# Chemistry of Thienopyridines. XXXVII. Syntheses in the Cyclopenta, Cyclohexa-, and Cycloheptathieno[2,3-*b*]pyridine Series. Three Analogs of 9-Amino-1,2,3,4-tetrahydroacridine [1]



L. H. Klemm,* Jun Wang [2], and Sandip K. Sur

Department of Chemistry, University of Oregon,
Eugene, Oregon 97403

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4-Aminocyclopenta-, 4-aminocyclohexa-, and 4-aminocycloheptathieno[2,3-*b*]pyridines were synthesized in very low overall yield by four-step procedures starting from bis(2-thienylammonium) hexachlorostannate(IV) and 2-hydroxymethylenecyclopentanone, 2-methoxymethylenecyclohexanone, and 2-hydroxymethylenecycloheptanone, respectively.

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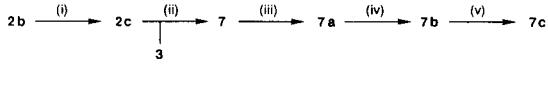
9-Amino-1,2,3,4-tetrahydroacridine (tacrine or THA) (**1b**) and its homologs and analogs exhibit a variety of biological activities. Thus, **1b** inhibits cholinesterase [3] and enhances memory in patients suffering from Alzheimer's disease and related maladies [4], albeit with some deleterious side effects [5]. Bleiberg reported that for a series of THA homologs, wherein RNH replaces the primary amino group, there is potent inhibitory activity of the cholinesterase type for R equals methyl and ethyl [6]. However, higher homologs show only weak activity of this type, though they possess stimulatory action which is nicotinic in character [6]. It is also reported that activity of THA is changed by changing the value of *n*, *i.e.* by altering the size of ring *A*, as well as on the introduction of substituents such as chlorine (*i.e.* on variation of electronic effects) in ring *C* [7,8]. Other pharmacological effects of THA and its analogs have been described [9].

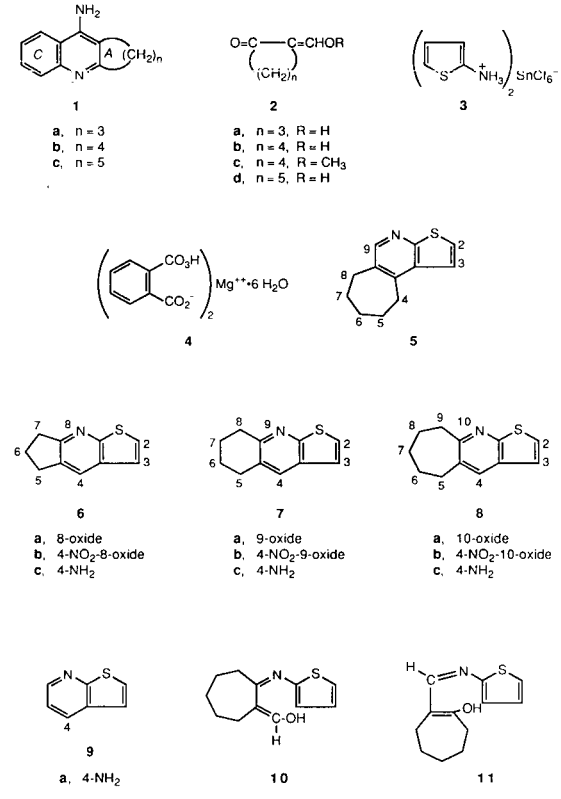
The concept of bioisosterism as a rational approach to the selection of synthetic goals for potential agonists and antagonists of biologically active drugs is well known [10]. Particularly notable in this regard is the replacement of a benzene ring in the model compound by a thiophene ring in the chemical mimic [10]. This manuscript concerns the syntheses of 4-aminocyclopenta-, 4-aminocyclohexa-, and 4-aminocycloheptathieno[2,3-*b*]pyridines **6c**, **7c**, and **8c**, isosteres of **1a**, **1b**, and **1c**, respectively.

