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Highly Diastereoselective [3+2] Cyclopenta[*b*]annulation of Indoles with 2-Arylcyclopropyl Ketones and Diesters

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Dedicated to Prof. Dr. Hartmut Laatsch on the occasion of his 60th birthday

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A highly diastereoselective Lewis acid (BF_3·Et_2O or $TiCl_4$) induced [3+2] cycloaddition of substituted and unsubstituted indoles with 2-arylcyclopropyl ketones/diesters yielding cyclopenta[*b*]indoles in high yields is reported. This methodology has also been extended to tetrahydrocarbazole, cyclopenta[*b*]- and cyclohepta[*b*]indoles affording tetracyclic propellane type frameworks in modest yields.

Introduction

Cyclopenta[*b*]indole ring systems occur in a number of indole alkaloids,[1] notably tremorgenic mycotoxins such as paxilline, lolitrems, penitrems, janthitrems, and paspaline[2] and in monoterpenoid alkaloid yuehchukene[3] which has been shown to exhibit mixed estrogen and antiestrogen, as well as potent antiimplantation, activities.[4–6] Recently a cyclopenta[*b*]indole derivative has been identified as a promising prostaglandin D_2 (PGD_2) receptor antagonist in the alleviation of various allergic disorders.[7] Another class of naturally occurring cyclopenta[*b*]indole alkaloids are represented by kopsane,[8] possessing an architecturally beautiful tetracyclic propellane type annulated indole substructure exhibiting cholinergic activity.[9,10] Several syntheses of yuechukene[11–13] and cyclopenta[*b*]indole frameworks have been reported in the literature.[14–19] Kerr and co-workers recently described an elegant approach for cyclopenta[*b*]indoles by reaction of 1,3-dimethylindoles with 1,1-cyclopropane diesters in the presence of ytterbium trifluoromethanesulfonate.[20–21] They further elaborated this reaction for the synthesis of substrates possessing a tetracyclic core present in kopsane and related alkaloids by reacting tetrahydrocarbazole with cyclopropane diesters. The presence of a 3-methyl substituent in the indole ring was necessary for the success of this cyclopenta[*b*]annulation to avoid deprotonation and rearomatization of the putative imminium ion intermediate formed by attack at the 3-position of indole on cyclopropane diesters. With 3-unsubstituted indoles, the product formed was one in which alkylation took place to yield 2-alkoxycarbonyl-4-(3-indolyl)butanoate.[22,23] Also with *N*-unsubstituted indoles, these reactions were complicated by the formation of *N*-alkylated products by attack of the nitrogen atom of indole on a second equivalent of the cyclopropane diester, thus requiring *N*-protection of indole. During the course of our continued work on carbocationic rearrangements of a range of cyclopropyl ketones,[24] we examined the formal [3+2] cycloaddition of the indole 2,3-double bond with few aryl cyclopropyl ketones and observed that 1,3-unsubstituted indoles react with 4-methoxyphenyl-substituted cyclopropyl ketones in the presence of BF_3·Et_2O to give substituted cyclopenta[*b*]indoles in high yields and with complete diastereoselectivity. We herein describe the results of these studies in this paper.

Results and Discussion

The cyclopropyl ketone **2a** derived from (4-methoxybenzylidene)acetophenone was selected for this model study because of its donor-acceptor character due to the presence of the cation stabilizing 4-methoxyphenyl group. Initially, a study was undertaken to probe the optimal conditions for the annulation reaction (Scheme 1). Table 1 illustrates the results of our studies in which several Lewis acids [BF_3·Et_2O, $Yb(OTf)_3$, $SnCl_4$, and $TiCl_4$] were surveyed under varying conditions. Best results were obtained with BF_3·Et_2O in nitromethane (entry 5) which gave the cyclopentannulated indole **3a** in 92% yield within 2 h, surprisingly as a single diastereomer, in contrast with Kerr's obser-

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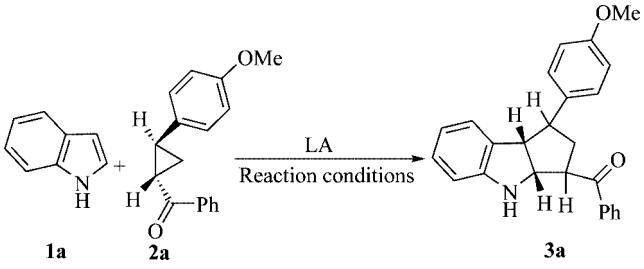
vation. The structure and stereochemistry of the cyclopentannulated indole **3a** was established with the help of spectral and X-ray crystallographic data (Figure 1). Encouraged by these results, we undertook a detailed study of this reaction by varying the substituents on the indole ring as well as on the aryl group of cyclopropyl ketones with a view to examine the scope of this [3+2] cycloaddition reaction. These results are summarized in the Scheme 2 and Table 2. Thus, 5-bromoindole **1b** reacted smoothly with cyclopropyl ketone **2a** furnishing the cyclopenta[*b*]indole **3b** in 70% yield as a single diastereomer (entry 2). The cyclization was equally facile with *N*-methylindole and the product **3c** was obtained in 83% yield (entry 3). The presence of a methyl group either at the 2- or 3-position of the indole (**1d** and **1e**) did not affect the course of reaction and the cycloadducts **3d**–**e** were obtained in 80% and 83% yields, respectively, as single diastereomers (entries 4–5). The X-ray crystallographic studies of **3d** also displayed all three tertiary and quaternary hydrogens *syn* to the 2-methyl group. Similarly, the corresponding 2,3-dimethylindole **1f** also underwent facile reaction with **2a** under identical conditions yielding the sterically crowded annulated indole **3f** in 93% yield, having two vicinal quaternary centers adjacent to two tertiary centers (entry 6). On the other hand, the corresponding 1,2,3-trimethylindole **1g** failed to react with the cyclopropyl ketone **2a** under varying conditions, yielding only the indole **1g** along with a polymeric product (entry 7).

Surprisingly the cyclopropyl ketone **2b** from (3,4-dimethoxybenzylidene)acetophenone failed to yield the cyclopentannulated product when reacted with indole **1a** in the presence of $BF_3{\cdot}Et_2O$ in nitromethane. The product isolated from the reaction mixture was characterized as the



Scheme 1.

Table 1. Formation of cyclopenta[*b*]indole **3a** under the influence of various Lewis acids.

Entry	Lewis acid	Solvent	Conditions	Time [h]	Yield [%]
1	$Yb(OTf)_3$[a]	CH_3CN	0 °C to room temp.	36	31(1:1)[b]
2	$Yb(OTf)_3$[a]	CH_2Cl_2	0 °C to room temp.	36	–[d]
3	$BF_3{\cdot}Et_2O$	CH_2Cl_2	0 °C to room temp.	5	42 (2:1)[b]
4	$BF_3{\cdot}Et_2O$	CH_3CN	0 °C to room temp.	3	48 (1:1)[b]
5	$BF_3{\cdot}Et_2O$	CH_3NO_2	0 °C to room temp.	2	92[c]
6	$SnCl_4$	CH_2Cl_2	0 °C to room temp.	6	28 (2:1)[b]
7	$SnCl_4$	CH_3NO_2	0 °C to room temp.	6	31 (4:1)[b]
8	$TiCl_4$	CH_2Cl_2	–78 °C to room temp.	4	70[c]
9	$TiCl_4$	CH_2Cl_2	0 °C to room temp.	5	42 (5:1)[b]

[a] 10 mol-% catalyst. [b] Mixture of diastereomers. [c] Single diastereomer. [d] No reaction.

