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1, 9-SUBSTITUTED FLUORENES

III. Synthesis and Transformations of 3-Chloropyridazino-[4, 5, 6-m, 1]Fluorene*

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Syntheses of 3-chloropyridazino[4, 5, 6-m, 1]fluorene and its 9-methyl and 9-chloro derivatives are described. Products in which a chlorine atom of these compounds is exchanged with NH_3, $C_6H_5NH_2$, $NH_2 \cdot NH_2$, H_2O, $C_6H_5NHNH_2$, CH_3ONa, and compounds containing an active methylene group are prepared. Treatment of 3-hydrazinopyridazino[4, 5, 6-m, 1]fluorene and 3-hydrazino-9-methylpyridazino[4, 5, 6-m, 1]fluorene with alcoholic alkali and HgO give respectively pyridazino[4, 5, 6-m, 1]fluorene and 9-methylpyridazino[4, 5, 6-m, 1]fluorene, while 3-phenylhydrazinopyridazino[4, 5, 6-m, 1]fluorene is oxidized under the same conditions to 3-phenylazopyridazino[4, 5, 6-m, 1]fluorene.

In a Letter to the Editor [1], 3-chloropyridazino[4, 5, 6-m, 1]fluorene (3-chloroindeno[1, 2, 3-d, e]phthalazine) (I), was mentioned as the starting material for the synthesis of 3-hydrazinopyridazino[4, 5, 6-m, 1]fluorene (VII). The conditions of preparation, properties, and other transformations of the compound, which are of interest on account of its reactivity, were not described.

The readily accessible 2, 3H-pyridazino[4, 5, 6-m, 1]fluoren-3-one [3] and fluorene ring substituted derivatives[3] when heated with phosphorus oxychloride give I, 3-chloro-9-methylpyridazino[4, 5, 6-m, 1]fluorene (Ia), and 3, 9-dichloropyridazino[4, 5, 6-m, 1]fluorene (Ic). The chlorine atoms of those compounds are readily exchanged for other substituents. Reaction of I with ammonia gives 3-aminopyridazino[4, 5, 6-m, 1]fluorene (II), with aniline gives 3-phenylaminopyridazino[4, 5, 6-m, 1]fluorene (III), and with sodium methoxide gives 3-methoxypyridazino[4, 5, 6-m, 1]fluorene (IV).

Condensation with compounds containing active methylene groups, e. g., substituted 3-hydroxythionaphthenes, gives dyes V, VI, identical with those prepared from 2, 3H-pyridazino[4, 5, 6-m1]fluorene-3-thione [2].

Reaction of I, and Ia with hydrazine hydrate gives the hydrates of 3-hydrazinopyridazino[4, 5, 6-m, 1]fluorene (VII) and 3-hydrazino-9-methylpyridazino[4, 5, 6-m, 1]fluorene (VIIa), which when oxidized with mercuric oxide in alcoholic alkali give pyridazino[4, 5, 6-m, 1]fluorene (VIII) and 9-methylpyridazino[4, 5, 6-m, 1]fluorene (VIIIa) [1].

Unlike these, the product of reaction of I with phenylhydrazine, which is 3-phenylhydrazinopyridazino[4, 5, 6-m, 1]fluorene (IX) when similarly oxidized gives 3-phenylazopyridazino[4, 5, 6-m, 1]fluorene (X).

Reaction of the hydrazine-substituted derivative VII with 2-methyl-2, 3H-pyridazino[4, 5, 6-m, 1]fluorene-3-methylthionium methylsulfate gives a diazacyanine dye XI.

