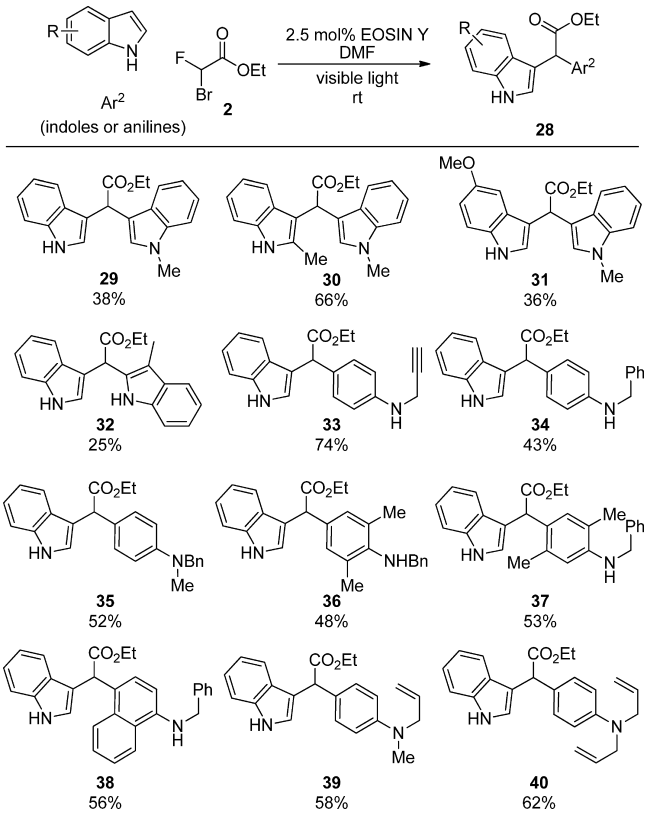


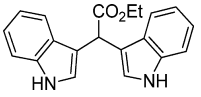

**Table 3. Synthesis of Unsymmetrical Diarylacetates**[a]




[a]Isolated yields.

**General Experimental Procedure (I) for the Synthesis of Symmetrical Diarylacetates.** A dried vial equipped with a magnetic stir bar was charged with indole (1 equiv), ethyl bromofluoroacetate (2 equiv), diisopropyl ethylamine (2 equiv), Eosin Y (0.025 equiv), and dry DMF (2 mL). The mixture was sparged with argon for 10 min and then exposed to green (530 nm) LEDs for 36 h (207 cm LED strip wrapped around a beaker; total power 18 W). After the completion of the reaction (confirmed by TLC), the mixture was poured into a separatory funnel containing 50 mL of ethyl acetate/water (1:1). The layers were separated, and the aqueous layer was extracted with ethyl acetate (2 × 15 mL). The combined organic layers were dried over sodium sulfate and concentrated in vacuo. The residue was purified by column chromatography on silica gel (ethyl acetate/petroleum ether)

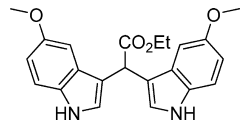
**General Procedure for the Synthesis of Unsymmetrical Diarylacetates (II).** A dried vial equipped with a magnetic stir bar was charged with indole ($Ar^1$, 1 equiv), substituted indole ($Ar^2$, 2 equiv)/*N*-substituted aniline ($Ar^2$, 3 equiv), ethyl bromofluoroacetate (2 equiv), diisopropyl ethylamine (2 equiv), Eosin Y (0.025 equiv), and dry DMF (3 mL). The mixture was sparged with argon for 10 min and then exposed to green (530 nm) LEDs for 36 h (207 cm LED strip wrapped around a beaker; total power 18 W). After the completion of reaction (confirmed by TLC), the mixture was poured into a separatory funnel containing 50 mL of ethyl acetate/water (1:1). The layers were separated, and the aqueous layer was extracted with ethyl acetate (2 × 15 mL). The combined organic layers were dried over sodium sulfate and concentrated in vacuo. The residue was purified by column chromatography on silica gel (ethyl acetate/petroleum ether)



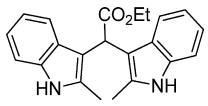
**Ethyl 2,2-Di(1*H*-indol-3-yl)acetate (3).**[4] According to the general procedure (**I**), indole (200 mg, 1.71 mmol) provided **3** after flash column chromatography (15−25% ethyl acetate in petroleum ether) as a flame red solid (226 mg, 83%). $R_f$ = 0.3 (30% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}$/cm$^{-1}$3413, 3051, 2928, 1734. Mp = 69−71 °C. $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ 8.02 (s, 2H), 7.64 (d, *J* = 7.8 Hz, 2H), 7.26 (d, *J* = 8.1 Hz, 2H), 7.18 (t, *J* = 7.4 Hz, 2H), 7.10 (t, *J* = 7.3 Hz, 2H), 6.92 (s, 2H), 5.50 (s, 1H), 4.22 (q, *J* = 7.0 Hz, 2H), 1.26 (t, *J* = 7.1 Hz, 3H). $^{13}$C NMR (125 MHz, Chloroform-*d*) $\delta$ 173.0, 135.2, 125.4, 122.5, 120.9, 118.4, 118.1, 112.1, 110.4, 60.2, 39.5, 13.1. Exact mass calculated for $C_{20}H_{19}N_2O_2^+$ [M + H]$^+$: 319.1441; found: 319.1447.



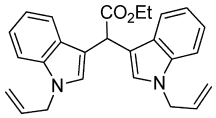
DOI: 10.1021/acs.joc.5b01736
J. Org. Chem. 2015, 80, 10187−10196



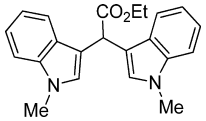
**Ethyl 2,2-Bis(5-methoxy-1*H*-indol-3-yl)acetate (4).**[17] According to the general procedure (**I**), 5-methoxy indole (100 mg, 0.679 mmol) provided **4** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a dark brown solid (96 mg, 75%). $R_f$ = 0.4 (30% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}/cm^{-1}$ 3405, 2959, 2925, 2853, 1720. Mp = 175−178 °C. $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ 7.96 (s, 2H), 7.23 (d, $J$ = 8.8 Hz, 2H), 7.08 (s, 4H), 6.84 (dd, $J$ = 8.8, 2.2 Hz, 2H), 5.39 (s, 1H), 4.22 (q, $J$ = 7.1 Hz, 2H), 3.79 (s, 6H), 1.28 (d, $J$ = 7.1 Hz, 3H). $^{13}$C NMR (125 MHz, Chloroform-*d*) $\delta$ 172.6, 136.0, 126.9, 126.0, 120.6, 118.3, 118.0, 111.2, 108.2, 60.0, 39.3, 31.7, 13.2. Exact mass calculated for $C_{22}H_{23}N_2O_4^+$ [M + H]$^+$: 379.1652; found: 379.1658.



