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NOVEL SYNTHESIS OF 1,2-DIHYDRO-4*H*-3,1-BENZOXAZINE-4-THIONES BY THE REACTION OF NEWSYNTHESIZED METHYL DITHIOANTHRANILATE HYDROBROMIDE WITH CARBONYL COMPOUNDS AND THE SYNTHESIS OF ANOTHER NEW CLASS OF 1,2-DIHYDRO-4*H*-3,1-BENZOTHIAZINE-4-THIONES FROM THE SAME REACTANTS IN THE PRESENCE OF EXCESS SODIUM HYDROGENSULFIDE

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Abstract — Methyl dithioanthranilate hydrobromide (**6**) was synthesized by the deprotection of *Z*-protected methyl dithioanthranilate (**5**) which was obtained by treatment of *Z*-protected methylthioiminium iodide **4** with H_2S. The 1,2-dihydro-4*H*-3,1-benzoxazine-4-thiones **10a-m** were first synthesized by the reaction of methyl dithioanthranilate hydrobromide (**6**) with each aldehyde or ketone. Formaldehyde, in this reaction, gave *N*-(methylthio)methyl-4*H*-3,1-benzoxazine-4-thione (**11**). Another new class of 1,2-dihydro-4*H*-3,1-benzothiazine-4-thiones **12a-e** were synthesized from the same reactants in the presence of two equivalents of sodium hydrogensulfide.

INTRODUCTION

To the best of our knowledge, neither free dithioanthranilic acid (2-aminodithiobenzoic acid) nor its alkyl or aryl ester has been synthesized so far. Stable 3-amino-2,3-unsaturated alicyclic dithiocarboxylic acids, such as 2-aminocyclopent-1-ene-1-dithiocarboxylic and -cyclohex-1-ene-1-dithiocarboxylic acids were first synthesized by Takeshima and co-workers.[1,2]

Muraoka et al. also reported the synthesis of stable 3-amino-2-cyanodithiocrotonic acid, the parent

3-amino-2-cyanodithiocinnamic acid and its homologous dithioacids bearing an alkyl substituent on the aromatic ring.[3]

Reactions of 3-amino-2,3-unsaturated alicyclic dithiocarboxylic acids, 3-amino-2-cyanodithiocrotonic and -2-cyanodithiocinnamic acids with carbonyl compounds, carbon disulfide, or phenyl isothiocyanate to give 1,3-thiazine-6-thiones[2,4,5-7] or -2,6-dithiones[4,8,9] have been reported by Takeshima, Muraoka, and their co-workers. Unstable 2-thioxodithiocarboxylic acids generated during the procedure of reaction mixture were oxidized by air to give 1,2-dithiol-3-thiones.[9] Subsequently 1,2,4-trithiols were formed by the oxidation of stable 2-imino-1-dithiocarboxylic acids with I_2.[2,3] The 1,3-dithietanes[2,3] were produced by the intramolecular elimination of H_2S with DCC or upon heating to about 70 °C. The 1,3-benzodithiols[2,3,6] were produced by the reaction of these dithiocarboxylic acids with picryl chloride. Pyrazole derivatives[6] were also obtained when the iminodithiocarboxylic acids were treated with hydrazine.

In addition to the above-mentioned reactions of the dithioacids to form various heterocyclic compounds, addition reactions of 2-aminocyclopent-1-ene-1-dithiocarboxylic acid to strongly electrophilic olefins to form stable dithioesters were also reported.[10]

No further studies regarding the synthesis of heterocyclic compounds using 3-amino-2,3-unsaturated alicyclic dithiocarboxylic acids or 3-amino-2-cyanodithiocinnamic acids have thus been reported for over 36 years until we began to study the synthesis and reactions of methyl dithioanthranilate.

