Table II. Summary Experimental Details for Experiments 1 and 3-8

expt	6A, mmol	solvent, mL	$NaBH_4$, mmoles; reduction temperature, °C[a]
1	0.28	3	0.27; 22
3	0.21	3	0.27; 22
4	0.20	3.5	0.27; 22
5	0.30	3	0.27; 22
6	0.29[b]	3	0.54; 22
7	0.40	3	0.54; -78
8	0.32	3	0.54; -78

[a] In all cases, MeOH (3 mL) was added along with the $NaBH_4$ to the crude reaction products. [b] The amount of Me_3SiCl was 0.3 mmol.

treated with $NaIO_4$ (310 mg, 1.6 mmol) with magnetic stirring at 25 °C for 1 h. The crude dialdehyde **6A** was extracted into EtOAc (2 × 25 mL), and the combined EtOAc extracts were washed with 5% aqueous $Na_2S_2O_3$ and then brine and dried with Na_2SO_4. Evaporation in vacuo gave crude **6A** (320 mg, 1.25 mmol, 95%).

A portion of this dialdehyde **6A** (92 mg, 0.36 mmol) dissolved in Ac_2O (4 mL) at ice-bath temperatures was treated with (*i*-Pr)$_2$NEt (100 μL) and 4-(dimethylamino)pyridine (3 mg). The reaction mixture was stirred magnetically at ice-bath temperatures for 24 h, and then it was poured onto ice (10 g) containing excess solid $NaHCO_3$. After 1 h the crude reaction products were extracted into EtOAc (3 × 20 mL); the combined EtOAc extracts were washed with brine, 1 N HCl, saturated aqueous $NaHCO_3$, and brine and then dried with Na_2SO_4. After solvent removal in vacuo, the resulting oil was dissolved in MeOH (5 mL), cooled to -78 °C, and treated with excess $NaBH_4$ (20 mg) at this temperature for 2 h. The crude reaction products were extracted into EtOAc (3 × 15 mL) after acidification of the cold reaction mixture with 1 N HCl and the combined EtOAc extracts were washed with saturated aqueous $NaHCO_3$ and brine, dried (Na_2SO_4), and evaporated in vacuo to give a yellow oil. Generally, PLC purification of this oil as described below for expt 2 gave the individual C-1 epimers of compounds **4** and **10**-**13**. However, for expt 9, the crude mixture of **10** and **11** was acetylated (Ac_2O-pyridine (2:1), 3 mL; 25 °C; 18 h; workup by quenching with ice (20 g), Et_2O extraction, and 1 N HCl, saturated aqueous $NaHCO_3$, brine treatment) and the crude acetates (75 mg) obtained by solvent removal were purified by PLC in EtOAc-Skelly B (1:1) to give 7,10-diacetyl-**10a,b** (58 mg, 48%) and 10-acetyl-**11a,b**[5] (5 mg, 5%). The structures of these two acetates were confirmed by correlation to **10a,b** and **11a,b**.

Experiment 2. Crude **6A** (300 mg, 1.16 mmol) in absolute MeOH (3 mL) was added to $Mg(OMe)_2$ (from Mg metal turnings, 30 mg, 1.25 mmol) in absolute MeOH (10 mL) at 0 °C udner N_2. After the mixture was stirred for 5 min, $NaBH_4$ (43 mg, excess) was added to the reaction mixture and stirring was continued for 30 min at 0 °C. Then solid NH_4Cl (100 mg) was added to the mixture and the solvent was removed in vacuo. The resulting oily solid was extracted with EtOAc (2 × 75 mL), and the combined EtOAc extracts were washed with brine and dried over Na_2SO_4. Solvent removal in vacuo gave an oily residue that was purified by PLC in $CHCl_3$-MeOH (15:1, twice developed) to give, in order of increasing polarity, **4b** (26 mg, 10%), **4a**[6] (39 mg, 16%), **12**[4] (16 mg, 7%), **13**[4] (33 mg, 13%), **10a**[5] (33 mg, 13%), and **10b** (22 mg, 7%).