Synthetic routes to **7c** and **8c** are shown in Schemes 1 and 2. Thus, 2-hydroxymethylenecyclohexanone (**2b**) was first stabilized by conversion to the methyl ether **2c**, which

Scheme 1

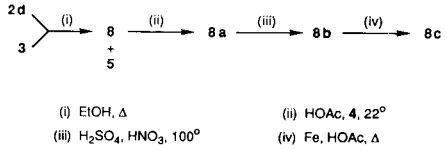



reacted with the amine salt **3** (perhaps in two steps) to form the tetrahydrothienoquinoline parent structure **7** (13%), isolated as a low-melting solid. Compound **7** was reported as a liquid previously from direct reaction of **2b** with **3**




(5% yield) [11]. Conversion of **7** into amine **7c** followed the general method developed for transformation of thieno[2,3-*b*]pyridine (**9**) into the 4-amino derivative **9a**, *i.e.* by successive steps of *N*-oxidation, nitration in the position gamma to the heteronitrogen atom, and reduction of the nitro *N*-oxide with iron and acetic acid [12]. However, instead of using hydrogen peroxide in glacial acetic acid or *m*-chloroperoxybenzoic acid in chloroform [13] for the first step we employed magnesium monoperoxyphthalate hexahydrate (**4**) in glacial acetic acid [14]. Yields for the three steps were 67%, 16%, and 73%, respectively.

Scheme 2




Synthesis in the cycloheptathieno[2,3-*b*]pyridine series (Scheme 2) was modified from that in Scheme 1, with variable results. First, a 2-hydroxymethylenecycloalkanone (**2d**), rather than its methyl ether, was reacted directly with amine salt **3**. The yield of condensed products **5** and **8** was very low (3% total) and probably involved the intermediates **11** and **10** from initial condensations of the aldehyde and keto groups of **2d**, respectively, with the amino group of **3**. Products **5** and **8** were easily separable by chromatography on silica gel. As expected, compound **8** was less strongly retained, consistent with its greater steric hindrance to H-bonding from the silica gel to the heteronitrogen atom than would occur in **5** [15]. Considerably improved yields (over those in Scheme 1) were obtained in the *N*-oxidation (96%) and nitration (39%) steps by operating at lower temperatures for the major parts of the reactions. The yield on the last step in Scheme 2 (reduction to amine **8c**) was essentially the same (74%) as in Scheme 1. Surprisingly, nitro *N*-oxide **8b** rapidly changed to a brown tar at room temperature so that it was only partially characterized before it was reduced to the stable amine **8c**.

The synthetic route to 4-aminocyclopenta[*f*]thieno-[2,3-*b*]pyridine (**6c**) followed fairly closely that of Scheme 2 but with use of 2-hydroxymethylenecyclopentanone (**2a**), instead of **2d**, in the first step to give an 8% yield of **6**, free of any angular isomer analogous to **5**. Yields in successive steps were 84% of **6a**, 6% of **6b**, and 57% of **6c**. The nitration step in this series was conducted at a much lower temperature (largely ambient, plus a brief period at 100°) than in the cyclohexa or cyclohepta compounds, but the yield of the nitro *N*-oxide **6b** was considerably lower than in the other nitrations.

Although we succeeded in synthesizing small amounts of amino compounds **6c-8c** it is clear that our overall reaction pathway is very poor (0.2-1% overall yield). In all three series unsatisfactory yields were obtained in two of the four steps, specifically in the condensation of the substituted cycloalkanones with **3** and in the nitration of the *N*-oxides with nitric and sulfuric acids. While it seems likely that marked improvements could be made in the nitration step, the low yields in step one indicate clearly that alternative synthetic routes to the target amines are highly desirable.

Interestingly, all of the *N*-oxides and nitro *N*-oxides give positive Katritzky tests (*vide infra*). The most abundant mass spectral peak for each *N*-oxide results from loss of hydroxyl radical from the molecular ion. For the nitro *N*-oxides the most abundant fragment results from loss of nitrogen dioxide plus water from the molecular ion.

## EXPERIMENTAL [16]

2-Methoxymethylenecyclohexanone (**2c**) [17].

A mixture of 97.3 g each of freshly distilled 2-hydroxymethylenecyclohexanone (**2b**) [18], methanol, and methyl orthoformate with two drops of concentrated hydrochloric acid was kept at room temperature for 24 hours [19], basified with 10% aqueous sodium hydroxide, and extracted twice with 300-ml portions of ether. The ether layer was washed with water, dried (magnesium sulfate), and evaporated. Fractional distillation of the residue gave 93.5 g (86%) of **2c**, bp 65° (1 mm).

5,6,7,8-Tetrahydrothieno[2,3-*b*]quinoline (**7**) [20].