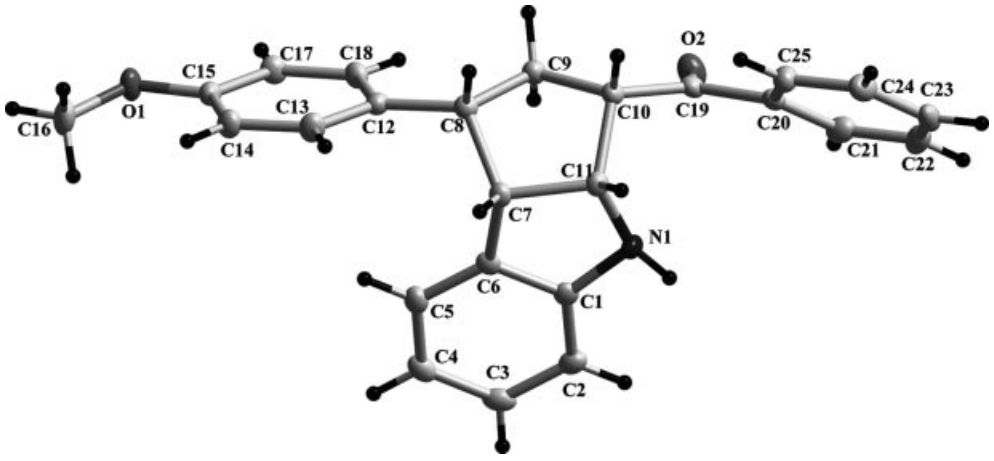
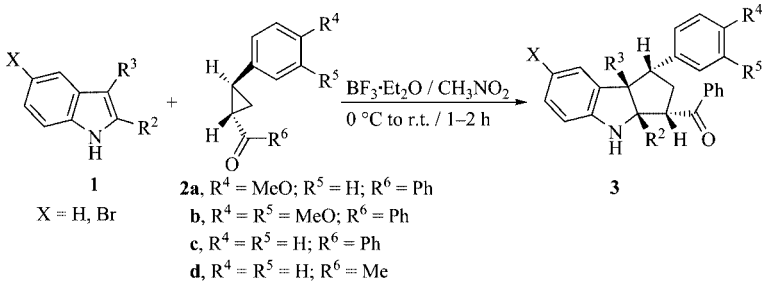


Figure 1. Molecular structure of **3a** shown at 50% ellipsoidal probability level.



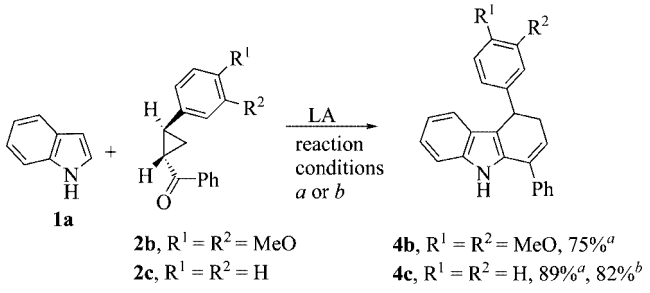
Scheme 2.

Table 2. Cyclopentannulation of indoles **1** with cyclopropyl ketones **2**.

Entry	1	2	Product	% Yield[a]
1[b]	**1a**, X = H	**2a**	**3a**, X = H	92
2[b]	**1b**, X = Br	**2a**	**3b**, X = Br	70
3[b]	**1c**	**2a**	**3c**	83
4[b]	**1d**	**2a**	**3d**	80
5[b]	**1e**	**2a**	**3e**	83
6[b]	**1f**	**2a**	**3f**	93
7[b]	**1g**	**2a**	–	–[d]
8[c]	**1a**	**2b**	**5a**, $R^1 = R^2 = R^3 = H$	84
9[c]	**1c**	**2b**	**5c**, $R^1 = Me$; $R^2 = R^3 = H$	85
10[c]	**1f**	**2b**	**5f**, $R^1 = H$; $R^2 = R^3 = Me$	83
11[b]	**1e**	**2c**	**6e'** **6e''** (2:1)	85[e]
12[b]	**1e**	**2d**	**7e'** **7e''** (3:1)	70
13[b]	**1a**		**8** **9a**, $R^1 = H$	88
14[b]	**1e**		**8** **9e**, $R^1 = Me$	79

[a] Yield of pure isolated product. [b] Reaction conditions: $BF_3{\cdot}Et_2O$, 0 °C to room temp., 2 h. [c] Reaction conditions: $TiCl_4$, CH_2Cl_2, –78 °C, 2 h. [d] Indole **1g** was recovered fully. [e] Pure **6e′** was separated in 45% yield.

1,4-diaryl-3,4-dihydrocarbazole **4b** (75%) on the basis of spectral and analytical data (Scheme 3). However, on changing the Lewis acid to $TiCl_4$ at lower temperature (–78 °C), the reaction proceeded smoothly in dichloromethane yielding the cyclopentannulated adduct **5a** in 84% yield as single diastereomer (Scheme 2, Table 2, entry 8). Similarly, the corresponding 1-methyl- (**1c**) and 2,3-dimethylindole (**1f**) also underwent smooth cycloaddition with the 2-(3,4-dimethoxyphenyl)cyclopropyl ketone **2b** in the presence of $TiCl_4/CH_2Cl_2$ catalyst to afford cyclopentaannulated indoles **5c** and **5e** in 85% and 83% yields, respectively, in a highly stereocontrolled fashion (Table 2, entries 9–10). Cyclopentannulation of the indole **1a** with phenyl 2-phenylcyclopropyl ketone (**2c**), with lesser cationic stabilization in comparison with **2a**, was investigated next. Thus, the reaction of **1a** with **2c** in the presence of either $BF_3{\cdot}Et_2O$ or $TiCl_4$ or other Lewis acids [$Yb(OTf)_3$, $SnCl_4$] failed to yield the corresponding cyclopentannulated indole adduct and the only product isolated (with either $BF_3{\cdot}Et_2O$ or $TiCl_4$) was found to be the 1,4-diaryl-3,4-dihydrocarbazole **4c** (Scheme 3), whereas with $Yb(OTf)_3/CH_3CN$ the indole **1a** was recovered unchanged even after prolonged reaction time (48 h). On the other hand, the corresponding 3-methylindole **1e** underwent smooth cyclopentaannulation with ketone **2c** to give the cycloadduct **6e** in 85% overall yield as mixture of two diastereomers **6e′** and **6e′′** (2:1) (entry 11, Table 2). Similarly, the corresponding 1-phenyl-2-acetylcyclopropane **2d** also reacted with 3-methylindole **1e** under identical conditions to give the diastereomeric mixture of cycloadducts **7e′** and **7e′′** (3:1) in 70% overall yield (entry 12, Table 2).

