New Pyridone Approach: Total Synthesis of Mappicine Ketone (Nothapodytine B)†

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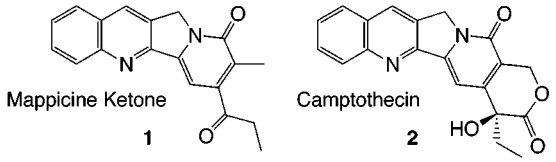
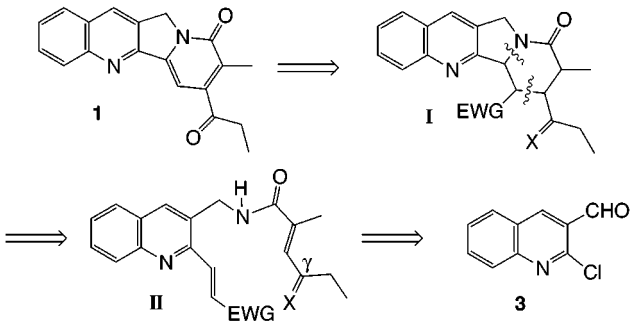
A novel synthesis of mappicine ketone, which possesses strong selective activity against the herpes viruses HSV-1 and HSV-2, including those Acyclovir-resistant, and human cytomegalovirus (HCMV) has been efficiently accomplished. The synthesis highlights a new pyridone approach that effectively combines a double, intramolecular Michael addition in a conjugated ester−conjugated amide with oxidation−decarboxylation of the resulting piperidone.

Mappicine ketone (or nothapodytine B, **1**) has been isolated in low yield from *Nothapodytes foetida*[1] and shown to possess strong, selective activity against the herpes viruses HSV-1 and HSV-2, including those Acyclovir-resistant, and human cytomegalovirus (HCMV).[2] While degradation of natural camptothecin (**2**) provides an alternative means of securing mappicine ketone,[3] the cost and the analogue limitations inherent in such an approach combine to make total synthesis more attractive.[4] In this paper, we report a conceptually new and efficient approach to this important natural alkaloid.



The approach, shown retrosynthetically in Scheme 1, was based on the premise that an efficient piperidone to pyridone transformation with concomitant or subsequent removal of the EWG could be accomplished following an intramolecular double Michael addition, which was envisioned for accessing the indolizino quinoline ring system directly from an appropriate 2,3-disubstituted quinoline. The Meth−Cohn quinolinecarboxaldehyde **3**, easily prepared and available commercially,[5] appeared to be the ideal starting material for this endeavor. As will be seen, the success of this synthetic approach ultimately proved to be critically dependent on the nature of the X group.

Scheme 1



X = O or synthetic equiv; EWG = electron-withdrawing group

In our initial effort, the Meth−Cohn quinolinecarboxaldehyde **3** was converted in good yield into amine **4c** via the known[6] dibromide **4a** and the azide **4b** (Scheme 2). Acylation of this amine with (*E*)-2-methyl-2-hexenoyl chloride to give **5a** was followed by Stille coupling with methyl (*E*)-3-(tributylstannanyl)acrylate[7] to provide the desired 2,3-disubstituted quinoline **5b**. To our satisfaction, this material underwent efficient double Michael

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† This paper is dedicated to Professor André Rassat on the occasion of his retirement.

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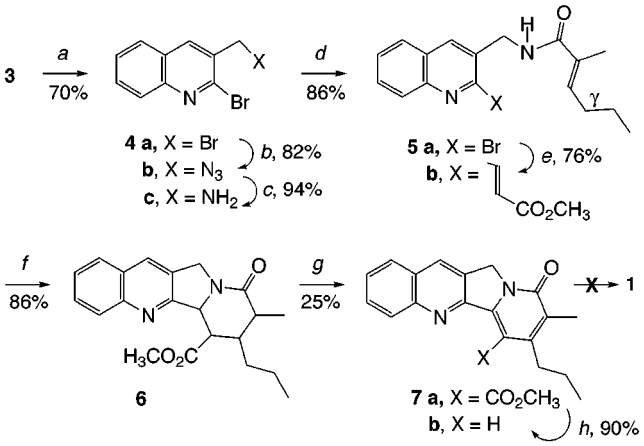
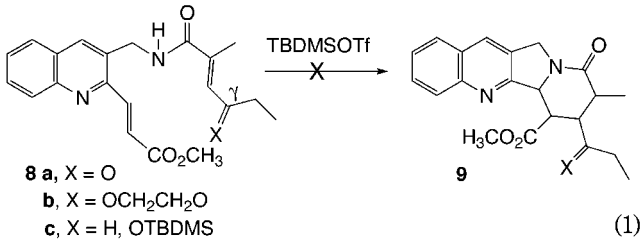
Scheme 2