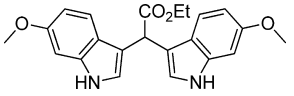
**Ethyl 2,2-Bis(2-methyl-1*H*-indol-3-yl)acetate (5).**[18] According to the general procedure (**I**), 2-methylindole (100 mg, 0.762 mmol) provided **5** after flash chromatography (15−25% ethyl acetate in pet ether) as a brick red solid (103 mg, 78%). $R_f$ = 0.3 (30% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}/cm^{-1}$ 3396, 3048, 2924, 2854, 1720. Mp = 196−198 °C. $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ 7.69 (s, 2H), 7.32−7.29 (m, 2H), 7.12 (dt, $J$ = 8.1, 0.9 Hz, 2H), 6.99 (ddd, $J$ = 8.1, 7.1, 1.2 Hz, 2H), 6.90 (ddd, $J$ = 8.0, 7.1, 1.1 Hz, 2H), 5.37 (s, 1H), 4.18 (q, $J$ = 7.1 Hz, 2H), 2.07 (s, 6H), 1.15 (d, $J$ = 7.1 Hz, 3H). $^{13}$C NMR (125 MHz, Chloroform-*d*) $\delta$ 173.8, 135.0, 132.3, 128.4, 121.0, 119.5, 118.8, 110.3, 108.8, 61.1, 40.2, 14.4, 12.4. Exact mass calculated for $C_{22}H_{22}N_2NaO_2^+$ [M + Na]$^+$: 369.1573; found: 369.1576.



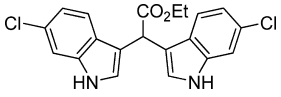
**Ethyl 2,2-Bis(1-allyl-1*H*-indol-3-yl)acetate (6).** According to the general procedure (**I**), *N*-allyl indole indole (100 mg, 0.636 mmol) provided **6** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a reddish brown paste (102 mg, 80%). $R_f$ = 0.4 (30% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}/cm^{-1}$ 3052, 2981, 2925, 1733, 1644. $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ 7.56 (d, $J$ = 7.9 Hz, 2H), 7.20 (d, $J$ = 8.2 Hz, 2H), 7.13−7.08 (m, 2H), 7.03−6.95 (m, 4H), 5.85 (ddt, $J$ = 16.9, 10.5, 5.4 Hz, 2H), 5.41(s, 1H), 5.10−5.03 (m, 2H), 5.01−4.92 (m, 2H), 4.58−4.51 (m, 4H), 4.12 (q, $J$ = 7.1 Hz, 2H), 1.17 (t, $J$ = 7.1 Hz, 3H). $^{13}$C NMR (125 MHz, Chloroform-*d*) $\delta$ 173.6, 136.7, 133.6, 127.5, 127.2, 121.8, 119.7, 119.3, 117.3, 112.7, 109.8, 61.1, 49.0, 40.7, 14.4. Exact mass calculated for $C_{26}H_{26}N_2NaO_2^+$ [M + Na]$^+$: 421.1886; found: 421.1894.



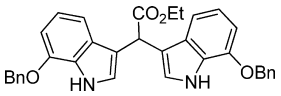
**Ethyl 2,2-Bis(1-methyl-1*H*-indol-3-yl)acetate (7).**[19] According to the general procedure (**I**), *N*-methylindole (100 mg, 0.762 mmol) provided **7** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a pink solid (93 mg, 70%). $R_f$ = 0.4 (30% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}/cm^{-1}$ 3051, 2927, 2855, 1733. Mp = 138−141 °C. $^1$H NMR (500 MHz, Chloroform-*d*) $\delta$ 7.57 (d, $J$ = 8.0 Hz, 2H), 7.21 (d, $J$ = 8.3 Hz, 2H), 7.18−7.11 (m, 2H), 7.05−6.98 (m, 2H), 6.94 (s, 2H), 5.42 (s, 1H), 4.13 (q, $J$ = 7.0 Hz, 2H), 3.64 (s, 6H), 1.19 (t, $J$ = 7.1 Hz, 3H). $^{13}$C NMR (125 MHz, Chloroform-*d*) $\delta$ 172.6, 136.0, 126.9, 126.0, 120.6, 118.3, 118.0, 111.2, 108.2, 60.0, 39.3, 31.7, 13.2. Exact mass calculated for $C_{22}H_{23}N_2O_2^+$ [M + H]$^+$: 347.1754; found: 347.1766.



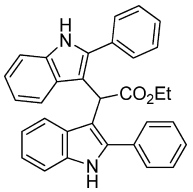
**Ethyl 2,2-Bis(6-methoxy-1*H*-indol-3-yl)acetate (8).** According to the general procedure (**I**), 6-methoxyindole (100 mg, 0.68 mmol) provided **8** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a dark brown solid (93 mg, 72%). $R_f$ = 0.4 (30% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}/cm^{-1}$ 3406, 2960, 2929, 2835, 1720. Mp = 59−62 °C. $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ 7.91 (s, 2H), 7.48 (d, $J$ = 8.6 Hz, 2H), 6.92 (d, $J$ = 2.0 Hz, 2H), 6.79−6.72 (m, 4H), 5.39 (s, 1H), 4.19 (q, $J$ = 7.1 Hz, 2H), 3.80 (s, 6H), 1.24 (t, $J$ = 7.1 Hz, 3H). $^{13}$C NMR (100 MHz, Chloroform-*d*) $\delta$ 173.5, 154.1, 131.6, 127.2, 124.1, 113.4, 112.5, 112.0, 101.2, 61.2, 55.9, 40.9, 14.5. Exact mass calculated $C_{22}H_{22}N_2NaO_4^+$ [M + Na]$^+$: 401.1472; found: 401.1472.



**Ethyl 2,2-Bis(6-chloro-1*H*-indol-3-yl)acetate (9).** According to the general procedure (**I**), 6-chloroindole (100 mg, 0.66 mmol) provided **9** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a yellowish paste (104 mg, 81%). $R_f$ = 0.6 (30% ethyl acetate in petroleum ether). **IR** (neat): $\nu_{max}/cm^{-1}$ 3414, 2925, 1714, 1619, 1455. $^1$H NMR (400 MHz, DMSO-$d_6$) $\delta$ 11.07 (s, 2H), 7.45 (d, $J$ = 8.5 Hz, 2H), 7.35 (d, $J$ = 1.9 Hz, 2H), 7.23 (d, $J$ = 2.1 Hz, 2H), 6.92 (dd, $J$ = 8.5, 1.9 Hz, 2H), 5.40 (s, 1H), 4.07 (t, $J$ = 7.1 Hz, 2H), 1.12 (t, $J$ = 7.1 Hz, 3H). $^{13}$C NMR (100 MHz, DMSO-$D_6$) $\delta$ 172.9, 137.2, 126.4, 125.6, 125.4, 120.8, 119.4, 112.9, 111.7, 61.0, 14.6. Exact mass calculated for $C_{20}H_{16}$ $Cl_2N_2O_2^+$ [M]$^+$: 386.0583; found: 386.0584.



