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Dibenzotetracyclic Derivatives. II.[1] Synthesis of 9-Aminoalkyl-9,10-dihydro-9,10-methanoanthracenes

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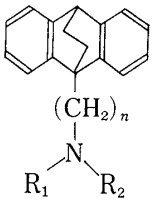
A synthesis of 9-aminoalkyl-9,10-dihydro-9,10-methanoanthracenes (**2**) is reported. A key intermediate, 9-formyl-9,10-dihydro-9,10-methanoanthracene (**4**), was synthesized from 9-amino-12-hydroxy-9,10-dihydro-9,10-ethanoanthracene (**3b**) by nitrous acid deamination. The amino-alcohol (**3b**) was synthesized in 5 steps starting from anthracene-9-carbaldehyde.

Keywords——antidepressant; neuroleptics; 9-substituted-9,10-dihydro-9,10-methanoanthracene; ring contraction; nitrous acid deamination

The synthesis of various 9-aminoalkyl-9,10-dihydro-9,10-ethanoanthracene derivatives (**1**) was reported by Wilhelm and Schmidt in 1969.[3] Among these compounds, **1a** (maprotiline) and **1b** (benzoctamine) have now been developed into clinically useful psychotropic drugs. Maprotiline (**1a**) has attracted considerable attention as a new type of tetracyclic antidepressant in contrast with the so-called tricyclic antidepressants such as imipramine, amitriptyline, protriptyline, etc.

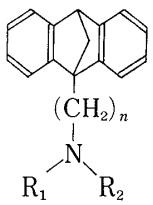
In spite of extensive work on the ethanoanthracene series (**1**), no study on the corresponding methanoanthracene series (**2**) has yet been reported.[4]

It is assumed from molecular model studies that the dihedral angle between the two benzene ring planes of the methanoanthracene system is significantly smaller than that of the ethanoanthracene system, and such a difference might be reflected in its pharmacological activities. The present paper is concerned with the synthesis of methanoanthracene derivatives **2**.



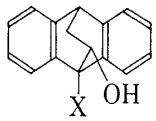
1

1a : $n=3$, $R_1=CH_3$, $R_2=H$
1b : $n=1$, $R_1=CH_3$, $R_2=H$



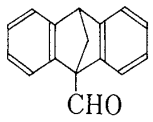
2

Chart 1



3

3a : X=Br
3b : X=NH_2



4

Chart 2

1) A part of this work was presented in a preliminary communication: M. Sunagawa, J. Katsube, and H. Yamamoto, *Tetrahedron Lett.*, **1978**, 1281.
2) Location: *2-1, Takatsukasa 4-chome, Takarazuka-shi, Hyogo, Japan*; *a*) To whom correspondence should be addressed.
3) von M. Wilhelm and P. Schmidt, *Helv. Chim. Acta*, **52**, 1385 (1969).
4) The synthesis of the corresponding methanoanthracene drivatives has been described in Japan. Patent [(unexamined) No. 52-73853 (1977)] by H. Tanida and T. Irie, and we have decribed some of this work in Japan. Patent (unexamined) No. 51-125269 (1976).

So far, only a limited number of synthetic approahes to the methanoanthracene skeleton have been presented. That is, the synthesis of the skeleton itself and that of 11-substituted derivatives have been reported, but no effective synthetic route to 9-substituted derivatives has hitherto been demonstrated. Therefore, our initial efforts were directed toward the development of an efficient synthetic route for the 9-substituted methanoanthracene skeleton.

A synthetic approach to 9-substituted-9,10-dihydro-9,10-methanoanthracene by ring contraction of an ethanoanthracene skeleton seemed an attractive possibility, because the starting ethanoanthracene derivative is readily available. Thus, it was decided to examine the rearrangement of the ethanoanthracene skeleton. That is, as shown in Chart 2, the ethanoanthracene derivative (**3**), in which some leaving group is present on C-9 and which carries 12-OH, might be rearranged into 9,10-dihydro-9,10-methanoanthracene-9-carbaldehyde (**4**) by a pinacol-type rearrangement.