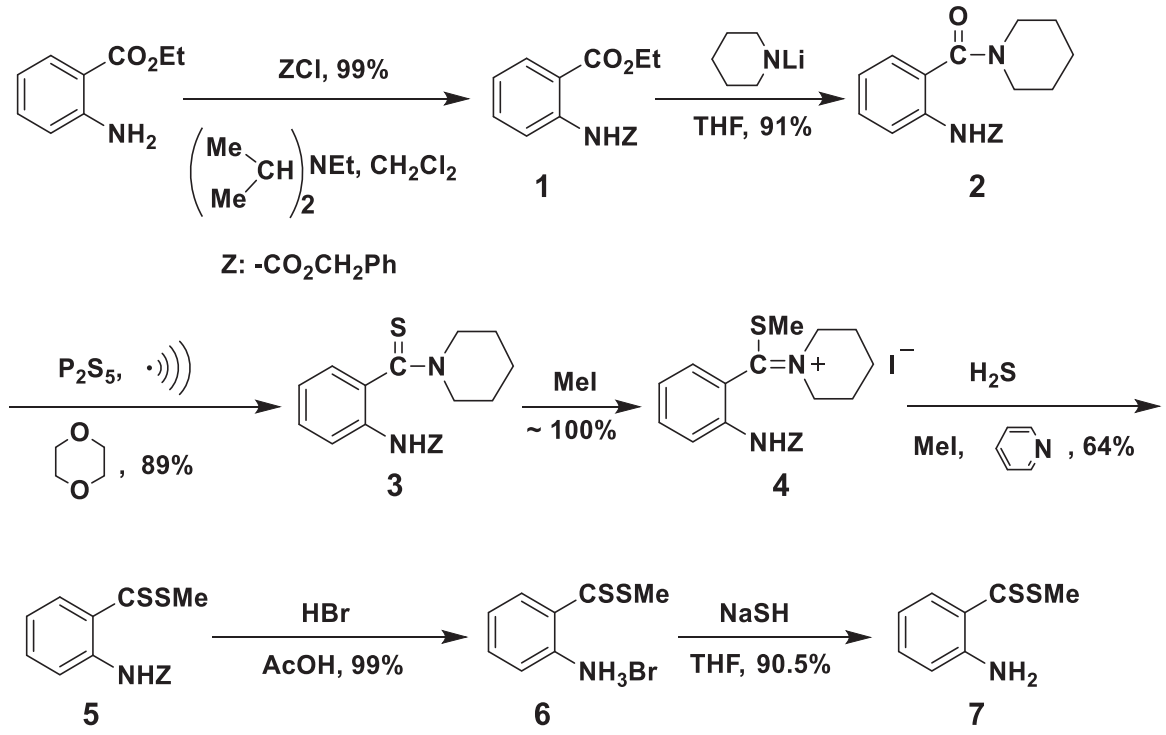
Dithioanthranilic acid is considered to be a special case of 3-amino-2,3-unsaturated dithiocarboxylic acids, and is expected to give rise to some new types of heterocyclic compounds fused to benzene ring by allowing it to react with electrophilic reagents such as carbonyl compounds.

Jourdan and co-workers[11] reported the formation of sodium dithioanthranilate by the reaction of 2-aminobenzotrifluoride with sodium sulfide in boiling dimethyl sulfoxide, but they isolated neither free dithioanthranilic acid nor any of its esters. The synthesis of the regioisomer of methyl dithioanthranilate, methyl 4-aminodithiobenzoate, which is utilized as a precursor compound for dyeing keratin fibers, was reported by Leon and co-worker.[12] Mckinnon and co-workers reported the synthesis of *N*-methyl derivative of methyl dithioanthranilate.[13]

RESULTS AND DISCUSSION

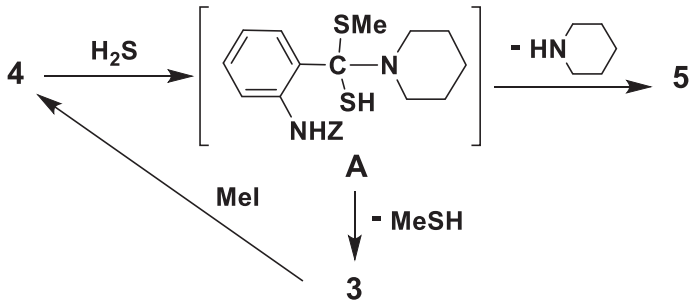
We are strongly interested in the physical and chemical properties and reactions of dithioanthranilic acid and its ester with electrophiles. These do not seem to be any way to introduce dithiocarboxyl group to the

2-position of aniline and vice versa. Alkyl dithioanthranilate is expected to be useful as a reagent for the synthesis of N,O- or N,S-containing fused heterocyclic compounds. Therefore, we converted ethyl anthranilate into methyl dithioanthranilate hydrobromide (**6**) to use as a starting material for synthesizing N,O- or N,S-containing fused heterocyclic compounds (**Scheme 1**).