The IR, ^1H NMR, and mass spectral data of the already known compounds were consistent with the literature values.[4-6] **4b**: IR ($CHCl_3$) ν 3500, 1705, 1635, 1440 cm^{-1}; UV (MeOH) 236 nm (ϵ 1.06 × 10^4); ^1H NMR δ 7.39 (d, J = 1.3 Hz, 1 H), 4.88 (d, J = 3.0 Hz, 1 H), 4.41 (m, 1 H), 3.85 (m, 2 H), 3.70 (s, 3 H), 3.42 (s, 3 H), 3.05 (m, 1 H), 2.57-1.60 (m, 4 H); mass spectrum, m/e (relative intensity) 258.1110 (2) (calcd for $C_{12}H_{18}O_6$ 258.1101), 240 (3), 227 (5), 226 (11), 210 (6), 209 (6), 208 (15), 195 (3), 190 (9), 180 (3), 179 (3), 178 (7), 177 (5), 176 (6), 84 (97). **10b**: IR ($CHCl_3$) ν 3480, 1705, 1635, 1440, 1290 cm^{-1}; UV (MeOH) 237 nm (ϵ 1.02 × 10^4); ^1H NMR δ 7.42 (d, J = 1.2 Hz, 1 H), 4.93 (d, J = 2.1 Hz, 1 H), 3.98 (m, 1 H), 3.70 (s, 3 H), 3.70 (m, 2 H), 3.50 (s, 3 H), 3.00-1.20 (m, 4 H); mass spectrum, m/e (relative intensity) 258.1106 (10) (calcd for $C_{12}H_{18}O_6$ 258.1101), 227 (3), 226 (6), 222 (5), 209 (3), 208 (5), 195 (6), 191 (4), 190 (22), 178 (6), 177 (5), 163 (3), 157 (4), 146 (3), 139 (10), 84 (100). Compound **10a**'s structure was confirmed by its conversion to the known 7,10-diacetyl-**4a** according to Tietze.[5]

Synthesis of 7-*O*-Acetyl-5b. This compound was obtained from **4b** by Tietze's methods[5] via intermediates **14** [IR ($CHCl_3$) ν 1740, 1710, 1640, 1635, 1440 cm^{-1}; UV (MeOH) 235 nm (ϵ 1.04 × 10^4); ^1H NMR δ 7.41 (d, J = 1.2 Hz, 1 H), 5.36 (dt, J = 2.1, 5.4 Hz, 1 H), 4.88 (d, J = 3.3 Hz, 1 H), 4.30 (d, J = 7.5 Hz, 2 H plus ABXm, 2 H), 3.69 (s, 3 H), 3.42 (s, 3 H), 2.77 (s, 3 H), 2.01 (s, 3 H), 3.14-1.65 (m, 3 H); mass spectrum, m/e (relative intensity) 378.0986 (6) (calcd for $C_{13}H_{20}O_8S$ 378.0985), 347 (13), 318 (44), 286 (34), 251 (16), 222 (28), 191 (40), 84 (100)] and **15** [IR ($CHCl_3$) ν 1730, 1709, 1640, 1635, 1440 cm^{-1}; UV (MeOH) 236 nm (ϵ 1.03 × 10^4); ^1H NMR δ 7.42 (d, J = 1.6 Hz, 1 H), 5.30 (m, 1 H), 5.02 (d, J = 3.6 Hz, 1 H), 3.70 (s, 3 H), 3.40 (s, 3 H), 3.10-2.70 (m, 1 H), 2.53 (q, J = 7.5 Hz, 2 H), 2.70-1.60 (m + s, 9 H), 1.25 (t, J = 7.5 Hz, 3 H); mass spectrum, m/e (relative intensity) 344.1297 (7) (calcd for $C_{16}H_{24}O_6S$ 344.1293), 312 (33), 283 (17), 252 (12), 223 (33), 209 (24), 191 (29), 177 (56), 75 (100)]. 7-*O*-Acetyl-**5b**: ^1H NMR δ 7.41 (d, J = 1.3 Hz, 1 H), 5.23 (dt, J = 3.0, 6.5 Hz, 1 H), 4.91 (d, J = 3.2 Hz, 1 H), 3.71 (s, 3 H), 3.43 (s, 3 H), 3.04 (q, J = 8.9 Hz, 1 H), 2.56-1.66 (m, 4 H), 2.04 (s, 3 H), 1.02 (d, J = 7.0 Hz, 3 H). The rest of this compound's spectral parameters were equivalent to those of 7-*O*-acetyl-**5a**.[5]