Firstly, bromine was tested as the leaving group. Typical pinacol-type rearrangement of the bromohydrin (**3a**), mp 112—113°, which was easily prepared by cycloaddition between 9-bromoanthracene and vinyl acetate with subsequent hydrolysis, did not give a satisfactory result. The difficulty of the rearrangement of **3a** might be due to poor reactivity of the Br–C_9 bond.[5]

Finally, the synthesis of **4** was successfully accomplished by nitrous acid deamination of the 9-amino derivative (**3b**).[1] That is, treatment of **3a** in acetic acid with aqueous sodium nitrite afforded **4** in good yield. The structure of **4** was assigned on the basis of the nuclear magnetic resonance (NMR) spectrum, in which the bridgehead proton and formyl proton appear at 3.34 ppm as a triplet and at 10.45 ppm as a singlet, respectively.

Many molecular rearrangements of bicyclic amines have been reported as a result of deamination. However, ring contraction, *via* a bridgehead carbonium ion, of a bicyclic skeleton fused by two benzene rings has not been reported.

The starting amino-alcohol was synthesized from anthracene-9-carbaldehyde as follows;

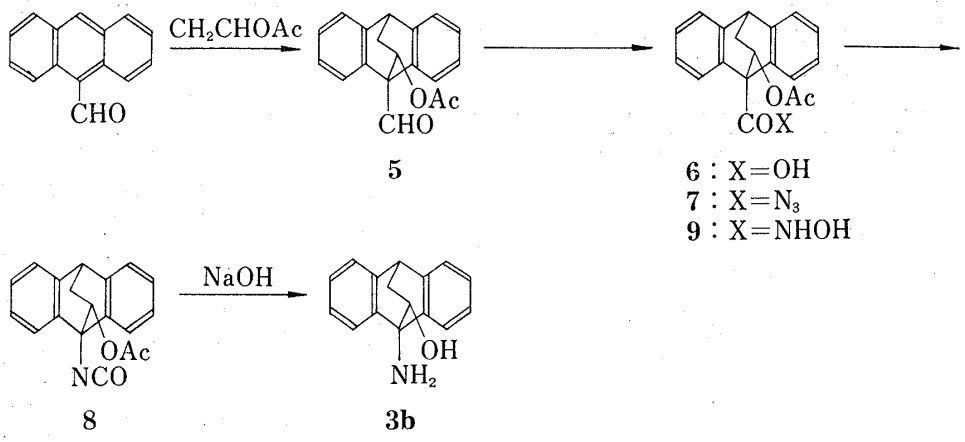


Chart 3

A solution of anthracene-9-carbaldehyde in vinyl acetate was heated at 170—175° for 20 hours and the excess vinyl acetate was evaporated off to give crude 12-acetoxy-9,10-dihydro-9,10-ethanoanthracene-9-carbaldehyde (**5**), which was purified by recrystallization from ethanol.

The oxidation of **5** with Jones' reagent[6] in acetone afforded the corresponding carboxylic acid (**6**) in quantitative yield, and this was converted to the acyl azide (**7**) by treatment with

5) von M. Wilhelm and D.Y. Curtin, *Helv. Chim. Acta*, **40**, 2129 (1957).
6) C. Djerassi, R.R. Engle, and A. Bowers, *J. Org. Chem*, **21**, 1547 (1956).

thionyl chloride then sodium azide. The solution of **7** in benzene was refluxed and the resulting isocyanate (**8**) was hydrolyzed in ethanolic alkaline solution to yield **3b**.[7]

3b was also prepared form **6** by means of the Lossen rearrangement.[7] The carboxylic acid (**6**) was converted to the corresponding hydroxamic acid (**9**) by treatment with thionyl chloride and then hydroxylamine. Treatment of **9** with a base, and subsequent alkaline hydrolysis afforded **3b** in good yield.