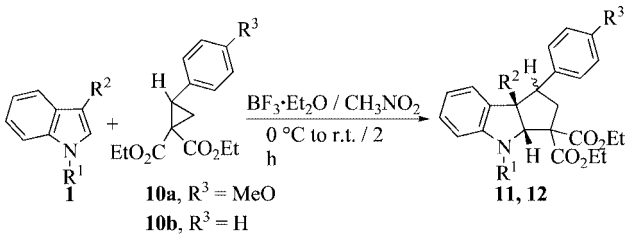


[a] $BF_3{\cdot}Et_2O$, CH_3NO_2, 0 °C to r.t., 89%
[b] $TiCl_4$, –78 °C to r.t., CH_2Cl_2

Scheme 3.

Cyclopentaannulation of the indole **1a** with 1-(styrenyl)-2-benzoylcyclopropane **8** was examined next with a view to probe the effect of the styrenyl group towards cationic stabilization during the ring opening of the cyclopropyl ketone **8** in the presence of Lewis acid. Thus, when the indole **1a** and phenyl 2-(α-styryl)cyclopropyl ketone (**8**) were exposed to $BF_3{\cdot}Et_2O$ in nitromethane under standard reaction conditions, the styrenyl-substituted cycloadduct **9a** was formed in 88% yield as a single diastereomer with the four cyclopentane hydrogens having *syn* stereochemistry (Table 2, entry 13). Similarly, the corresponding 3-methylindole **1e** also yielded the styrenyl-substituted cyclopenta-[*b*]indole **9e** in 79% yield with high stereoselection (Table 2, entry 14).

Next we extended our studies to the cycloaddition of indoles with aryl and styrenyl-substituted cyclopropyl diesters **10a**–**b** and **13** (Scheme 4, Table 3). The presence of two electron-withdrawing substitutents at the acceptor carbon is expected to facilitate the cationic ring opening of arylcyclopropanes in the presence of Lewis acids. Thus, when the indole **1a** was treated with 4-methoxyphenylcyclopropyl diester **10a**, in the presence of $BF_3{\cdot}Et_2O$, analysis of the product mixture revealed formation of both the diastereomers (**11a**′ and **11a**′′) of the cyclopenta[*b*]indole **11a** (2:1) in overall yield of 86% (Scheme 4, Table 3, entry 1). Similarly, the *N*-methylindole **1c** also afforded the adduct **11c** (90%) in 1:1 diastereomeric ratio when reacted with cyclopropyl diesters **10a** under identical conditions (Scheme 4, Table 3, entry 2). On the other hand, cyclopentannulation of 3-methylindole **1e** with either 4-methoxyphenyl or phenyl-substituted cyclopropyl diesters (**10a** or **10b**) proceeded in highly diastereoselective fashion yielding only diastereomers **11e** and **12e** in 89% and 72% yields, respectively (Table 3, entries 3 and 4). The stereochemical assignment of the adducts **11e** and **12e**, having all three contiguous hydrogens *syn* to each other, was established with the help of NOESY correlation spectra. The reaction of styrenyl-substituted cyclopropyl diester **13** with the indole **1a** in the presence of either $BF_3{\cdot}Et_2O$ or $TiCl_4$ gave only a complex mixture of products, whereas use of $Yb(OTf)_3$ in CH_3CN furnished the cycloadduct **14** in 49% yield (Table 3, entry 5).



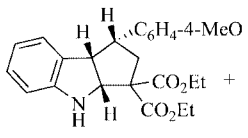
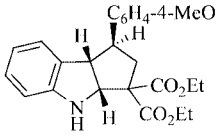
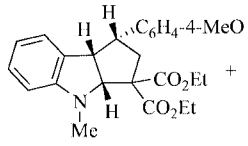
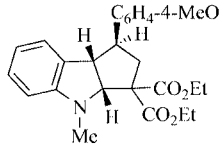
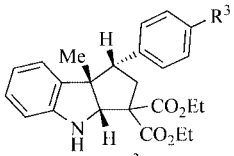
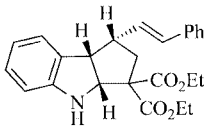
1 **10a**, R^3 = MeO **10b**, R^3 = H **11, 12**

Scheme 4.

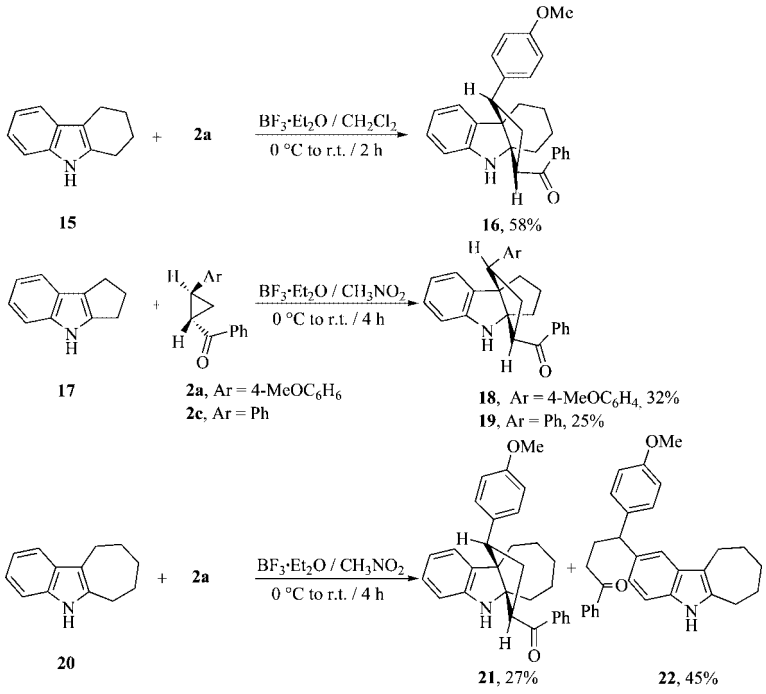
The success of the cyclopenta[*b*]annulation of the various substituted indoles, especially 2,3-dimethylindole **1f**, prompted us to extend this reaction to tetrahydrocarbazole **15** as a dipolarophile with a view to synthesize propellane type annulation products (Scheme 5). Thus, under optimized reaction conditions, the reaction of tetrahydrocarbazole with cyclopropyl ketone **2a** in the presence of $BF_3{\cdot}Et_2O$ in CH_2Cl_2 afforded a product (58%) which was characterized as the propellane **16**. The product was formed as a single diastereomer (Scheme 5) and is in contrast to the results of Kerr with phenylcyclopropyl diester **12e** yielding a 1:1 mixture of diastereomers. Attempts to isolate the other diastereomer from the reaction mixture were not successful.

The reaction of the corresponding cyclopenta[*b*]indole **17** with the 2-arylcyclopropyl ketones **2a** and **2c** also afforded the propellane derivatives **18** and **19** as single diastereomers in modest yields under similar conditions (Scheme 5). Similarly, the propellane synthesis was also extended to cy-

Table 3. Cyclopentannulation of indoles **1** with cyclopropyl diesters **10**.