[a] $NaBH_4$, CH_3OH; PBr_3, Δ.[6] [b] NaN_3, DMF. [c] H_2, PtO_2, C_2H_5OH. [d] (*E*)-2-Methyl-2- hexenoyl chloride, $(C_2H_5)_3N$, DMAP, CH_2Cl_2. [e] Methyl (*E*)-3-(tributylstannanyl)-acrylate, Pd_2dba_3, $(C_6H_5)_3As$, dioxane, Δ. [f] TBDMSOTf, $(C_2H_5)_3N$, CH_2Cl_2, 10 °C. [g] DDQ, C_6H_6, Δ. [h] HBr(aq), Δ.

addition in the presence of *tert*-butyldimethylsilyl triflate[8] to give the desired indolizino quinoline derivative **6** as a mixture of epimers.[9] On exposure to dichlorodicyanobenzoquinone (DDQ) in refluxing benzene, this derivative suffered dehydrogenation to afford pyridone **7a**, albeit in poor yield, which in hot hydrobromic acid[10] was cleanly converted into deoxo mappicine ketone **7b**. Unfortunately, however, no procedure could be found, despite considerable effort, for effecting the requisite side-chain oxidation. For this approach to be successful, it appeared that a γ oxygen substituent, or latent oxygen substituent, would have to be present prior to cyclization (i.e., in the acylating derivative).

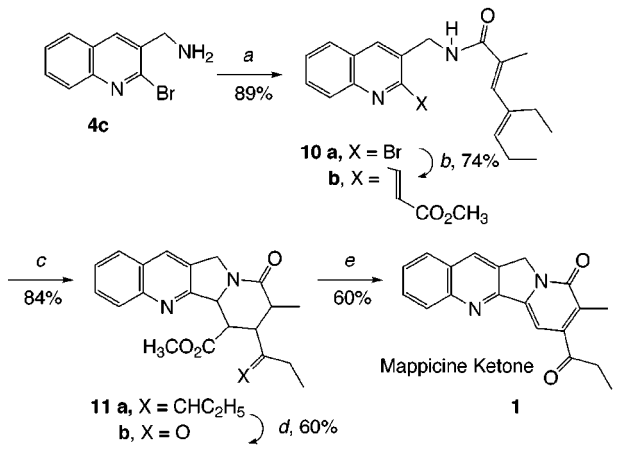
Thus, the keto, acetal, and silyl ether derivatives **8a**−**c** were prepared as above; to our dismay, however, none of these derivatives could be coaxed into cyclizing (eq 1).



(1)

In the belief that the additional oxygen substituents might be affording new coordination sites and in this way interfering with the desired course of the reaction, it was concluded that olefin **10b** could be a worthwhile substrate to examine (Scheme 3). This substrate could readily be secured from amine **4c** by acylation with (*E*,*E*)-4-ethyl-2-methyl-2,4-heptadienoic acid[11] to afford amide **10a**, followed by Stille coupling. Pleasingly, on treatment of **10b** with *tert*-butyldimethylsilyl triflate in the presence

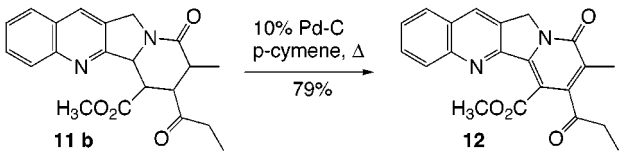
Scheme 3



[a] (*E*,*E*)-4-Ethyl-2-methyl-2,4-heptadienoic acid, DCC, DMAP, CH_2Cl_2. [b] Methyl (*E*)-3-(tributylstannanyl)-acrylate, Pd_2dba_3, $(C_6H_5)_3As$, dioxane, Δ. [c] TBDMSOTf, $(C_2H_5)_3N$, CH_2Cl_2, 10 °C. [d] O_3, CH_2Cl_2, -78 °C; CH_3SCH_3, -78 → 20 °C. [e] aq NaOH, CH_3OH-CH_2Cl_2; 10% Pd-C, *p*-cymene, Δ.

of triethylamine in dichloromethane, clean cyclization ensued to produce the desired tetracycle **11a** as a mixture of epimers in 84% yield. Carefully controlled ozonolysis of **11a** then unveiled the keto function to provide **11b**, but now DDQ entirely failed to effect oxidation to the corresponding pyridone.