A flask filled with nitrogen gas and protected from atmospheric moisture was charged with a mixture of 57 g (0.107 mole) of bis(2-thienylammonium) hexachlorostannate(IV) (**3**) [21], 2 g of anhydrous zinc chloride (freshly fused), and 150 ml of absolute ethanol. This mixture was stirred mechanically and slowly treated with a solution of 30 g of **2c** (0.214 mole) in 30 ml of absolute ethanol. The total mixture was stirred and refluxed for 2 hours, whereupon tlc indicated that all of **3** had reacted. The black mixture was allowed to stand at room temperature for 10 hours and then acidified with a solution of 12 g of anhydrous hydrogen chloride in absolute ethanol. The acidic mixture was stirred for 3.5 hours, concentrated to a small volume by rotoevaporation, basified strongly with 50% aqueous sodium hydroxide solution, and steam distilled until 5 ℓ of distillate was collected. The distillate was extracted with three 100-ml portions of carbon tetrachloride. The dried (magnesium sulfate) organic extract was evaporated to yield 5.3 g (13%) of slightly brown **7**, obtained as a colorless liquid on molecular distillation at 110° (0.5 mm). This product was crystallized from ether and then from absolute ethanol to give colorless prisms, mp 62-64°; ir: 1378 and 708 $cm^{-1}$; $^1H$ nmr (trideuterioacetonitrile): $\delta$ 7.83 (s, 1H, H-4), 7.51 (d, $J_{2,3}$ = 6 Hz, 1H, H-2), 7.24 (d, 1H, H-3), 2.97 (t, $J_{7,8}$ = 6 Hz, 2H, 2 H-8), 2.88 (t, $J_{5,6}$ = 6 Hz, 2H, 2 H-5), 1.75-1.95 (m, 4H, 2 H-6 plus 2 H-7); ms: m/e 190 (23), 189 ($M^+$, 100), 174 ($M^+$ - NH, 27), 173 (22), 161 ($M^+$ - $C_2H_4$, 46), 160 (24).

*Anal.* Calcd. for $C_{11}H_{11}NS$: C, 69.80; H, 5.86; N, 7.40. Found: C, 69.68; H, 5.81; N, 7.43.

5,6,7,8-Tetrahydrothieno[2,3-*b*]quinoline 9-Oxide (**7a**).

To a stirred solution of 6.12 g (32.4 mmoles) of **7** in 60 ml of glacial acetic acid was added a warm solution of 10.05 g (16.3 mmoles) of 80% magnesium monoperoxyphthalate hexahydrate (**4**) (Aldrich) [14] in 10 ml of the same solvent. The mixture was stirred and maintained at 110° for 3 hours, whereupon tlc (alumina/ether) indicated that all of **7** had reacted. The mixture was diluted with water, tested for the presence of peroxides (negative starch-iodide test), evaporated partially, neutralized with solid sodium bicarbonate, and extracted with chloroform. Evaporation of the dried (magnesium sulfate) organic layer left 4.44 g (67%) of crude **7a**, mp 80-100°, purified by sublimation at 110° (0.1 mm) to give white prisms, mp 128-130°, positive Katritzky test [22]; ir: 1313 $cm^{-1}$ (*N*-oxide); $^1H$ nmr (deuteriochloroform): $\delta$ 7.59 (s, 1H, H-4), 7.46 (d, $J_{2,3}$ = 5.4 Hz, 1H, H-2), 7.25 (d, 1H, H-3), 3.21 and

2.96 (dt, $J_{5,6} = J_{7,8} = 6.1$ Hz, 2H each, 2 H-5 and 2 H-8), 2.1-1.8 (dm, 4H, 2 H-6 and 2 H-7); ms: m/e 205 ($M^+$, 46), 189 (23), 188 ($M^+$ -OH, 100), 186 (30), 173 (68).

*Anal.* Calcd. for $C_{11}H_{11}NOS$: C, 64.36; H, 5.40; N, 6.82. Found: C, 64.54; H, 5.30; N, 6.73.

4-Nitro-5,6,7,8-tetrahydrothieno[2,3-*b*]quinoline 9-Oxide (**7b**).