Registry No. 4a, 61557-82-2; **4a** 7,10-diacetyl derivative, 61557-84-4; **4b**, 74742-20-4; **5a** 7-*O*-acetyl derivative, 29971-34-4; **5b**, 39947-66-5; **5b** 7-*O*-acetyl derivative, 74742-21-5; **6Aa**, 67488-17-9; **6Ab**, 67487-44-9; **6B**, 74684-71-2; **9**, 74684-72-3; **10a**, 61557-83-3; **10a** 7,10-diacetyl derivative, 74742-22-6; **10b**, 74742-23-7; **10b** 7,10-diacetyl derivative, 74742-24-8; **11a**, 73610-58-9; **11a** 10-acetyl derivative, 73582-38-4; **11b**, 74742-25-9; **11b** 10-acetyl derivative, 74742-26-0; **12a**, 67441-38-7; **12b**, 67463-67-6; **13a**, 67487-45-0; **13b**, 67488-18-0; **14**, 74742-27-1; **15**, 74742-28-2.

Preparative Methods for Ergoline Synthons: Uhle's Ketone and the C-Homo Analogue

G. S. Ponticello,* J. J. Baldwin, P. K. Lumma, and D. E. McClure*

Department of Medicinal Chemistry, Merck Sharp & Dohme Research Laboratories, West Point, Pennsylvania 19486

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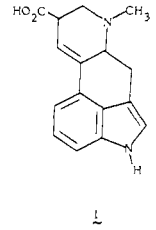
The ergoline nucleus has long been viewed as a challenging target for total synthesis with attempts dating back to the classic work by Uhle[1] and culminating in the synthesis of lysergic acid (**1**) by Kornfeld, Woodward, and



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co-workers.[2] Continuing research in this area has concentrated on sequence simplification, novel approaches, and the development of new synthons.[3-5] Most of these efforts have proceeded through the tricyclic ketone **8** first

(1) Uhle, F. C. *J. Am. Chem. Soc.* **1949**, *71*, 761.
(2) (a) Kornfeld, E. C.; Fornefeld, E. J.; Kline, G. B.; Mann, M. J.; Jones, R. G.; Woodward, R. B. *J. Am. Chem. Soc.* **1954**, *76*, 5256. (b) Kornfeld, E. C.; Fornefeld, E. J.; Kline, G. B.; Mann, M. J.; Morrison, D. E.; Jones, R. G.; Woodward, R. B. *Ibid.* **1956**, *78*, 3087.
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(4) Trost, B. M.; Reiffin, M.; Crimmin, M. *J. Am. Chem. Soc.* **1979**, *101*, 257.
(5) (a) Kozikowski, A. P.; Kuniak, M. P. *J. Org. Chem.* **1978**, *43*, 2083. (b) Plieninger, H.; Völkl, A. *Chem. Ber.* **1976**, *109*, 2125.

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prepared by Uhle[1] in 1949 even though the laborious nature of this synthesis itself has been one of the major roadblocks. Several attempts to improve the preparation of **8** have been described[6] and that of Bowman and coworkers[7] is generally considered the most suitable for synthesis on a multigram scale. Although this sequence provides the intermediate **5** in high overall yield, the cyclization–decarboxylation of **5** to **8** proceeds in only 55% yield and requires a tedious and cumbersome isolation procedure.

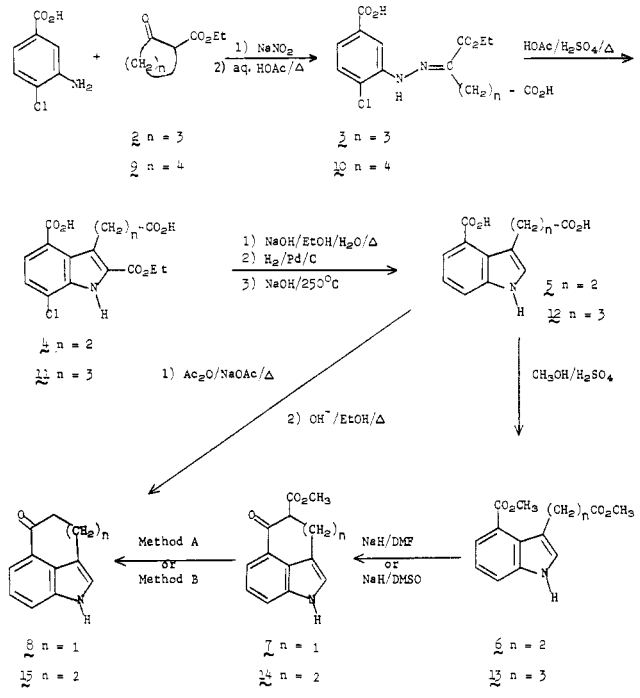
We report on a significant improvement in the Bowman procedure which allows for the first practical large-scale synthesis of **8** and, in addition, is suitable for the preparation of the C-homo analogue **15**, a compound not obtainable under the standard Bowman conditions. This C-homo derivative may be viewed as a potential synthon in the total construction of the corresponding homoergolines. Conformational analysis of this C-homo system indicates that this class may also exhibit interesting and potentially useful pharmacologic properties.[8]