Experimental

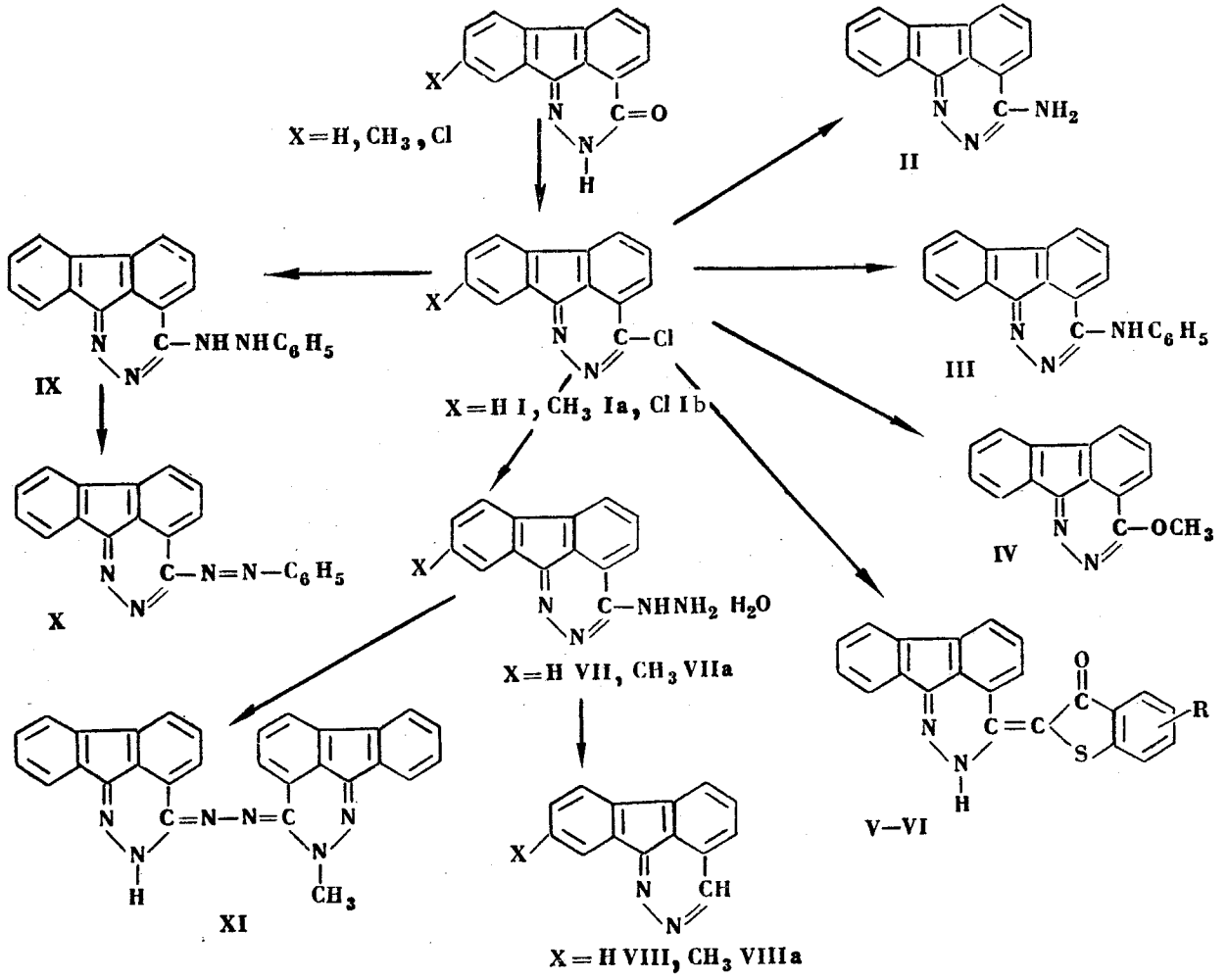
3-Chloropyridazino[4, 5, 6-m, 1]fluorene (I). 1. 2 g (5. 5 mmole) 2, 3H-pyridazino[4, 5, 6-m, 1]fluoren-3-one [2] and 10 ml $POCl_3$ were refluxed together for 3 hr, 6. 5 ml distilled off, the residue cooled, poured on to ice, neutralized with 10% aqueous sodium carbonate solution, filtered, and the solid washed with ice water and dried in a vacuum. Yield of I, 1. 24 g (95. 3%) mp 182-189°. Yellow prisms from benzene mp 186. 6-188. 4°, soluble in benzene, chlorobenzene, sparingly soluble in ether, λ_{max} (lg ε) (benzene): 280 (4. 52), 315 (3. 81), 355 mμ (3. 72). Found: N 11. 45, 11. 53; Cl 14. 55, 14. 27%. Calculated for $C_{14}H_7ClN_2$: N 11. 74; Cl 14. 86%.

