Synthesis of 7-Azabicyclo[2.2.1]heptane Derivatives by Transformation of Tropinone
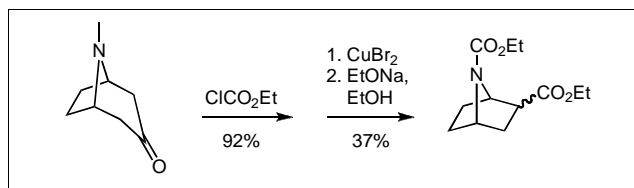
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The bromination (CuBr$_2$, AcOEt/CHCl$_3$) plus Favorskii rearrangement (EtONa, EtOH) of *N*-carbethoxytropinone (**4**), readily available from tropinone (**3**), affords mixtures of *exo-* and *endo*-isomers of 2,7-dicarbethoxy-7-azabicyclo[2.2.1]heptane (**1b**) in variable and moderate chemical yield (maximum 37%). The bromination (Br$_2$, HBr/AcOH) reaction of compound **4** gives ethyl *trans*-2,4-dibromo-3-oxo-8-azabicyclo[3.2.1]octane-8-carboxylate (**5**) in 99% yield, a product that on Favorskii rearrangement (EtONa/EtOH) affords ethyl 2,2-diethoxy-3-oxo-8-azabicyclo[3.2.1]octane-8-carboxylate in moderate yield (**6**) (52%).

Introduction.

Exo-2-substituted 7-azabicyclo[2.2.1]heptane derivatives (**1**) are useful synthetic intermediates [1,2] for the synthesis of a number of natural products, such as epibatidine (**2**) (Scheme 1) [3]. One of the first and best known synthetic approaches starts from commercially

[4]. Finally, epiboxidine has been synthesized from compound **1c** (Scheme 1) by Pandey and colleagues [7].

In this context, and in connection with a current project in progress in our laboratory, we have investigated the synthesis of 7-azabicyclo[2.2.1]heptane derivatives starting from tropinone, and we report here our results.

Scheme 1

Tropinone (**3**)

a R= Et, R'= Me
b R, R'= Et
c R, R'= Me
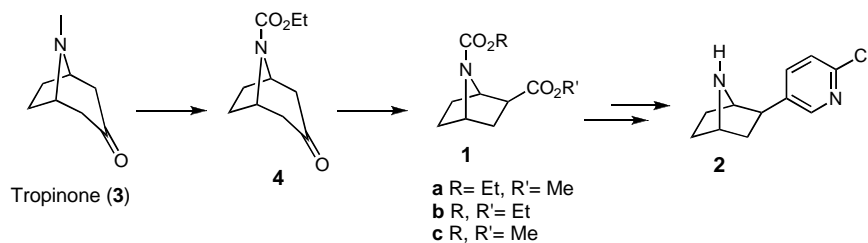
available tropinone (**3**). Bai and co-workers reported a synthesis of epibatidine [4] that used **1a** as a key intermediate (Scheme 1). The latter compound was obtained in 56% yield from *N*-carbethoxy-7-azabicyclo-[3.2.1]heptane (**4**) [5], after bromination (CuBr$_2$, AcOEt/CHCl$_3$) followed by Favorskii rearrangement (MeONa, DME). Daly and associates also prepared intermediate **1b** (Scheme 1), in their approach to epiboxidine [5]. They obtained and isolated compound **1b** in an overall 12.5% yield from **4** after bromination (Br$_2$, HBr/AcOH) followed by Favorskii rearrangement (EtONa, EtOH). In a more recent communication [6] some epibatidine analogues have been synthesized from **1a** (Scheme 1), this compound being prepared as reported
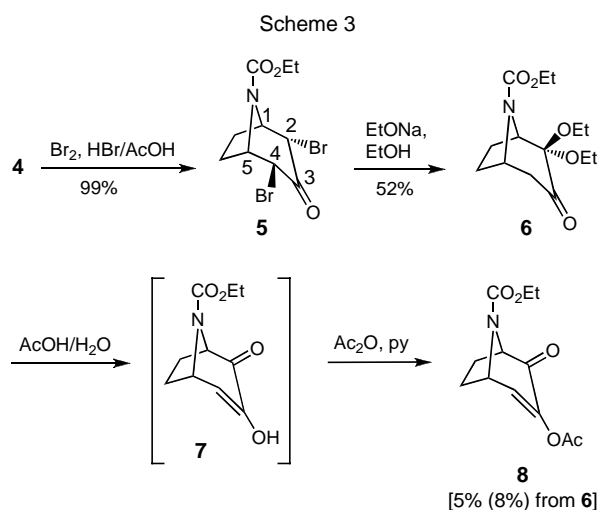
Scheme 2
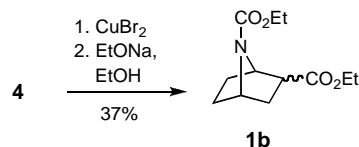
Results and Discussion.