A mixture of 1 g (4.9 mmoles) of crude **7a**, 0.58 ml of 96% sulfuric acid, and 0.64 ml (10 mmoles) of 70% nitric acid (density, 1.42 g/ml) at 0° was warmed to 110°, where it was maintained for 1.5 hours. The brown mixture was poured onto ice and the resultant yellow precipitate was collected by suction filtration, washed free of acid with cold water, and dried in air. Thick layer chromatography (silica gel/ether) of the crude product showed three bands. The yellow middle band (extracted into acetone) yielded 195 mg (16%) of **7b**, mp 168-170°; positive Katritzky test. Sublimation of this product at 140° (0.1 mm) gave yellow prisms, mp 174° dec; ir: 1518 and 1317 (nitro group), 1294 $cm^{-1}$ (*N*-oxide); $^1H$ nmr (deuteriochloroform): $\delta$ 7.57 (dd, AB system, $J_{2,3} = 5.7$ Hz, $\Delta\delta = 23$ Hz, H-2 and H-3), 3.13 and 3.07 (2 t, J = 6-7 Hz, 4H total, 2 H-5, and 2 H-8), 2.1-1.8 (dm, 4H, 2 H-6 and 2 H-7); ms: m/e 250 ($M^+$, 45), 233 ($M^+$ - OH, 43), 187 (30), 186 ($M^+$ - $NO_2$ - $H_2O$, 100), 45 ($CHS^+$, 20).

*Anal.* Calcd. for $C_{11}H_{10}N_2O_3S$: C, 52.79; H, 4.03. Found: C, 53.09; H, 3.88.

4-Amino-5,6,7,8-tetrahydrothieno[2,3-*b*]quinoline (**7c**).

A mixture of 200 mg (3.6 mg-atoms) of iron powder and a bright yellow solution of 100 mg (0.4 mmole) of nitro *N*-oxide **7b** in 20 ml of glacial acetic acid was stirred (in an atmosphere of nitrogen gas and protected from atmospheric moisture) and heated at 100-110° for a period of 3 hours. During this time the color of the solution changed to dark brown, a white precipitate formed, and tlc (alumina/ether) indicated that all **7b** had reacted. The mixture was made strongly basic with aqueous sodium hydroxide and extracted repeatedly with chloroform. The organic extract was dried (magnesium sulfate) and evaporated to give 60 mg (73%) of light brown **7c**. Sublimation at 120° (0.1 mm) gave fine, faintly cream needles, mp 150-152°, soluble in DMSO, acetone, and dilute hydrochloric acid, insoluble in water and ether; ir: 3453 and 3291 (amino group), 3125, 2928, 1638, 1553 $cm^{-1}$; $^1H$ nmr (deuteriochloroform/DMSO-$d_6$): $\delta$ 7.34 and 7.11 (dd, $J_{2,3} = 5.9$ Hz, 2H, H-2 and H-3), 5.64 (broad s, amino group), 2.93 (t, $J_{7,8} = 5.9$ Hz, 2H, 2 H-8), 2.46 (t, $J_{5,6} = 5.9$ Hz, 2H, 2 H-5), 1.82 (m, 4H, 2 H-6 plus 2 H-7); ms: m/e 205 (19), 204 ($M^+$, 100), 203 (75), 188 ($M^+$ - $NH_2$, 18), 177 ($M^+$ - HCN, 36).

*Anal.* Calcd. for $C_{11}H_{12}N_2S$: C, 64.67; H, 5.92. Found: C, 64.45; H, 5.90.

Cyclohepta[*e*]- **5** and Cyclohepta[*f*]thieno[2,3-*b*]pyridines **8**.

A mixture of 10 g (71.4 mmoles) of 2-hydroxymethylenecycloheptanone (**2d**) [23], 20 g (37.5 mmoles) of tin salt **3**, and 100 ml of absolute ethanol was stirred and refluxed for 1.5 hours until tlc (silica gel/ether) indicated that all **2d** had reacted. The green solution was acidified with 50 ml of concentrated hydrochloric acid and refluxed 1.5 hours more. The dark mixture was basified with concentrated sodium hydroxide and steam distilled. Extraction of the distillate with chloroform and molecular distillation at 120° (0.1 mm) of the residue from evaporation of the extract gave 0.48 g (3%) of white solid, mp 44-52°, consisting of approximately equimolar amounts of **5** and **8** as based on $^1H$ nmr. These isomers were separated by thick-layer chromatography (silica gel/ether-petroleum ether (30-60°), 1:1.38 by volume) to give **8** (92 mg, $R_f$ 0.72) and **5** (83 mg, $R_f$ 0.58). Each isomer was recrystallized from ether.