The desired 9-aminoalkyl-9,10-dihydro-9,10-methanoanthracene derivatives (**2**) were then synthesized starting from the 9-formyl compound (**4**) as follows; **4** was converted to the carboxylic acid derivatives (**10**), (**12**) and (**15**) as shown in Chart 4. Oxidation of the formyl

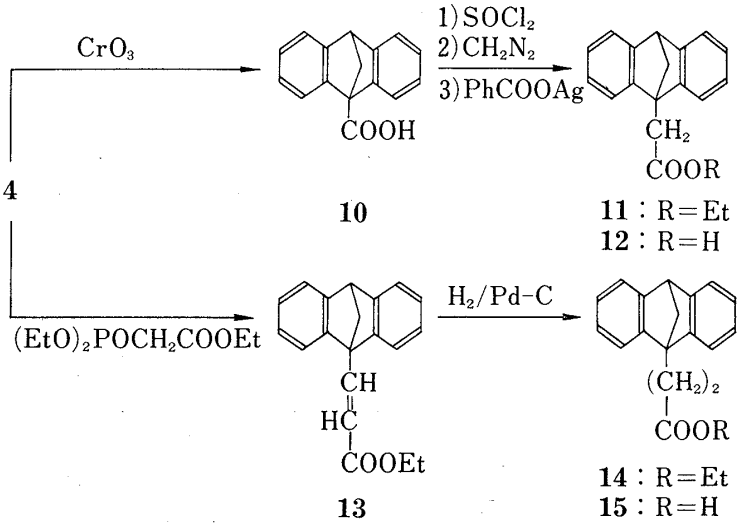
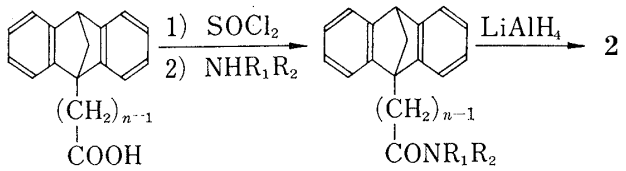


Chart 4

compound (**4**) by treatment with chromium trioxide gave the corresponding carboxylic acid (**10**). **10** was converted to (9,10-dihydro-9,10-methano-9-anthryl) acetic acid ethyl ester (**11**) by means of the Arndt-Eistert reaction.[8] Hydrolysis of the ethyl ester (**11**) afforded the corresponding carboxylic acid (**12**).

For the two-carbon extension, a Wittig type reaction was applied. The formyl compound (**4**) was treated with triethylphosphonoacetate in the presence of a base to yield the α,β-unsaturated ethyl ester (**13**), which was converted to the saturated carboxylic acid (**15**) by catalytic hydrogenation and subsequent hydrolysis, *via* the saturated ethyl ester (**14**).



10 : $n=1$
12 : $n=2$
15 : $n=3$

16

Chart 5

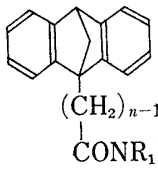
The carboxylic acid derivatives (**10**), (**12**) and (**15**) were easily converted to the corresponding amide derivatives (**16a—f**) by treatment with thionyl chloride and then methylamine and/or dimethylamine as shown in Chart 5.

The prepared amides are listed in Table I.

The desired compounds (**2a—f**) were prepared from the corresponding amides (**10a—f**) by lithium aluminum hydride reduction and were converted to the corresponding hydrochlorides (Table II).

7) P.A.S. Smith, "Organic Reactions," Vol. 3, John Wiley and Sons, Inc., New York, N.Y., 1962, p. 337.
8) W.E. Bachmann and W.S. Struve, "Organic Reactions," Vol. 1, John Wiley and Sons, Inc., New York, N.Y., 1957, p. 38.

TABLE I.



