Substitution and Ring Closure Reactions of Phthalazine Derivatives

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1-(Phenylthio)- and 1-(hydroxycarbonylmethylthio)-4-methylphthalazines were prepared from 1-chloro-4-methylphthalazines (**1**). A series of 2-benzyl- and benzenesulphonyl derivatives was prepared from the corresponding halides and 4-methyl-1(2*H*)-phthalazinone (**4**). 4-Methyl-1(2*H*)-phthalazinthione (**6**) was substituted at SH group to give 1-(benzylthio)- and 1-(ethoxycarbonylmethylthio)-4-methylphthalazines, **7** and **8** respectively. Treatment of hydrazine hydrate with **8** produced 1-hydrazino-4-methylphthalazine (**10**). However, when the latter compound was treated with **1** it gave 1,2-bis-(4-methylphthalazinyl)hydrazine.

Treatment of **10** with aromatic aldehydes in glacial acetic acid gave the corresponding 3-phenyl-*s*-triazolo-[3,4-*a*]-6-methylphthalazines **13**. 1-Hydrazino-4-methylphthalazine (**10**) underwent cyclization reactions with acetic anhydride, ethyl chloroformate, carbon disulphide, ethylformate, ethyl oxalate and with nitrous acid to give the corresponding triazolo-, triazino- and tetrazolophthalazine compounds.

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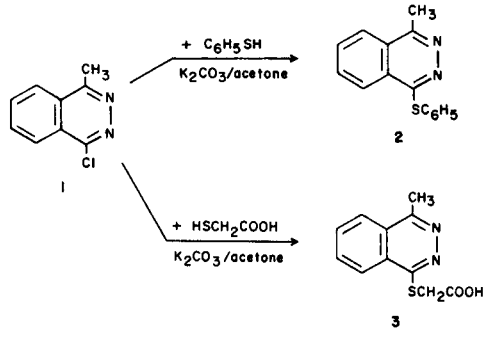
Substitution by alkyl group on phthalazinones has long been known to give either *O*-alkyl or *N*-alkyl derivatives [1]. *O*-Acyl derivatives were the predominant product separated [2]. *N*-Acylation was also reported [3]. Halogens at 1-or 4-positions of phthalazine readily undergo displacement by amines [4], alkoxides [5] or thiols [6] to give the corresponding amino, alkoxy or thiophthalazines.

1-Hydrazinophthalazine, a precursor of hypotensive agents, has been reported to undergo enzymatic acetylation leading to 3-methyl-*s*-triazolo[3,4-*a*]phthalazine [7,8]. Ring closure in phthalazine series was also observed to give triazines [7] and tetrazolo [9] ring systems.

In the present paper we investigate the susceptibility of 1-substituted phthalazines towards displacement reactions and towards cyclization reactions with different carbonyl compounds and other reagents into the *s*-triazolo, *as*-triazino and tetrazole derivatives.

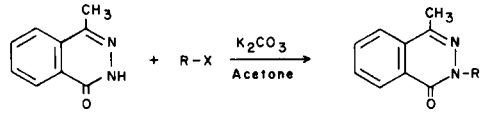
Results and Discussion.

Reaction of 1-chloro-4-methylphthalazine (**1**) with thiophenol or thioglycolic acid in presence of anhydrous potassium carbonate in dry acetone gave the corresponding 1-(phenylthio)- and 1-(hydroxy-carbonylmethylthio)-4-methylphthalazines **2** and **3** respectively. The ir spectrum



of **3** showed (C=O) band at 1720 cm^{-1} and group of small bands at 2500-2900 cm^{-1} of the associated (OH) of the carboxyl group.

Treatment of 4-methyl-1-(2H)-phthalazinone (**4**) with aralkyl and arylsulphonyl halides in presence of anhydrous potassium carbonate in dry acetone, gave the corresponding 4-methyl-2-substituted-1-phthalazinones (**5a-d**).