Entry	**1**	**10**	Product		% Yield[a]
1[b]	**1a**	**10a**	 **11a'**	 **11a"** (2:1)	86
2[b]	**1c**	**10a**	 **11c'**	 **11c"** (1:1)	90
3[b]	**1e**	**10a**	 **11e**, R^3 = MeO	–	89
4[b]	**1e**	**10b**	**12e**, R^3 = H	–	72
5[c]	**1a**	**13**	 **14**	–	49

[a] Yields of pure isolated products. [b] Reaction conditions: $BF_3{\cdot}Et_2O$, CH_3NO_2, 0 °C to room temp., 2 h. [c] 10 mol-% $Yb(OTf)_3$, CH_3CN, room temp., 14 h.



Scheme 5.

clohepta[*b*]indole **20** which on reaction with the cyclopropyl ketone **2a** afforded two products of which the minor one (27%) was characterized as the propellane derivative **19** as a single diastereomer, whereas the structure of the major product (45%) was established as **22** on the basis of spectral and analytical data (Scheme 5).

In the ^{1}H NMR spectra of all newly prepared cyclopenta[2,3-*b*]indoles **3a**–**f**, **5a**, **5c**, **5f**, **6e**, **7e**, **9a**, and **9e**, the *trans* coupling constants (JH^{1}H$^{2''}$, JH$^{2''}$H^3) and the geminal coupling constants (JH$^{2'}$H$^{2''}$) are in the range of 12–13 Hz, whereas the three *cis* coupling constants (JH^{1}H$^{2'}$, JH$^{2'}$H^3 and JH^{3}H^{3a}) are in the range of 5–6.1 Hz (Figure 2). The *trans* geminal proton (H$^{2''}$) appears as a quartet with coupling constants between range of 12–13 Hz in all the ^{1}H NMR spectra of these compounds. On the other hand, the *cis* protons H$^{2'}$ and H^3 appear as triplets of doublets with two middle peaks merging (showing five peaks) with two coupling constants in the range of 5–6.1 Hz (triplet) and 12–13 Hz (doublet). The *cis* coupling constants JH^{1}H^{8b} and JH^{3a}H^{8b} are in the range of 8.5–10.1 Hz. The H^1 proton appears as a difficult to analyze multiplet in all the ^{1}H NMR spectra. The same trend is also observed in the ^{1}H NMR spectra of products **11a**, **11c**, **11e**, **12e**, and **14** (JH$^{2''}$H^3 and JH$^{2'}$H$^{2''}$ = 13.3–14.6 Hz), **16**, **18**, **19**, and **21**. Average values of coupling constants are reported.

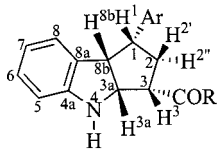
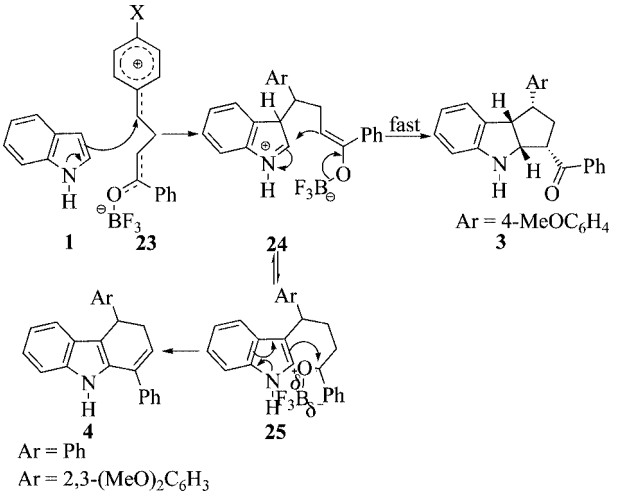


Figure 2. Proton designation for cyclopenta[2,3-*b*]indole ring.

Mechanism and Stereochemistry

The probable mechanism for this unprecedented [3+2] annulation of 3-unsubtituted indoles (**1a**–**d**) with cyclopropyl ketone **2a** is shown in the Scheme 6. Apparently the formation of stable zwitterionic intermediates via facile ring opening of cyclopropyl ketone is the key factor for this facile [3+2] cycloaddition of 3-unsubstituted indoles to cyclopentannulated products **3** via the imminium ion intermediate **24** in a kinetically controlled process. In the absence of the cation stabilizing 4-methoxy group, the ring opening of cyclopropyl ketone is slow and the resulting imminium ion **24** (Ar = Ph) undergoes slow tautomerization to indole **25** followed by its BF_3·Et_2O induced intramolecular cyclocondensation furnishing the 1,4-diaryl-3,4-dihydrocarbazole **4** as the exclusive product.



Scheme 6.

Another noteworthy feature of this [3+2] cycloannulation is the remarkable stereoselectivity which deserves comment. In all the cyclopentaannulation reactions of the indoles **1a**–**g** and methoxyaryl-(or α-styryl-)cyclopropyl ketones **2a**–**b**, only one diastereomer was obtained which has a *trans* relationship between its angular substitutents (H or Me) and the substituents (Ar or ArCO) on the newly formed cyclopentane ring which are in an *endo* relationship with the bent ring system. The possible conformations for the transition states for the intramolecular cyclization of imminium ion intermediate **24** are shown in Figure 3. For the *Z* enolate the possible transition states are **24A** and **24C** whereas structures **24B** and **24D** represent possible transition states for the *E* enolate. Apparently the conformations **24C** and **24D**, which will yield *trans* products, are of higher energy than **24A** and **24B** because of pseudodiaxial interactions shown in Figure 3. Therefore, all *cis* products **3** are formed through cyclization of intermediates **24A** or **24B** with minimal pseudodiaxial interactions.

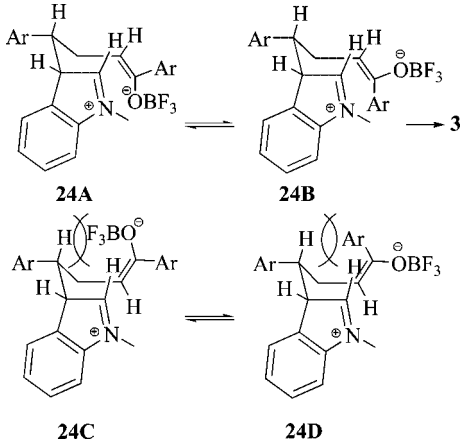


Figure 3. Possible conformations for the formation of cyclopenta[2,3-*b*]indoles.

Conclusion

In summary, we have demonstrated an unusual [3+2] cycloannulation of 1,3-unsubstituted/substituted indoles with aryl-(or α-styryl-)cyclopropyl ketones under $BF_3{\cdot}Et_2O$ (or $TiCl_4$) induced reaction conditions yielding cyclopentannulated indolines in high yields and in a highly stereocontrolled fashion as single diastereomers. The reaction has also been extended to tetrahydrocarbazole, cyclopenta[*b*]- and cyclohepta[*b*]indoles affording tetracyclic propellane type annulated substructures present in kopsane type alkaloids. Further work to study the detailed mechanism and the scope of this annulation methodology are in progress.