In our preliminary experiments tropinone (**3**) was transformed into carbamate **4** which was submitted to the bromination reaction [CuBr$_2$ (2 equiv) added in 4 h 30 min] in a mixture of ethyl acetate/chloroform [4b], followed by Favorskii rearrangement using sodium

ethoxide in ethanol to give product **1b** (Scheme 2). In our hands this two-step protocol gave mixtures of the *exo-* and *endo-***1b** isomers in variable yields, ranging from 19-30% and 7-13%, respectively. In the best experiment we obtained *exo-***1b** and *endo-***1b** in 30% and 7% yield (37% total yield), respectively, from compound **4**. The formation of the *endo-***1b** is the result of a partial epimerization process in the basic reaction medium. Although our conditions are somewhat different with respect to Bai's procedure (DME, temperature), the isolation of both epimers and thus, lack of complete diastereoselectivity has already been reported in patent literature while following Bai's procedure (3:1, exo:endo) [8d].

Major compound *exo-***1b** has been previously reported in patents [8] and by Daly [5], while minor *endo-***2** isomer has been reported in patent literature [8]. The spectroscopic data for compounds *exo-***1b** and *endo-***1b** are in very good agreement with those recorded for 7-carbethoxy-2-*exo*-(carbomethoxy)-7-azabicyclo[2.2.1]-heptane [4b] and for 7-carbomethoxy-2-*exo* or *(endo)*-(carbomethoxy)-7-azabicyclo[2.2.1]heptane [7].

We have also explored the bromination step using Br_2 in HBr/AcOH [5]. Under these conditions we obtained the

Scheme 3

trans-2,4-dibromo derivative **5** in 99% yield (based on Br_2; Scheme 3). Other non-identified minor products where also obtained, to account for the rest of the starting material. The structure of this compound was deduced from its NMR data. In the ¹H NMR spectrum we analyzed the multiplet for H1 and H5 centered at $\delta_H = 4.86$ ppm, as well as two signals at δ 5.37 (d, *J* = 3.6 Hz) and 4.34 (d, *J* = 2.0 Hz) that correlate (HMQC experiment) with tertiary carbons at 54.2 and 52.9 ppm corresponding to C4 and C2, respectively. Confirming our assignments no nOe

effect was observed when irradiating protons H2 and H4 in the ¹H NMR spectrum. The elemental analysis and the mass spectrum are in good agreement for a compound with a $C_{10}H_{13}Br_2NO_3$ formula. These data strongly support the non symmetrical, *trans*-2,4-dibromo structure **5** for this compound.