Isomer **8** was obtained as prisms, 228 mg, mp 79.5-81°; ir: 2924, 2850, 1382, 913, 737, 670, 659 $cm^{-1}$; $^1H$ nmr (deuteriochloroform): $\delta$ 7.82 (s, 1H, H-4), 7.44 (d, $J_{2,3} = 6$ Hz, 1H, H-2), 7.19 (d, 1H, H-3), 3.19 (m, 2 H-9), 2.91 (m, 2 H-5), 1.6-2.0 (m, 6H, 2 H-6, 2 H-7, and 2 H-8); ms: m/e 204 (18), 203 ($M^+$, 100), 202 (57), 188 ($M^+$ -$CH_3$, 26), 175 (20), 174 ($M^+$ -$C_2H_5$, 53), 173 (20).

*Anal.* Calcd. for $C_{12}H_{13}NS$: C, 70.89; H, 6.45; N, 6.89. Found: C, 70.66; H, 6.50; N, 6.84.

Isomer **5** was obtained as prisms, 250 mg, mp 79-80°; ir: 2925, 2847, 1344, 706, 663 $cm^{-1}$; $^1H$ nmr (deuteriochloroform): $\delta$ 8.29 (s, 1H, H-9), 7.42 (m, 1H, H-2), 7.32 (m, 1H, H-3), 3.0-3.2 (m, 2 H-4), 2.8-3.0 (m, 2 H-8), 1.6-2.0 (m, 6H, 2 H-5, 2 H-6 and 2 H-7); ms: m/e 204 (25), 203 ($M^+$, 100), 202 (43), 188 ($M^+$ -$CH_3$, 29), 175 (30), 174 ($M^+$ -$C_2H_5$, 64), 173 (27), 162 (44), 161 (36).

*Anal.* Calcd. for $C_{12}H_{13}NS$: C, 70.89; H, 6.45; N, 6.89. Found: C, 70.49; H, 6.43; N, 6.78.

Cyclohepta[*f*]thieno[2,3-*b*]pyridine 10-Oxide (**8a**).

A mixture of 786 mg (3.87 mmoles) of **8**, 1.48 g (2.4 mmoles) of oxidizing agent **4** (80%), and 30 ml of glacial acetic acid was allowed to stand at room temperature for 12 hours. Then an additional 0.1 g of **4** was added and the mixture was refluxed for 30 seconds, whereupon tlc (silica gel/ether) indicated that all of **8** had reacted. The peroxide-free mixture was basified with saturated aqueous sodium carbonate solution and extracted with chloroform. Evaporation of the dried (sodium sulfate) organic layer gave 818 mg (96%) of faintly yellow solid, mp 135-140°, purified further by thick-layer chromatography (silica gel/ether) plus molecular distillation at 140° (0.1 mm) to give off-white prisms, mp 153.5-155°, positive Katritzky test; ir: 1447, 1431, 1319 (*N*-oxide), 1047 $cm^{-1}$; $^1H$ nmr (deuteriochloroform): $\delta$ 7.52 (s, 1H, H-4), 7.47 (d, $J_{2,3} = 5.7$ Hz, 1H, H-2), 7.22 (d, 1H, H-3), 3.55 and 2.94 (2m, 2H each, 2 H-5 and 2 H-9), 1.6-2.0 (m, 6H, 2 H-6, 2 H-7, and 2 H-8); ms: m/e 219 ($M^+$, 33), 203 (26), 202 ($M^+$ - OH, 100), 187 (22), 186 (22), 174 (18), 173 (20).

*Anal.* Calcd. for $C_{12}H_{13}NOS$: C, 65.72; H, 5.97; N, 6.39. Found: C, 65.32; H, 5.90; N, 6.29.

4-Nitrocyclohepta[*f*]thieno[2,3-*b*]pyridine 10-Oxide (**8b**).

