[Chem. Pharm. Bull.
23(3) 494—496 (1975)]

UDC 547.853.3'532'821.057

Polycyclic N-Hetero Compounds. III.[1] Synthesis of 1,3,10-Triazaphenanthrenes

Takaji Koyama, Takashi Hirota, Yurie Shinohara,
Sumio Fukuoka, Masatoshi Yamato, and Shinji Ohmori

Faculty of Pharmaceutical Sciences, Medical School, Okayama University[2]

(Received June 12, 1974)

1,3,10-Triazaphenanthrenes (II, IV) were obtained from 4-amino-5-arylpyrimidines (I, III) on heating with a large excess of formic acid and phosphoryl chloride.

It was reported, in a previous paper,[3] that 9-methyl-1,3,10-triazaphenanthrenes were obtained from 4-acetamino-5-arylpyrimidines on heating with polyphosphoric acid, but during the reaction deacetylation occurred easily and the purification of acetaminopyrimidines were somewhat difficult because of the deacetylation. The present paper deals with one step synthesis of 1,3,10-triazaphenanthrenes from 4-amino-5-arylpyrimidines.

As shown in Chart 1, 1,3,10-triazaphenanthrenes (II, IV) were obtained when 4-amino-5-arylpyrimidines (I, III) were heated with a large excess of formic acid and phosphoryl chloride. These products had no N-H band in infrared (IR) spectra and their nuclear magnetic resonance (NMR) spectra showed three singlets (each 1H) at the lower field resulted from heterocyclic protons adjacent to nitrogen atom but certain assignment of the three protons were unestablished.

It was only reported that Bellomonte, *et al.*[4] obtained 9-hydroxy-1,3,10-triazaphenanthrene from homophthalic anhydride on heating with formamide.

Elemental analyses and mass spectral data agreed with the structure of 1,3,10-triazaphenanthrenes (II, IV) and their ultraviolet (UV) spectra had multiple absorption peaks in ethanol or chloroform.

Experimental[5]

6,8-Dimethoxy-1,3,10-triazaphenanthrene (IIa)——A mixture of 10 ml of HCOOH and 0.5 g of 4-amino-5-(3,5-dimethoxyphenyl)pyrimidine (Ia) was refluxed for 2 hr and evaporated the unreactive HCOOH *in vacuo*, the residue was refluxed with $POCl_3$ for 7 hr and evaporated the excess $POCl_3$ *in vacuo*, the viscous residue was dissolved in H_2O under cooling, basified with Na_2CO_3, and extracted with $CHCl_3$. The $CHCl_3$ layer was washed with H_2O, dried over Na_2SO_4, and $CHCl_3$ was evaporated. The residue was sublimated under reduced pressure to 0.29 g (58%) of IIa as light brown needles, mp above 300°. *Anal.* Calcd. for $C_{13}H_{11}O_2N_3$: C, 64.72; H, 4.60; N, 17.42. Found: C, 64.85; H, 4.69; N, 17.30. Mass Spectrum: m/e $(M^+)=$ 241.0848 (calcd. 241.0850). NMR (CF_3COOD): 5.68, 5.63 (each 3H, s., 2-OCH_3), 2.77 (1H, d., $J=2$ Hz, C_7-H), 1.84 (1H, d., $J=2$ Hz, C_5-H), 0.18, −0.03, −0.80 (each 1H, s., C_9, C_4, C_2-H). UV $\lambda_{\max}^{CHCl_3}$ nm (log ε): 266 (4.23), 280 (shoulder), 325 (3.81), 362 (3.87).

6,7-Dimethoxy-1,3,10-triazaphenanthrene (IIb)——A mixture of 1.5 g of 4-amino-5-(3,4-dimethoxyphenyl)pyrimidine (Ib), 12 ml of HCOOH, and 27 ml of $POCl_3$ was heated at 70—80° for 5 hr subsequently at 110° for 10 hr. The viscous brown material was dissolved in H_2O under cooling, basified with Na_2CO_3,

---

[1] Part II: T. Koyama, T. Hirota, T. Yoshida, H. Hara, and S. Ohmori, *Chem. Pharm. Bull.* (Tokyo), 22, 1451 (1974).

[2] Location: *1-1, Tsushima naka 1-chome, Okayama.*

[3] T. Koyama, T. Hirota, M. Yamato, and N. Ohta, *Yakugaku Zasshi*, **93**, 330 (1973).

[4] G. Bellomonte, G. Caronna, and S. Parazo, *Gazz. Chim. Italy.*, **96**, 1108 (1966).

[5] Melting points are uncorrected. NMR spectra were taken on a Hitachi Model R-22 spectrometer (90 MHz) in $CDCl_3$, except where otherwise noted, with tetramethylsilane as an internal standard (τ values), s., singlet; d., doublet; t., triplet; m., multiplet; b., broad. Mass spectrum were taken on a Hitachi RMU-7M spectrometer in direct inlet system.