The reaction of compound **5** with sodium ethoxide in ethanol gave a new product in 52% yield, the structure of which has been tentatively assigned to ketone **6** (Scheme 3). The same protocol (Br_2, HBr/AcOH followed by reaction with EtONa/EtOH) but without isolation of the intermediate, gave the same ketone **6** in a poorer yield (29%). Finally, when the bromination was carried using $CuBr_2$ (3 equiv.) added in small portions over a period of 28 h (allowing for the green color caused by each addition of $CuBr_2$ to disappear), followed by the usual Favorskii rearrangement protocol, we obtained again ketone **6** in 22% yield from carbamate **4**. In these cases we observed very complex reactions mixtures, detecting only traces of *exo-***1b** product. Regarding the structure assignment for compound **6**, the elemental analysis and the mass spectrum (*m/z* 285 M⁺·) are in good agreement with a $C_{14}H_{23}NO_5$ formula. The IR spectrum of **6** showed a strong absorption at 1735 cm⁻¹, suggesting the presence of a ketone substituted in the α-position with an electronwithdrawing group, as one or two ethoxy groups, and a band at 1705 cm⁻¹, typical of a carbamate. These functional moieties were confirmed in the ¹³C NMR spectrum by a signal at 203.9 ppm (ketone) and at 154.5 ppm (carbamate group); in addition, we observed a quaternary carbon at 101.9 ppm, corresponding to the acetal moiety installed at C2, three ethoxy groups (signals for the methylene and the methyl groups at 61.2, 58.4, 57.0 ppm, and at 15.5, 15.1, 14.7 ppm, respectively). Accordingly, the ¹H NMR spectrum showed for protons H1 and H5 multiplets centered at 4.49 ppm, and two multiplets at 2.87 ppm (t, 14.9 Hz) and at 2.29 ppm (d, 14.9 Hz) for H4. These protons couple in the HMQC experiment with the secondary carbon at 46.8 ppm.
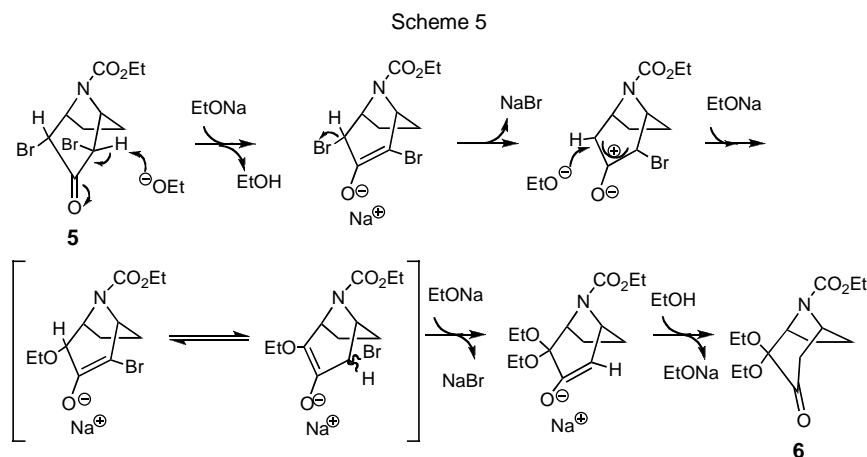
At this point, several considerations concerning the bromination step have to be made. While for the previous conditions ($CuBr_2$, $CHCl_3$/AcOEt) Bai and co-workers only described the formation of two isomeric monobromides whose spectroscopic data were not provided, under the same experimental conditions, but using AcOEt as a solvent, the patent literature also described the formation of some dibromide (5%), as well as the desired monobromides and unreacted starting material [8d]. A mixture of dibromo derivatives (20%) was also obtained by Daly *et al.* during their synthesis of

intermediate **1b**, just as described earlier for similar conditions (Br₂, AcOH) and compounds [9].

On the other hand, the diaxial dibromide **9** (whose data was neither reported) was described by Bai as the only product when treating **4** with Br₂ in ether (66%). However, when this product was submitted to several different basic conditions (NaOMe/DME or toluene or DCM; Et₃N/MeOH or EtOH) no Favorskii product was detected, obtaining product **10** (Scheme 4) instead [4d].

Scheme 4

R=Me, Et.

9   **10**
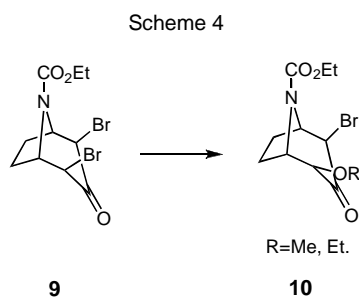
In scheme 5 we show a possible mechanism that accounts for the appearance of product **6** in the Favorskii reaction of compound **5**. As it can be noted, this mechanism does not rely on the typical cyclopropanone intermediate that would lead to Favorskii products, but on a recent proposal made by Föhlisch [10]. It is possible that in the early stages of the mechanism the preferred pseudo-equatorial orientation of the leaving bromide in compound **5** would account for the observed result, explaining why in the case of Bai's diaxial dibromide no product **6** was detected.

informative was a band at 1770 cm⁻¹ in the IR spectrum, suggesting the presence of a vinyl acetate moiety, confirmed by the signals at 168.3 (OCOCH₃), 144.4 and 138.7 ppm (*C=C*-OCOCH₃) in the ¹³C NMR spectrum. In the ¹H NMR spectrum we located the typical signals for the carbamate moiety, indicating that this group has resisted the acetal acid hydrolysis conditions, as well as a vinylic proton (H4 at δ 6.91, d, *J*= 5.4 Hz) coupled with the triplet at 4.93 ppm (H5), according to the ¹H-¹H COSY experiment. This product is the result of the acetylation of the not isolated, intermediate α-diketone (**7**), mostly present in the stabilized α,β-unsaturated keto-enol tautomer form (Scheme 3), obtained in the acid hydrolysis of compound **6**.