Compd.	n	R_1	R_2	mp, °C	Yield (%)	Formula	Analysis (%) Calcd. C	H	N	(Found) C	H	N
16a	1	H	CH_3	198.5—199	89.8	$C_{17}H_{15}NO$	81.90	6.06	5.62	81.77	5.99	5.46
16b	1	CH_3	CH_3	142.5—143	91.0	$C_{18}H_{17}NO$	82.10	6.51	5.32	81.80	6.43	5.25
16c	2	H	CH_3	187.5—188	90.6	$C_{18}H_{17}NO$	82.10	6.51	5.32	82.44	6.42	5.15
16d	2	CH_3	CH_3	107 —108	91.5	$C_{19}H_{19}NO$	82.28	6.91	5.05	82.57	6.87	5.09
16e	3	H	CH_3	201.5—202	93.8	$C_{19}H_{19}NO$	82.28	6.91	5.05	82.02	6.91	5.02
16f	3	CH_3	CH_3	188.5—189	92.6	$C_{20}H_{21}NO$	82.44	7.26	4.81	82.16	7.23	4.75

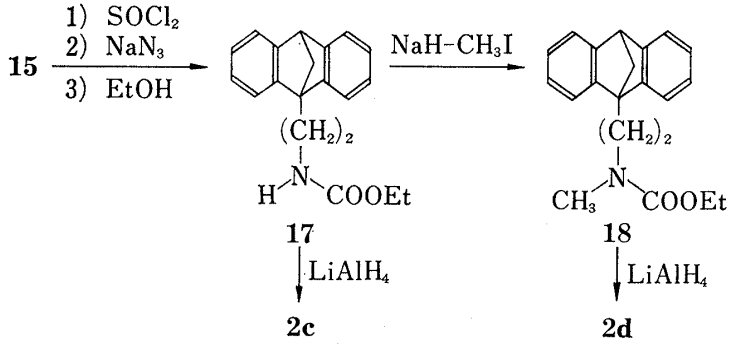
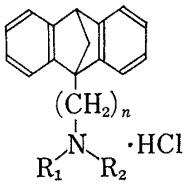


Chart 6

TABLE II.



Compd.	n	R_1	R_2	mp, °C	Recrystn solvent	Yield (%)	Formula	Analysis (%) Calcd. (Found) C	H	N	Cl
2a	1	H	CH_3	287.5—288	IPA[a)]	78.8	$C_{17}H_{17}N\cdot HCl$	75.13 (75.27)	6.68 6.70	5.15 5.11	13.04 13.34)
2b	1	CH_3	CH_3	265—265.5	IPA	81.0	$C_{18}H_{19}N\cdot HCl$	75.64 (75.75	7.05 7.12	4.90 4.60	12.40 12.28)
2c	2	H	CH_3	>300	CH_3CN	71.4	$C_{18}H_{19}N\cdot HCl$	75.64 (75.44	7.05 7.17	4.90 4.83	12.40 12.62)
2d	2	CH_3	CH_3	241.5—242.5	CH_3CN	76.5	$C_{19}H_{21}N\cdot HCl$	76.11 (76.14	7.40 7.43	4.67 4.69	11.82 11.74)
2e	3	H	CH_3	260.5—261	IPA	72.9	$C_{19}H_{21}N\cdot HCl$	76.11 (76.17	7.40 7.36	4.67 4.69	11.82 11.85)
2f	3	CH_3	CH_3	246—247	IPA	83.8	$C_{20}H_{23}N\cdot HCl$	76.53 (76.35	7.71 7.68	4.46 4.47	11.30 11.20)

a) Isopropyl alcohol.

The aminoethyl derivatives (**2c**) and (**2d**) were also easily prepared from the propionic acid (**15**) as shown in Chart 6 by means of the Curtius rearrangement.

Urethane (**17**) was prepared by treatment with thionyl chloride then sodium azide with subsequent heating in ethanol. Reduction of **17** with lithium aluminum hydride gave **2c**. Methylations of **17** by treatment with sodium hydride and methyl iodide afforded **18**, which was easily converted to **2d** by reduction with lithium aluminum hydride.

The antidepressive activity[9] of **2** was evaluated using the anti-tetrabenzine test according to the method described in the preceding paper.[9] It was found that the activity decreases in the order $n=3$, 2 and 1 in the general formula (**2**), and **2e** and **2f** appeared to be more active than maprotiline.

In the case of the aminomethyl derivatives (**2a** and **2b**), an apparent potentiating effect rather than an antagonistic effect to tetrabenazine-induced ptosis and hypothermia was observed.