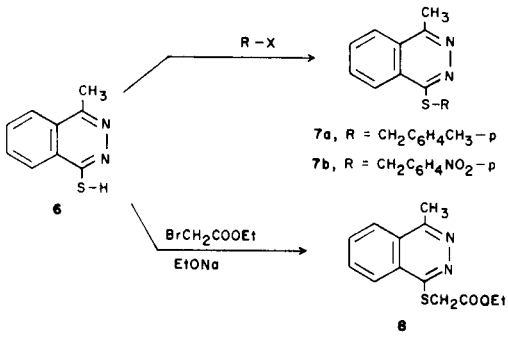


R

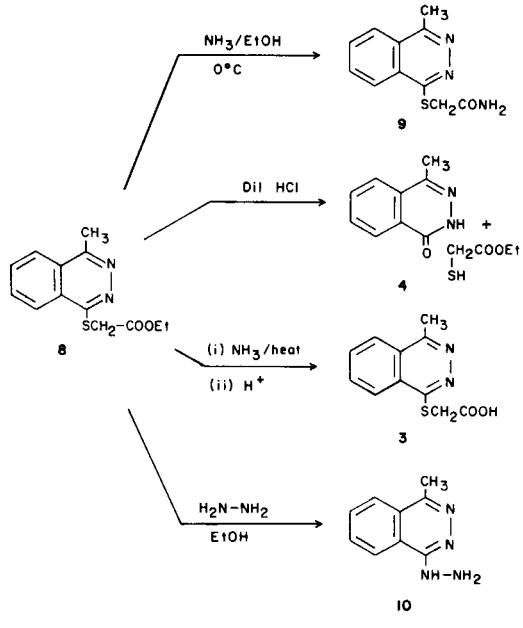
5a, $CH_2C_6H_4CH_3$-p
5b, $CH_2C_6H_4NO_2$-p
5c, $SO_2C_6H_5$
5d, $SO_2C_6H_4CH_3$-p

The ir spectrum of **5a** showed disappearance of (NH) at 3200-3150 cm^{-1} and of **5d** showed the appearance of bands at 1380 and 1195 cm^{-1} of ($N-SO_2$) group. The electronic absorption of **5a,b** at 286-290 nm is coincidant with that of the parent compound **4** which verify the non-alteration in the conjugation character of the nucleus. The nmr spectrum of (**5a**) in trifluoroacetic acid showed a singlet at δ 1.75 (3H, Ar-CH_3), singlet at δ 2.4 (3H, -CH_3), singlet at δ 5.16 (2H, -CH_2-) and a multiplet at δ 6.7-7.7 (8H, aromatic protons).

However, treatment of 4-methyl-1(2*H*)-phthalazinethione **6** with aralkyl halides and anhydrous potassium carbonate in dry acetone gave the corresponding 1-aralkylthio-4-methylphthalazines (**7**). On the other hand, treatment of **6** with ethyl bromoacetate in presence of sodium ethoxide gave 1-(ethoxycarbonylmethylthio)-4-methylphthalazine (**8**). The ir spectrum showed the ester (C=O) band at 1740 cm^{-1}.



Hydrolysis of **8** with dilute hydrochloric acid gives **4** again. Hydrolysis by heating with aqueous ammonia followed by acidification gives 1-(Hydroxycarbonylmethylthio)-4-methylphthalazine (**3**) in 90% yield. However, treatment of **8** in absolute ethanol with excess ammonia at 0° produced 1-(carboxamidomethylthio)-4-methylphthalazine (**9**). The ir spectrum shows the appearance of (C=O) band at 1685 cm^{-1} and (NH_2) band at 3350, 3180 cm^{-1}. Such reactions suggest that hydrolysis goes through ammonolysis to the acid amide [10] followed by hydrolysis to the carboxylic acid **3** which was separated on acidification.