Scheme 1

Thus, Z-protected ethyl anthranilate **1** was *tert*-amidated by treating it with lithium piperidide. Then, the *tert*-amide **2**[14] was changed to the thioamide **3** by sulfurization with diphosphorus pentasulfide in 1,4-dioxane under Ar-bubbling and ultrasonic irradiation.[15] Purified thioamide **3** was dissolved in iodomethane and converted into 2-benzyloxycarbonylamino(α-methylthio)benzylidenepiperidinium iodide (**4**). This salt **4** was then dissolved in pyridine and to this solution was added iodomethane. H_2S gas continued to be passed through the solution until the solution no longer absorbed the gas. Some amount of thioamide **3** was inevitably reproduced on preparation of Z-protected methyl dithioanthranilate (**5**). The yield of compound **5** was improved a little by adding iodomethane to the solution of the salt **4** through partial re-formation of compound **4** from the thioamide **3** formed by the elimination of methanethiol from intermediate **A** (**Scheme 2**).

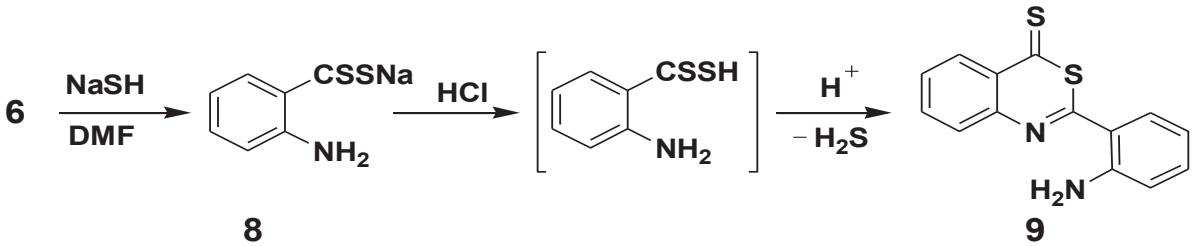


Scheme 2

Methyl dithioanthranilate (**7**) was obtained by neutralizing the hydrobromide **6** with sodium hydrogensulfide and its structure was confirmed by the IR, ^{1}H- and ^{13}C NMR spectra as well as its elemental analysis. Both the NMR and IR spectra of compounds **3**, **5**, and **6** were in good agreement with the proposed structures for these compounds.

The formation of sodium dithioanthranilate (**8**) in *N,N*-dimethylformamide was attained by allowing a solution of compound **6** and two equivalents of sodium hydrogensulfide in *N,N*-dimethylformamide to stand overnight with gently warming under Ar. The existence of sodium dithioanthranilate **(8)** in the solution was confirmed by the intense bluish purple coloration upon the addition of one drop of very dilute aqueous Ni(II)$(NO_3)_2$ or Ni(II)Cl_2 to a highly diluted solution of the reaction mixture with acetone. This coloration indicates that the dithiocarboxyl group and amino group are at ortho positions to each other on benzene ring and form a chelate-type complex with Ni(II) ion. Similar deep purple complex formations were observed whenever one drop of dilute aqueous Ni(II)$(NO_3)_2$ was added to highly diluted alcoholic or acetonic solution of each alicyclic α-amino-α,β-unsaturated dithiocarboxylic acid.[1,3,16]