Similarly 3. 6 g (15. 5 mmole) 9-methyl-2, 3H-pyridazino[4, 5, 6-m, 1]fluoren-3-one [3] gave 3. 61 g (98. 3%) Ia. After chromatographing on Al_2O_3 and recrystallizing from benzene, yellow needle-shaped prisms mp 202. 2-203. 0°, λ_{max} (lg ε) (benzene): 290 (4. 58), 315 (3. 90), 360 mμ (3. 69). Found: N 10. 92, 10. 78; Cl 14. 30, 14. 59%. Calculated for $C_{15}H_9ClN_2$: N 11. 09; Cl 14. 03%.

4. 6 g (18 mmole) 9-chloro-2, 3H-pyridazino[4, 5, 6-m, 1]fluoren-3-one [3] gave 0. 51 g (10. 6%) Ib. After chromatographing on Al_2O_3 and crystallizing from benzene, yellow needle-shaped prisms mp 272. 8-273. 7°. λ_{max} (lg ε) (benzene): 280, 285, 290 (4. 63), 315 (3. 89), 355 mμ (3. 65). Found: N 10. 29, 10. 23; Cl 25. 35, 15. 20%. Calculated for $C_{14}H_6Cl_2N_2$: N 10. 25; Cl 26. 00%.

3-Aminopyridazino[4, 5, 6-m, 1]fluorene (II). 2 g (8. 5 mmole) I was heated with 40 ml liquid ammonia in an autoclave at 180-190° for 20 hr. After cooling the products were dissolved in 12% hydrochloric acid, and the free amine

*For Part II see [1].


X=H, CH3, Cl
II
III
IV
V–VI
IX
X
XI
X=H I, CH3 Ia, Cl Ib
X=H VII, CH3 VIIa
X=H VIII, CH3 VIIIa

liberated by rendering alkaline with aqueous ammonia. Yield 1.02 g (55%) II. Recrystallization from ethyl acetate gave pale yellow needle-shaped prisms mp 248.5-249.5° (decomp.) or 348.5-351° (decomp.); sparingly soluble in benzene, ethers, rather more soluble in acetic and hydrochloric acids. Found: C 76.94, 76.71; H 4.51, 4.44; N 19.41, 19.23%. Calculated for $C_{14}H_9N_3$: C 76.69; H 4.13; N 19.17%. λ_{max} (lg ε) (benzene): 305 (4.10), 360, 365 mμ (3.95). The diacetyl derivative of II had an mp 171-171.5° (decomp.). Found: C 71.31, 71.32; H 4.38, 4.45; N 14.20, 14.20%. Calculated for $C_{18}H_{13}N_3O_2$: C 71.26; H 4.32; N 13.89%.

3-Phenylaminopyridazino[4, 5, 6-m, 1]fluorene (III). 0.24 g (1 mmole) I was refluxed for 1 hr 30 min with 6 ml aniline. The reaction products were cooled, poured into dilute HCl, the mixture made alkaline, and excess aniline steam-distilled off. The residue was filtered off, washed with water, and dried. Yield 0.27 g (91%) III. From benzene-methanol it formed flat yellow prisms, mp 244.9-245.1°. λ_{max} (lg ε) (benzene): 280 (4.53), 315 (3.76), 380, 385, 390 mμ (4.03). Found: C 81.18, 81.05; H 4.37, 4.58; N 14.16, 14.16%. Calculated for $C_{20}H_{13}N_3$: C 81.33; H 4.44; N 14.23%.

3-Methoxypyridazino[4, 5, 6-m, 1]fluorene (IV) was prepared by the method described for 3-methoxy-6-methylpyridazine [4]. 0.48 g (2 mmole) I was added to a solution of 1.3 g Na in 40 ml methanol, and the mixture refluxed for 5 hr. The precipitate obtained on cooling was filtered off, washed with a small amount of water, and dried. Yield 0.47 g (100%) IV mp 204.7-206.0°. From toluene it formed colorless long prisms mp 206.5-208.1°, soluble in benzene, somewhat less soluble in chlorobenzene, toluene, hot alcohol, $CHCl_3$, ether. λ_{max} (lg ε) (benzene): 290 (4.50), 355 mμ (3.71). Found: C 76.68, 76.82; H 4.41, 4.28; N 11.91, 11.68%. Calculated for $C_{15}H_{10}N_2O$: C 76.90; H 4.30; N 11.96%.

