SPIROHETEROCYCLIC SYSTEMS: PART I: SYNTHESIS OF SOME NEW SPIROHETEROCYCLES RELATED TO 1-OXA-4-THIASPIRO[4,4]NONAN-2-ONE AND/OR [4,5]DECAN-2-ONE

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Spiro derivatives exhibit photochromic properties, biological and optical activities[1,2]. As continuation to our previous work[3 - 5], we report herein the synthesis of some new spirothiazolopyrazoles *VIIa*, *VIIb*, *IXa*, *IXb*, spirothiazoloisoxazoles *VIIIa*, *VIIIb*, spirothiazolopyrimidinones *Xa*, *Xb* and spirothiazolothiopyrimidinones *XIa*, *XIb*.

EXPERIMENTAL

All melting points are uncorrected. IR spectra were recorded on a Pye-Unicam SP 200-G spectrophotometer, ^{1}H NMR spectra were measured on EM-360 90-MHz spectrometer. Elemental analyses were determined on Perkin–Elmer 240 C microanalyser.

1-Oxa-4-thiaspiro[4,4]nonan-2-one (*I*) and 1-Oxa-4-thiaspiro[4,5]decan-2-one (*II*)

A mixture of cyclopentanone or cyclohexanone (0.1 mol), thioglycolic acid (0.1 mol) and *p*-toluenesulfonic acid (200 mg) in dry benzene (300 ml) was refluxed for 5 h on water bath, whereby the liberated water was removed by a water separator. The reaction mixture was cooled to room temperature, benzene was removed under reduced pressure and the oily residue was left at room temperature for one week to give solid product. The product was treated with diethyl ether to form a crystalline compound. The pure product was collected by filtration. Compound *I*: ^{1}H NMR spectrum ($(CD_3)_2SO$): 1.3 – 1.8 m, 4 H; 2.0 – 2.2 m, 4 H; 3.80 s, 12 H. IR spectrum (KBr): 675 (C–S); 1 265, 1 320 (C=O); 1 710 (C=O); 2 920 (C–H aliph.). Compound *II*: ^{1}H NMR spectrum ($(CD_3)_2SO$): 1.7 – 1.9 m, 6 H; 2.0 – 2.2 m, 4 H; 3.90 s, 2 H. IR spectrum (KBr): 700 (C–S); 1 265, 1 320 (C–O); 1 695 (C=O); 2 930 (C–H aliph.).

1-Thia-4-alkyl(aryl)azaspiro[4,4]nonan-3-ones (*IIIa – IIId*) and 1-Thia-4-alkyl(aryl)azaspiro[4,5]-decan-3-ones (*IVa – IVd*)

General procedure: A mixture of the spiro derivatives *I* or *II* (0.01 mol) and respective amine (0.01 mol) in absolute ethanol (100 ml) was stirred at room temperature or refluxed on a water bath. The reaction mixtu-

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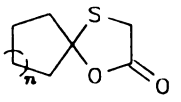
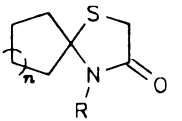
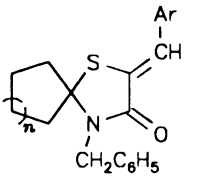
re was cooled, concentrated by distillation under reduced pressure and the product was collected by filtration and crystallized from a proper solvent (Table I). ^{1}H NMR ($(CD_3)_2SO$): 1.8 m, 4 H; 2.2 m, 4 H; 3.7 s, 2 H; 4.0 s, 2 H; 7.0 – 7.5 m, 5 H arom. for compound *IIIa* and 1.6 – 1.9 m, 6 H; 2.0 – 2.4 m, 4 H; 3.7 s, 2 H; 7.0 – 7.60 m, 5 H arom. for compound *IVa*. IR spectrum (KBr): 710 (C–S); 1 685 (C=O); 2 920 (C–H aliph.); 3 050 (C–H arom.) for *IIIa* and 675 (C–S); 1 695 (C=O); 2 825 (C–H aliph.); 3 020 (C–H arom.) for *IVa*.



I, $n = 1$
II, $n = 2$



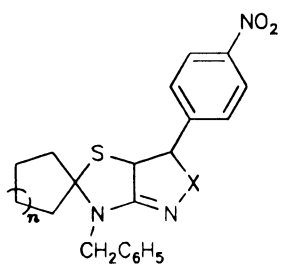
IIIa–IIId, $n = 1$
IVa–IVd, $n = 2$

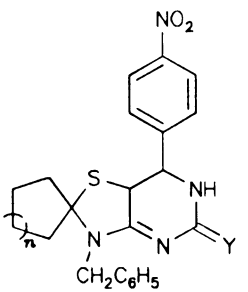


Va–Vd, $n = 1$
VIa–VId, $n = 2$

In formulae *III*, *IV* :
a, R = $C_6H_5CH_2$
b, R = C_6H_5
c, R = CH_3
d, R = $(CH_3)_2CHCH_2$