**Ethyl 2,2-Bis(7-(benzyloxy)-1*H*-indol-3-yl)acetate (10).** According to the general procedure (**I**), 7-benzyloxy indole (100 mg, 0.448 mmol) provided **10** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a yellowish paste (64 mg, 54%). $R_f$ = 0.6 (30% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}/cm^{-1}$ 3393, 2934, 1719, 1489, 1455. $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ 8.25 (s, 2H), 7.44 (d, $J$ = 7.0 Hz, 4H), 7.40−7.30 (m, 6H), 7.24 (d, $J$ = 8.0 Hz, 2H), 7.04 (d, $J$ = 2.3 Hz, 2H), 6.97 (t, $J$ = 7.9 Hz, 2H), 6.68 (d, $J$ = 7.7 Hz, 2H), 5.44 (s, 1H), 5.16 (s, 4H), 4.18 (q, $J$ = 7.1 Hz, 2H), 1.23 (t, $J$ = 7.1 Hz, 3H). $^{13}$C NMR (100 MHz, Chloroform-*d*) $\delta$ 173.4, 145.5, 137.2, 128.7, 128.3, 128.2, 127.9, 127.1, 123.0, 120.0, 114.3, 112.5, 103.3, 70.3, 61.1, 41.0, 14.4. Exact mass calculated for $C_{34}H_{30}N_2NaO_4^+$ [M + Na]$^+$: 553.2098; found: 553.2092.



**Ethyl 2,2-Bis(2-phenyl-1*H*-indol-3-yl)acetate (11).** According to the general procedure (**I**), 2-phenyl indole (100 mg, 0.517 mmol) provided **11** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a blue solid (96 mg, 79%). $R_f$ = 0.5 (30% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}/cm^{-1}$ 3392, 3058, 2985, 2924, 1719. Mp = 186−189 °C. $^1$H NMR (400 MHz, Chloroform-*d*)



DOI: 10.1021/acs.joc.5b01736
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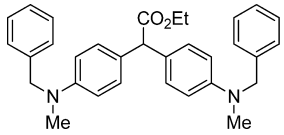
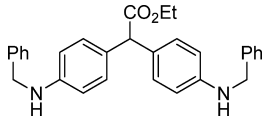
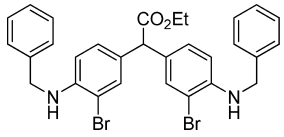
$\delta$ 7.95 (s, 2H), 7.30 (s, 4H), 7.24−7.17 (m, 10H), 7.02 (t, $J$ = 7.5 Hz, 2H), 6.84 (t, $J$ = 7.5 Hz, 2H), 5.63 (s, 1H), 3.91 (q, $J$ = 7.1 Hz, 2H), 1.00 (t, $J$ = 7.1 Hz, 3H). $^{13}$C NMR (100 MHz, Chloroform-$d$) $\delta$ 172.2, 135.1, 134.6, 131.9, 127.5, 127.3, 126.7, 120.9, 119.9, 118.7, 109.5, 109.0, 98.9, 59.9, 40.6, 13.0. Exact mass calculated for $C_{32}H_{26}NaN_2O_2^+$ $[M + Na]^+$: 493.1886; found: 493.1892.



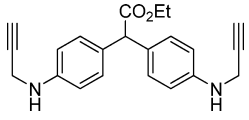

**Ethyl 2,2-Bis(4-(benzyl(methyl)amino)phenyl)acetate (12).** According to the general procedure (**I**), *N*-benzyl-*N*-methyl aniline (100 mg, 0.507 mmol) provided **12** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a yellowish paste (84 mg, 69%). $R_f$ = 0.4 (20% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}$/cm$^{-1}$ 2956, 2924, 2854, 1730. $^1$H NMR (400 MHz, Chloroform-$d$) $\delta$ 7.20 (d, $J$ = 7.1 Hz, 4H), 7.14 (t, $J$ = 6.6 Hz, 6H), 7.07 (d, $J$ = 8.6 Hz, 4H), 6.60 (d, $J$ = 8.4 Hz, 4H), 4.72 (s, 1H), 4.39 (s, 4H), 4.07 (q, $J$ = 7.1 Hz, 2H), 2.89 (s, 6H), 1.15 (t, $J$ = 7.1 Hz, 3H). $^{13}$C NMR (100 MHz, Chloroform-$d$) $\delta$ 173.7, 148.8, 139.1, 129.4, 128.7, 127.6, 127.0, 126.9, 112.5, 60.9, 56.9, 55.5, 38.7, 14.3. Exact mass calculated for $C_{32}H_{34}N_2O_2^+$ $[M + H]^+$: 479.2693; found: 479.2692.



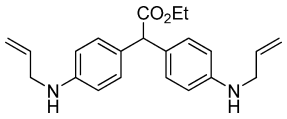

**Ethyl 2,2-Bis(4-(benzylamino)phenyl)acetate (13).** According to the general procedure (**I**), *N*-benzylaniline (100 mg, 0.546 mmol) provided **13** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a brown paste (73 mg, 59%). $R_f$ = 0.4 (20% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}$/cm$^{-1}$ 3414, 3027, 2923, 2853, 1725. $^1$H NMR (400 MHz, Chloroform-$d$) $\delta$ 7.36−7.26 (m, 10H), 7.10 (d, $J$ = 8.5 Hz, 4H), 6.57 (d, $J$ = 8.5 Hz, 4H), 4.78 (s, 1H), 4.29 (s, 4H), 4.16 (q, $J$ = 7.1 Hz, 2H), 1.23 (t, $J$ = 7.1 Hz, 3H). $^{13}$C NMR (125 MHz, Chloroform-$d$) $\delta$ 172.5, 146.0, 138.3, 128.3, 127.6, 127.5, 126.5, 126.2, 111.9, 59.8, 54.5, 47.5, 13.2. Exact mass calculated for $C_{30}H_{30}N_2O_2^+$ $[M + H]^+$: 451.2380; found: 451.2383.



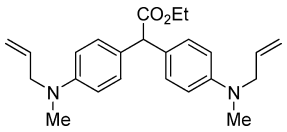

**Ethyl 2,2-Bis(4-(benzylamino)-2-bromophenyl)acetate (14).** According to the general procedure (**I**), *N*-benzyl-2-bromoaniline (100 mg, 0.381 mmol) provided **14** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a yellowish paste (68 mg, 59%). $R_f$ = 0.4 (20% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}$/cm$^{-1}$ 3413, 3061, 3029, 2961, 2924, 2851, 1730. $^1$H NMR (400 MHz, Chloroform-$d$) $\delta$ 7.32−7.24 (m, 10H), 7.18 (d, $J$ = 0.5 Hz, 2H), 6.97 (dd, $J$ = 8.4, 2.1 Hz, 2H), 6.51 (d, $J$ = 8.4 Hz, 2H), 4.62 (s, 1H), 4.31 (s, 4H), 4.09 (q, $J$ = 7.1 Hz, 2H), 1.16 (t, $J$ = 7.1 Hz, 3H). $^{13}$C NMR (100 MHz, Chloroform-$d$) $\delta$ 171.5, 142.4, 137.1, 131.2, 127.7 (C-2), 127.5, 126.4, 126.4, 111.1, 108.9, 60.2, 53.6, 47.3, 13.1. Exact mass calculated for $C_{30}H_{28}Br_2N_2O_2^+$ $[M + H]^+$: 607.0590; found: 607.0594.