It was found that **2a** and **2b** alone caused ptosis and hypothermia in mice. Futhermore, **2a** and **2b** show potent inhibiting action towards norepinephrine, as evaluated by the method of Nakamura and Fukushima.[10,11] Therefore, **2a** and **2b** appear to be neuroleptics.

In the 9-aminoalkyl-9,10-dihydro-9,10-methanoanthracene system, the aminopropyl side chain seems to act as an antidepressant, in analogy with the case of the ethanoanthracene system and the so-called tricyclic antidepressants, while the derivative with the aminomethyl side chain shows neuroleptic activity and the derivative with the aminoehtyl side chain, shows no marked psychotropic activity.

Experimental

All melting points were taken on a Thomas-Hoover capillary melting point apparatus and are uncorrected. NMR spectra were taken in $CDCl_3$ on a Varian T-60 spectrometer using tetramethylsilane as an internal standard. Infrared (IR) spectra were obtained on a Hitachi type-285 grating spectrophotometer.

12-Acetoxy-9,10-dihydro-9,10-ethanoanthracene-9-carbaldehyde (**5**)——A mixture of anthracene-9-carbaldehyde (2.0 g) in vinyl acetate (6.0 g) was heated at 170—175° in an autoclave for 20 hr.

Excess vinyl acetate in the reaction mixture was evaporated off *in vacuo* to give crude **5**, which was recrystallized from EtOH to afford **5** (2.43 g 85.7%), mp 163.5—165°. *Anal.* Calcd. for $C_{19}H_{16}O_3$: C, 78.06; H, 5.52. Found: C, 78.36; H, 5.55. IR ν_{max}^{Nujol} (cm^{-1}): 1735 (C=O).

12-Acetoxy-9,10-dihydro-9,10-ethanoanthracene-9-carboxylic Acid (**6**)——Jones'reagent[6] (12.12 g) was added dropwise to a solution of **5** (7.0 g) in acetone (28 ml) at room temperature.

The reaction mixture was stirred for 30 min at room temperature. Water was added and the resulting crystals were collected by filtration to give **6** in quantitative yield. An analytical sample was prepared by recrystallization from benzene. mp 260.5—262°; *Anal.* Calcd. for $C_{19}H_{16}O_3$: C, 74.01; H, 5.23. Found: C, 74.01; H, 5.40. IR ν_{max}^{Nujol} (cm^{-1}): 1748 ($-COCH_3$), 1700 (–COOH).

12-Acetoxy-9,10-dihydro-9,10-ethanoanthracene-9-carboxylic Acid Azide (**7**)——A mixture of **6** (1.0 g) in toluene (10 ml) and $SOCl_2$ (0.5 g) was refluxed for 4 hr. Removal of excess thionyl chloride and toluene by evaporation gave the corresponding acid chloride, which was dissolved in dry acetone (25.0 ml). A solution of NaN_3 (0.63 g) in water was added to the solution at 0—5° and the resulting reaction mixture was stirred for 2 hr at the same temperature. Water was added and the mixture was extracted with benzene. The extract was washed with water, and dried over Na_2SO_4. The above acyl azide solution in benzene was used in the next step without further treatment. A sample for IR was obtained by removal of benzene at 15—20° *in vacuo*, IR ν_{max}^{film} (cm^{-1}): 2130 ($-N_3$).

9-Amino-12-hydroxy-9,10-dihydro-9,10-ethanoanthracene (**3b**) **(From 7)**——The above solution of **7** was refluxed for 2 hr and evaporated to dryness to give 12-acetoxy-9,10-dihydro-9,10-ethanoanthracene-9-isocyanate (**8**), ν_{max}^{film} (cm^{-1}) 2250 (–N=C=O).

A solution of **8** in ethanol (12 ml) and 20% NaOH aq. (12 ml) was refluxed for 6 hr. After removal of EtOH by evaporation, the reaction mixture was diluted with water and extracted with AcOEt. The extract was washed with water, dried over Na_2SO_4 and evaporated to dryness to give **3b** (0.72 g 93.5% from **5**).