Experimental Section

General: ^1H NMR (400 MHz) and ^{13}C NMR (100 MHz) spectra were recorded in $CDCl_3$ and TMS was used as an internal reference. Melting points are uncorrected. Chromatographic purification was conducted by column chromatography using 100–200 mesh silica gel obtained from Acme Synthetic Chemicals. DMF and DMSO were distilled from CaH_2 and stored with molecular sieves. THF was distilled from sodium/benzophenone prior to use. NaH (as 60% suspension in oil), $SnCl_4$, $BF_3{\cdot}Et_2O$ (50% solution in Et_2O), $TiCl_4$, $Yb(OTf)_3$, and nitromethane (AR grade) were purchased from standard firms and used directly. The cyclopropyl ketones **2a**, **2b**, **2c**, **2d**, **8**, and diesters **10a**, **10b**, and **13** were prepared according to the literature procedure[25] in nearly quantitative yields. Single-crystal X-ray crystallographic data on **3a** and **3d** were collected at 100 K on a Bruker SMART APEX CCD diffractometer with graphite-monochromated Mo-K_α (λ = 0.71073 A) radiation using the ω–θ scan technique. The hydrogen atoms were fixed in their ideal positions and refined as a riding model except for the hydrogen atom of the chiral center, which was located from the difference Fourier map and refined isotropically. See Supporting Information for more details on X-ray crystal data and molecular structure of **3a** and **3d**.

General Procedure for the Cycloaddition of Cyclopropyl Ketones 2a, 2b, 2c, 2d, and 8 or Diesters 10a, 10b, and 13 to Indoles 1a–g, 15, 17, and 20 in the Presence of $BF_3{\cdot}Et_2O$ as a Lewis Acid: A solution of the Lewis acid (3.0 mmol) in dry solvent (nitromethane or CH_2Cl_2 or CH_3CN) (5 mL) was added dropwise at 0 °C to a stirred solution of the cyclopropyl ketone (**2a**, **2b**, **2c**, **2d**, or **8** or diesters **10a**, **10b**, or **13**) (2.0 mmol) and the appropriate indole (**1a**–**g**, **15**, **17**, or **20**) (2.0 mmol) in respective solvent (10 mL). After the complete addition, the reaction mixture was stirred at room temp. for 1–4 h (monitored by TLC). It was then diluted with an ice-cold saturated $NaHCO_3$ solution (10 mL), and extracted by $CHCl_3$ (2 × 25 mL), washed with water (1 × 25 mL), followed by brine (25 mL) and dried with anhydrous Na_2SO_4. The solvent was evaporated under reduced pressure to afford the cyclopentannulated indoles **3a**–**f**, **6**, **7**, **9a**, **9e**, **11a**, **11c**, **11e**, **12e**, and **14**, and dihydrocarbazoles **4b** and **4c**, or propellanes **16**, **18**, **19**, and **21** which were purified by column chromatography using silica gel and hexane/EtOAc as eluent.

(1*R,3*S**,3a*R**,8b*S**)-[1-(4-Methoxyphenyl)-1,2,3,3a,4,8b-hexahydrocyclopenta[*b*]indol-3-yl]phenylmethanone (3a):** Yield 92% (0.67 g); colorless crystals; m.p. 174–175 °C; R_f 0.66 (3:1 hexanes/EtOAc). IR (KBr): $\tilde{\nu}$ = 3367, 1676, 1602, 1512, 1463, 1362, 1258, 1178, 1034, 749 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ = 2.08 (td, J = 12.80, 5.8 Hz, 1 H, $H^{2'}$), 2.47 (q, J = 12.80 Hz, 1 H, $H^{2''}$), 3.62 (m, 1 H, H^1), 3.78 (s, 3 H, OCH_3), 3.93 (td, J = 12.80, 5.8 Hz, 1 H, H^3), 4.12 (t, J = 9.6 Hz, 1 H, H^{8b}), 4.94 (dd, J = 9.6, 5.8 Hz, 1 H, H^{3a}), 5.79 (d, J = 7.3 Hz, 1 H, ArH), 6.28 (t, J = 7.3 Hz, 1 H, ArH), 6.42 (d, J = 7.8 Hz, 1 H, ArH), 6.77 (d, J = 8.5 Hz, 2 H, ArH), 6.85 (t, J = 7.5 Hz, 1 H, ArH), 6.96 (d, J = 8.5 Hz, 2 H, ArH), 7.51 (t, J = 7.0 Hz, 2 H, ArH), 7.59 (t, J = 7.3 Hz, 1 H, ArH), 8.04 (dd, J = 8.0 Hz, 1.2 Hz, 2 H, ArH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 30.9, 48.8, 52.5, 54.4, 55.2, 65.2, 108.6, 113.2, 117.6, 126.6, 127.5, 127.6, 128.2, 128.8, 129.7, 131.5, 133.1, 137.2, 151.4, 158.2, 199.5 ppm. MS: *m*/*z* (%) = 369 (100) [M^+]. $C_{25}H_{23}NO_2$ (369.46): calcd. C 81.27, H 6.27, N 3.79%; found C 81.11, H 6.09, N 3.54%.

(1*R,3*S**,3a*R**,8b*S**)-[(4-Methoxyphenyl)-3a-methyl-1,2,3,3a,4,8b-hexahydrocyclopenta[*b*]indol-3-yl]phenylmethanone (3d):** Yield 80% (0.61 g); colorless crystals; m.p. 170–171 °C; R_f 0.5 (6:1 hexanes/EtOAc). IR (KBr): $\tilde{\nu}$ = 3393, 1676, 1603, 1512, 1463, 1232, 1177, 1031, 828, 752, 707 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ = 1.50 (s, 3 H, CH_3), 2.17 (td, J = 12.5, 5.4 Hz, 1 H, $H^{2'}$), 2.42 (q, J = 12.5 Hz, 1 H, $H^{2''}$), 3.54 (d, J = 9.8 Hz, 1 H, H^{8b}), 3.67 (m, 1 H,

H^1), 3.74 (s, 3 H, OCH_3), 3.83 (dd, J = 12.5, 5.4 Hz, 1 H, H^3), 4.86 (br. s, 1 H, NH), 5.89 (d, J = 7.3 Hz, 1 H, ArH), 6.26 (dt, J = 7.4, 1.0 Hz, 1 H, ArH), 6.51 (d, J = 7.5 Hz, 1 H, ArH), 6.76 (d, J = 8.6 Hz, 2 H, ArH), 6.83 (d, J = 8.6 Hz, 2 H, ArH), 6.90 (dt, J = 7.7, 1.0 Hz, 1 H, ArH), 7.47 (t, J = 7.2 Hz, 2 H, ArH), 7.56 (t, J = 7.3 Hz, 1 H, ArH), 7.96 (dd, J = 8.4, 1.1 Hz, 2 H, ArH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 27.7, 35.7, 49.1, 55.1, 57.0, 59.4, 72.3, 108.0, 113.0, 116.9, 126.7, 126.9, 127.5, 128.3, 128.5, 129.6, 131.7, 133.0, 138.2, 150.9, 158.0, 201.2 ppm. MS: *m*/*z* (%) = 383 (22) [M^+], (100) [263]. $C_{26}H_{25}NO_2$ (383.48): calcd. C 81.43, H 6.57, N 3.65%; found C 81.31, H 6.34, N 3.42%.