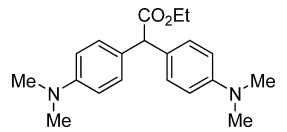

**Ethyl 2,2-Bis(4-(prop-2-ynylamino)phenyl)acetate (15).** According to the general procedure (**I**), *N*-propargyl aniline (100 mg, 0.762 mmol) provided **15** after flash chromatography (15−25% ethyl acetate in petroleum ether) as an orange-red solid (65 mg, 49%). $R_f$ = 0.4 (20% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}$/cm$^{-1}$ 3397, 3284, 2957, 2924, 2853, 2120, 1721. Mp = 132−134 °C. $^1$H NMR (400 MHz, Chloroform-$d$) $\delta$ 7.08 (d, $J$ = 8.5 Hz, 4H), 6.55 (d, $J$ = 8.6 Hz, 4H), 4.74 (s, 1H), 4.13−4.07 (m, 2H), 3.83 (d, $J$ = 2.4 Hz, 4H), 2.13 (t, $J$ = 2.4 Hz, 2H), 1.19 (t, $J$ = 7.6 Hz, 3H) (NH proton not observed). $^{13}$C NMR (100 MHz, Chloroform-$d$) $\delta$ 172.3, 144.8, 128.3, 128.3, 112.4, 80.0, 70.3, 59.9, 54.5, 28.7, 13.2. Exact mass calculated for $C_{22}H_{22}N_2O_2^+$ $[M + H]^+$: 347.1754; found: 347.1761.




**Ethyl 2,2-Bis(4-(allylamino)phenyl)acetate (16).** According to the general procedure (**I**), *N*-allyl aniline (100 mg, 0.751 mmol) provided **16** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a light yellow liquid (74 mg, 56%). $R_f$ = 0.4 (20% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}$/cm$^{-1}$ 3405, 2979, 2925, 2854, 1727, 1644. $^1$H NMR (400 MHz, Chloroform-$d$) $\delta$ 7.03 (d, $J$ = 8.6 Hz, 4H), 6.50 (d, $J$ = 8.5 Hz, 4H), 5.86 (ddt, $J$ = 17.0, 10.7, 5.4 Hz, 2H), 5.19 (dd, $J$ = 17.2, 1.6 Hz, 2H), 5.08 (dd, $J$ = 10.3, 1.5 Hz, 2H), 4.71 (s, 1H), 4.09 (d, $J$ = 7.1 Hz, 2H), 3.67 (d, $J$ = 5.4 Hz, 4H), 1.16 (t, $J$ = 7.1 Hz, 3H) (NH proton not observed). $^{13}$C NMR (100 MHz, Chloroform-$d$) $\delta$ 172.5, 145.9, 134.4, 128.3, 127.4, 115.2, 111.9, 59.8, 54.5, 45.6, 13.2. Exact mass calculated for $C_{22}H_{27}N_2O_2^+$ $[M + H]^+$: 351.2067; found: 351.2070.




**Ethyl 2,2-Bis(4-(allyl(methyl)amino)phenyl)acetate (17).** According to the general procedure (**I**), *N*-allyl-*N*-methyl aniline (100 mg, 0.679 mmol) provided **17** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a brown liquid (85 mg, 66%). $R_f$ = 0.4 (20% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}$/cm$^{-1}$ 2973, 2925, 2854, 1732, 1677. $^1$H NMR (400 MHz, Chloroform-$d$) $\delta$ 7.11−7.07 (m, 4H), 6.59 (d, $J$ = 8.6 Hz, 4H), 5.75 (ddd, $J$ = 12.0, 10.3, 5.1 Hz, 2H), 5.11−5.04 (m, 4H), 4.73 (s, 1H), 4.10 (q, $J$ = 7.1 Hz, 2H), 3.80 (dt, $J$ = 5.0, 1.5 Hz, 4H), 2.83 (s, 6H), 1.16 (d, $J$ = 7.1 Hz, 3H) (NH proton not observed). $^{13}$C NMR (100 MHz, Chloroform-$d$) $\delta$ 172.6, 147.4, 132.9, 128.1, 126.2, 115.1, 111.3, 98.9, 59.8, 54.3, 37.0, 28.7, 13.2. Exact mass calculated for $C_{24}H_{30}N_2O_2^+$ $[M + H]^+$: 379.2380; found: 379.2382.

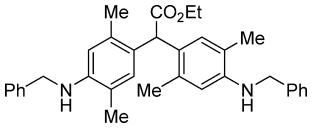



**Ethyl 2,2-Bis(4-(dimethylamino)phenyl)acetate (18).**[20] According to the general procedure (**I**), *N*,*N*-dimethyl aniline (100 mg, 0.825 mmol) provided **18** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a green solid (46 mg, 34%). $R_f$ = 0.4 (20% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}$/cm$^{-1}$ 3051, 2928, 2852, 1733. Mp = 186−188 °C. $^1$H NMR (400 MHz, Chloroform-$d$) $\delta$ 7.10 (d, $J$ = 8.7 Hz, 4H), 6.61 (d, $J$ = 8.8 Hz, 4H), 4.76 (s, 1H), 4.10 (q, $J$ = 7.1 Hz, 2H), 2.83 (s, 12H), 1.17 (t, $J$ = 7.1 Hz, 3H). $^{13}$C NMR (125 MHz, Chloroform-$d$) $\delta$ 172.5, 148.4, 128.1, 126.6, 111.7, 59.8, 54.3, 39.7, 13.2. Exact mass calculated for $C_{20}H_{26}N_2O_2^+$ $[M + H]^+$: 327.2067; found: 327.2071.

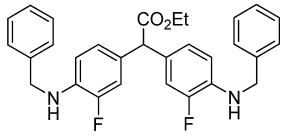
**Ethyl 2,2-Bis(4-(benzylamino)-2,5-dimethylphenyl)acetate (19).** According to the general procedure (**I**), *N*-benzyl-2,5-dimethylaniline (100 mg, 0.473 mmol) provided **19** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a yellowish solid



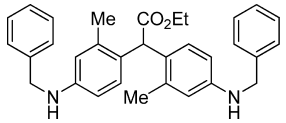
DOI: 10.1021/acs.joc.5b01736
J. Org. Chem. 2015, 80, 10187−10196



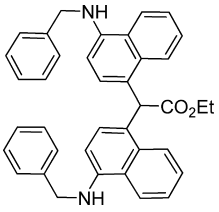
(82 mg, 68%). $R_f$ = 0.4 (20% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}/cm^{-1}$ 3434, 3026, 2924, 2856, 1729. Mp = 64−67 °C. $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ 7.35−7.20 (m, 10H), 6.73 (s, 2H), 6.40 (s, 2H), 5.00 (s, 1H), 4.26 (s, 4H), 4.12 (q, *J* = 7.1 Hz, 2H), 3.65 (s, 2H), 2.09 (s, 6H), 1.99 (s, 6H), 1.18−1.15 (m, 3H). $^{13}$C NMR (100 MHz, Chloroform-*d*) $\delta$ 173.1, 143.8, 138.6, 133.8, 129.0, 127.6 (C-2), 126.7, 126.2, 124.7, 118.4, 111.2, 59.7, 48.5, 47.5, 18.7, 16.3, 13.3. Exact mass calculated for $C_{34}H_{38}N_2O_2^+$ $[M + H]^+$: 507.3006; found: 507.3019.