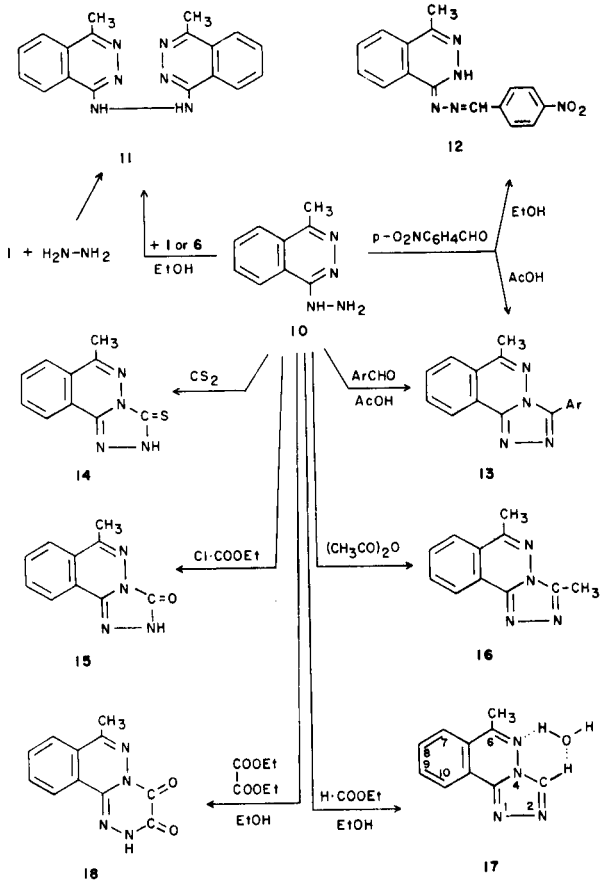
Treatment of **8** with excess hydrazine hydrate in absolute ethanol produced 1-hydrazino-4-methylphthalazine (**10**). The ir spectrum shows (NH_2) bands at 3390, 3290 cm^{-1} and an (NH) band at 3180 cm^{-1}. The nmr spectrum in deuteriochloroform showed a singlet at δ 2.56 (3H, $-CH_3$), multiplet between δ 7.53-8.18 (4H, aromatic protons), a weak broad signal at δ 5.1 (NH_2 protons) and another broad band at δ 11.65 (ring NH-proton) which are disappeared on addition of deuterium oxide. This confirms its predominant existance as the hydrazone tautomer **10'**. The molecular ion peak appears at m/e 174. Attempted preparation of **10** by treatment of **1** with hydrazine hydrate was unsuccessful, instead, 1,2-bis(4-methylphthalazinyl)hydrazine (**11**) was produced which is also produced by refluxing of **10** with either **1** or **6** in absolute ethanol. The ir spectrum of **11** shows only the (NH) band at 3410 cm^{-1}. The nmr spectrum in trifluoroacetic acid showed a singlet at δ 2.68 (6H, two-CH_3), multiplet at δ 7.9-8.35 (8H, aromatic protons) and the protonated (NH) appears downfield.

Refluxing **10** with *p*-nitrobenzaldehyde in absolute ethanol produces *N*-(1-methylphthalazin-4-yl)-*p*-nitrobenzaldehyde hydrazone (**12**). The ir spectrum shows (NH) band at 3350 cm^{-1} and (C=N) band at 1620 cm^{-1}. The nmr spectrum in trifluoroacetic acid showed a singlet at δ 2.58 (3H, $-CH_3$), multiplet at δ 7.68-8.50 (8H, aromatic protons), a singlet at δ 8.8 (1H, -N=CH-proton) and the protonated (NH) appears downfield. The electronic absorption spectra of phenyl azo compounds are known [11] to show a strong K-band in the region 270-280 nm, while the corresponding monophenyl hydrazones give a weak absorption band (or no band) at 285-295 nm and a strong band at 350 nm or higher. Consequently the observed band at 412 nm (ϵ max 4450) favours the assumption that **12** exists as 1-phthalazinyl hydrazone tautomer [12]. This is confirmed by the fact that **12** undergoes ring closure upon refluxing with glacial acetic acid to produce 3-(*p*-nitrophenyl)-*s*-triazolo[3,4-*a*]-6-methylphthalazine (**13a**). The same triazolo compound was obtained directly by refluxing **10** and *p*-nitrobenzaldehyde in glacial acetic acid. The electronic absorption spectrum of **13a** showed a band at 314 nm (ϵ, 2880) with an observed blue shift when compared to its precursor **12**. This is due to the shortened conjugation as a result of cyclization. The ir spectrum showed the disappearance of (NH). The nmr spectrum in trifluoroacetic acid showed a singlet at δ 2.90 (3H, $-CH_3$), multiplet at 8.0-8.75 (8H, aromatic protons).