(1*R,3*S**,3a*S**,8b*S**)-[(4-Methoxyphenyl)-8b-methyl-1,2,3,3a,4,8b-hexahydrocyclopenta[*b*]indol-3-yl]phenylmethanone (3e):** Yield 83% (0.63 g); colorless crystals; m.p. 141–142 °C; R_f 0.60 (6:1 hexanes/EtOAc). IR (KBr): $\tilde{\nu}$ = 3369, 2957, 1674, 1600, 1512, 1461, 1358, 1301, 1248, 1185, 1029, 822, 744, 703 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.55 (s, 3 H, CH_3), 2.05 (td, J = 12.8, 5.6 Hz, 1 H, $H^{2'}$), 2.54 (q, J = 12.8 Hz, 1 H, $H^{2''}$), 3.19 (dd, J = 12.8, 5.6 Hz, 1 H, H^1), 3.77 (s, 3 H, OCH_3), 3.94 (td, J = 12.8, 5.6 Hz, 1 H, H^3), 4.47 (d, J = 5.6 Hz, 1 H, H^{3a}), 5.68 (d, J = 7.3 Hz, 1 H, ArH), 6.29 (t, J = 7.3 Hz, 1 H, ArH), 6.43 (d, J = 7.8 Hz, 1 H, ArH), 6.75 (d, J = 8.56 Hz, 2 H, ArH), 6.86 (t, J = 5.6 Hz, 1 H, ArH), 6.90 (d, J = 8.5 Hz, 2 H, ArH), 7.51 (t, J = 7.4 Hz, 2 H, ArH), 7.59 (t, J = 7.3 Hz, 1 H, ArH), 8.04 (d, J = 7.8 Hz, 2 H, ArH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 28.4, 32.5, 52.8, 55.1, 56.4, 57.8, 72.6, 108.3, 112.9, 117.4, 125.6, 127.3, 128.1, 128.8, 129.8, 131.3, 131.7, 133.0, 137.2, 150.8, 158.3, 199.6 ppm. MS: *m*/*z* (%) = 383 (100) [M^+]. $C_{26}H_{25}NO_2$ (383.48): calcd. C 81.43, H 6.57, N 3.65%; found C 81.62, H 6.31, N 3.79%.

(1*R,3*S**,3a*S**,8b*S**)-[(4-Methoxyphenyl)-3a,8b-dimethyl-1,2,3,3a,4,8b-hexahydrocyclopenta[*b*]indol-3-yl]phenylmethanone (3f):** Yield 93% (0.73 g); yellow viscous oil; R_f 0.72 (19:1 hexanes/EtOAc). IR (CH_2Cl_2): $\tilde{\nu}$ = 3397, 2965, 2834, 2361, 1676, 1607, 1512, 1485, 1464, 1446, 1379, 1319, 1247, 1179, 1110, 1035, 829, 742 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.30 (s, 3 H, CH_3), 1.34 (s, 3 H, CH_3), 2.07 (td, J = 12.5, 5.6 Hz, 1 H, $H^{2'}$), 2.35 (q, J = 12.5 Hz, 1 H, $H^{2''}$), 3.06 (dd, J = 12.5, 5.6 Hz, 1 H, H^1), 3.65 (s, 3 H, OCH_3), 3.70 (dd, J = 12.5, 5.6 Hz, 1 H, H^3), 4.43 (br. s, 1 H, NH), 5.74 (d, J = 7.1 Hz, 1 H, ArH), 6.18 (t, J = 7.3 Hz, 1 H, ArH), 6.43 (d, J = 7.8 Hz, 1 H, ArH), 6.58 (d, J = 8.7 Hz, 2 H, ArH), 6.66 (d, J = 8.7 Hz, 2 H, ArH), 6.81 (t, J = 7.3 Hz, 1 H, ArH), 7.39 (t, J = 7.6 Hz, 2 H, ArH), 7.48 (t, J = 7.3 Hz, 1 H, ArH), 7.90 (dd, J = 8.5, 1.5 Hz, 2 H, ArH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 23.3, 35.6, 55.1, 55.6, 58.3, 58.9, 74.3, 107.6, 112.8, 116.8, 125.3, 127.5, 128.2, 128.5, 129.7, 130.0, 131.4, 131.9, 133.0, 138.1, 149.5, 158.2, 201.5 ppm. MS: *m*/*z* (%) = 397 (100) [M^+]. $C_{27}H_{27}NO_2$ (397.20): calcd. C 81.58, H 6.85, N 3.52%; found C 81.70, H 6.72, N 3.62%.

(1*S,3*S**,3a*R**,8b*S**)-Phenyl-(1-styryl-1,2,3,3a,4,8b-hexahydrocyclopenta[*b*]indol-3-yl)methanone (9a):** Yield 88% (0.64 g); colorless solid; m.p. 150–151 °C; R_f 0.40 (9:1 hexanes/EtOAc). IR (KBr): $\tilde{\nu}$ = 3368, 3027, 2926, 2374, 1679, 1599, 1482, 1364, 1322, 1251, 1150, 968, 745, 691 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.96 (td, J = 12.5, 5.7 Hz, 1 H, $H^{2'}$), 2.11 (q, J = 12.5 Hz, 1 H, $H^{2''}$), 3.06–3.11 (m, 1 H, H^1), 3.82 (td, J = 12.5, 5.7 Hz, 1 H, H^3), 4.02 (t, J = 8.5 Hz, 1 H, H^{8b}), 4.87 (dd, J = 8.5, 5.7 Hz, 1 H, H^{3a}), 5.96 (dd, J = 15.9, 9.0 Hz, 1 H, =CH), 6.42 (d, J = 15.9 Hz, 1 H, =CH), 6.44 (d, J = 7.5 Hz, 1 H, ArH), 6.55 (t, J = 7.3 Hz, 1 H, ArH), 6.89–6.94 (m, 2 H, ArH), 7.12–7.25 (m, 5 H, ArH), 7.42–7.54 (m, 3 H, ArH), 7.96 (d, J = 8.1 Hz, 2 H, ArH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 32.9, 47.5, 51.8, 54.2, 65.6, 109.2, 118.0, 126.1, 126.5, 127.0, 127.5, 127.8, 128.2, 128.5, 128.8, 130.3, 131.0, 133.1, 137.1, 137.3, 151.2, 199.4 ppm. MS: *m*/*z* (%) = 365 (100) [M^+]. $C_{26}H_{23}NO$ (365.47): calcd. C 85.45, H 6.34, N 3.83%; found C 85.61, H 6.12, N 4.11%.