It was soon discovered, however, that 10% palladium on carbon in refluxing *p*-cymene[12] was capable of delivering the corresponding pyridone in a remarkable 79% purified yield (**11b** → **12**, eq 2).[13] *Even better, though, the*



(2)

corresponding acid under the same conditions engendered directly mappicine ketone in 60% yield after purification![14] (Scheme 3). This was particularly gratifying since both

(8) See: Ihara, M.; Kirihara, T.; Kawaguchi, A.; Tsuruta, M.; Fukumoto, K.; Kametani, T. *J. Chem. Soc., Perkin Trans. 1* **1987**, 1719−1726. A Diels−Alder reaction of the silyl imino ether is also possible.

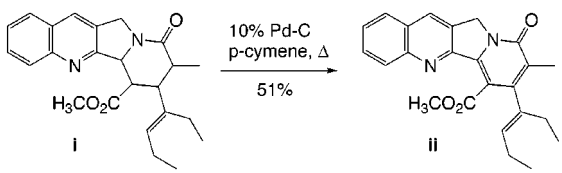
(9) In a closely related model system, it was found that a *p*-tolylsulfonyl group could not be used in place of the methoxycarbonyl in this cyclization.

(10) Shen, W.; Coburn, C. A.; Bornmann, W. G.; Danishefsky, S. J. *J. Org. Chem.* **1993**, *58*, 611−617.

(11) For the efficient preparation of the corresponding ester, see: Negishi, E.; Okukado, N.; King, A. O.; Van Horn, D. E.; Spiegel, B. I. *J. Am. Chem. Soc.* **1978**, *100*, 2254−2256. The acid reacted also with azide **4b** in the presence of triphenylphosphine to provide more directly the same amide, but in lower yield (60%) than achieved in the two-step conversion (82%). For this synthetic method, see: Garcia, J.; Urpi, F.; Vilarrasa, J. *Tetrahedron Lett.* **1984**, *25*, 4841−4844.

(12) These conditions have previously been used to effect the conversion of a terpenoid enol lactone into the corresponding α-pyrone. See: Rosenthal, D.; Grabowich, P.; Sabo, E. F.; Fried, J. *J. Am. Chem. Soc.* **1963**, *85*, 3971−3979.

(13) That the presence of the keto function was not critical in this transformation was demonstrated by the transformation of **i** to **ii**. (For comparison, DDQ provided **ii** in only 20% yield.)



(14) The mixture of minor stereoisomers formed in the cyclization of ester **10b** was also converted, in the same manner and with an identical overall yield, into mappicine ketone.

ester **12** and the corresponding acid resisted transformation into mappicine ketone under a variety of conditions, including those used above. The synthetic mappicine ketone so obtained was identical (mp, mmp, MS, IR, NMR) with a sample derived[3c] from natural camptothecin.

In summary, a novel synthesis of mappicine ketone from the readily available amino quinoline **4c** has been accomplished in six steps and 20% overall yield. The synthesis of this biologically important substance highlights a new pyridone approach that effectively combines a double, intramolecular Michael addition in a conjugated ester−conjugated amide[8] with oxidation−decarboxylation of the resulting piperidone. Application of this approach[15] for the preparation of related alkaloids is currently under study.

Experimental Section

The reaction mixture was generally poured into water, and the separated aqueous phase was then thoroughly extracted with the specified solvent. After being washed with 10% aqueous HCl and/or $NaHCO_3$ (if required), water, and saturated aqueous NaCl, the combined organic phases were dried over anhydrous Na_2SO_4 or $MgSO_4$ and then filtered and concentrated under reduced pressure on a Büchi Rotovapor to yield the crude reaction product. Dioxane and ether were distilled from sodium−benzophenone, and dichloromethane, dimethylformamide, benzene, and triethylamine were distilled from calcium hydride.