On the other hand, condensation of **10** with other aromatic aldehydes, (benzaldehyde, *p*-anisaldehyde, *m*-tolualdehyde and salicylaldehyde) proceeds only by refluxing in glacial acetic acid producing the corresponding 3-(substituted-phenyl)-*s*-triazolo[3,4-*a*]-6-methylphthalazines **13b-e**. In agreement with such ring closure reaction is the fact that compound **13-b** was produced by fusion of **10** with either of benzaldehyde of benzoyl chloride. The nmr spectrum of **13-b** in deuteriochloroform showed a singlet at δ 2.78 (3H, $-CH_3$) and multiplet at δ 7.60-8.78 (9H, aromatic protons.

Refluxing **10** with carbon disulfide, produces *s*-triazolo[3,4-*a*]-6-methylphthalazine-3-thione (**14**). The ir spectrum shows (C=S) band at 1505 cm^{-1}, (NH) band at 3395 cm^{-1} and (triazine C=N) at 1620 cm^{-1} and the absence of (SH) band at 2600 cm^{-1}, which revealed its existance as the thione tautomer. On the other hand, refluxing **10** with ethylchloroformate produced triazolo[3,4-*a*]-6-

methylphthalazine-3-one (**15**). The ir spectrum shows the amide (C=O) band at 1665 cm^{-1} and (NH) band at 3200 cm^{-1} confirming the assumption that it exists as the keto tautomer. The nmr spectrum in (DMSO-d_6) showed a singlet at δ 2.28 (3H, -CH_3) singlet at 8.80 (1H, NH) and multiplet centered at δ 8.1 (4H, aromatic protons).



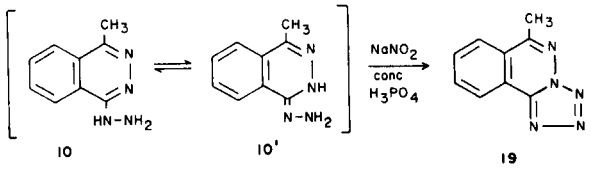
When **10** was refluxed with acetic anhydride, 3-methyl-*s*-triazolo[3,4-*a*]-6-methylphthalazine (**16**) was produced. The nmr spectrum in deuteriochloroform showed a singlet at δ 2.80 (3H, -CH_3 triazolo), singlet at δ 2.83 (3H, -CH_3 phthalazine nucleus).

On the other hand, refluxing **10** with ethyl formate in absolute ethanol produced *s*-triazolo[3,4-*a*]-6-methylphthalazine hydrate (**17**).

The existance of water of crystallisation was confirmed by the ir spectrum which showed a strong broad band at 3420 cm^{-1}. This was confirmed by the nmr spectrum in deuteriochloroform which showed a singlet at δ 2.02 (2H, water), singlet at δ 2.83 (3H, -CH_3), multiplet at δ 7.75-8.1 (3H, aromatic protons 7, 8 and 9), doublet at δ 8.7 (1H, aromatic proton 10) and a singlet at δ 8.95 (1H, -CH=N).

Moreover refluxing **10** with diethyl oxalate in absolute ethanol produced 2-H-*as*-triazino[3,4-*a*]-7-methylphthalazine-3,4-dione (**18**). The ir spectrum showed the amide (C=O) band at 1695 cm^{-1}, the second (C=O) band at 1735 cm^{-1}, the (NH) band at 3230 cm^{-1}. The nmr spectrum in trifluoroacetic acid showed a singlet at δ 2.35 (3H, -CH_3) and multiplet at δ 7.30-8.25 (4H, aromatic protons), the protonated (NH) appear downfield.

The ring closure reactions of 1-hydrazino-4-methylphthalazine (**10**) with different carbonyl compounds favour the assumption that it predominantly exists as the hydrazone tautomer **10'** as confirmed from the nmr spectrum [12]. This assumption was farther confirmed by the formation of tetrazolo[5,1-*a*]-6-methylphthalazine (**19**) on treatment of (**10'**) with sodium nitrite in concentrated phosphoric acid, where its diazonium salt underwent internal cyclisation [13].



EXPERIMENTAL

Melting points reported are uncorrected. Infrared spectra were recorded on a Beckman 20 infrared spectrophotometer using potassium bromide Wafer technique. Ultraviolet spectra in ethanol on a Pye-Unicam SP 8000 spectrophotometer and nmr spectra were recorded on a 90 MHz Brucker Spectrospin and Varian EM-390 90 MHz.