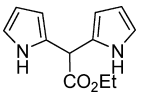
**Ethyl 2,2-Bis(4-(benzylamino)-3-fluorophenyl)acetate (20).** According to the general procedure (**I**), *N*-benzyl-2-fluoroaniline (100 mg, 0.497 mmol) provided **20** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a brown paste (79 mg, 65%). $R_f$ = 0.4 (20% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}/cm^{-1}$ 3429, 3029, 2925, 2851, 1730. $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ 7.29−7.17 (m, 10H), 6.88 (dd, *J* = 12.6, 1.9 Hz, 2H), 6.79 (d, *J* = 8.3 Hz, 2H), 6.53 (t, *J* = 8.6 Hz, 2H), 4.66 (s, 1H), 4.27 (s, 4H), 4.09 (t, *J* = 7.1 Hz, 2H), 1.17 (d, *J* = 7.1 Hz, 3H) (NH proton not observed). $^{13}$C NMR (100 MHz, Chloroform-*d*) $\delta$ 171.7, 150.2 (d, *J* = 239 Hz, 1C), 137.8, 134.6 (d, *J* = 11.8, 2C), 127.7, 126.6 (d, *J* = 6.5 Hz, 1C), 126.3, 123.4 (d, *J* = 3.14 Hz, 1C), 113.6 (d, *J* = 19.5 Hz, 1C), 110.9 (d, *J* = 3.8 Hz, 1C), 60.1, 54.0, 46.8, 13.1. Exact mass calculated for $C_{30}H_{28}F_2N_2O_2^+$ $[M + H]^+$: 487.2192; found: 487.2191.



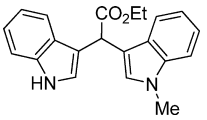
**Ethyl 2,2-Bis(4-(benzylamino)-2-methylphenyl)acetate (21).** According to the general procedure (**I**), *N*-benzyl-3-toluidine (100 mg, 0.5 mmol) provided **21** after flash chromatography (15−25% ethyl acetate in petroleum ether) as an orange paste (62 mg, 53%). $R_f$ = 0.4 (20% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}/cm^{-1}$ 3411, 3054, 2924, 2854, 1727. $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ 7.37−7.27 (m, 10H), 6.88 (d, *J* = 8.3 Hz, 2H), 6.48 (d, *J* = 2.2 Hz, 2H), 6.43 (dd, *J* = 8.4, 2.4 Hz, 2H), 5.06 (s, 1H), 4.28 (s, 4H), 4.18 (d, *J* = 7.1 Hz, 2H), 2.15 (s, 6H), 1.23 (t, *J* = 7.1 Hz, 3H) (NH proton not observed). $^{13}$C NMR (125 MHz, Chloroform-*d*) $\delta$ 172.7, 145.8, 138.4, 136.2, 128.1, 127.6, 126.6, 126.2, 125.5, 114.1, 109.4, 59.8, 48.6, 47.5, 18.8, 13.2. Exact mass calculated for $C_{32}H_{34}N_2O_2^+$ $[M + H]^+$: 479.2693; found: 479.2692.



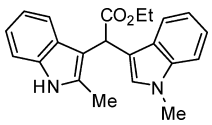
**Ethyl 2,2-Bis(4-(benzylamino)naphthalen-1-yl)acetate (22).** According to the general procedure (**I**), *N*-benzylnaphthalen-1-amine (100 mg, 0.854 mmol) provided **22** after flash chromatography (10−20% ethyl acetate in petroleum ether) as a yellowish solid (87 mg, 80%). $R_f$ = 0.5 (10−20% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}/cm^{-1}$ 3442, 2977, 2924, 2851, 1728. Mp = 82−84 °C. $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ 7.37−7.27 (m, 10H), 6.88 (d, *J* = 8.3 Hz, 2H), 6.48 (d, *J* = 2.2 Hz, 2H), 6.43 (dd, *J* = 8.4, 2.4 Hz, 2H), 5.06 (s, 1H), 4.28 (s, 4H), 4.18 (d, *J* = 7.1 Hz, 2H), 2.15 (s, 6H), 1.24 (s, 3H) (NH proton not observed). $^{13}$C NMR (100 MHz, Chloroform-*d*) $\delta$ 174.1, 142.9, 139.1, 132.5, 129.1, 128.8, 127.9, 127.5, 127.5, 126.4, 124.7, 124.1, 124.1, 120.8, 104.6, 61.2, 49.7, 48.8, 14.4. Exact mass calculated for $C_{38}H_{35}N_2O_2^+$ $[M + H]^+$: 551.2693; found: 551.2691.



**Ethyl 2,2-Di(1*H*-pyrrol-2-yl)acetate (23).**[21] According to the general procedure (**I**), pyrrole (100 mg, 1.49 mmol) provided **23** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a dark blue solid (49 mg, 30%). $R_f$ = 0.5 (15−20% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}/cm^{-1}$ 3388, 3103, 2980, 2926, 1724. Mp = 60−62 °C. $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ 8.39 (s, 2H), 6.65−6.62 (m, 2H), 6.08 (d, *J* = 2.9 Hz, 2H), 6.03−5.99 (m, 2H), 5.02 (s, 1H), 4.16 (q, *J* = 7.2 Hz, 2H), 1.23 (t, *J* = 7.2 Hz, 3H). $^{13}$C NMR (100 MHz, Chloroform-*d*) $\delta$ 170.6, 125.7, 117.0, 107.4, 106.0, 60.7, 42.7, 13.1. Exact mass calculated for $C_{12}H_{15}N_2O_2^+$ $[M + H]^+$: 219.1128; found: 219.1139.



**Ethyl 2-(1*H*-Indol-3-yl)-2-(1-methyl-1*H*-indol-3-yl)acetate (29).**[22] According to the general procedure (**II**), indole (100 mg, 0.854 mmol) and *N*-methylindole (224 mg, 1.71 mmol) provided **29** after flash chromatography (10−20% ethyl acetate in petroleum ether) as a brown paste (109 mg, 38%). $R_f$ = 0.6 (10−25% EtOAc/pet. ether). IR (neat): $\nu_{max}/cm^{-1}$ 3406, 3054, 2979, 2929, 1730. $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ 8.02 (s, 1H), 7.63 (dq, *J* = 7.8, 1.1 Hz, 2H), 7.30−7.25 (m, 2H), 7.24−7.19 (m, 1H), 7.16 (ddd, *J* = 8.1, 7.0, 1.2 Hz, 1H), 7.08 (ddd, *J* = 8.1, 6.9, 1.3 Hz, 2H), 7.06−7.02 (m, 1H), 6.96 (s, 1H), 5.52−5.46 (m, 1H), 4.20 (q, *J* = 7.1 Hz, 2H), 3.65 (s, 3H), 1.25 (t, *J* = 7.1 Hz, 3H). $^{13}$C NMR (100 MHz, Chloroform-*d*) $\delta$ 173.7, 137.3, 136.5, 128.1, 127.2, 126.8, 123.4, 122.2, 121.8, 119.6, 119.6, 119.4, 119.2, 113.9, 112.2, 111.4, 109.5, 61.2, 40.7, 32.9, 14.4. Exact mass calculated for $C_{21}H_{21}N_2O_2^+$ $[M + H]^+$: 333.1598; found: 333.1608.