A mixture of 202 mg (0.92 mmole) of **8a**, 0.08 ml of 96% sulfuric acid, and 0.1 ml (1.6 mmoles) of 70% nitric acid was heated at 100° for one hour and raised to 120° for one minute, whereupon tlc (silica gel/ether) indicated that **8a** was no longer present. The reaction mixture was processed in the same manner as used in the preparation of **7b**, except that drying of the product was accomplished in a vacuum desiccator. Thick-layer chromatography gave 100 mg (39%) of **8b** monohydrate as a yellow, unstable solid, mp 117° dec, which fairly rapidly turned brown in air and/or daylight, positive Katritzky test; $^1H$ nmr (deuteriochloroform): $\delta$ 7.61 (d, $J_{2,3} = 6$ Hz, 1H, H-3), 7.35 (d, 1H, H-2), 3.5-3.6 (m, 2 H-5), 2.9-3.0 (m, 2 H-9), 1.7-2.0 (m, 6 aliphatic protons), 1.61 (s, 2H, probably water); ms: m/e 264 ($M^+$, 81), 247 ($M^+$ - OH, 76), 202 (36), 201 (52), 200 ($M^+$ - $NO_2$ -$H_2O$, 100), 186 (28), 172 (31), 45 ($CHS^+$, 45).

4-Aminocyclohepta[*f*]thieno[2,3-*b*]pyridine (**8c**).

A stirred mixture of 74 mg of **8b** monohydrate, 200 mg of iron powder, and 15 ml of glacial acetic acid was refluxed for four hours until all iron had reacted. The mixture was processed as in

the preparation of **7c**, but with extraction both with chloroform and ether. Sublimation at 160° (0.1 mm) produced 42 mg (74%) of **8c** as a white solid, mp 179-185°, which was washed with ether and resublimed as needles, mp 180-182°; ir: 3461 and 3301 (amino group), 3152, 2918, 1641, 1553 $cm^{-1}$; $^1H$ nmr (hexadeuterioacetone): δ 7.45 (d, $J_{2,3}$ = 6 Hz, 1H, H-2), 7.27 (d, 1H, H-3), 2.98 and 2.78 (2m, 2H each, 2 H-5 and 2 H-9), 2.90 (s, 2H, amino group), 1.5-1.9 (m, 6 aliphatic protons); ms: 219 (22), 218 ($M^+$, 100), 217 (61), 203 ($M^+$ - NH, 30), 190 (35), 189 ($M^+$ - $CH_2$=NH, 62), 164 (17).

*Anal.* Calcd. for $C_{12}H_{14}N_2S$: C, 66.02; H, 6.46: N, 12.83. Found: C, 66.05; H, 6.47; N, 12.53.

Cyclopenta[*f*]thieno[2,3-*b*]pyridine (**6**).

A mixture of 15 g (28.1 mmoles) of tin salt **3**, 4.4 g (39.3 mmoles) of 2-hydroxymethylenecyclopentanone (**2a**) [24], and 50 ml of absolute ethanol was treated by the procedure used to synthesize **5** and **8**, except that the black mixture which resulted from refluxing with concentrated hydrochloric acid was allowed to stand at room temperature for 15 hours before it was basified. Evaporation of the chloroform extract left 0.55 g (8%) of crude product, mp 52-60°, purified by recrystallization from ethanol and then molecular distillation at 100-110° (0.1 mm) to yield white prisms, mp 81.5-82.5°; ir: 1481, 1375, 1316, 691 $cm^{-1}$; $^1H$ nmr (deuteriochloroform): δ 7.87 (s, 1H, H-4), 7.41 (d, $J_{2,3}$ = 6 Hz, 1H, H-2), 7.19 (d, 1H, H-3), 3.13 (t, J = 7.5 Hz, 2H) and 3.04 (t, J = 7.2 Hz, 2H, 2 H-5 and 2 H-7), 2.22 (pentet, J = 7.5 Hz, 2H, 2 H-6); ms: m/e 176 (14), 175 ($M^+$, 77), 174 ($M^+$ - H, 100), 173 (22), 45 ($CHS^+$, 12).

*Anal.* Calcd. for $C_{10}H_9NS$: C, 68.54; H, 5.18; N, 7.99. Found: C, 68.64; H, 5.13; N, 7.93.

Cyclopenta[*f*]thieno[2,3-*b*]pyridine 8-Oxide (**6a**).