Picrate of IV mp 152-153.5°. Found: N 14.85, 15.50%. Calculated for $C_{15}H_{10}N_2O \cdot (NO_2)_3C_6H_2OH$: N 15.12%.

3-(6-Chloro-3-hydroxythionaphthenylidene)-2, 3H-pyridazino[4, 5, 6-m, 1]fluorene (V). 0.47 g (0.002 mole) I, and 0.37 g (0.002 mole) 6-chloro-3-hydroxythionaphthene were refluxed together in 20 ml trichlorobenzene until evolution of HCl ceased (28 hr). After cooling, the precipitate was filtered off, washed with methanol, and dried. Yield of dye V 0.48 g (63.0%), red needle-shaped prisms mp 332-335° (decomp.). λ_{max} (lg ε) (H_2SO_4): 420, 426 (4.55), 495, 500, 505, 510 mμ (4.49). The dye prepared by reacting 2, 3H-pyridazino[4, 5, 6-m, 1]fluorene-3-thione with 6-chloro-3-hydroxythionaphthene [2] (332-333.5°) gave mixed mp 332-334.5°.

3-(4, 5-Benzo-3-hydroxythionaphthenylidene)2, 3H-pyridazino-(4, 5, 6-m, 1]fluorene (VI). 0.47 g (0.002 mole) I and 0.4 g (0.002 mole) 4, 5-benzo-3-hydroxythionaphthene were refluxed together in 20 ml trichlorobenzene until evolution of HCl ceased. The dye was isolated as described above. Yield of VI 0.66 g (83.4%). From trichlorobenzene it separated as red prisms mp 320-324° (decomp.). λ_{max} (lg ε) (H_2SO_4): 470, 475, 480, 485 mμ (4.43). The dye prepared by reacting 2, 3H-pyridazino[4, 5, 6-m, 1]fluorene-3-thione with 4, 5-benzo-3-hydroxythionaphthene [2] gave an undepressed mixed mp with it.

3-Hydrazinopyridazino[4, 5, 6-m, 1]fluorene hydrate (VII). 0.48 g (2 mmole) I and 20 ml hydrazine hydrate were refluxed together for 15 hr. The red precipitate which came down on cooling was filtered off, washed with water, and dried. Yield 0.43 g (85%) VII mp 255.5-256° (decomp.). Red needle-shaped prisms, soluble in hot chlorobenzene, $CHCl_3$, benzene, less soluble in alcohol. λ_{max} (lg ε) (benzene): 360, 365, 370 mμ (3.74). Found: C 66.73, 66.57; H 4.37, 4.39; N 22.14, 22.10%. Calculated for $C_{14}H_{10}N_4H_2O$: C 66.65; H 4.79; N 22.21%.

Similarly 1.5 g compound Ia gave 1.41 g (90%) VIIa. Crystallized from toluene it formed orange needle-shaped prisms mp 277.5-278° (decomp.); moderately soluble in benzene, toluene, alcohol. λ_{max} (lg ε) (benzene): 315 (3.73), 330 (3.65), 360, 365, 370, 375 mμ (3.76). Found: N 21.06, 21.02%. Calculated for $C_{15}H_{12}N_4 \cdot H_2O$: N 21.04%.

Pyridazino[4, 5, 6-m, 1]fluorene (VIII).

1) 0.5 g (0.002 mole) VII was agitated with 50 ml ethanol, 1 g NaOH, and 0.44 g (0.002 mole) HgO for 1 hr. The whole was then diluted with water, filtered, the filter washed with water, and the filtrate extracted with benzene. The benzene extract was washed with water, dried over $CaCl_2$, and excess benzene distilled off till the residue amounted to 20-30 ml. This benzene solution was then chromatographed over Al_2O_3, using benzene as the eluant, and the yellow, middle layer collected. After removing excess solvent there was obtained 0.32 g (80%) VIII. From white spirit the product separated as yellowish prisms mp 123.1-125°; soluble in ethyl acetate, benzene, acetone, alcohols, dichloroethane, and in hot petroleum ether, insoluble in light petroleum ether. λ_{max} (lg ε) (benzene): 310 (5.59), 355 (5.55), 280, 285 mμ (6.43). Found: C 82.86, 82.27; H 4.14, 4.04; N 13.45, 13.56%. Calculated for $C_{14}H_8N_2$: C 82.34; H 3.95; N 13.72%.