Our initial attempts toward the C-homo series utilized the route described by Nagasaka and Ohki;[6] however, in our hands the Japp–Klingemann reaction could not be reproduced and the synthesis was thus impractical. In addition, the conversion of **12** to **15**, under the conditions found successful by Bowman for the preparation of **8**, produced little, if any, of the desired product. Instead, a complicated mixture resulted as determined by TLC and none of the derived products could be readily identified by ^{1}H NMR analysis. The expected slower rate of formation of the seven-membered ring may account for this observed difference, allowing, under these conditions (Ac_2O–NaOAc), other competing electrophilic processes to become predominant.

We have found that these tricyclic ketones, **8** and **15**, can be conveniently prepared via the Dieckmann condensation reaction of diesters **6** and **13**, respectively. Although Uhle reported that attempts to cyclize **6** under the conditions of the Dieckmann condensation failed, more recent work by Plieninger[9] suggested that this approach should be reinvestigated. As outlined in Scheme I, the sequences used to prepare the intermediate diacids, **5** and **12**, were essentially those described by Bowman. Modifications of this procedure as applied to the synthesis of **4** and **11** are described in the experimental section. The diesters, **6** and **13**, were obtained from **5**[10] and **12**, respectively, via Fischer esterification conditions. Treatment of **6** with NaH in Et_2O containing a catalytic amount of CH_3OH failed to yield **7**. However, when Et_2O was replaced by DMF or Me_2SO, the cyclization proceeded smoothly at 25 °C. After workup, the crude β-keto ester **7** was hydrolyzed with concomitant decarboxylation, using EtOH–10% aqueous NaOH to provide Uhle's ketone **8** in yields ranging from 61–70%.

The synthesis of the seven-membered C-ring derivative **15** could also be readily accomplished by following an analogous sequence. In this case, the overall yield for the cyclization–decarboxylation conversion of **13** to **15** was in the range of 50–80%. Under these basic nucleophilic conditions, the side reactions available to the reactant under the Bowman process were apparently eliminated, thereby producing satisfactory yields of **15**.

Scheme I



The possibility of conducting this Dieckmann cyclization–decarboxylation in a combined two-step operation was next investigated.[11] The cyclization of **6** to **7** was accomplished by using NaH in Me_2SO and the resulting sodium salt of the β-keto ester **7** neutralized by the addition of 1 equiv of concentrated HCl. The Me_2SO reaction mixture was then degassed by purging with N_2 and heated at 150 °C for 3–6 h. After workup, 65–88% yields of **8** were obtained and thus compare favorably to those via the stepwise process. It should be noted that reactions conducted in DMF under identical conditions failed to give comparable yields. The addition of KCN to dealkylate the ester with simultaneous decarboxylation was also investigated.[11] However, this reagent offered no significant improvement in yield while the addition of other inorganic salts (LiCl, NaOAc, etc.) had a deleterious effect upon this dealkylative decarboxylation sequence. The use of this one-pot procedure for the synthesis of **15** was found to offer no advantage over the two-step sequence.

In summary, the Dieckmann decarboxylation sequence must be viewed as the method of choice for multigram preparation of Uhle's ketone **8**. In addition, the C-homo analogue **15** is now available by a reliable method and should prove to be a useful synthon for the interesting C-homoergolines.