9) For **2e** (ID-9206), the charactaristic pharmacological profile of an antidepressant was reported by H. Fukushima, N. Nakamura, and H. Yamamoto, *Arch. Int. Pharmacodyn.*, **227**, 161 (1977).
10) M. Nakamura and H. Fukushima, *Europ. J. Pharmacol.*, **38**, 343 (1977).
11) The present pharmacological evaluation was conducted by M. Nakamura and H. Fukushima.

An analytical sample was prepared by recrystallization from benzene. mp 183—183.5°. *Anal.* Calcd. for $C_{16}H_{15}NO$: C, 80.98; H, 6.37; N, 5.90. Found: C, 80.88; H, 6.51; N, 5.61.

12-Acetoxy-9,10-dihydro-9,10-ethanoanthracene-9-hydroxamic Acid (9)——A solution of acid chloride in dry THF (40 ml), which was prepared from **6** (10 g) as described above, was added dropwise to a solution of NH_2OH, which was prepared from $NH_2OH \cdot HCl$ (9.02 g) and NaOH (5.19 g) in water (20 ml), at 0—5°. The reaction mixture was stirred for 1.5 hr and acidified with HCl.

Extraction with EtOAC, followed by washing with water, drying over Na_2SO_4 and removal of the solvent afforded **9** (10.35 g, 98.7%). An analytical sample was prepared by recrystallization from EtOH. mp 213—214°. *Anal.* Calcd. for $C_{19}H_{17}NO_4$: C, 70.57; H, 5.30; N, 4.33. Found: C, 70.59; H, 5.27; N, 4.39. IR ν_{max}^{Nujol} (cm^{-1}) 1650 (C=O).

9-Amino-12-hydroxy-9,10-dihydro-9,10-ethanoanthracene (3b) (From 9)——A mixture of **9** (2.0 g), NaH (63% oily dispersion, 0.284 g) and *t*-butanol (0.688 g) in dry toluene (25 ml) was refluxed for 3 hr. After removal of most of the toluene by evaporation, 10% NaOH aq. (10 ml) and EtOH (10 ml) were added. The resulting reaction mixture was refluxed for 3 hr with stirring. The usual work-up gave crude **3b**, which was crystallized from benzene to afford **3b** (1.06 g, 72.3%), which was identical with the **3b** prepared from **7**.

9,10-Dihydro-9,10-methanoanthracene-9-carbaldehyde (4)——A solution of $NaNO_2$ (2.18 g) in water (7 ml) was added dropwise to a solution of **3b** (2.37 g) in AcOH (24 ml) at 15°, and the solution was stirred at the same temperature for 2 hr then at room temperature for 2 hr. The reaction mixture was diluted with water and extracted with AcOEt. The extract was washed with water, dried over Na_2SO_4 and evaporated to dryness to give **4** (2.14 g, 97.3%). An analytical sample was prepared by recrystallization from EtOH, mp 102.5°. *Anal.* Calcd. for $C_{16}H_{12}O$: 87.25; H, 5.48. Found: C, 87.38; H, 5.73. IR ν_{max}^{Nujol} 2750, 1718 (-CHO), NMR ($CDCl_3$) δ: 10.45 (1H, s), 4.34 (1H, t, J=1.5 Hz), 2.75 (2H, d, J=1.5 Hz), 6.7—7.6 (8H, m).

9,10-Dihydro-9,10-metanoanthracene-9-carboxylic Acid (10)——Jone's reagent[6] (5 ml) was added dropwise to a solution of **4** (3.5 g) in acetone (17 ml) at room temperature. The reaction mixture was stirred at room temperature for 1 hr. Water was added and the mixture was extracted with AcOEt. The extract was washed with water, dried over Na_2SO_4 and evaporated down to give 3.67 g (97.8%) of **10**. Recrystallization of this material from benzene afforded analytically pure **10**, mp 199.5—200°. *Anal.* Calcd. for $C_{16}H_{12}O_2$: C, 81.34; H, 5.12. Found: C, 81.63; H, 5.08. IR ν_{max}^{Nujol} (cm^{-1}): 1700 (C=O): NMR ($CDCl_3$) δ: 4.33 (1H, br, s), 2.85 (2H, d, J=1.5 Hz), 8.90 (1H, br, s).