4-(3,4-Dimethoxyphenyl)-1-phenyl-4,9-dihydro-3*H*-carbazole (4b): Yield 75% (0.57 g); colorless crystals; m.p. 177–178 °C; R_f 0.39 (6:1 hexanes/EtOAc). IR (KBr): $\tilde{\nu}$ = 3338, 1593, 1512, 1458, 1247, 1133, 1025, 759 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.75 (ddd, J = 17.1, 10.2, 4.5 Hz, 1 H, H^3), 2.95 (ddd, J = 17.1, 8.2, 4.5 Hz, 1 H, H^3), 3.77 (s, 3 H, OCH_3), 3.85 (s, 3 H, OCH_3), 4.37 (dd, J = 10.2, 8.2 Hz, 1 H, H^4), 5.97 (t, J = 4.5 Hz, 1 H, =CH), 6.80 (d, J = 8.3 Hz, 1 H, ArH), 6.88–6.95 (m, 4 H, ArH), 7.06 (dt, J = 7.1, 2.4 Hz, 1 H, ArH), 7.19–7.26 (m, 1 H, ArH), 7.38–7.61 (m, 5 H, ArH), 7.98 (br. s, 1 H, NH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 35.2, 38.5, 55.7, 55.8, 110.9, 111.1, 112.8, 119.5, 119.7, 119.9, 121.6, 124.8, 126.6, 127.4, 127.8, 128.9, 129.2, 132.6, 133.2, 135.8, 137.6, 138.1, 147.5, 148.8 ppm. MS: *m*/*z* (%) = 381 (40) [M^+]. $C_{26}H_{23}NO_2$ (381.47): calcd. C 81.86, H 6.08, N 3.67%; found C 81.97, H 5.83, N 3.42%.

Diethyl (1*S,3a*R**,8b*S**)-1-(4-methoxyphenyl)-8b-methyl-1,3a,4,8b-tetrahydrocyclopenta[*b*]indole-3,3(2*H*)-dicarboxylate (11e):** Yield 89% (0.75 g); colorless viscous liquid; R_f 0.35 (9:1 hexanes/EtOAc). IR (neat): $\tilde{\nu}$ = 3468, 2363, 1726, 1597, 1516, 1351, 1263, 669 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.19 (t, J = 7.4 Hz, 3 H, CH_3), 1.23 (t, J = 7.4 Hz, 3 H, CH_3), 1.47 (s, 3 H, CH_3), 2.22 (dd, J = 13.6, 5.1 Hz, 1 H, $H^{2'}$), 2.57 (dd, J = 14.5, 13.1 Hz, 1 H, $H^{2''}$), 3.03 (dd, J = 14.5, 5.1 Hz, 1 H, H^1), 3.70 (s, 3 H, OCH_3), 3.91 (br. s, 1 H, NH), 4.06–4.28 (m, 4 H, 2×CH_2), 4.64 (s, 1 H, H^{3a}), 5.53 (d, J = 7.5 Hz, 1 H, ArH), 6.24 (t, J = 7.4 Hz, 1 H, ArH), 6.41 (d, J = 7.5 Hz, 1 H, ArH), 6.69 (d, J = 8.5 Hz, 2 H, ArH), 6.81 (d, J = 8.5 Hz, 2 H, ArH), 6.82 (t, J = 7.8 Hz, 1 H, ArH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 14.0, 14.1, 27.8, 36.3, 53.3, 55.1, 57.5, 61.2, 61.5, 65.8, 73.3, 108.6, 112.9, 117.7, 126.0, 127.4, 129.8, 130.4, 132.0, 150.4, 158.4, 169.1, 170.9 ppm. MS: *m*/*z* (%) = 423 (100) [M^+]. $C_{25}H_{29}NO_5$ (423.50): calcd. C 70.90, H 6.90, N 3.31%; found C 70.73, H 7.13, N 3.11%.

(1*S,3*S**,4a*R**,9a*R**)-3-[4-Methoxyphenyl]-1,2,3,4,9-pentahydro-4a,9a-propanocarbazole Derivative 16:** Yield 58% (0.49 g); viscous liquid; R_f 0.75 (6:1 hexanes/EtOAc). IR (neat): $\tilde{\nu}$ = 3446, 2921, 2851, 2365, 1597, 1352, 1251, 1032, 669 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.11–1.25 (m, 2 H, CH_2), 1.33–1.37 (m, 2 H, CH_2), 1.60–1.65 (m, 1 H, CH), 1.70–1.76 (m, 1 H, CH), 1.81–1.90 (m, 1 H, CH), 2.08–2.13 (m, 2 H, cyclohexane CH and $H^{2'}$), 2.36 (q, J = 12.6 Hz, 1 H, $H^{2''}$), 3.14 (dd, J = 12.6, 5.9 Hz, 1 H, H^1), 3.67 (s, 3 H, OCH_3), 3.86 (dd, J = 12.6, 5.2 Hz, 1 H, H^3), 4.23 (br. s, 1 H, NH), 5.72 (d, J = 7.5 Hz, 1 H, ArH), 6.17 (t, J = 7.4 Hz, 1 H, ArH), 6.42 (d, J = 7.5 Hz, 1 H, ArH), 6.59 (d, J = 8.5 Hz, 2 H, ArH), 6.73 (d, J = 8.5 Hz, 2 H, ArH), 6.80 (t, J = 7.5 Hz, 1 H, ArH), 7.41 (t, J = 7.4 Hz, 2 H, ArH), 7.50 (t, J = 7.0 Hz, 1 H, ArH), 7.91 (d, J = 8.3 Hz, 2 H, ArH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 17.8, 18.9, 32.7, 33.4, 34.8, 54.1, 55.1, 57.5, 59.4, 74.0, 107.6, 112.8, 116.8, 125.2, 127.3, 128.2, 128.6, 129.6, 130.0, 132.1, 133.0, 138.3, 151.2, 158.1, 201.7 ppm. MS: *m*/*z* (%) = 423 (100) [M^+]. $C_{29}H_{29}NO_2$ (423.55): calcd. C 82.24, H 6.90, N 3.31%; found C 82.53, H 6.71, N 3.51%.

(1*S,3*S**,3a*R**,8b*R**)-1-Phenyl-1,2,3,4-tetrahydro-3a,8b-propanocyclopenta[*b*]indole Derivative 19:** Yield 25% (0.18 g); colorless crystals; m.p. 180–183 °C; R_f 0.61 (19:1 hexanes/EtOAc). IR (KBr): $\tilde{\nu}$ = 3355, 3058, 2941, 2363, 1662, 1598, 1484, 1457, 1401, 1319, 1254, 1207, 1159, 1015, 746, 707 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.08–1.26 (m, 3 H, CH_2, CH), 1.50–1.56 (m, 1 H, CH), 1.62–1.69 (m, 2 H, CH_2), 1.91 (td, J = 13.0, 5.0 Hz, 1 H, $H^{2'}$), 2.64 (q, J = 13.0 Hz, 1 H, $H^{2''}$), 3.32 (dd, J = 13.0, 5.0 Hz, 1 H, H^1), 3.97 (dd,

J = 13.0, 5.0 Hz, 1 H, H^3), 6.54 (d, *J* = 7.8 Hz, 1 H, ArH), 6.67 (t, *J* = 7.3 Hz, 1 H, ArH), 6.94 (d, *J* = 7.5 Hz, 1 H, ArH), 7.00 (dt, *J* = 7.1, 1.0 Hz, 1 H, ArH), 7.23 (t, *J* = 7.1 Hz, 1 H, ArH), 7.31 (t, *J* = 7.4 Hz, 2 H, ArH), 7.39 (d, *J* = 7.3 Hz, 2 H, ArH), 7.46 (t, *J* = 7.5 Hz, 2 H, ArH), 7.54 (t, *J* = 7.4 Hz, 1 H, ArH), 8.11 (d, *J* = 7.8 Hz, 2 H, ArH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 25.1, 31.6, 36.8, 38.5, 52.4, 59.0, 69.1, 82.6, 108.9, 119.0, 124.0, 126.7, 127.8, 128.0, 128.3, 128.6, 128.91, 128.95, 133.1, 135.9, 137.8, 139.9, 201.3 ppm. MS: *m*/*z* (%) = 379 (100) [M^+]. $C_{27}H_{25}NO$ (379.49): calcd. C 85.45, H 6.64, N 3.69%; found C 85.21, H 6.91, N 3.92%.