1-Chloro-4-methylphthalazine (**1**) [14,15].

Colourless crystals from water, mp 130°.

Reactions of 1-Chloro-4-methylphthalazine (**1**) With Thiophenol and Thioglycolic Acid.

General Procedure.

A mixture of **1** (0.01 mole), thiophenol (0.015 mole) or thioglycolic acid (0.01 mole) and anhydrous potassium carbonate was refluxed in acetone for 5 hours. The solid product was filtered and recrystallized.

1-(Phenylthio)-4-methylphthalazine (**2**).

White crystals from petroleum ether (60-80°), yield 2.7 g (98%), mp 130°.

Anal. Calcd. for $C_{15}H_{12}N_2S$: C, 71.41; H, 4.79; N, 11.11. Found: C, 71.43; H, 4.75; N, 10.86.

1-(Hydroxycarbonylmethylthio)-4-methylphthalazine (**3**).

White crystals were obtained from ethanol, yield 1.9 g (81%), mp 225°.

Anal. Calcd. for $C_{11}H_{10}N_2O_2S$; C, 56.41; H, 4.76; N, 11.01. Found: C, 56.28; H, 4.67; N, 11.06.

4-Methyl-1(2*H*)-phthalazinones (**4**) [16].

Colourless crystals, mp 219-220° were obtained.

Reactions of 4-Methyl-1(2*H*)-phthalazinone (**4**) With Aralkyl and Arylsulphonyl Halides.

General Procedure.

A mixture of **4** (0.01 mole), aralkyl halide or arylsulphonyl halide (0.01 mole) and anhydrous potassium carbonate was refluxed for 4 hours in dry acetone (30 ml). The produced *N*-substituted derivative was crystallised from the proper solvent.

4-Methyl-2-(*p*-methylbenzyl)-1-phthalazinone (**5a**).

Colourless crystals were obtained from acetone, yield 2.4 g (74%), mp 142°.

Anal. Calcd. for $C_{17}H_{16}N_2O$: C, 77.25; H, 6.10; N, 10.60. Found: C, 77.09; H, 6.20; N, 10.60.

4-Methyl-2-(*p*-nitrobenzyl)-1-phthalazinone (**5b**).

Colourless crystals were obtained from acetone, yield 2.7 g (75%), mp 160°.

Anal. Calcd. for $C_{16}H_{13}N_3O_3$: C, 65.08; H, 4.44; N, 14.23. Found: C, 64.83; H, 4.69; N, 14.01.

4-Methyl-2-(benzenesulphonyl)-1-phthalazinone (**5c**).

Colourless crystals were obtained from benzene, yield 2.3 g (75%), mp 109°.

Anal. Calcd. for $C_{15}H_{12}N_2O_3S$: C, 60.00; H, 4.03; N, 9.33. Found: C, 60.15; H. 4.12; N, 9.73.

4-Methyl-2-(*p*-toluenesulphonyl)-1-phthalazinone (**5d**).

Colourless crystals were obtained from benzene, yield 2.4 g (75%), mp 167-168.

Anal. Calcd. for $C_{16}H_{14}N_2O_3S$: C, 61.14; H, 4.49; N, 8.91. Found: C, 61.35; H, 4.67; N, 9.00.

4-Methyl-1(2*H*)-phthalazinethione (**6**).

A mixture of **4** (0.02 mole) and phosphorus pentasulfide (0.022 mole) was refluxed in dry pyridine for 4½ hours. The solvent evaporated and the residue treated with acetic acid. The solid filtered and recrystallized from absolute ethanol or acetic acid as brownish crystals, yield 2.64 g (75%), mp 239-240°, lit [17] mp 243° from acetic acid.

Anal. Calcd. for $C_9H_8N_2S$: C, 61.36; H, 4.58; N, 15.96. Found: C, 61.25; H, 4.80; N, 15.80.

Reactions of 4-Methyl-(2*H*)-phthalazinethione (**6**) With Aralkyl Halides.

General Procedure.

A mixture of **6** (0.01 mole), aralkyl bromide (0.01 mole) and anhydrous potassium carbonate was refluxed for 4 hours in dry acetone (30 ml). The product was recrystallized.