Experimental Section

^{1}H NMR spectra were determined in the indicated solvent on a Varian T-60 or an EM390 spectrometer, using tetramethylsilane as an internal standard. Melting points were determined on a Thomas-Hoover apparatus in open capillary tubes and are uncorrected. Solutions were dried over Na_2SO_4 and concentrated

(6) This paper contains an extensive list of references relevant to the preparation of Uhle's ketone 8 and related compounds: Nagasaka, T.; Ohki, S. *Chem. Pharm. Bull.* **1977**, *11*, 3023.

(7) Bowman, R. E.; Goodburn, T. G.; Reynolds, A. A. *J. Chem. Soc.* **1972**, 1121.

(8) Floss, H. G.; Cassady, J. M.; Robbers, J. E. *J. Pharm. Sci.* **1973**, *62*, 699. Cassady, J. M.; Li, G. S.; Spitzner, E. B.; Floss, H. G.; Clemens, J. A. *J. Med. Chem.* **1974**, *17*, 300. Rubin, A.; Lemberger, L.; Dhahir, P.; Warrick, P.; Crabtree, R. E.; Obermeyer, B. D.; Woler, R. L.; Rowe, H. *Clin. Pharmacol. Ther.* **1978**, *23*, 272. Fluckiger, E.; Wagner, H. R. *Experientia* **1968**, *24*, 1130. Schneider, H. R.; Stadler, P. A.; Stutz, P.; Troxler, F.; Seres, J. *Ibid.* **1977**, *33*, 1412.

(9) Plieninger, H.; Muller, W. *Chem. Ber.* **1960**, *93*, 2029.

(10) The diacid **5** was prepared by Dr. J. H. Jones and Mr. G. F. Lundell, Merck Sharp & Dohme Research Laboratories.

(11) Krapcho, A. P.; Weimaster, J. F.; Eldridge, J. M.; Jahngen, E. G. E., Jr.; Lorey, A. J.; Stephens, W. P. *J. Org. Chem.* **1978**, *43*, 138.

to dryness by using a Buchi rotary evaporator under water aspirator pressure (20 mm).

4-Carboxy-7-chloro-2-(ethoxycarbonyl)-3-indolepropionic Acid (4). To a stirred solution of **3** (40 g, 0.11 mol) in HOAc (200 mL) heated at reflux was added dropwise a solution of H_2SO_4 (16.8 mL) and HOAc (35 mL). After 2 h at reflux, the solution was cooled to room temperature. The suspension was then filtered to yield 28 g (81%) of **4**: mp 244–250 °C (lit.[7] mp 259–260 °C); ^{1}H NMR (Me_2SO-d_6) δ 1.4 (3 H, t), 2.6 (2 H, m), 3.5 (2 H, m), 4.4 (2 H, q), 7.5 (2 H, s). The ^{1}H NMR spectrum exhibited an exchangeable triplet at δ 7.2 for NH_4^+ (J = 51 Hz), presumably arising from contamination by $NH_4(HSO_4)$. This material was used directly in the next step without further purification. Recrystallization from acetic acid provided essentially pure **4**, mp 256–259 °C.

Methyl 4-(Carbomethoxy)-3-indolepropionate (6). Compound **6** was prepared from diacid **5**[10] according to the procedure of Uhle.[1] The compound was purified by crystallization from hexane–EtOH (2:1) to yield **6** (93%): mp 94.5–95.5 °C (lit.[1] mp 84–85 °C); ^{1}H NMR ($CDCl_3$) δ 2.6 (2 H, m), 3.15 (2 H, m), 3.5 (3 H, s), 3.9 (3 H, s), 7.3 (4 H, m), 8.5 (1 H, br s, exch).

5-Oxo-1,3,4,5-tetrahydrobenz[*cd*]indole (8). Method A. Into a flame-dried flask under N_2 were placed NaH (50% oil dispersion, 22 g, 0.46 mol) and DMF (250 mL) and the mixture was stirred at room temperature. After 5 min, a solution of **6** (55 g, 0.21 mol) in DMF (100 mL) containing 2 drops of CH_3OH was added dropwise with stirring at 25 °C. After 20 h, the resulting solid mixture was treated with H_2O (1 L), acidified with concentrated HCl (50 mL), and extracted with hot (40–50 °C) EtOAc (4 ×). The combined organic extracts were washed with H_2O and saturated NaCl solution, dried, filtered, and concentrated. The residue was dissolved in EtOH (600 mL) and 10% NaOH solution (600 mL) and heated on a steam bath with stirring until gas evolution ceased (15–30 min). The solution was cooled and the EtOH removed under reduced pressure. The aqueous layer was extracted with Et_2O (4 ×), and the organic layer was dried, filtered, and concentrated. The residue was triturated with hexane and filtered to yield 25.2 g of **8** (70%): mp 159–162 °C (lit.[1,7] 162–164 °C); ^{1}H NMR ($CDCl_3$) δ 3.05 (4 H, m), 7.35 (4 H, m), 8.55 (1 H, br s, exch).