3-(Azidomethyl)-2-bromoquinoline (4b). To a stirred solution of 3.69 g (12.3 mmol) of 2-bromo-3-bromomethylquinoline (**4a**)[6a] in 65 mL of dimethylformamide under argon at 20 °C was added 4.0 g (62 mmol) of sodium azide. After being stirred for 17 h, the crude product was isolated with dichloromethane in the usual way and purified by dry column silica gel chromatography with 5% ethyl acetate in cyclohexane to afford 2.63 g (82%) of azide **4b**: mp 54−56 °C; IR (Nujol) 1706 cm^{-1}; ^1H NMR ($CDCl_3$, 200 MHz) δ 8.06 (s, 1 H), 7.99 (dd, J = 8.2, 1.4 Hz, 1 H), 7.78 (dd, J = 7.9, 1.4 Hz, 1 H), 7.68 (ddd, J = 8.2, 7.0, 1.4 Hz, 1 H), 7.55 (ddd, J = 7.9, 7.0, 1.4 Hz, 1 H), 4.60 (s, 2 H); ^{13}C NMR ($CDCl_3$, 50.3 MHz) δ 147.7, 142.2, 136.8, 130.7, 129.4, 128.3, 127.6, 127.5, 127.0, 53.7. Anal. Calcd for $C_{10}H_7BrN_4$: C, 45.65; H, 2.68; N, 21.30; M_r, 261.9854. Found: C, 45.75; H, 2.70; N, 20.96; M_r (mass spectrum, EI), 261.9860.

3-(Aminomethyl)-2-bromoquinoline (4c). A mixture of 1.02 g (3.88 mmol) of azide **4b** and 30 mg (0.13 mmol) of platinum oxide in 110 mL of 95% ethanol under hydrogen was stirred for 2 h at 20 °C. The hydrogen was then replaced with argon, and the mixture was filtered through Celite and the filtrate concentrated to provide 863 mg (94%) of amine **4c**: IR (KBr) 3338, 1614 cm^{-1}; ^1H NMR ($CDCl_3$, 200 MHz) δ 8.11 (s, 1 H), 7.99 (d, J = 8.2 Hz, 1 H), 7.78 (dd, J = 7.9, 1.4 Hz, 1 H), 7.66 (ddd, J = 8.2, 7.0, 1.4 Hz, 1 H), 7.53 (ddd, J = 7.9, 7.0, 1.4 Hz, 1 H), 4.04 (s, 2 H); ^{13}C NMR ($CDCl_3$, 50.3 MHz) δ 147.4, 143.5, 136.2, 135.6, 129.9, 128.2, 127.6, 127.4, 127.2, 45.8. Anal. Calcd for $C_{10}H_9BrN_2$: M_r, 235.9949. Found: M_r (mass spectrum, EI), 235.9954.

***(E,E)*-*N*-(2-Bromoquinolin-3-ylmethyl)-4-ethyl-2-methyl-2,4-heptadienamide (10a).** A stirred solution of 1.58 g (8.67 mmol) of methyl (*E*,*E*)-4-ethyl-2-methyl-2,4-heptadienoate[11] in 17 mL of methanol was treated with 10.8 mL (10.8 mmol) of 1 N aqueous sodium hydroxide and then refluxed for 30 min. After being allowed to cool to ambient temperature, the solution was processed in the usual way to afford 1.20 g (82%) of the expected acid: IR (film) 3249, 1678, 1627 cm^{-1}; ^1H NMR ($CDCl_3$, 200 MHz) δ 10.4 (br s, 1 H), 7.20 (br s, 1 H), 5.53 (t, J = 7.2 Hz, 1 H), 2.26−2.06 (m, 4 H), 1.97 (d, J = 1.6 Hz, 3 H), 1.01 (t, J = 7.2 Hz, 3 H), 0.96 (t, J = 7.8 Hz, 3 H).