In summary, we have analyzed the synthesis of 7-azabicyclo[2.2.1]heptane derivatives from tropinone, *via* the usual two step protocol: bromination and Favorskii rearrangement. We have found that the bromination (CuBr₂, AcOEt/CHCl₃) plus Favorskii rearrangement (EtONa, EtOH) of *N*-carbethoxytropinone (**4**), affords mixtures of *exo*- and *endo*-isomers of 2,7-dicarbethoxy-7-azabicyclo[2.2.1]heptane (**1b**) in variable and moderate chemical yields (maximum 37%); that the bromination (Br₂, HBr/AcOH) of compound **4** gives ethyl *trans*-2,4-dibromo-3-oxo-8-azabicyclo[3.2.1]octane-8-carboxylate (**5**) in 99% yield (Br₂ as limiting reagent), a product that on Favorskii rearrangement (EtONa/EtOH) affords ethyl 2,2-diethoxy-3-oxo-8-azabicyclo[3.2.1]octane-8-carboxylate (**6**) (52%).

Scheme 5

5

6

Final confirmation of the structure proposed for **6** was obtained upon acid hydrolysis of ketone **6** in AcOH/H₂O followed by acetylation (Scheme 3) to give compound **8** [λ_max(EtOH)= 225.0 nm, log ε= 3.66]. The structure of this molecule was easily established by its analytical and spectroscopic data. Particularly

EXPERIMENTAL

Reactions were monitored by TLC using precoated silica gel aluminium plates containing a fluorescent indicator (Merck, 5539). Anhydrous Na₂SO₄ was used to dry organic solutions during work-ups and the removal of solvents was carried out

under vacuum with a rotary evaporator. Flash column chromatography was performed using silica gel 60 (230-400 mesh, Merck). ^{1}H spectra were recorded with a Varian VXR-200S spectrometer and ^{13}C NMR spectra were recorded with a Bruker WP-200-SY. Values with (*) can be interchanged.

7-Carbethoxy-2-*endo*-(carbethoxy)-7-azabicyclo[2.2.1]heptane (***endo*-1b**) 7-carbethoxy-2-*exo*-(carbethoxy)-7-azabicyclo[2.2.1]-heptane (***exo*-1b**).