Method B. To a suspension of hexane-washed NaH (50% oil dispersion, 22.7 g, 0.47 mol) in Me_2SO (200 mL) containing 2 drops of CH_3OH was added dropwise a solution of **6** (56.0 g, 0.215 mol) in Me_2SO (200 mL) over 0.5 h. After the mixture was stirred for 3 h at 25 °C, concentrated HCl (38 mL, 0.46 mol) was added dropwise and then the reaction was purged with N_2 for 15 min. The solution was heated at 150 °C for 6 h (evolution of gases ceased), cooled, and poured into H_2O (1.5 L). The aqueous solution was extracted with EtOAc (4 × 400 mL) followed by backwashing the organic layers with H_2O, drying, and concentrating to yield 32.5 g of **8** (88%). Recrystallization from toluene gave pure **8** (71%) which was identical in all respects with material prepared by Method A.

4-Carboxy-7-chloro-2-(ethoxycarbonyl)-3-indolebutyric Acid (11). To a cooled suspension (−5 to 0 °C) of 3-amino-4-chlorobenzoic acid (172 g, 1.0 mol) in a solution of concentrated HCl (210 mL) and H_2O (425 mL) was added dropwise $NaNO_2$ (71 g, 1.03 mol) in H_2O (125 mL) while the internal temperature was maintained below 5 °C. After the mixture was stirred in an ice bath for 1 h, solid $NaOAc{\cdot}3H_2O$ (177 g, 1.3 mol) was added in one portion followed by rapid dropwise addition of a precooled EtOH solution of **9** (170 g, 1.0 mol) while the temperature was maintained below 5 °C. The solution was then stirred for 3–4 h with ice cooling and the mixture allowed to warm to room temperature while being stirred overnight. The resulting solid was filtered, washed with (1:1) EtOH–H_2O (2 × 200 mL) and H_2O (2 × 400 mL), dissolved in 80% aqueous HOAc (1 L), and heated on a steam bath for 1.5 h. The mixture was then cooled, filtered, and dried under vacuum [70 °C (25 mmHg)] overnight to yield 245 g of **10** (66%). An analytical sample was prepared by recrystallization from EtOH to yield yellow crystals of **10**: mp 170–174 °C; ^{1}H NMR (Me_2SO-d_6) δ 1.3 (3 H, t), 1.6 (4 H, m), 2.3 (4 H, m), 4.3 (2 H, q), 7.5 (2 H, s), 8.1 (1 H, s).

Anal. Calcd for $C_{16}H_{19}ClN_2O_6$: C, 51.82; H, 5.16; N, 7.56. Found: C, 51.97; H, 5.13; N, 7.50.

Crude **10** (265 g, 0.71 mol) was dissolved in HOAc (1.75 L) and heated at reflux while a mixture of concentrated H_2SO_4 (110 mL) and HOAc (220 mL) was added dropwise to the hot solution of **10** over 1 h. After 2 h of additional heating, the solution was cooled, and the solid was filtered, washed with HOAc, and dried in a vacuum oven [70 °C (25 mmHg)] for 18 h to yield crude **11** (84%). The ^{1}H NMR spectrum exhibited an exchangeable triplet at δ 7.2 for NH_4^+ (J = 51 Hz), presumably arising from contamination by $NH_4(HSO_4)$. This material was used directly in the next step without further purification.

An analytical sample was prepared by dissolving crude **11** in saturated $NaHCO_3$–Na_2CO_3 followed by acidification with concentrated HCl to precipitate the product. Recrystallization of this material from HOAc yielded white crystals of **11**: mp 255–257 °C; ^{1}H NMR (Me_2SO-d_6) δ 1.4 (3 H, t), 1.85 (2 H, t), 2.3 (2 H, m), 3.3 (2 H, t), 4.45 (2 H, q), 7.5 (2 H, s).