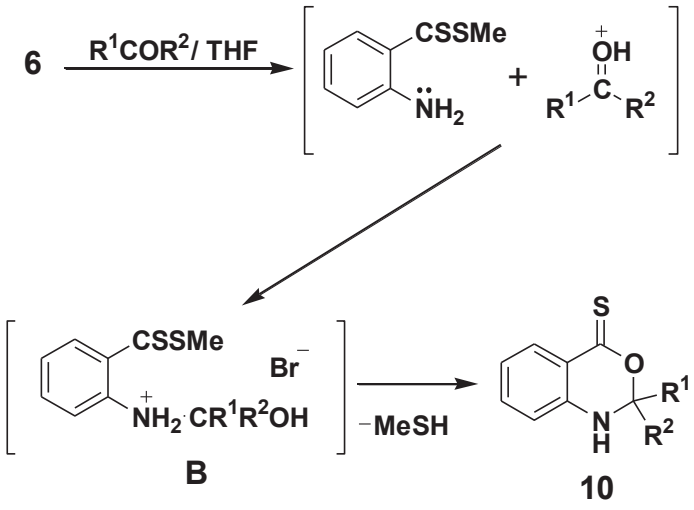
Aiming to obtain free dithioanthranilic acid, dilute hydrochloric acid was added to a solution containing sodium dithioanthranilate in aqueous *N,N*-dimethylformamide, but no trace of dithioanthranilic acid was found. Instead, 2-(2-aminophenyl)-4*H*-3,1-benzothiazine-4-thione (**9**) was isolated by immediate decomposition of the generated dithioanthranilic acid (**Scheme 3**).



Scheme 3

Jourdan and co-workers first reported the formation and isolation of compound **9** in high yield upon the acidification of the reaction mixture obtained by the reaction of 2-aminobenzotrifluoride with sodium

sulfide in dimethyl sulfoxide.[11] They did not try to obtain any alkyl esters of dithioanthranilic acid, but applied the reaction mixture containing sodium dithioanthranilate to the synthesis of trithioisatoic anhydride and isothiazole derivatives.



	R^1	R^2	Yields(%)
10a	H	Me	74
10b	H	Et	61
10c	H	Ph	65
10d	H	*p*-MeC_6H_4	37
10e	H	*p*-$MeOC_6H_4$	52
10f	H	1-$C_{10}H_7$	54
10g	H	2-$C_{10}H_7$	50
10h	Me	Me	57
10i	Me	Et	88
10j	Et	Et	57
10k	Me	Ph	57
10l	$(CH_2)_4$		7
10m	$(CH_2)_5$		43