In formulae *V*, *VI* :
a, Ar = 4-$NO_2C_6H_4$
b, Ar = 4-ClC_6H_4
c, Ar = 4-$CH_3OC_6H_4$
d, Ar = C_6H_5





VII, X = NH
VIII, X = O
IX, X = NC_6H_5

X, Y = O
XI, Y = S

In formulae *VII–XI* : *a*, $n = 1$
b, $n = 2$

TABLE I
Physico-chemical data of compounds *I* – *XI*

Compound	M. p., °C Yield, %	Formula (M. w.)	Calculated/Found			
			% C	% H	% N	% S
I	130 – 132[a] 90	$C_7H_{10}O_2S$ (158.2)	53.16 53.11	6.32 6.29	– –	20.25 20.11
II	142 – 144[a] 95	$C_8H_{12}O_2S$ (172.3)	55.81 55.71	6.97 6.88	– –	18.60 18.51
IIIa	160 – 162[b] 95	$C_{14}H_{17}ONS$ (247.4	68.01 68.00	6.88 6.81	5.66 5.61	12.95 12.81
IIIb	85 – 87[b] 85	$C_{13}H_{15}ONS$ (233.3)	66.95 66.81	6.43 6.31	6.00 5.89	13.73 13.61
IIIc	90 – 92[b] 85	$C_8H_{13}ONS$ (171.3)	56.14 56.00	7.60 7.51	8.18 8.11	18.71 18.61
IIId	115 – 117[b] 80	$C_{11}H_{19}ONS$ (213.4)	61.97 61.81	8.92 8.79	6.57 6.42	15.02 15.00
IVa	115 – 117[b] 80	$C_{15}H_{19}ONS$ (261.4)	68.96 68.81	7.27 7.11	5.36 5.22	12.26 12.11
IVb	105 – 107[c] 85	$C_{14}H_{17}ONS$ (247.4)	68.01 68.00	6.88 6.71	5.66 5.51	12.95 12.81
IVc	120 – 122[c] 82	$C_9H_{15}ONS$ (185.3)	58.37 58.12	8.10 8.00	7.56 7.49	17.29 17.11
IVd	127 – 129[b] 88	$C_{12}H_{21}ONS$ (227.4)	63.43 63.32	9.25 9.17	6.16 6.09	14.09 14.00
Va	110 – 112[d,f] 90	$C_{21}H_{20}O_3N_2S$ (380.5)	66.31 66.21	5.26 5.16	7.36 7.26	8.42 8.41
Vb	145 – 147[d,f] 78	$C_{21}H_{20}ONSCl$ (369.9)	68.29 68.00	5.42 5.31	3.79 3.61	8.67 8.57
Vc	140 – 142[e,f] 85	$C_{22}H_{23}O_2NS$ (365.5)	72.32 71.29	6.30 6.21	3.83 3.71	8.76 8.61
Vd	135 – 137[e,f] 80	$C_{21}H_{21}NOS$ (335.5)	75.22 75.11	6.26 6.19	4.17 4.11	9.55 9.41
VIa	165 – 167[e,g] 90	$C_{22}H_{22}O_3N_2S$ (394.5)	67.00 66.81	5.58 5.49	7.10 7.00	8.12 8.10

TABLE I
(*Continued*)

Compound	M. p., °C Yield, %	Formula (M. w.)	Calculated/Found			
			% C	% H	% N	% S
VIb	159 – 160[c,f] 86	$C_{22}H_{22}ONSCl$ (383.9)	68.92 68.88	5.74 5.69	3.65 3.61	8.35 8.21
VIc	165 – 167[c] 85	$C_{23}H_{25}O_2NS$ (379.5)	72.82 72.71	6.59 6.49	3.69 3.59	8.44 8.41
VId	163 – 165[e] 82	$C_{22}H_{23}NOS$ (349.5)	75.64 75.51	6.59 6.49	4.01 4.00	9.16 9.00
VIIa	255 – 257[c,f] 80	$C_{21}H_{22}O_2N_4S$ (394.5)	63.95 63.87	5.58 5.54	14.21 14.11	8.11 8.11
VIIb	270 – 272[b,f] 84	$C_{22}H_{24}O_2N_4S$ (408.5)	64.70 64.61	5.88 5.78	13.72 13.61	7.84 7.71
VIIIa	127 – 130[c,f] 67	$C_{21}H_{21}O_3N_3S$ (395.5)	63.79 63.61	5.31 5.27	10.63 10.51	8.10 8.00
VIIIb	130 – 133[b,f] 70	$C_{22}H_{23}O_3N_3S$ (409.5)	64.54 64.39	5.62 5.51	10.26 10.11	7.82 7.69
IXa	115 – 117[b,f] 70	$C_{27}H_{26}O_2N_4S$ (470.6)	68.93 68.70	5.53 5.41	11.91 11.81	6.80 6.70
IXb	120 – 122[b,f] 75	$C_{28}H_{28}O_2N_4S$ (484.6)	69.42 69.32	5.78 5.62	11.57 11.43	6.61 6.51
Xa	173 – 175[b,f] 67	$C_{22}H_{22}O_3N_4S$ (422.5)	62.55 62.45	5.21 5.11	13.27 13.17	7.58 7.48
Xb	135 – 137[c,f] 65	$C_{23}H_{24}O_3N_4S$ (436.5)	63.30 63.10	5.5 5.3	12.84 12.61	7.33 7.23
XIa	150 – 152[c,f] 60	$C_{22}H_{22}O_2N_4S_2$ (438.6)	60.27 60.10	5.02 5.00	12.78 12.61	14.61 14.40
XIb	110 – 112[b,f] 55	$C_{23}H_{24}O_2N_4S_2$ (452.6)	61.06 61.00	5.30 5.22	12.38 12.31	7.07 7.00