Anal. Calcd for $C_{16}H_{16}ClNO_6$: C, 54.32; H, 4.56; N, 3.96. Found: C, 53.86; H, 4.49; N, 3.67.

4-Carboxy-3-indolebutyric Acid (12). A solution of **11** (50.2 g, 0.14 mol) in H_2O (180 mL) containing KOH (38 g) was heated at reflux with mechanical stirring. After 2 h, the solution was cooled and hydrogenated at 20 °C with 10% Pd/C (5 g) under 30 atm of H_2. After the theoretical amount of H_2 was utilized, the catalyst was filtered, and the filtrate was purged with N_2 and heated rapidly to 250 °C in a stainless steel autoclave for 6 h. The reaction was then cooled and acidified with concentrated HCl. The resulting solid was filtered off and recrystallized from H_2O to yield 17.4 g of **12** (49%). An analytical sample was prepared by recrystallization from H_2O to yield a white solid: mp 168–171 °C; ^{1}H NMR (Me_2SO-d_6) δ 1.8 (2 H, m), 2.2 (2 H, t), 2.9 (2 H, t), 7.4 (4 H, m).

Anal. Calcd for $C_{13}H_{13}NO_4$: C, 63.15; H, 5.30; N, 5.67. Found: C, 62.98; H, 5.27; N, 5.78.

Methyl 4-(Carbomethoxy)-3-indolebutyrate (13). A solution of **12** (3.9 g, 0.016 mol) in CH_3OH (40 mL) and H_2SO_4 (1.3 mL) was heated at reflux with stirring for 17 h. The reaction mixture was cooled and the CH_3OH removed in vacuo. The residual liquid was poured into a solution of H_2O (16 mL) and saturated Na_2CO_3 solution (10 mL). After the solution cooled to room temperature, the product was extracted with Et_2O (4 ×). The organic layer was washed with H_2O, dried, filtered, and concentrated to yield 4.1 g of **13** (94%). An analytical sample was prepared by recrystallization from cyclohexane to yield white crystals of **13**: mp 62–65 °C; ^{1}H NMR (Me_2SO-d_6) δ 1.8 (2 H, m), 2.3 (2 H, t), 2.8 (2 H, t), 3.55 (3 H, s), 3.9 (3 H, s), 7.4 (4 H, m).

Anal. Calcd for $C_{15}H_{17}NO_4$: C, 65.44; H, 6.23; N, 5.09. Found: C, 65.23; H, 6.50; N, 5.12.

6-Oxocyclohept[*cd*]indole (15). To a suspension of NaH (50% oil dispersion, 1.76 g, 0.037 mol) in DMF (20 mL) under N_2 was added dropwise a solution of **13** (4.63 g, 0.017 mol) in DMF (8 mL) containing 1 drop of CH_3OH with stirring over 0.5 h. After the mixture was stirred overnight at 25 °C, H_2O (40 mL) was added slowly with stirring. The aqueous mixture was then poured into H_2O (40 mL) containing concentrated HCl (4 mL) and extracted with warm EtOAc (4 ×). The combined extracts were washed with saturated NaCl solution, dried, filtered, and concentrated to yield **14**. The crude β-keto ester **14** was dissolved in EtOH (48 mL) and 10% NaOH (48 mL) and heated on a steam bath with stirring until gas evolution ceased (2.5 h). After the solution was cooled, the EtOH was removed in vacuo and the resulting yellow solid filtered off to yield 2.2 g of **15** (70%). An analytical sample of **15** was prepared by recrystallization from toluene to yield yellow crystals: mp 175–179 °C (lit.[6] 176–177 °C); ^{1}H NMR (Me_2SO-d_6) δ 2.0 (2 H, m), 2.95 (4 H, m), 7.4 (4 H, m).

Anal. Calcd for $C_{12}H_{11}NO$: C, 77.81; H, 5.99; N, 7.56. Found: C, 78.01; H, 6.16; N, 7.35.

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Registry No. **3**, 36800-66-5; **4**, 36800-68-7; **5**, 36800-70-1; **6**, 74724-96-2; **7**, 74724-97-3; **8**, 3744-82-9; **9**, 1655-07-8; **10**, 74724-98-4; **11**, 74724-99-5; **12**, 74725-00-1; **13**, 74725-01-2; **14**, 74725-02-3; **15**, 42137-36-0; 3-amino-4-chlorobenzoic acid, 2840-28-0.