1-(*p*-Methylbenzylthio)-4-methylphthalazine (**7a**).

Colourless crystals were obtained from petroleum ether (60-80°), yield 2.5 g (72%), mp 95°.

Anal. Calcd. for $C_{17}H_{16}N_2S$: C, 68.85; H, 6.56; N, 11.48. Found: C, 68.79; H, 6.48; N, 11.67.

1-(*p*-Nitrobenzylthio)-4-methylphthalazine (**7b**).

Colourless crystals were obtained from acetone, yield 2.8 g (74%), mp 130°.

Anal. Calcd. for $C_{16}H_{13}N_3O_2S$: C, 61.73; H, 4.21; N, 13.50. Found: C, 61.71; H, 4.20; N, 13.46.

1-(Ethoxycarbonylmethylthio)-4-methylphthalazine (**8**).

Ethyl bromoacetate (0.01 mole) was added dropwise to a stirred solution of sodium ethoxide (0.01 mole sodium metal in 100 ml ethanol) and **6** (0.01 mole). After refluxing the mixture for 2 hours and cooling, the solid separated was filtered and recrystallized from absolute ethanol to give **8** as colourless crystals, yield 2.7 g (77%), mp 130°.

Anal. Calcd. for $C_{13}H_{14}N_2O_2S$: C, 59.53; H, 5.38; N, 10.68. Found: C, 59.52; H, 5.36; N, 10.67.

1-(Aminocarbonylmethylthio)-4-methylphthalazine (**9**).

Excess ammonia solution (28%) was added to a solution of **8** (0.01 mole) in absolute ethanol and the mixture cooled down at 0° for 3 days. The solid separated filtered off and recrystallized from absolute ethanol to give **9** as colourless crystals, yield 1.3 g (50%), mp 200°.

Anal. Calcd. for $C_{11}H_{11}N_3OS$: C, 56.65; H, 4.75; N, 18.02. Found: C, 56.60; H, 4.71; N, 18.06.

1-Hydrazino-4-methylphthalazine (**10**).

By refluxing a mixture of **8** (0.1 mole) and excess hydrazine hydrate (90%) in absolute ethanol (15 ml). The solid separated on cooling was filtered and recrystallized from benzene to give **10** in its hydrochloride salt as yellow crystals, yield 1.7 g (65%) mp 286°. The original base compound **10** mp 112° was not changed by admixture with a reference sample prepared from **6** and hydrazine hydrate in ethanol [15].

1,2-bis(4-Methylphthalazinyl)hydrazine (**11**).

A mixture of **10** (0.01 mole) and **1** (0.01 mole) or **6** (0.01 mole) was refluxed in absolute ethanol. the solid product filtered and recrystallized from pyridine to give **11** as orange crystals, yield 3.8 g (85%), mp 310°.

Anal. Calcd. for $C_{18}H_{16}N_6$: C, 67.89; H, 5.15; N, 26.70. Found: C, 67.55; H, 5.10; N, 26.67.

The same product was separated by refluxing **1** and hydrazine hydrate in ethanol as solvent. (lit [17] mp > 305°).

Reactions of 1-Hydrazino-4-methylphthalazine (**10**) With Aromatic Aldehydes.

i) *N*-(4-Methylphthalazin-1-yl)-*p*-nitrobenzaldehyde Hydrazone (**12**).

By refluxing **10** (0.01 mole) and *p*-nitrobenzaldehyde (0.01 mole) in ethanol. The solid separated on cooling filtered and recrystallized from benzene to give **12** as red orange crystals, yield 2.76 g (85%), mp 255°.

Anal. Calcd. for $C_{16}H_{13}N_5O_2$: C, 56.64; H, 3.84; N, 20.65. Found: C, 56.92; H, 3.76; N, 20.84.

ii) 3-(Substituted-phenyl)-6-methyl-*s*-triazolo[3,4-*a*]phthalazines (**13**).

General Procedure.

A mixture of 1-hydrazino-4-methyl phthalazine (0.01 mole) and the aromatic (0.01 mole) was refluxed in glacial acetic acid. After cooling, the separated solid recrystallized from the proper solvent.

3-(*p*-Nitrophenyl-6-methyl-*s*-triazolo[3,4-*a*]phthalazine (**13a**).