To a stirred suspension of 1.08 g (4.56 mmol) of amine (**4c**) and 90 mg (0.74 mmol) of DMAP in 22 mL of dichloromethane at 5 °C was added 1.04 g (5.04 mmol) of dicyclohexylcarbodiimide (DCC), followed by a solution of 850 mg (5.06 mmol) of the above acid in 6 mL of dichloromethane. The reaction mixture was then stirred at 20 °C for 60 h, after which time 20 mL of ether was added and the resulting precipitate was removed by filtration through Celite. The filtrate was evaporated under reduced pressure, and the crude product was purified by dry column silica gel chromatography with 4% ether in dichloromethane to provide 1.57 g (89%) of amide **10a**: IR (film) 3363, 1656 cm^{-1}; ^1H NMR ($CDCl_3$, 200 MHz) δ 8.18 (s, 1 H), 7.99 (d, J = 8.6 Hz, 1 H), 7.80 (d, J = 7.8 Hz, 1 H), 7.69 (ddd, J = 8.4, 7.0, 1.7 Hz, 1 H), 7.54 (ddd, J = 8.0, 7.0, 1.4 Hz, 1 H), 6.78 (br s, 1 H), 6.49 (br s, 1 H), 5.36 (t, J = 7.6 Hz, 1 H), 4.68 (2 s, 2 H), 2.14 (q, J = 7.6 Hz, 4 H), 1.99 (d, J = 1.7 Hz, 3 H), 0.98 (t, J = 7.6 Hz, 3 H), 0.93 (t, J = 7.8 Hz, 3 H); ^{13}C NMR ($CDCl_3$, 50.3 MHz) δ 169.7, 147.5, 143.1, 138.1, 137.9, 136.9, 134.3, 131.5, 130.3, 129.0, 128.1, 127.7, 127.3, 127.3, 43.4, 23.4, 21.1, 14.2, 14.1, 13.4.

Anal. Calcd for $C_{20}H_{23}BrN_2O$: M_r, 386.0994. Found: M_r (mass spectrum, EI), 386.0998.

Methyl (*E*)-3-(3-(((*E*,*E*)-4-Ethyl-2-methyl-2,4-heptadienamido)-methyl)quinolin-2-yl)acrylate (10b). A mixture of 1.47 g (3.80 mmol) of amide **10a** and 120 mg (0.13 mmol) of tris(dibenzylideneacetone)dipalladium in 59 mL of dry dioxane under argon at 20 °C was stirred for 15 min (with brief periods of sonication for homogeneity) and then treated with 162 mg (0.53 mmol) of triphenylarsine. After being stirred for 30 min (again with brief periods of sonication), 2.28 g (6.08 mmol) of (*E*)-methyl 3-(tributylstannyl)acrylate in 10 mL of dioxane was added, followed by a few crystals of BHT, and the resulting reaction mixture was heated at 80 °C for 7 h. After being permitted to cool to ambient temperature, the mixture was treated with a few drops of aqueous potassium fluoride (2:1), stirred for 10 min, and then processed with dichloromethane in the usual manner to give the crude product. Purification of this material by dry silica gel chromatography with ether in dichloromethane gave 1.10 g (74%) of ester **10b**: mp 119−121 °C; IR (film) 3371, 1716, 1656 cm^{-1}; ^1H NMR ($CDCl_3$, 200 MHz) δ 8.12 (s, 1 H), 8.08−7.96 (m, 1 H), 7.77 (d, J = 7.8 Hz, 1 H), 7.69 (t, J = 7.2 Hz, 1 H), 7.64 (ABq, δ_a = 8.03, δ_b = 7.25, J_{ab}= 15.2 Hz, 2 H), 7.51 (t, J = 7.2 Hz, 1 H), 6.74 (br s, 1 H), 6.13 (br s, 1 H), 5.36 (t, J = 7.6 Hz, 1 H), 4.79 (2 s, 2 H), 3.83 (s, 3 H), 2.19−2.06 (m, 4 H), 1.98 (s, 3 H), 1.02 (t, J = 7.6 Hz, 3 H), 0.92 (t, J = 7.9 Hz, 3 H); ^{13}C NMR ($CDCl_3$, 50.3 MHz) δ 169.8, 167.0, 151.1, 147.3, 139.1, 137.6, 136.9, 136.3, 134.3, 130.2, 130.0, 129.5, 129.2, 128.1, 127.4, 127.3, 125.0, 51.9, 41.0, 23.4, 21.2, 14.2, 14.1, 13.4. Anal. Calcd for $C_{24}H_{28}N_2O_3$: C, 73.44; H, 7.19; N, 7.14. Found: C, 73.54; H, 7.39; N, 7.16.