**Ethyl 2-(1-Methyl-1*H*-indol-3-yl)-2-(2-methyl-1*H*-indol-3-yl)-acetate (30).** According to the general procedure (**II**), 2-methylindole (100 mg, 0.763 mmol) and *N*-methylindole (200 mg, 1.52 mmol) provided **30** after flash chromatography (10−20% ethyl acetate in petroleum ether) as a dark brown paste (174 mg, 66%). $R_f$ = 0.6 (10−20% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}/cm^{-1}$ 3397, 3054, 2974, 2927, 1730. $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ 7.86 (s, 1H), 7.71 (d, *J* = 7.9 Hz, 1H), 7.44 (dt, *J* = 8.0, 0.9 Hz, 1H), 7.26−7.16 (m, 3H), 7.10−7.01 (m, 3H), 6.92 (d, *J* = 1.1 Hz, 1H), 5.42 (d, *J* = 1.1 Hz, 1H), 4.24−4.10 (m, 2H), 3.64 (s, 3H), 2.33 (s, 3H), 1.20 (t, *J* = 7.1 Hz, 3H). $^{13}$C NMR (100 MHz, Chloroform-*d*) $\delta$ 173.4, 137.2, 135.2, 132.7, 128.1, 128.0, 127.5, 121.7, 121.0, 119.8, 119.4, 119.1, 119.1, 112.1, 110.3, 109.4, 108.6, 61.1, 40.3, 32.8, 14.4, 12.2. Exact mass calculated for $C_{22}H_{22}N_2O_2^+$ $[M]^+$: 346.1681; found: 346.1687.

**Ethyl 2-(5-Methoxy-1*H*-indol-3-yl)-2-(1-methyl-1*H*-indol-3-yl)-acetate (31).** According to the general procedure (**II**), 5-methoxy indole (100 mg, 679.47 $\mu$mol) and *N*-methylindole (179 mg, 1.36 mmol) provided **31** after flash chromatography (10−20% ethyl acetate in petroleum ether) as a yellowish paste (89 mg, 36%). $R_f$ = 0.5 (30% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}/cm^{-1}$ 3408, 3052,



DOI: 10.1021/acs.joc.5b01736
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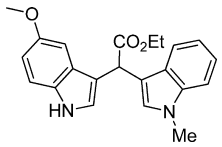
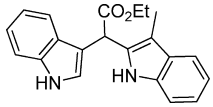
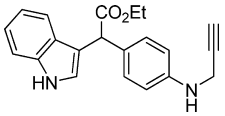


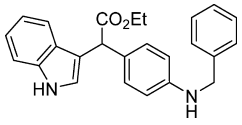
2981, 2936, 2829, 1733. $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ 7.87 (s, 1H), 7.57 (d, *J* = 7.9 Hz, 1H), 7.21 (s, 1H), 7.18−7.12 (m, 3H), 7.02 (dd, *J* = 9.1, 2.4 Hz, 2H), 6.92 (s, 1H), 6.77 (dd, *J* = 8.8, 2.4 Hz, 1H), 5.37 (s, 1H), 4.15 (d, *J* = 7.1 Hz, 2H), 3.73 (s, 3H), 3.63 (s, 3H), 1.21 (d, *J* = 7.1 Hz, 3H). $^{13}$C NMR (100 MHz, Chloroform-*d*) $\delta$ 173.6, 154.1, 137.2, 131.5, 128.1, 127.2, 127.2, 124.1, 121.8, 119.5, 119.1, 113.7, 112.5, 112.1, 112.0, 109.4, 101.2, 61.1, 56.0, 40.7, 32.8, 14.4. Exact mass calculated for $C_{22}H_{22}N_2O_3^+$ $[M]^+$ 362.1630, found 362.1634.



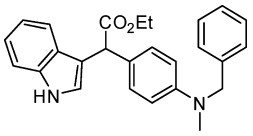
**Ethyl 2-(1*H*-Indol-3-yl)-2-(3-methyl-1*H*-indol-2-yl)acetate (32).** According to the general procedure (**II**), indole (100 mg, 0.854 mmol) and 3-methylindole (280 mg, 2.13 mmol) provided **32** after flash chromatography (10−20% ethyl acetate in petroleum ether) as a brown solid (72 mg, 25%). $R_f$ = 0.4 (10−20% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}$/cm$^{-1}$ 3407, 3048, 2972, 2919, 2853, 1720. Mp = 112−115 °C. $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ 8.51 (s, 1H), 8.01 (s, 1H), 7.48 (t, *J* = 7.4 Hz, 2H), 7.27 (d, *J* = 8.1 Hz, 1H), 7.21−7.14 (m, 2H), 7.17−7.06 (m, 2H), 7.02 (dd, *J* = 2.7, 1.1 Hz, 2H), 5.44 (d, *J* = 0.8 Hz, 1H), 4.16 (tt, *J* = 7.1, 3.5 Hz, 2H), 2.28 (s, 3H), 1.22 (d, *J* = 7.1 Hz, 3H). $^{13}$C NMR (125 MHz, Chloroform-*d*) $\delta$ 171.4, 135.2, 134.3, 129.1, 127.8, 125.2, 122.0, 121.5, 120.6, 119.0, 118.0, 117.8, 117.5, 111.6, 110.3, 109.8, 107.4, 60.6, 39.4, 13.2, 7.5. Exact mass calculated for $C_{21}H_{20}N_2O_2^+$ $[M + H]^+$: 333.1598; found: 333.1600.



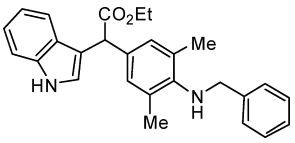
**Ethyl 2-(1*H*-Indol-3-yl)-2-(4-(prop-2-ynylamino)phenyl)-acetate (33).** According to the general procedure (**II**), indole (100 mg, 0.853 mmol) and *N*-propargylaniline (336 mg, 2.56 mmol) provided **33** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a brown solid (211 mg, 74%). $R_f$ = 0.3 (30% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}$/cm$^{-1}$ 3410, 3286, 2980, 2925, 2853, 1721. Mp = 109−111 °C. $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ 8.08 (s, 1H), 7.46 (d, *J* = 8.4 Hz, 1H), 7.31 (d, *J* = 8.1 Hz, 2H), 7.26 (d, *J* = 8.7 Hz, 2H), 7.18−7.13 (m, 2H), 7.05 (t, *J* = 7.9 Hz, 1H), 6.62 (d, *J* = 8.6 Hz, 2H), 5.14 (s, 1H), 4.27−4.13 (m, 2H), 3.89 (d, *J* = 2.5 Hz, 2H), 2.20 (t, *J* = 2.4 Hz, 1H), 1.25 (t, *J* = 7.1 Hz, 3H). $^{13}$C NMR (100 MHz, Chloroform-*d*) $\delta$ 173.5, 146.1, 136.4, 129.4, 128.7, 126.8, 123.2, 122.2, 119.7, 119.2, 114.4, 113.6, 111.3, 81.1, 71.4, 61.1, 48.3, 33.8, 14.3. Exact mass calculated for $C_{21}H_{20}N_2O_2^+$ $[M]^+$: 332.1519; found: 332.1520.