(1*S,3*S**,5a*R**,10b*R**)-1-(4-Methoxyphenyl)-1,2,3,4,5,6-hexahydro-5a,10b-propanocyclohepta[*b*]indole Derivative 21:** Yield 27% (0.23 g); colorless solid; m.p. 142–144 °C; R_f 0.67 (9:1 hexanes/EtOAc). IR (KBr): $\tilde{\nu}$ = 3413, 2930, 2854, 2363, 1676, 1604, 1512, 1486, 1448, 1363, 1248, 1222, 1179, 1035, 831, 742, 703 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.98–1.08 (m, 2 H, CH_2), 1.10–1.31 (m, 3 H, CH_2, CH), 1.40–1.55 (m, 2 H, CH_2), 1.78 (t, *J* = 14.4 Hz, 1 H, CH), 1.90–1.96 (m, 2 H, $H^{2'}$ and CH), 2.11 (dd, *J* = 14.4, 7.1 Hz, 1 H, CH), 2.30 (q, *J* = 12.9 Hz, 1 H, $H^{2''}$), 3.03 (dd, *J* = 12.9, 5.1 Hz, 1 H, H^1), 3.66 (s, 3 H, OCH_3), 3.77 (dd, *J* = 12.9, 4.6 Hz, 1 H, H^3), 4.65 (br. s, 1 H, NH), 5.45 (d, *J* = 7.3 Hz, 1 H, ArH), 6.14 (t, *J* = 7.3 Hz, 1 H, ArH), 6.47 (d, *J* = 7.6 Hz, 1 H, ArH), 6.61 (br. s, 4 H, ArH), 6.84 (t, *J* = 7.5 Hz, 1 H, ArH), 7.37 (t, *J* = 7.4 Hz, 2 H, ArH), 7.47 (t, *J* = 8.3 Hz, 1 H, ArH), 7.87 (d, *J* = 7.3 Hz, 2 H, ArH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 23.4, 25.1, 29.6, 31.2, 35.1, 36.4, 40.2, 55.1, 56.1, 58.7, 64.7, 106.6, 112.6, 115.6, 126.4, 127.3, 128.2, 128.5, 129.0, 130.4, 131.0, 133.0, 138.3, 151.0, 158.2, 202.2 ppm. MS: *m*/*z* (%) = 437 (100) [M^+]. $C_{30}H_{31}NO_2$ (437.57): calcd. C 82.35, H 7.14, N 3.20%; found C 82.12, H 7.32, N 3.47%.

General Procedure for the [3+2] Cycloaddition of 2-(3,4-Dimethoxyphenyl)cyclopropyl Phenyl Ketone (2b) to Indoles 1a, 1c, and 1f in Presence of $TiCl_4$ as the Lewis Acid: A dilute solution of $TiCl_4$ (0.21 mL, 1.94 mmol) in dry CH_2Cl_2 (5 mL) was added dropwise at –78 °C to a stirred solution of **2b** (0.50 g, 1.77 mmol) and appropriate indoles **1a**, **1c** or **1f** (1.77 mmol) in CH_2Cl_2 (10 mL). After the complete addition of $TiCl_4$, the reaction mixture was stirred at –78 °C for 1–2 h. It was then diluted with ice-cold saturated $NaHCO_3$ solution (10 mL) and the white precipitate was filtered, washed with $CHCl_3$ (2 × 25 mL). The filtrate was washed with water (1 × 25 mL), followed by brine (25 mL) and dried with anhydrous Na_2SO_4. The solvent was evaporated under reduced pressure to afford cyclopentannulated indoles **5a**, **5c**, and **5f**, which were purified by column chromatography using silica gel and hexane/EtOAc as eluent.

(1*R,3*S**,3a*R**,8b*S**)-[1-(3,4-Dimethoxyphenyl)-1,2,3,3a,4,8b-hexahydrocyclopenta[*b*]indol-3-yl]phenylmethanone (5a):** Yield 84% (0.59 g); colorless crystals; m.p. 145–146 °C; R_f 0.58 (3:1 hexanes/EtOAc). IR (KBr): $\tilde{\nu}$ = 3337, 1659, 1597, 1515, 1460, 1328, 1249, 1144, 1028, 756 cm^{-1}. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.21 (q, *J* = 12.2 Hz, 1 H, $H^{2''}$), 2.31 (td, *J* = 12.2, 6.1 Hz, 1 H, $H^{2'}$), 3.24 (m, 1 H, H^1), 3.85 (t, *J* = 10.1 Hz, 1 H, H^{8b}), 3.89 (s, 6 H, 2 × OCH_3), 4.02 (td, *J* = 12.2, 6.1 Hz, 1 H, H^3), 4.80 (dd, *J* = 10.1, 6.1 Hz, 1 H, H^{3a}), 6.63–6.68 (m, 2 H, ArH), 6.84–6.87 (m, 4 H, ArH), 7.06 (t, *J* = 7.56 Hz, 1 H, ArH), 7.51 (t, *J* = 7.3 Hz, 2 H, ArH), 7.60 (t, *J* = 7.3 Hz, 1 H, ArH), 8.06 (dd, *J* = 8.3, 1.2 Hz, 2 H, ArH) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 39.8, 53.9, 55.6, 55.9, 56.0, 56.9, 66.8, 109.8, 110.5, 111.3, 118.8, 119.6, 124.3, 127.9, 128.6, 128.8, 131.6, 133.4, 134.9, 137.0, 147.8, 149.1, 149.7, 201.5 ppm. MS: *m*/*z* (%) = 399 (100) [M^+]. $C_{26}H_{25}NO_3$ (399.48): calcd. C 78.17, H 6.31, N 3.51%; found C 78.30, H 6.12, N 3.69%.

Supporting Information (see also the footnote on the first page of this article): ^{1}H and ^{13}C NMR spectroscopic data for all new compounds **3b**, **3c**, **5c**, **5f**, **4c**, **6e′**, **7e′**, **7e′′**, **9e′**, **11a′**, **11a′′**, **11c′**, **11c′′**, **12e**, **14**, **18**, **and 22**, and X-ray crystal structure data for compounds **3a** and **3d** are available.

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