A mixture of 386 mg (2.20 mmoles) of **6**, 1.44 g (2.34 mmoles) of **4** (80%), and 15 ml of glacial acetic acid was allowed to stand at room temperature for 40 hours, whereupon tlc (silica gel/ether) and starch-iodide tests showed that all **6** and **4** had reacted. The solution was basified with solid sodium carbonate and extracted with chloroform. The dried (sodium sulfate) organic extract was evaporated to leave 368 mg (84%) of *N*-oxide hydrate as a faintly yellow solid, mp 115-120° dec, positive Katritzky test. Molecular distillation at 120-130° (0.1 mm) gave white prisms, mp 139° dec; ir: 3367 and 3283 (broad, water), 1337 and 1326 (*N*-oxide), 1049 $cm^{-1}$; $^1H$ nmr (deuteriochloroform): δ 7.55 (s, 1H, H-4), 7.42 (d, $J_{2,3}$ = 5.7 Hz, 1H, H-2), 7.21 (d, 1H, H-3), 3.29 (t, J = 7.5 Hz) and 3.0-3.2 (m, 4H total, 2 H-5 and 2 H-7), 2.25 (pentet, J = 7.5 Hz, 2H, 2 H-6); ms: m/e 191 ($M^+$, 81), 175 (21), 174 ($M^+$ -OH, 100), 173 (51).

*Anal.* Calcd. for $C_{10}H_9NOS \cdot \frac{1}{2}H_2O$: C, 59.98; H, 5.03; N, 7.00. Found: C, 60.08; H, 4.67; N, 6.83.

4-Nitrocyclopenta[*f*]thieno[2,3-*b*]pyridine 8-Oxide (**6b**).

A mixture of 100 mg (0.5 mmole) of **6a**, 0.03 ml (0.47 mmole) of 70% nitric acid, and 0.03 ml of 96% sulfuric acid was left at room temperature for 20 hours and then heated at 100° for 20 minutes, whereupon tlc (silica gel/ether) indicated that no **6a** remained. The mixture was poured onto ice. The yellow precipitate which formed was collected by filtration, washed free of acids with water, and dried in air. Thick layer chromatography (silica gel/ether) gave 6.5 mg (6%) of **6b** as bright yellow crystals, mp 152° dec, unchanged on recrystallization from ether, positive Katritzky test; ir: 1513 and 1316 (nitro group), 1267 and 1281 $cm^{-1}$ (*N*-oxide); $^1H$ nmr (deuteriochloroform): δ 8.04 (d, $J_{2,3}$ = 6 Hz, 1H, H-3), 7.69 (d, 1H, H-2), 3.64 (t, $J_{5,6}$ = 7.5 Hz, 2 H-5), 3.36 (t, $J_{6,7}$ = 7.8 Hz, 2 H-7), 2.38 (pentet, J = 7.8 Hz, 2 H-6); ms: m/e 237 (17), 236 ($M^+$, 100), 189 ($M^+$ -$HNO_2$, 22), 173 (32), 172 ($M^+$ -$NO_2$ -$H_2O$, 66), 45 ($CHS^+$, 23).

*Anal.* Calcd. for $C_{10}H_8N_2O_3S$: C, 50.84; H, 3.41. Found: C, 51.08; H, 3.38.

4-Aminocyclopenta[*f*]thieno[2,3-*b*]pyridine (**6c**).

Reduction of 16.3 mg of **6b** was conducted by means of 200 mg of iron powder and 10 ml of glacial acetic acid in the manner used to prepare **8c**. The resultant crude, light-brown solid was sublimed at 148° (0.1 mm) to yield 7.5 mg (57%) of white solid, mp 165-170° dec. For further purification this product was separated by thick-layer chromatography (alumina/ether) and resublimed at 140° (0.1 mm) to yield prisms, mp 190-192° dec; ir: 3422 and 3293 (amino group), 3137, 2961, 2914, 1638, 1559 $cm^{-1}$; $^1H$ nmr (deuteriochloroform): δ 7.18 (AB system, J = 6 Hz, Δδ = 31.8 Hz, H-2 and H-3), 4.36 (broad s, 2H, amino group), 3.07 (t, $J_{6,7}$ = 7.6 Hz, 2H, 2 H-7), 2.82 (t, $J_{5,6}$ = 7.4 Hz, 2H, 2 H-5), 2.22 (m, 2H, 2 H-6); ms: 191 (20), 190 ($M^+$, 85), 189 ($M^+$ -H, 100), 188 (18), 174 ($M^+$ -$NH_2$, 10).

*Anal.* Calcd. for $C_{10}H_{10}N_2S$: C, 63.13; H, 5.30. Found: C, 62.81; H, 5.38.

## REFERENCES AND NOTES

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