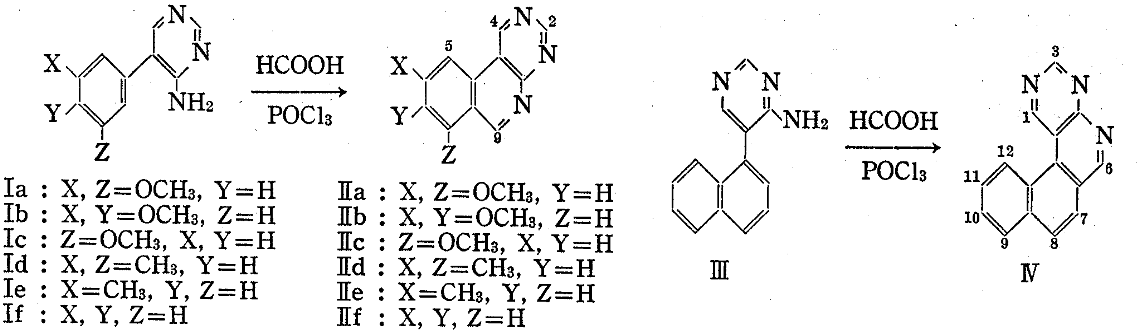

Chart 1

and extracted with $CHCl_3$, The $CHCl_3$ layer was washed with H_2O, dried over Na_2SO_4, and $CHCl_3$ was evaporated. The residue was recrystallized alternately from benzene and EtOH to 0.25 g (16%) of IIb as pale yellow needles, mp 251—253°. *Anal.* Calcd. for $C_{13}H_{11}O_2N_3$: C, 64.72; H, 4.60; N, 17.42. Found: C, 64.50; H, 4.72; N, 17.63. Mass Spectrum: *m/e* (M^+)=241. NMR: 5.99, 5.83 (each 3H, s., 2-OCH_3), 2.50 (1H, s., C_8-H), 2.02 (1H, s., C_5-H), 0.46, 0.41, −0.06 (each 1H, s., C_9, C_4, C_2-H). UV $\lambda_{\max}^{\text{EtOH}}$ nm (log ε): 228 (4.70), 268 (4.40), 280 (4.12), 341 (4.05).

8-Methoxy-1,3,10-triazaphenanthrene (IIc)——A mixture of 0.5 g of 4-amino-5-(3-methoxyphenyl)-pyrimidine (Ic), 15 ml of HCOOH, and 15 ml of $POCl_3$ was heated at 70—80° for 6 hr subsequently at 110—120° for 10 hr. The viscous brown material was dissolved in H_2O, basified with Na_2CO_3, and extracted with $CHCl_3$. The $CHCl_3$ layer was washed with H_2O, dried over Na_2SO_4, and $CHCl_3$ was evaporated. The residue was repeatedly purified by thin-layer chromatography (TLC) (Merck, Al_2O_3, basic, acetone: CH_2Cl_2: ether: EtOH=33: 33: 33: 1) and the fraction of *Rf* value *ca.* 0.6 which had light blue fluorescence was collected. Purification with sublimation under reduced pressure gave 57 mg (11%) of IIc as pale yellow needles, mp 172—174°. *Anal.* Calcd. for $C_{12}H_9ON_3$: C, 68.23; H, 4.30; N, 19.90. Found: C, 67.98; H, 4.46; N, 19.76. Mass Spectrum: *m/e* (M^+)=211. NMR :5.91 (3H, s., OCH_3), 2.80 (1H, b.d., J=8 Hz, C_7-H), 2.09 (1H, b.t., J=8 Hz, C_6-H), 1.77 (1H, b.d., J=8 Hz, C_5-H), 0.44, −0.10, −0.15 (each 1H, s., C_9, C_4, C_2-H). UV $\lambda_{\max}^{\text{CHCl}_3}$ nm (log ε): 263 (4.02), 300 (3.45), 364 (3.56).

6,8-Dimethyl-1,3,10-triazaphenanthrene (IId)——A mixture of 0.6 g of 4-amino-5-(3,5-dimethylphenyl)-pyrimidine (Id), 20 ml of HCOOH, and 20 ml of $POCl_3$ was heated at 70—80° for 2 hr furthermore at 110—120° for 2 hr. The brown viscous material was dissolved in H_2O, basified with Na_2CO_3, and extracted with $CHCl_3$. The $CHCl_3$ layer was washed with H_2O, dried over Na_2SO_4, and $CHCl_3$ was evaporated. The residue was separated by TLC (Merck, Al_2O_3 basic, acetone: $CHCl_3$: ether=1: 1: 1). The fraction of *Rf* value *ca.* 0.5 which had light blue fluorescence was collected and was recrystallized from EtOH to 57 mg (9%) of IId as pale yellow needles, mp 243—245°. *Anal.* Calcd. for $C_{13}H_{11}N_3$: C, 74.62; H, 5.30; N, 20.08. Found: C, 74.79; H, 5.20; N, 20.31. Mass Spectrum: *m/e* (M^+)=209. NMR: 7.38, 7.15 (each 3H, s., 2-CH_3), 2.55 (1H, b.s., C_7-H), 1.69 (1H, b.s., C_5-H), 0.49, 0.14, −0.10 (each 1H, s., C_9, C_4, C_2-H). UV $\lambda_{\max}^{\text{EtOH}}$ nm (log ε): 228 (4.61), 258 (4.40), 307 (3.90), 340 (3.80), 354 (3.81).