To a solution of *N*-carbethoxytropinone (**4**) [5] (730 mg, 3.70 mmol) in AcOEt (7.5 mL) and CHCl$_3$ (7.5 mL), under argon and stirring, at reflux, CuBr$_2$ (1.653 g, 7.40 mmol) was added in three portions, during 4 h 30 min. After 4 h, the reaction was filtered, and the solvent was evaporated. The residue was dissolved in AcOEt, washed with water, a 5% aqueous solution of NaHCO$_3$, and brine. The organic phase was dried (Na$_2$SO$_4$), filtered and evaporated. The resulting crude was dissolved in ethanol (20 mL) and treated with recently prepared EtONa (403 mg, 17.53 mmol) in ethanol (14.6 mL) at rt. After 3.5 h, water was added and the mass was extracted with AcOEt. The organic phase was washed with water, dried (Na$_2$SO$_4$), filtered, and the solvent was evaporated to give a crude that was submitted to chromatography (hexane: AcOEt, 15%) to give 7-carbethoxy-2-*endo*-(carbethoxy)-7-azabicyclo[2.2.1]heptane (***endo*-1b**) [8] (66 mg, 7% from **4**) {[oil; IR (film) ν 2927, 1712, 1375, 1299, 1191, 1164, 1102 cm^{-1}; ^{1}H NMR (CDCl$_3$, 200 MHz) δ 4.50 (t, *J*= 4.49 Hz, 1 H, H1), 4.30 (t, *J*= 4.40 Hz, 1 H, H4), 4.18 (q, *J*= 7.14 Hz, 2 H, OC*H*$_2$CH$_3$), 4.14 (q, *J*= 7.14 Hz, 2 H, OC*H*$_2$CH$_3$), 3.05 (m, 1 H, H2), 1.92-1.81 (m, 2 H, H3),1.70 (m, 2 H, H5, H6), 1.42 (m, 2 H, H5, H6), 1.29 (t, 3 H, OCH$_2$C*H*$_3$), 1.28 (t, 3 H, OCH$_2$C*H*$_3$); ^{13}C NMR (CDCl$_3$, 75 MHz) δ 172.8 (*C*O$_2$CH$_2$CH$_3$), 156.0 (OCON), 61.5 (O*C*H$_2$CH$_3$), 61.10 (O*C*H$_2$CH$_3$), 58.5 (C1), 57.4 (C4), 46.9 (C2), 32.8 (C3), 29.6 (C5)*, 25.8 (C6)*, 14.6 (OCH$_2$*C*H$_3$), 14.4 (OCH$_2$*C*H$_3$); MS (CI) *m/z* 196.1 [M-OEt]$^+$, 242.1 [M+1]$^+$, 264 [M+Na]$^+$. *Anal*. Calcd. for C$_{12}$H$_{19}$NO$_4$: C, 59.73; H, 7.94; N, 5.81. Found: C, 59.65; H, 7.81; N, 5.66} and 7-carbethoxy-2-*exo*-(carbethoxy)-7-aza-bicyclo[2.2.1]heptane (***exo*-1b**) [8] (262 mg, 30%) {oil; IR (film) ν 2980, 1735, 1707, 1376, 1315, 1184, 1159, 1101 cm^{-1}; ^{1}H NMR (CDCl$_3$, 200 MHz) δ 4.59 (d, *J*= 4.03 Hz, 1 H, H1), 4.40 (t, *J*= 4.03 Hz, 1 H, H4), 4.17 (q, *J*=7.14 Hz, 2 H, OC*H*$_2$CH$_3$), 4.11 (q, *J*=7.14 Hz, 2 H, OC*H*$_2$CH$_3$), 2.58 (dd, *J*= 8.97, 4.94 Hz, 1 H, H2), 2.28 (m, 1 H, H3-*exo*), 1.83 (m, 2 H, H5, H6), 1.68 (dd, *J*= 8.79, 12.36 Hz, 1H, H3-*endo*), 1.48 (m, 2 H, H5, H6), 1.30 (t, 3H, OCH$_2$C*H*$_3$), 1.26 ; ^{13}C NMR (CDCl$_3$, 75 MHz): δ 173.7 (*C*O$_2$CH$_2$CH$_3$), 155.7 (OCON), 61.4 (O*C*H$_2$CH$_3$), 61.2 (O*C*H$_2$CH$_3$), 59.6 (C1), 56.2 (C4), 47.9 (C2), 33.7 (C3), 29.8 (C5)*, 29.2 (C6)*, 14.9 (OCH$_2$*C*H$_3$), 14.5 (OCH$_2$*C*H$_3$); MS (CI): *m/z* 196.1 [M-OEt]$^+$, 242.1 [M+1]$^+$, 264.0 [M+Na]$^+$, 505.2 [2M+Na]$^+$. *Anal*. Calcd. for C$_{12}$H$_{19}$NO$_4$: C, 59.73; H, 7.94; N, 5.81. Found: C, 59.81; H, 8.01; N, 5.92}.

Ethyl *trans*-2,4-dibromo-3-oxo-8-azabicyclo[3.2.1]octane-8-carboxylate (**5**).

To a solution of *N*-carbethoxytropinone (**4**) (504 mg, 2.56 mmol) in CH$_2$Cl$_2$ (2 mL), Br$_2$ (0.16 mL, 3.12 mmol) in 30% HBr/AcOH (1.48 mL) was added. After 4 h, the mixture was neutralized with aqueous saturated solution of NaHCO$_3$, extracted with ethyl acetate, washed with water, dried, and the solvent evaporated. The residue was submitted to chromatography (hexane: AcOEt, 15%) to give compound **5**