2) Under similar conditions, 0.25 g VII, without HgO, gave 0.11 g (55%) VIII. Mixed mp with the substance prepared by method 1) undepressed.

VIII picrate, mp 221-222° (decomp.). Found: C 56.19, 55.88; H 2.50, 2.83; N 15.90, 15.70%. Calculated for $C_{14}H_8N_2 \cdot (NO_2)_3C_6H_2OH$: C 55.43; H 2.56; N 16.16%.

VIII methiodide, mp 254-257° (decomp.). Found: N 8.08, 8.38; I 36.65, 36.50%. Calculated for $C_{15}H_{11}IN_2$: N 8.09; I 36.67%.

9-Methylpyridazino[4, 5, 6-m, 1]fluorene (VIIIa). 0.37 g (1.4 mmole) VIIa was agitated with 50 ml ethanol, 1 g NaOH, and 0.44 (2 mmole) HgO for 5 hr. The product was isolated as described above. Yield 0.16 g (53%) VIIIa mp 140-143.5°. Cryatallized from white spirit it forms slightly yellowish flat prisms, mp 145.4-146.3°. λ_{max} (lg ε) (benzene): 280, 285 (4.63); 310 (3.73), 355 mμ (3.61). Found: C 82.84, 82.76; H 4.57, 4.50; N 12.65, 12.30%. Calculated for $C_{15}H_{10}N_2$: C 82.54; H 4.62; N 12.84%.

VIIIa methiodide, mp 260.5-262° (decomp.). Found: N 8.32, 8.28%. Calculated for $C_{16}H_{13}IN_2$: N 7.78%.

3-Phenylhydrazinopyridazino[4, 5, 6-m, 1]fluorene (IX). 0.65 g (2.7 mmole) I and 15 ml phenylhydrazine were heated together at 145-150° for 15 hr. After cooling, the products were filtered, and the precipitate washed with ethanol. Yield of IX 0.4 g (47.6%). It crystallized from benzene-ethanol as red needle-shaped prisms, mp 199.2-202.0°; soluble in ethanol and benzene. λ_{max} (lg ε) (benzene): 380 mμ (3.92). Found: C 77.58, 77.81; H 4.31, 4.60; N 18.04, 17.89%. Calculated for $C_{20}H_{14}N_4$: C 77.40; H 4.54; N 18.06%.

3-Phenylazopyridazino[4, 5, 6-m, 1]fluorene (X). 0.1 g (0.3 mmole) IX was agitated with 50 ml ethanol, 4 ml 25% aqueous ammonia, and 0.16 g (0.7 mmole) HgO until the solution was decolorized, after which the latter was filtered, the filter washed with a small amount of ethanol, and the filtrate evaporated to dryness under reduced pressure. Yield of X 0.1 g (100%). It crystallized from ethanol as elongated orange prisms, mp 188.2-189.0°, soluble in hot benzene and alcohol, λ_{max} (lg ε) (benzene): 330, 335 (3.88), 365, 370 mμ (3.89). Found: C 77.66, 77.85; H 3.93, 3.91; N 18.34, 18.30%. Calculated for $C_{20}H_{12}N_4$: C 77.90; H 3.92; N 18.17%.

Bis(2, 3H-pyridazino[4, 5, 6-m, 1]fluorene)-2-methyl-3, 3'-azine (XI). 0.25 g (1 mmole) VII, 0.37 g (1 mmole) 2-methyl-2, 3H-pyridazino[4, 5, 6-m, 1]fluorene-3-methylthionium methyl sulfate, 0.19 g (1 mmole) triethylamine, and 45 ml absolute alcohol were refluxed together for 3 hr. After cooling, the products were filtered, and the filter washed with methanol. Yield 0.43 g (95.5%) XI mp 202-203° (decomp.). It crystallized from benzene as reddish-brown crystals with a violet reflex mp 208.5-209.5° (decomp.); moderately soluble in benzene and chlorobenzene, insoluble in alcohol and water. λ_{max} (lg ε) (m-xylene): 495, 500, 505 mμ (4.11). Found: N 18.23, 18.33%. Calculated for $C_{29}H_{18}N_6$: N 18.66%.

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