Crystallized from [a] water, [b] ethanol, [c] methanol, [d] water/ethanol, [e] ether, [f] decomposes, [g] sublimes.

2-Arylidine-1-thiabenzylazaspiro[4,4]nonan-3-ones (*Va – Vd*) and 2-Arylidine-1-thia-4-benzylazaspiro[4,5]decan-3-ones (*VIa – VId*)

General procedure: A mixture of *IIIa* or *IVa* (0.01 mol) and the aromatic aldehyde (0.012 mol) was fused for 5 min in bath heated at 150 °C to give an oily product which was left overnight to afford crude solid product. The crude product was triturated with diethyl ether and collected by filtration. ^{1}H NMR ($(CD_3)_2SO$): 1.3 – 2.2 m, 4 H; 3.7 s, 2 H; 6.9 s, 1 H; 7.0 – 7.78 m, 9 H arom. for compound *Va* and 1.7 – 1.9 m, 6 H; 2.0 – 2.4 m, 4 H; 3.7 s, 2 H; 6.8 s, 1 H; 7.0 – 7.9 m, 9 H arom. for compound *VIa*. IR spectrum (KBr): 700 (C–S); 1 690 (C=O); 2 880 (C–H aliph.); 3 080 (C–H arom.).

Synthesis of Spiroheterocycles *VII – XI*

General procedure: A mixture of *Va* or *VIa* (0.001 mol) and respective reagent (hydrazine sulfate, hydroxylamine, phenylhydrazine, urea and thiourea, respectively) (0.001 mol) in a mixture of ethanol–pyridine (1 : 1, 50 ml) was refluxed for 2 h. The reaction mixture was cooled, concentrated, diluted with cold water whereby the desired product was precipitated and crystallized from the suitable solvent.

Compound *VIIa*: ^{1}H NMR ($(CD_3)_2SO$): 1.3 – 1.8 m, 4 H; 2.0 – 2.2 m, 4 H; 3.8 s, 2 H; 8.1 s, 1 H; 4.3 d, 2 H; 7.0 – 7.8 m, 9 H complex. IR spectrum (KBr): 720 (C–S); 1 350, 1 225 ($-NO_2$); 1 600 (C=N); 2 900 (C–H aliph.); 3 202 (C–H arom.); 3 200 (NH).

Compound *VIIIb*: ^{1}H NMR ($(CD_3)_2CO$): 1.5 – 1.9 m, 6 H; 2.0 – 2.2 m, 4 H; 3.7 s, 2 H; 4.0 d, 2 H; 7.0 – 7.8 m, 9 H complex. IR spectrum (KBr): 710 (C–S); 1 356, 1 525 ($-NO_2$); 1 600 (C=N); 2 880 (C–H aliph.); 3 020 (C–H arom.).

Compound *IXa*: ^{1}H NMR ($(CD_3)_2SO$): 1.3 – 1.7 m, 4 H; 2.0 – 2.2 m, 4 H; 3.7 s, 2 H; 4.3 d, 2 H; 7.0 – 8.2 m, 14 H complex. IR spectrum (KBr): 700 (C–S), 1 356, 1 525 ($-NO_2$), 1 600 (C=N), 2 890 (C–H aliph.), 3 030 (C–H arom.).

Compound *Xb*: ^{1}H NMR ($(CD_3)_2SO$): 1.3 – 1.9 m, 6 H; 2.0 – 2.2 m, 4 H; 3.8 s, 2 H; 8.1 s, 1 H; 4.2 d, 2 H; 7.0 – 8.0 m, 9 H complex.

Compound *XIa*: ^{1}H NMR ($(CD_3)_2SO$): 1.4 – 1.7 m, 4 H; 2.0 – 2.2 m, 4 H; 3.7 s, 2 H; 8.1 s, 1 H; 4.3 d, 2 H; 7.0 – 7.9 m, 9 H complex. IR spectrum (KBr): 700 (C–S); 1 110 (C=S); 1 350, 1 525 (NO_2); 2 850 – 2 870 (C–H aliph.); 3 030 (C–H arom.).

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