(9,10-Dihydro-9,10-methano-9-anthryl)acetic Acid Ethyl Ester (11)——A solution of **10** (1.77 g) and $SOCl_2$ (2.0 g) in benzene (8 ml) was refluxed for 4 hr and evaporated to dryness to give the corresponding acid chloride. A solution of the acid chloride in dry ether (20 ml) was added dropwise to a CH_2N_2 ether solution (3.95 g, 272 ml) in the presence of NEt_3 (1.43 g) at 0°.

The mixture was stirred at 0° for 3 hr, filtered to remove the resulting solid and evaporated to dryness to give the corresponding diazomethyl ketone. A mixture of the diazomethyl ketone, NEt_3 (2.4 ml) and silver benzoate (245 mg) in EtOH (60 ml) was refluxed for 13 hr. The reaction mixture was diluted with water and extracted with AcOEt. The extract was washed with $NaHCO_3$ aq. and then water, dried over Na_2SO_4 and evaporated down to give crude **11**, which was crystallized from EtOH to afford 1.66 g (79.6%) of **11**. An analytical sample was prepared by recrystallization from EtOH. mp 87—87.5°; *Anal.* Calcd. for $C_{19}H_{18}O_2$: C, 81.98; H, 6.52. Found: C, 82.22; H, 6.50. IR ν_{max}^{Nujol} (cm^{-1}): 1732 (C=O), NMR ($CDCl_3$) δ: 3.50 (2H, s), 1.20 (3H, t, J=7.0 Hz).

(9,10-Dihydro-9,10-methano-9-anthryl)acetic Acid (12)——A solution of **11** (1.36 g) in EtOH (28 ml) and 10% NaOH aq. (7 ml) was refluxed for 3 hr, then EtOH was evaporated off.

The residue was diluted with ice-water and acidified with 6 N HCl. The resulting crystals were collected by filtration to give 1.18 g (96.5%) of **12**. An analytical sample was prepared by recrystallization from benzene. mp 219.5—220.5°; *Anal.* Calcd. for $C_{17}H_{14}O_2$: C, 81.58; H, 5.64. Found: C, 81.54; H, 5.47.

β-(9,10-Dihydro-9,10-methano-9-anthryl)acrylic Acid Ethyl Ester (13)——Triethyl phosphonoacetate (5.3 g) in dry benzene (20 ml) was treated with 50% NaH (dispersion in mineral oil, 1.3 g) at 25—40° for 1 hr. A solution of **4** (4.0 g) in dry benzene (40 ml) was then added dropwise at room temperature under a nitrogen atmosphere. The reaction mixture was stirred at the same temperature for 3 hr then at 70° for 1 hr. Water was added and the mixture was extracted with AcOEt. The extract was washed with water, dried over Na_2SO_4 and evaporated down to give crude crystals, which were recrystallized from EtOH to give 4.86 g (92.2%) of **13**. mp 112—112.3°. *Anal.* Calcd. for $C_{20}H_{18}O_2$: C, 82.73; H, 6.25. Found: C, 82.74; H, 6.20.

β-(9,10-Dihydro-9,10-methano-9-anthryl)propionic Acid Ethyl Ester (14)——A mixture of **13** (2.7 g) and 5% Pd-C (0.27 g) in EtOH (27 ml) was stirred under a hydrogen atmosphere at 50° for 4 hr. The catalyst was removed by filtration. The solution was evaporated to dryness to give 2.67 g (98.2%) of **14**.

An analytical sample was prepared by recrystallization from EtOH, mp 81.5—82°. *Anal.* Calcd. for $C_{20}H_{20}O_2$: C, 82.15; H, 6.89. Found: C, 81.98; H, 6.87. IR ν_{max}^{Nujol} (cm^{-1}): 1736 (C=O): NMR ($CDCl_3$) δ: 2.73 (4H, m), 1.37 (3H, t, J=7.0 Hz).