6-Methyl-1,3,10-triazaphenanthrene (IIe)——A mixture of 1.85 g of 4-amino-5-(3-methylphenyl)pyrimidine (Ie), 17 ml of HCOOH, and 40 ml of $POCl_3$ was heated at 70—80° for 24 hr and the excess volatile liquid was evaporated under reduced pressure. The viscous residue was dissolved in H_2O under cooling, basified with Na_2CO_3, and extracted with $CHCl_3$. The $CHCl_3$ layer was washed with H_2O, dried over Na_2SO_4, and the solvent was evaporated. The residue was allowed to stand overnight and the crystals formed were recrystallized from benzene subsequently from EtOH to 0.11 g (5.5%) of IIe as pale yellow needles, mp 215—217°. *Anal.* Calcd. for $C_{12}H_9N_3$: C, 73.83; H, 4.65; N, 21.53. Found: C, 74.02; H, 4.50; N, 21.72. Mass Spectrum: *m/e* (M^+)=195.0792 (calcd. 195.0795). NMR: 7.31 (3H, s., CH_3), 2.31 (1H, b.d., J=8 Hz, C_7-H), 1.93 (1H, d., J=8 Hz, C_8-H), 1.52 (1H, b.s., C_5-H), 0.46, 0.34, −0.13 (each 1H, s.' C_9, C_4, C_2-H). UV $\lambda_{\max}^{\text{EtOH}}$ nm (log ε): 221 (4.65), 262 (4.23), 299 (3.92), 328 (3.86), 343 (3.84).

1,3,10-Triazaphenanthrene (IIf)——A mixture of 1.5 g of 4-amino-5-phenylpyrimidine (If), 17 ml of HCOOH, and 40 ml of $POCl_3$ was heated at 70—80° for 3 hr furthermore at 120° for 3 hr and the excess volatile liquid was evaporated under reduced pressure. The residue was dissolved in H_2O under cooling, basified with Na_2CO_3, and extracted with $CHCl_3$. The $CHCl_3$ layer was washed with H_2O, dried over Na_2SO_4, and the solvent was evaporated. Alternant recrystallization from EtOH and benzene gave 51 mg (3.5%) of IIf as pale yellow needles, mp 172—173°. *Anal.* Calcd. for $C_{11}H_7N_3$: C, 72.91; H, 3.89; N, 23.19. Found: C, 73.15; H, 4.01; N, 23.00. Mass Spectrum: *m/e* (M^+)=181.0638 (calcd. 181.0639). NMR: 2.16—1.77 (3H, m., C_6, C_7, C_8-H), 1.30 (1H, d.d., J=7, 2.5 Hz, C_5-H), 0.38, 0.25, −0.15 (each 1H, s., C_9, C_4, C_2-H). UV $\lambda_{\max}^{\text{EtOH}}$ nm (log ε): 231 (shoulder), 239 (4.32), 267 (shoulder), 288 (shoulder), 327 (3.63), 343 (3.52).

2,4,5-Triazabenzo[*c*]phenanthrene (IV)——A mixture of 2.2 g of 4-amino-5-(1-naphthyl)pyrimidine (III), 13 ml of HCOOH, and 30 ml of $POCl_3$ was heated at 70—80° for 2 hr furthermore at 110—120° for 3 hr and the excess volatile liquid was evaporated under reduced pressure. The viscous residue was dissolved in H_2O, basified with Na_2CO_3, and extracted with $CHCl_3$. The $CHCl_3$ layer was washed with H_2O, dried over Na_2SO_4, and the solvent was evaporated. The residue was recrystallized from AcOEt to 0.15 g (6.5%) of IV as pale yellow needles, mp 187—188°. *Anal.* Calcd. for $C_{15}H_9N_3$: C, 77.90; H, 3.92; N, 18.17. Found: C, 77.97; H, 3.96; N, 17.87. Mass Spectrum: m/e (M^+)=231.0795 (calcd. 231.0795). NMR: 2.15—1.73 (5H, m., C_{7-11}-H), 0.95 (1H, m., C_{12}-H), 0.37, 0.19, −0.57 (each 1H, s., C_6, C_3, C_1-H). UV $\lambda_{\max}^{CHCl_3}$ nm (log ε): 282 (4.57), 313 (3.98), 365 (3.62), 384 (3.58).

Acknowledgement The authors are very grateful to Mr. A. Iwadoh for microanalyses and measurement of NMR spectra.