Methyl 7-(1-Ethyl-1-butenyl)-8-methyl-5b,6,7,8-tetrahydro-11*H*-indolizino[1,2-*b*]quinolin-9-one-6-carboxylate (11a). A stirred solution of 340 mg (0.87 mmol) of ester **10b** and 600 μL (436 mg, 4.30 mmol) of triethylamine in 9 mL of dichloromethane at 10 °C under argon was treated with 590 μL (679 mg, 2.57 mmol) of *tert*-butyldimethylsilyl trifluoromethanesulfonate. After being stirred at 10 → 20 °C for 3.5 h, the reaction mixture was processed with dichloromethane in the usual way and the crude product was purified by dry column silica gel chromatography with 4−10% ether in dichloromethane to afford 240 mg of a major isomer and then 45 mg of a mixture of minor isomers (84% combined yield). The major isomer: IR (film) 3061, 1739, 1649 cm^{-1}; ^1H NMR ($CDCl_3$, 300 MHz) δ 8.05 (s, 1 H), 7.98 (d, J = 8.5 Hz, 1 H), 7.79 (d, J = 8.0 Hz, 1 H), 7.66 (ddd, J = 8.5, 6.9, 1.5 Hz, 1 H), 7.52 (ddd, J = 8.1, 7.0, 1.3 Hz, 1 H), 5.22−5.08 (m, 2 H), 4.93 (ABq, δ_a = 5.12, δ_b = 4.73, J_{ab}= 16.4 Hz, 2 H), 3.88 (s, 3 H), 3.16−2.76 (m, 3 H), 2.10−1.73 (m, 4 H), 1.10 (d, J = 7.2 Hz, 3 H), 0.93 (t, J = 7.0 Hz, 3 H), 0.90 (t, J = 7.6 Hz, 3 H); ^{13}C NMR ($CDCl_3$, 50.3 MHz) δ 173.4, 172.7, 160.5, 149.0, 138.0, 130.7, 130.2, 129.5, 129.3, 127.8, 127.7, 127.6, 126.7, 63.0, 51.9, 49.2, 48.4, 48.1, 38.5, 23.5, 21.0, 14.4, 13.5, 13.5; mass

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spectrum (CI), *m*/*z* 393 (MH^+). Anal. Calcd for $C_{24}H_{28}N_2O_3$: C, 73.44; H, 7.19; N, 7.13. Found: C, 73.25; H, 7.42; N, 7.16.

Methyl 8-Methyl-7-propionyl-5b,6,7,8-tetrahydro-11*H*-indolizino[1,2-*b*]quinolin-9-one-6-carboxylate (11b). A stirred solution of 100 mg (0.25 mmol) of the above olefin (major isomer)[14] in 14 mL of dichloromethane−methanol (6:1) at −78 °C was carefully treated with ozone until complete consumption of the starting material (TLC). After the excess ozone was removed with a stream of oxygen, 2 mL of dimethyl sulfide was added to the reaction mixture, and overnight the temperature was allowed reach 20 °C. The solvents were then removed under reduced pressure, and the residue was processed with dichloromethane in the usual way to give the crude reaction product. Purification of this material by dry column silica gel chromatography with 15% ether in dichloromethane yielded 56 mg (60%) of keto ester **11b**: mp 178−181 °C; IR (film) 1730, 1657 cm^{-1}; ^1H NMR ($CDCl_3$, 200 MHz) δ 8.04 (s, 1 H), 7.96 (d, J = 8.2 Hz, 1 H), 7.79 (dd, J = 8.1, 1.4 Hz, 1 H), 7.66 (ddd, J = 8.4, 6.8, 1.4 Hz, 1 H), 7.52 (ddd, J = 8.1, 6.8 1.4 Hz, 1 H), 5.33−5.08 (m, 2 H), 4.93 (ABq, δ_a = 5.15, δ_b = 4.72, J_{ab}= 15.9 Hz, 2 H), 3.90 (s, 3 H), 3.60−3.44 (m, 1 H), 3.10−2.92 (m, 1 H), 2.47 (dq, J = 7.2, 1.4 Hz, 2 H), 1.16 (d, J = 7.2 Hz, 3 H), 1.01 (t, J = 7.2 Hz, 3 H);^{13}C NMR ($CDCl_3$, 50.3 MHz) δ 209.5, 173.1, 170.5, 160.0, 149.1, 130.2, 129.5, 129.4, 127.8, 127.6, 127.5, 126.8, 62.2, 53.5, 52.4, 48.6, 45.3, 37.1, 36.1, 13.8, 7.3; mass spectrum (CI), *m*/*z* 367 (MH^+). Anal. Calcd for $C_{21}H_{22}N_2O_4$: C, 68.84; H, 6.05; N, 7.65. Found: C, 68.90; H, 6.10; N, 7.53.