β-(9,10-Dihydro-9,10-methano-9-anthryl)propionic Acid (15)——Hydrolysis of **8** (2.0 g) was carried out by the procedure described for the preparation of **12** from **11**, in 97.5% yield. An analytical sample was prepared by recrystallization from benzene. mp 158—159°; *Anal.* Calcd. for $C_{18}H_{16}O_2$: C, 81.79; H, 6.10. Found: C, 81.60; H, 6.05.

General Method for the Preparation of the Amide (16a—f)——A mixture of **10**, **12** or **15** (1 mmol) and $SOCl_2$ (1 ml) in benzene (3 ml) was refluxed for 3—7 hr then evaporated to dryness to give the corresponding acid chloride, which was dissolved in dry THF (4 ml). The THF solution was added dropwise to >25% NH_2CH_3 or $NH(CH_3)_2$ aq. (4 ml) at 0—5°. The reaction mixture was stirred at the same temperature for 1 hr, diluted with water and extracted with AcOEt. The extract was washed with water, dried over Na_2SO_4 and evaporated down to give the corresponding amide (**16**). An analytical sample was prepared by recrystallization from EtOH (Table I).

General Method for the Reduction of the Amide (16a—f) to Amine (2a—f)——The amide (**16**) (1 mmol) was added to a mixture of $LiAlH_4$ (0.1 g) in dry dioxane (10 ml), and the reaction mixture was stirred at 50—60° for 3—6 hr. Water was added to decompose excess $LiAlH_4$. AcOEt and Na_2SO_4 were added, and inorganic materials were removed by filtration. The filtrate was evaporated to dryness to give the corresponding amine (**2**), which was converted to the hydrochloride by treatment with HCl in isopropyl alcohol. An analytical sample was prepared by recrystallization from an appropriate solvent. (Table II)

9-β-Carboethoxyaminoethyl-9,10-dihydro-9,10-methanoanthracene (17)——A mixture of **15** (0.7 g) and $SOCl_2$ (2.0 ml) in dry benzene (5.5 ml) was refluxed for 4 hr and evaporated to dryness to give the corresponding acid chloride, which was dissolved in dry acetone (3.7 ml). The acetone solution was added dropwise to NaN_3 (0.52 g) in water (1 ml) at 0—5°. The reaction mixture was stirred at the same temperature for 3 hr, diluted with water and extracted with benzene. The extract was washed with water, dried over Na_2SO_4 and evaporated to dryness, keeping the temperature below 30° to give the corresponding acyl azide. The acyl azide in EtOH (7.5 ml) was refluxed for 11 hr and evaporated down to give crude crystals, which were recrystallized from isopropyl ether and *n*-hexane to afford 0.64 g (78.6%) of **17**, mp 124.5—125.5°. *Anal.* Calcd. for $C_{20}H_{21}NO_2$: C, 78.14; H, 6.89; N, 4.56. Found: C, 77.94; H, 6.84; N, 4.43.

9-β-N-Carboethoxy-N-methylaminoethyl-9,10-dihydro-9,10-methanoanthracene (18)——A mixture of **17** (120 mg) and 62% NaH (dispersion in mineral oil, 30 mg) in dry dioxane (4 ml) was stirred at 50—60° for 1 hr. MeI (0.5 ml) was added and the reaction mixture was stirred at the same temperature for 8 hr,d iluted with water and extracted with AcOEt. The extract was washed with water, dried over Na_2SO_4 and evaporated down to give an oily residue, which was crystallized from isopropyl alcohol to afford 108 mg (81, 3%) of **18**, mp 111.5—112.5°. *Anal.* Calcd. for $C_{21}H_{23}NO_2$: C, 78.47; H, 7.21; N, 4.36. Found: C, 78.67; H, 7.28; N, 4.36.

Reduction of Urethane (17 and 18)——The reduction of **17** and **18** was carried out by the procedure described for the reduction of **16** to **2**. The hydrochlorides of **2c** and **2d**, which were identical with **2c** and **2d** prepared from **16c** and **16d**, were obtained in 71 and 78% yield, respectively.

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