Colourless crystals were obtained from ethanol, yield 2.44 g (75%), mp 275°. The same product was separated in 95% yield by cyclization of **12**, on refluxing with glacial acetic acid.

Anal. Calcd. for $C_{16}H_{11}N_5O_2$: C, 56.98; H, 3.27; N, 20.78. Found: C, 56.73; H, 3.44; N, 20.91.

3-(Phenyl)-6-methyl-*s*-triazolo[3,4-*a*]phthalazine (**13b**).

Colourless crystals were obtained from ethanol, yield 1.1 g (40%), mp 215°. The same compound was produced in 75% yield by fusion of equimolecular amounts of **10** and benzaldehyde. The compound was also prepared by another route in 85% yield by refluxing **10** and excess benzoyl chloride for several hours.

Anal. Calcd. for $C_{16}H_{12}N_4$: C, 73.83; H, 4.65; N, 21.50. Found: C, 73.92; H, 4.57; N, 21.62.

3-(*p*-Methoxyphenyl)-6-methyl-*s*-triazolo[3,4-*a*]phthalazine (**13c**).

Colourless crystals were obtained from ethanol, yield 2.33 g (75%), mp 186°.

Anal. Calcd. for $C_{17}H_{14}N_4O$: C, 70.33; H, 4.86; N, 19.30. Found: C, 70.35; H, 4.91; N, 19.42.

3-(*m*-Methylphenyl)-6-methyl-*s*-triazolo[3,4-*a*]phthalazine (**13d**).

Colourless crystals were obtained from ethanol, yield 2.23 g (76%), mp 220°.

Anal. Calcd. for $C_{17}H_{14}N_4$: C, 74.43; H, 5.14; N, 20.43. Found: C, 74.50; H, 5.09; N, 20.43.

3-(*o*-Hydroxyphenyl)-6-methyl-*s*-triazolo[3,4-*a*]phthalazine (**13e**).

Colourless crystals were obtained from acetic acid, yield 2.23 g (75%), mp 242°.

Anal. Calcd. for $C_{16}H_{12}N_4O$: C, 69.96; H, 4.35; N, 20.29. Found: C, 69.75, H, 4.42; N, 20.43.

6-Methyl-*s*-triazolo[3,4-*a*]phthalazine-3-thione (**14**).

Compound **14** was obtained by refluxing carbon disulfide with **10** (0.005 mole). The solid product was recrystallized from ethanol to give **14** as colourless crystals, yield 1 g (90%), mp 323°.

Anal. Calcd. for $C_{10}H_8N_4S$: C, 55.55; H, 3.70; N, 25.90. Found: C, 55.46; H, 3.76; N, 25.82.

6-Methyl-*s*-triazolo[3,4-*a*]phthalazin-3-one (**15**).

Compound **15** was obtained by heating ethyl chloroformate (0.004 mole) and **10** (0.002 mole) in pyridine at 100°. The solvent was evaporated under vacuum and the solid separated and recrystallized from ethanol to give **15** as colourless crystals, yield 0.85 g (65%), mp 265° dec.

Anal. Calcd. for $C_{10}H_8N_4O$: N, 27.99. Found: N, 27.92.

3,6-Dimethyl-*s*-triazolo[3,4-*a*]phthalazine (**16**).

Compound **16** was obtained by refluxing **10** (0.005 mole) in excess acetic anhydride (10 ml). The solid separated was recrystallized from ethanol to give **16** as colourless crystals, yield 0.8 g (75%), mp 240°, lit [18] mp 236° by using triethyl orthoformate instead of acetic anhydride.

Anal. Calcd. for $C_{11}H_{10}N_4$: C, 66.65; H, 5.09; N, 28.27. Found: C, 66.68; H. 5.12; N, 28.31.

6-Methyl-*s*-triazolo[3,4-*a*]phthalazine Hydrate (**17**).

Compound **17** was obtained by refluxing **10** (0.01 mole) and ethyl formate (0.015 mole) in ethanol. The excess ester was removed and the solid obtained crystallized from benzene to give **17** as colourless crystals, yield 1.5 g (80%), mp 199-200°, lit [18] the anhydrous product mp 184-185°, dec 270°, was obtained by using formic acid or triethyl orthoformate with the corresponding hydrazine.