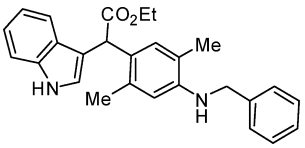
**Ethyl 2-(4-(Benzylamino)phenyl)-2-(1*H*-indol-3-yl)acetate (34).** According to the general procedure (**II**), indole (100 mg, 0.853 mmol) and *N*-benzylaniline (470 mg, 2.56 mmol) provided **34** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a yellowish paste (143 mg, 43%). $R_f$ = 0.3 (30% ethyl acetate in petroleum ether). IR (neat): $\nu_{max}$/cm$^{-1}$ 3407, 3057, 2981, 2926, 1719, 1621. $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ 8.05 (s, 1H), 7.46 (d, *J* = 7.9 Hz, 1H), 7.37−7.29 (m, 5H), 7.27 (dd, *J* = 6.0, 2.8 Hz, 1H), 7.23 (s, 2H), 7.18−7.11 (m, 2H), 7.05 (t, *J* = 7.5 Hz, 1H), 6.61−6.54 (m, 2H), 5.12 (s, 1H), 4.31−4.26 (m, 2H), 4.24−4.14 (m, 2H), 4.02 (s, 1H), 1.25 (t, *J* = 7.1 Hz, 3H). $^{13}$C NMR (100 MHz Chloroform-*d*) $\delta$ 173.6, 147.4, 139.5, 136.4, 129.4, 128.8, 127.7, 127.7, 127.4, 126.8, 123.2, 122.3, 119.7, 119.3, 114.6, 113.0, 111.2, 61.1, 48.6, 48.3, 14.4. Exact mass calculated for $C_{25}H_{24}N_2O_2^+$ $[M]^+$: 384.1832; found: 384.1834.



**Ethyl 2-(4-(Benzyl(methyl)amino)phenyl)-2-(1*H*-indol-3-yl)-acetate (35).** According to the general procedure (**II**), indole (100 mg, 0.853 mmol) and *N*-benzyl-2,6-dimethylaniline (541.13 mg, 2.56 mmol) provided **35** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a brown paste (157 mg, 52%). $R_f$ = 0.4 (30% ethyl acetate in petroleum ether). $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ = 8.09 (s, 1H), 7.51 (d, *J* = 8.0 Hz, 1H), 7.37−7.29 (m, 4H), 7.28 (d, *J* = 5.9 Hz, 1H), 7.27−7.21 (m, 3H), 7.20−7.15 (m, 2H), 7.08 (t, *J* = 7.0 Hz, 1H), 6.72 (d, *J* = 8.8 Hz, 2H), 5.17 (s, 1H), 4.51 (s, 2H), 4.29−4.16 (m, 2H), 3.00 (s, 3H), 1.28 (t, *J* = 7.1 Hz, 3H). $^{13}$C NMR (100 MHz, Chloroform-*d*) $\delta$ 173.7, 149.0, 139.2, 136.4, 129.3, 128.7, 127.0, 126.9, 126.8, 126.6, 123.2, 122.2, 119.6, 119.2, 114.6, 112.5, 111.3, 77.5, 77.2, 76.8, 61.0, 56.8, 48.2, 38.6, 14.3. Exact mass calculated for $C_{26}H_{26}NaN_2O_2^+$ $[M + Na]^+$: 421.1886; found: 421.1886.



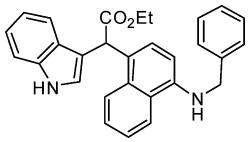
**Ethyl 2-(4-(Benzylamino)-3,5-dimethylphenyl)-2-(1*H*-indol-3-yl)-acetate (36).** According to the general procedure (**II**), indole (100 mg, 0.853 mmol) and *N*-benzyl-2,6-dimethylaniline (541.13 mg, 2.56 mmol) provided **36** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a yellowish paste (168 mg, 48%). $R_f$ = 0.4 (30% ethyl acetate in petroleum ether). $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ = 8.20 (s, 1H), 7.53 (d, *J* = 7.8 Hz, 1H), 7.41−7.27 (m, 6H), 7.22−7.16 (m, 2H), 7.11 (d, *J* = 7.8 Hz, 3H), 5.17 (s, 1H), 4.25 (dddd, *J* = 17.8, 10.8, 7.1, 3.7 Hz, 2H), 4.10 (s, 2H), 2.75 (s, 1H), 2.26 (s, 6H), 1.30 (t, *J* = 7.1 Hz, 5H). $^{13}$C NMR (126 MHz, Chloroform-*d*) $\delta$ 173.6, 145.0, 140.5, 136.4, 132.2, 129.9, 128.9, 128.7, 128.1, 127.4, 126.8, 123.3, 122.2, 119.6, 119.1, 114.3, 111.3, 61.1, 52.9, 48.4, 18.7, 14.3. Exact mass calculated for$C_{27}H_{28}NaN_2O_2^+$ $[M + Na]^+$: 435.2043; found: 435.2042.



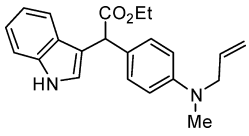
**Ethyl 2-(4-(Benzylamino)-2,5-dimethylphenyl)-2-(1*H*-indol-3-yl)acetate (37).** According to the general procedure (**II**), indole (100 mg, 0.853 mmol) and *N*-benzyl-2,6-dimethylaniline (541.13 mg, 2.56 mmol) provided **37** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a yellowish paste (185 mg, 53%). $R_f$ = 0.4 (30% ethyl acetate in petroleum ether). $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ = 8.12 (s, 1H), 7.48 (d, *J* = 7.9 Hz, 1H), 7.45−7.37 (m, 4H), 7.32 (d, *J* = 7.5 Hz, 2H), 7.22−7.16 (m, 1H), 7.09 (d, *J* = 5.2 Hz, 2H), 7.03 (d, *J* = 2.3 Hz, 1H), 6.53 (s, 1H), 5.37 (s, 1H), 4.38 (s, 2H), 4.25 (qq, *J* = 11.0, 7.2 Hz, 2H), 2.40 (s, 3H), 2.06 (s, 3H), 1.30 (t, *J* = 7.1 Hz, 3H). $^{13}$C NMR (100 MHz, Chloroform-*d*) $\delta$ 173.9, 145.1, 139.7, 136.4, 134.8, 129.9, 128.8, 127.8, 127.4, 127.0, 125.4, 123.7, 122.1, 119.8, 119.6, 119.0, 114.4, 112.2, 111.3, 61.0, 48.6, 44.6, 20.0, 17.3, 14.4. Exact mass calculated for $C_{27}H_{28}NaN_2O_2^+$ $[M + Na]^+$: 435.2043; found: 435.2043.