(550 mg, 99%, taking into account bromine is the limiting reagent): oil; IR (film) ν 3446, 2981, 1734, 1705, 1422, 1327, 1107, 1030, 1015 cm^{-1}; ^{1}H NMR (CDCl$_3$, 200 MHz) δ 5.37 (d, *J*= 3.6 Hz, 1 H, H4 exo), 4.86 (br s, 2 H, H1, H5), 4.34 (d, *J*= 2.0 Hz, 1 H, H2-*endo*), 4.28 (q, *J*= 7.1 Hz, 2 H, OC*H*$_2$CH$_3$), 2.32-2.20 (m, 1 H, H7-*exo*), 2.15-2.00 (m, 2 H, H6), 1.82-1.63 (m, 1 H, H7-*endo*), 1.36 (t, 3H, OCH$_2$C*H*$_3$); ^{13}C NMR (CDCl$_3$, 75 MHz): δ 193.3 (CO, C3), 153.5 (O*C*ON), 62.3 (O*C*H$_2$CH$_3$), 60.0 (C1)*, 58.6 (CH, C5)*, 54.1 (C4), 52.7 (C2), 29.8 (C7), 24.1 (C6), 14.7 (OCH$_2$*C*H$_3$); EM (CI): *m/z* 356.0 [M+1]$^+$.

    Anal. Calcd. for C$_{10}$H$_{13}$Br$_2$NO$_3$: C, 33.83; H, 3.69; N, 3.95. Found: C, 34.06; H, 3.80; N, 3.84.

Ethyl 2,2-diethoxy-3-oxo-8-azabicyclo[3.2.1]octane-8-carboxylate (**6**).

(A) From Compound **5**.

To a solution of compound **5** (300 mg, 0.87 mmol) in ethanol (13 mL) a solution of EtONa (6.04 mmol) in ethanol (5 mL) was added. After 3 h., the solvent was removed, water was added and the crude was extracted with AcOEt. The organic phase was washed with water, dried, and filtered. The residue was submitted to chromatography (hexane: AcOEt, 15%) to give compound **6** (129 mg, 52%).

(B1) From Product **4**.

To a solution of *N*-carbethoxytropinone (**4**) (673 mg, 3.41 mmol) in CH$_2$Cl$_2$ (2.5 mL) a mixture of Br$_2$ (0.2 mL, 3.89 mmol) in 30% HBr/AcOH (2 mL) was added in 15 min at rt. After 3.5 h the reaction was neutralized with an aqueous saturated solution of NaHCO$_3$, and extracted with AcOEt. The organic phase was washed with water, dried, filtered and evaporated to give a crude, that was dissolved in ethanol (15 mL). To this solution a recently prepared solution of EtONa (379.6 mg, 16.51 mmol) in ethanol (13.8 mL) was added dropwise. After 4.5 h the solvent was removed, water was added, extracted with ethyl acetate, washed with brine, dried (Na$_2$SO$_4$), and evaporated. The crude was submitted to chromatography (hexane: AcOEt, 20%) to give compound **6** (160 mg, 29%, taking into account bromine as the limiting reagent).

(B2) From Product **4**.

To a solution of *N*-carbethoxytropinone (**4**) (442.5 mg, 2.24 mmol) in CHCl$_3$:AcOEt (10 mL, 1:1), under argon and at reflux CuBr$_2$ (1.5 g 6.73 mmoles, 3 equiv) was slowly added in 28 h, allowing for the green color caused by each addition of CuBr$_2$ to disappear. After 4 h the reaction was cooled and filtered, and washed with CHCl$_3$. The solvent was removed and the crude dissolved in ethyl ether, washed with water, 5% aqueous solution of NaHCO$_3$ and brine. The organic phase was dried (Na$_2$SO$_4$), filtered, evaporated and the crude (590 mg) was dissolved in ethanol (12 mL) and treated with a solution of sodium ethoxide (273 mg, 11.88 mmol) in ethanol (9.9 mL). After 6 h the solvent was evaporated, water was added and the resulting solution was then extracted with ethyl acetate. The organic phase was washed with water, dried (Na$_2$SO$_4$), filtered and the solvent evaporated to give a crude that was submitted to chromatography (hexane: AcOEt, 15%) to yield compound **6** (140 mg, 22%): oil; IR (film) ν 3448, 2979, 1735, 1705, 1428, 1328, 1151, 1106, 1072 cm^{-1}; ^{1}H NMR (CDCl$_3$, 200 MHz) δ 4.49 (m, 2 H, H1, H5), 4.15 (q, *J*= 7.1 Hz, 2 H, OC*H*$_2$CH$_3$), 3.9-3.1 (m, 4 H, 2 x OC*H*$_2$CH$_3$), 2.87 ppm (t, *J*= 14.9 Hz, 1 H, H4), 2.29 ppm (d, 14.9 Hz), 3.00-2.83 (m, 1 H,