Anal. Calcd. for $C_{10}H_8N_4 \cdot H_2O$: C, 59.39; H, 4.98; N, 27.71. Found: C, 59.36; H, 4.98; N, 27.74.

2-*H*-*as*-Triazino[3,4-*a*]-7-methylphthalazine-3,4-dione (**18**).

By refluxing **10** (0.01 mole) and diethyloxalate (0.01 mole) in ethanol (30 ml). The excess ester was evaporated and the solid obtained was recrystallized from dimethylformamide to give **18** as brownish crystals, yield 1.7 g (75%), mp above 350°.

Anal. Calcd. for $C_{11}H_8N_4O_2$: C, 57.89; H, 3.53; N, 24.55. Found: C, 57.87; H, 3.52; N, 24.58.

Tetrazolo[5,1-*a*]-6-methylphthalazine (**19**).

To a cooled solution of **10** (0.01 mole) in concentrated phosphoric acid (20 ml) was added sodium nitrite solution (5*N*, 12.5 ml). The solid product separated was recrystallized from dimethylformamide to give **19** as colourless crystals, yield 1.6 g (85%), mp 222°.

Anal. Calcd. for $C_9H_7N_5$: C, 58.37; H, 3.81; N, 37.82. Found: C, 58.34; H, 3.79; N, 37.85.

The molecular ion peak appeared at m/e 185.

Acknowledgement.

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REFERENCES AND NOTES

[1] F. M. Rowe and A. T. Peters, *J. Chem. Soc.*, 1331 (1933).

[2] E. F. M. Stephenson, *ibid.*, 678 (1944); N. P. Buu Hoi, *Bull. Soc. Chim. France*, 351 (1942).

[3] V. Rothenburg, *J. Prakt. Chem., [2],* **51**, 140 (1895).

[4] A. Lieck, *Ber.*, **38**, 3918 (1905); N. L. Drake and R. M. Peek, *J. Am. Chem. Soc.*, **68**, 1313 (1946).

[5] H. Wolbing, *Ber.*, **38**, 3925 (1905); O. Bromberg, *ibid.*, **29**, 1443 (1896).

[6] T. Jerzy, S. Lidia and P. Danuta, *Ann. Pharm. (Poznam),* **11**, 101 (1975).

[7] H. Zimmer, J. McManus, T. Novinson, E. V. Hess and H. Litwin, *Anzneim.-Forsch.*, **20**, 1586 (1970).

[8] S. Edwards and F. H. Marquardt, *Hoppe-Seyler's. Z. Physiol. Chem.*, **350**, 85 (1969).

[9] R. Stolle and H. Storch, *J. Prakt. Chem.* [2], **135**, 128 (1932).

[10] Libermann and Rouaix, *Bull. Soc. Chem. France*, 1793 (1957).

[11] H. C. Yao and P. Resnick, *J. Am. Chem. Soc.*, **84**, 3514 (1962).

[12] B. L. Buzykin, N. N. Bystrykh, A. P. Stolyarov, S. A. Flegontov, V. V. Zverev and Yu. P. Kitaev, *Khim. Geterotsikl. Soedin.*, 402 (1976); *Chem. Abstr.*, **84**, 179558x (1976).

[13] Z. E. Jolles, "Chemistry of Carbon Compounds", Vol 3, Part A, E. H. Rodd, ed, Elsevier Publishing Co., 1954, pp 286.

[14] R. C. Evans and F. Y. Wiselogle, *J. Am. Chem. Soc.*, **67**, 60 (1945).

[15] R. F. Homer, H. Gregory, W. G. Overend and L. F. Wiggins, *J. Chem. Soc.*, 2195 (1948).

[16] Geistlich Sochne, A. G. Fuer, Chemische Industrie Belgique, 628, 255, May 29 (1963); British Application Feb 12 (1962); *Chem. Abstr.*, **60**, 1451b (1964).

[17] H. Jahine, H. A. Zaher, Y. Akhnookh and Z. El-Gendy, *Indian J. Chem.*, **16B**, 689 (1978).

[18] K. T. Potts and C. Lovelette, *J. Org. Chem.*, **34**, 3221 (1969).