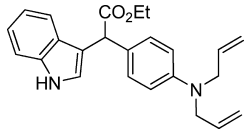
DOI: 10.1021/acs.joc.5b01736
*J. Org. Chem.* 2015, 80, 10187−10196



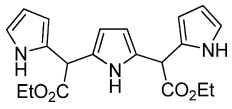
**Ethyl 2-(4-(Benzylamino)-3,5-dimethylphenyl)-2-(1*H*-indol-3-yl)acetate (38).** According to the general procedure (**II**), indole (100 mg, 0.853 mmol) and *N*-benzyl-naphthylamine (598 mg, 2.56 mmol) provided **38** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a yellowish paste (208 mg, 56%). $R_f$ = 0.4 (30% ethyl acetate in petroleum ether). $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ = 8.18 (d, *J* = 8.1 Hz, 1H), 8.08 (s, 1H), 7.88 (d, *J* = 8.9 Hz, 1H), 7.53−7.42 (m, 5H), 7.37 (t, *J* = 7.8 Hz, 2H), 7.31 (d, *J* = 16.5 Hz, 3H), 7.18 (t, *J* = 7.6 Hz, 1H), 7.07 (t, *J* = 7.9 Hz, 1H), 7.00 (d, *J* = 2.3 Hz, 1H), 6.55 (d, *J* = 8.0 Hz, 1H), 5.91 (s, 1H), 4.73 (s, 1H), 4.44 (s, 2H), 4.24 (q, *J* = 7.1 Hz, 2H), 1.26 (t, *J* = 7.1 Hz, 3H). $^{13}$C NMR (125 MHz, Chloroform-*d*) $\delta$ 173.8, 143.0, 139.2, 136.5, 132.5, 128.8, 127.9, 127.5, 127.1, 127.0, 126.3, 124.6, 124.3, 124.1, 124.0, 123.6, 122.3, 120.8, 119.7, 119.2, 114.0, 111.4, 104.6, 61.2, 48.7, 45.1, 14.4. Exact mass calculated for $C_{29}H_{27}N_2O_2^+$ [M + H]$^+$: 435.2067; found: 435.2068.



**Ethyl 2-(4-(Allyl(methyl)amino)phenyl)-2-(1*H*-indol-3-yl)acetate (39).** According to the general procedure (**II**), indole (100 mg, 0.853 mmol) and *N*-allyl-*N*-methylaniline (377 mg, 2.56 mmol) provided **39** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a pink paste (172 mg, 58%). $R_f$ = 0.4 (30% ethyl acetate in petroleum ether). $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ = 8.20 (s, 1H), 7.55 (d, *J* = 7.8 Hz, 1H), 7.32 (dd, *J* = 16.3, 8.4 Hz, 3H), 7.20 (t, *J* = 7.1 Hz, 1H), 7.14−7.08 (m, 2H), 6.72 (d, *J* = 8.8 Hz, 2H), 5.88 (ddt, *J* = 17.1, 10.2, 5.1 Hz, 1H), 5.20 (dt, *J* = 8.6, 6.5 Hz, 3H), 4.33−4.18 (m, 2H), 3.93 (d, *J* = 5.3 Hz, 2H), 2.95 (s, 3H), 1.31 (t, *J* = 7.1 Hz, 3H). $^{13}$C NMR (125 MHz, Chloroform-*d*) $\delta$ 173.7, 148.8, 136.4, 134.0, 129.2, 126.8, 126.5, 123.2, 122.2, 119.6, 119.2, 116.3, 114.6, 112.6, 111.3, 61.0, 55.4, 48.2, 38.1, 14.3. Exact mass calculated for $C_{22}H_{24}NaN_2O_2^+$ [M + Na]$^+$: 371.1730; found: 371.1724.



**Ethyl 2-(4-(Diallylamino)phenyl)-2-(1*H*-indol-3-yl)acetate (40).** According to the general procedure (**II**), indole (100 mg, 0.853 mmol) and *N*,*N*-allylaniline (444 mg, 2.56 mmol) provided **40** after flash chromatography (15−25% ethyl acetate in petroleum ether) as a yellowish paste (197 mg, 62%). $R_f$ = 0.4 (30% ethyl acetate in petroleum ether). $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ = 8.16 (s, 1H), 7.55 (d, *J* = 7.8 Hz, 1H), 7.30 (d, *J* = 8.6 Hz, 3H), 7.18 (d, *J* = 8.0 Hz, 1H), 7.14 (d, *J* = 2.4 Hz, 1H), 7.11 (t, *J* = 7.5 Hz, 1H), 6.70 (d, *J* = 8.8 Hz, 2H), 5.88 (ddt, *J* = 17.2, 10.0, 4.9 Hz, 2H), 5.26−5.15 (m, 5H), 4.25 (qq, *J* = 10.8, 7.1, 2H), 3.93 (d, *J* = 5.0 Hz, 4H), 1.30 (t, *J* = 7.1 Hz, 3H). $^{13}$C NMR (100 MHz, Chloroform-*d*) $\delta$ 173.8, 147.9, 136.4, 134.1, 129.1, 126.8, 126.3, 123.3, 122.1, 119.5, 119.1, 116.1, 114.4, 112.4, 111.3, 61.0, 52.8, 48.1, 14.3. Exact mass calculated for $C_{24}H_{26}KN_2O_2^+$ [M + K]$^+$: 413.1626; found: 413.1652.



**Diethyl 2,2′-(1*H*-Pyrrole-2,5-diyl)bis(2-(1*H*-pyrrol-2-yl)-acetate).** According to the general procedure (**I**), pyrrole (100 mg, 1.49 mmol) provided a trimer after flash chromatography (15−25% ethyl acetate in pet. ether) as a dark blue solid (103 mg, 65%). $R_f$ = 0.3 (20% EtOAc/Hexanes). IR (neat): $\nu_{max}$/cm$^{-1}$ 3383, 2974, 2919, 2846, 1725. Mp = 112−115 °C. $^1$H NMR (400 MHz, Chloroform-*d*) $\delta$ 8.63 (s, 1H), 8.47 (s, 2H), 6.64 (d, *J* = 1.6 Hz, 2H), 6.06 (d, *J* = 3.0 Hz, 2H), 5.98 (s, 2H), 5.88 (t, *J* = 2.4 Hz, 2H), 4.96 (s, 2H), 4.13 (d, *J* = 7.2 Hz, 4H), 1.22−1.19 (m, 6H). $^{13}$C NMR (100 MHz, Chloroform-*d*) $\delta$ 171.4, 127.3, 126.5, 118.1, 108.5, 107.5, 107.2, 61.8, 44.0, 14.2. Exact mass calculated for $C_{20}H_{24}N_3O_4^+$ [M + H]$^+$: 370.1761; found: 370.1762.

## ■ ASSOCIATED CONTENT

### Supporting Information

The Supporting Information is available free of charge on the ACS Publications website at DOI: 10.1021/acs.joc.5b01736.

X-ray data for compound **7** (CIF)
$^1$H and $^{13}$C spectra for all compounds (PDF)

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### Notes

The authors declare no competing financial interest.

## ■ ACKNOWLEDGMENTS

A.S. gratefully acknowledges IIT Kanpur (IITK/CHM/20130024) and BRNS (BRNS/CHM/2014118) for funding. The authors thank Ms. Sonam Mehrotra for solving the crystal structure of **7**. S.D.J. and D.B. thank UGC, New Delhi and IIT Kanpur respectively for research fellowships. A.S. thanks Professor Vinod K. Singh for the use of his laboratory during the execution of this work.

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DOI: 10.1021/acs.joc.5b01736
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*J. Org. Chem.* 2015, 80, 10187−10196