Methyl 8-Methyl-7-propionyl-11*H*-indolizino[1,2-*b*]quinolin-9-one-6-carboxylate (6-Methoxycarbonylmappicine Ketone) (12). A 23-mg (0.06 mmol) sample of keto ester **11b** was heated at reflux in 1.2 mL of *p*-cymene in the presence of 18 mg of 10% Pd−C with stirring under argon for 3.5 h. After being allowed to cool to ambient temperature, the reaction mixture was subjected directly to dry silica gel chromatography with 0−20% ether in dichloromethane to afford 18 mg (79%) of 6-(methoxycarbonyl)mappicine ketone (**12**): IR (film) 3053, 1717, 1656, 1624, 1605 cm^{-1}; ^1H NMR ($CDCl_3$, 200 MHz) δ 8.33 (s, 1 H), 8.09 (d, J = 8.5 Hz, 1 H), 7.89 (d, J = 7.9 Hz, 1 H), 7.77 (ddd, J = 8.4, 6.8, 1.4 Hz, 1 H), 7.62 (ddd, J = 8.1, 6.9, 1.4 Hz, 1 H), 5.25 (2 s, 2 H), 4.04 (s, 3 H), 2.86 (q, J = 7.3 Hz, 2 H), 2.17 (s, 3 H), 1.23 (t, J = 7.3 Hz, 3 H). Anal. Calcd for $C_{21}H_{18}N_2O_4$: M_r, 362.1267. Found: M_r (mass spectrum, EI), 362.1282.

8-Methyl-7-propionyl-11*H*-indolizino[1,2-*b*]quinolin-9-one (Mappicine Ketone) (1). A solution of 100 mg (0.27 mmol) of keto ester **11b** in 4 mL of dichloromethane and 0.9 mL of methanol was treated with 0.47 mL (0.94 mmol) of 2 N sodium hydroxide. After being stirred for 65 h at 20 °C, the reaction mixture was diluted with 8 mL of water, acidified to pH 2−2.5 with concentrated hydrochloric acid, and then processed with dichloromethane in the usual way. The resulting crude acid was heated at reflux in 4 mL of cymene in the presence of 75 mg of 10% Pd−C with stirring under argon for 1.5 h. After being allowed to cool to ambient temperature, the reaction mixture was subjected directly to dry silica gel chromatography with 0−2% methanol in dichloromethane to give essentially pure **1**, which on trituration with cold methanol provided 50 mg (60%) of pure mappicine ketone (**1**):[14] mp 236−237 °C (lit. 237−238 °C,[4a] 230−231 °C[4d]); IR (KBr) 3094, 1703, 1651, 1600 cm^{-1}; ^1H NMR ($CDCl_3$, 300 MHz) δ 8.34 (s, 1 H), 8.17 (d, J = 8.6 Hz, 1 H), 7.90 (d, J = 7.9 Hz, 1 H), 7.79 (ddd, J = 8.4, 6.9, 1.6 Hz, 1 H), 7.62 (ddd, J = 8.1, 6.8, 1.2 Hz, 1 H), 7.23 (s, 1 H), 5.27 (2 s, 2 H), 2.89 (q, J = 7.2 Hz, 2 H), 2.28 (s, 3 H), 1.22 (t, J = 7.2 Hz, 3 H); ^{13}C NMR ($CDCl_3$, 75.5 MHz) δ 205.5, 161.7, 152.8, 148.8, 148.1, 143.3, 131.0, 130.4, 129.5, 128.5, 128.1, 128.0, 127.7, 127.0, 97.8, 50.2, 36.0, 13.6, 7.7; mass spectrum (CI), *m*/*z* 305 (MH^+). Anal. Calcd for $C_{19}H_{16}N_2O_2$: C, 74.98; H, 5.30; N, 9.20; M_r, 304.1212. Found: C, 74.53; H, 5.23; N, 8.86 M_r (mass spectrum, EI), 304.1235.

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