H4), 2.41-2.23 (d, *J*= 14.93 Hz, 1 H, H 4), 1.94-1.52 (m, 4 H, H6, H7), 1.26 (t, *J*= 7.1 Hz, 3 H, OCH$_2$C*H$_3$*), 1.21 (t, *J*= 7.2 Hz, 3 H, OCH$_2$C*H$_3$*), 1.09 (t, *J*= 7.2 Hz, 3 H, OC*H$_2$*C*H$_3$*); ^{13}C NMR (CDCl$_3$, 75 MHz) δ 203.9 (CO, C3), 154.5 (OCON, C8), 101.9 (C2), 61.2 (OCH$_2$CH$_3$), 58.4 (OCH$_2$CH$_3$), 58.1 (C1)*, 57.0 (OCH$_2$CH$_3$), 53.6 (C5)*, 46.8 (C4), 27.8 (C6)**, 23.5 (C7)**, 15.5 (OCH$_2$CH$_3$), 15.1 (OCH$_2$CH$_3$), 14.7 (OCH$_2$CH$_3$); MS (CI): *m/z* 308.3 [M+23]$^+$; MS (EI): *m/z* 285 [M]$^+$.

Anal. Calcd. for C$_{14}$H$_{23}$NO$_5$: C, 58.93; H, 8.12; N, 4.91. Found: C, 58.76; H, 7.94; N, 4.86.

Acid Hydrolysis of Ethyl 2,2-diethoxy-3-oxo-8-azabicyclo-[3.2.1]octane-8-carboxylate (**6**).

A solution of compound **6** (95 mg, 33 mmol) in THF (2 mL) was treated with water (3.5 mL) and acetic acid (1.5 mL) at 80 ºC for 23 h. The solvent was removed, and the crude was submitted to chromatography (hexane/AcOEt, 30%) to give unreacted **6** (35.6 mg) and a new product (**7**), more polar (16 mg) that was acetylated as usual (pyridine/Ac$_2$O, 0.5 mL/0.5 mL) at rt for 22 h. The solvents were evaporated and the crude chromatographied (hexane/AcOEt, 20%) to give compound **8** [4 mg, 5% (8%) taking into account the unreacted compound **6**)] from **6**): oil; λ$_{max}$(EtOH)= 225.0 nm, log ε=3.66; IR (film) ν 2924, 1770, 1711, 1635, 1408, 1379, 1318, 1196, 1086 cm^{-1}; ^{1}H NMR (CDCl$_3$, 200 MHz) δ 6.91 (d, *J*= 5.4 Hz, 1 H, H4), 4.93 (t, *J*= 5.4 Hz, 1 H, H5), 4.73 (d, *J*= 7.0 Hz, 1 H, H1), 4.14 (q, *J*= 7.2 Hz, 2 H, NCO$_2$C*H$_2$*CH$_3$), 2.6-2.3 (m, 1 H, H7-*exo*), 2.23 (s, 3 H, OCOCH$_3$), 2.3-2.1 (m, 1 H, H6-*exo*), 1.98-1.72 (m, 2 H, H6-*endo*, H7-*endo*), 1.25 (t, 3 H, NCO$_2$CH$_2$C*H$_3$*); ^{13}C NMR (CDCl$_3$, 75 MHz) δ 189.7 [C(2)=O], 168.3 (OCOCH$_3$), 154.8 (NCO$_2$CH$_2$CH$_3$), 144.4 (C3), 138.7 (C4), 63.3 (C1), 62.0 (NCO$_2$CH$_2$CH$_3$), 54.0 (C5), 28.3 (C6), 24.5 (C7), 20.3 (OCOCH$_3$), 14.5 (NCO$_2$CH$_2$CH$_3$); MS (CI): *m/z* 254.1 [M+1]$^+$, 276.0 [M+23]$^+$.

Anal. Calcd. for C$_{12}$H$_{15}$NO$_5$: C, 56.91; H, 5.97; N, 5.53. Found: C, 56.82; H, 5.65; N, 5.71.

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