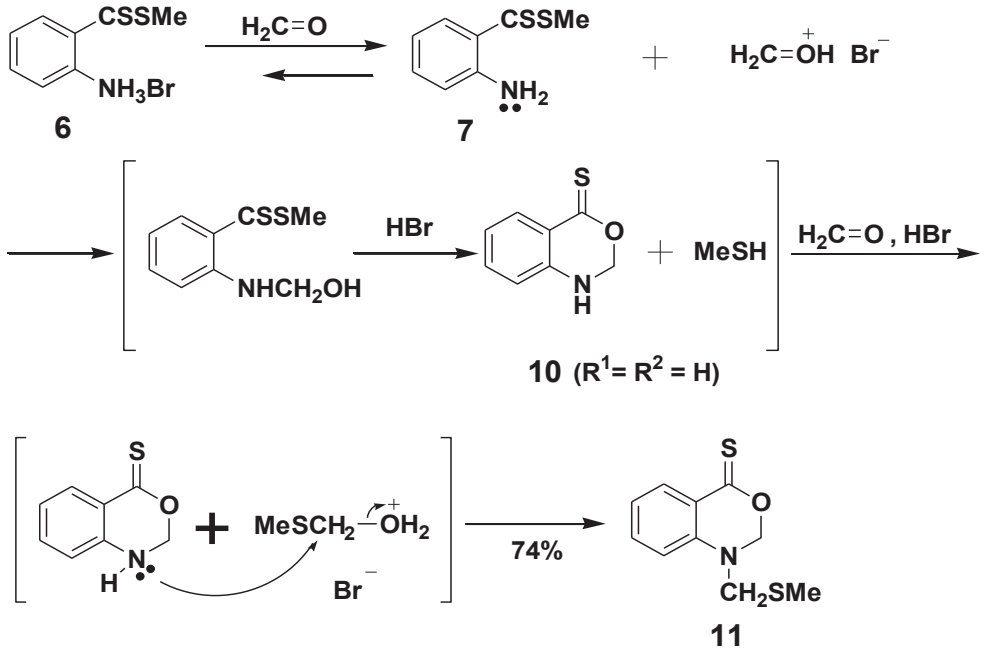
Scheme 4

When methyl dithioanthranilate hydrobromide (**6**) was refluxed with each aldehyde or ketone in tetrahydrofuran or methanol, 2-substituted or 2,2-disubstituted 1,2-dihydro-4*H*-3,1-benzoxazine-4-thiones **10a-m** were obtained as a new series of heterocyclic compounds fused with benzene ring**.**

These benzoxazine-4-thiones **10a-m** were probably formed via the cyclization of intermediates **B**, which may have arisen from the addition of deprotonated methyl dithioanthranilate to a protonated carbonyl compound formed by proton transfer (**Scheme 4**).

It is somewhat curious that cyclopentanone afforded 4-thioxo-1,2-dihydro-4*H*-3,1-benzoxazine-2-spirocyclopentane (**10l**) in very low yield. One explanation for this abnormally low yield may be that the proton transfer from the hydrobromide **6** to cyclopentanone would be difficult, and another one for the extraordinary low yield is that the amino group of free methyl dithioanthranilate is very weak nucleophile and is slow to add to the carbonyl of protonated cyclopentanone, which is more planar and having less space for the reaction to take place than that of cyclohexanone. By these reasons, the majority of the intermediate B would decompose before the formation of the benzoxazine **10**l.

In the reaction of methyl dithioanthranilate hydrobromide (**6**) with formaldehyde, the parent 1,2-dihydro-4*H*-3,1-benzoxazine-4-thione was never formed, but only *N*-(methylthio)methyl-1,2-dihydro-4*H*-3,1-benzoxazine-4-thione (**11**) was obtained.



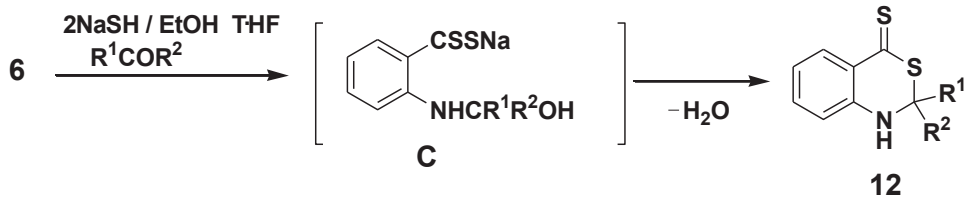
Scheme 5

The route for forming *N*-(methylthio)methylbenzoxazinethione **11** was arbitrarily proposed as follows: formaldehyde reacted first with the hydrobromide **6** to give parent 1,2-dihydoro-4*H*-3,1-benzoxazine-4-thione (**10**; R^1=R^2=H), but the excess formaldehyde existing *in situ* is so reactive that it also reacted with methanethiol liberated from the protonated intermediate **B** (in this case, R^1=R^2=H) to form protonated methylthiomethanol, which reacted rapidly with the parent 4*H*-3,1-benzoxazine-4-thione to give *N*-(methylthio)methylbenzoxazine-4-thione **11** (**Scheme 5**).

On the other hand, when a mixture of methyl dithioanthranilate hydrobromide (**6**) was warmed with equimolar aromatic aldehyde or an aliphatic ketone and two equivalents of sodium hydrogensulfide in mixed solvent of ethanol and tetrahydrofuran, another new class of fused heterocyclic compounds, 2-substituted or 2,2-disubstituted 1,2-dihydro-4*H*-3,1-benzothiazine-4-thiones **12a-e**, were obtained as deep red to reddish orange products in relatively high yields. Salem and Soliman first reported 2-[4-(chlorobenzoyl)vinyl]-4*H*-3,1-benzothiazine-4-thione[17] which corresponds to an example of dehydro type derivative of 1,2-dihydro-4*H*-3,1-benzothiazine-4-thiones synthesized by us.

Compared with high to medium yields of compounds **12a-d**, the yield of compound **12e** is below 50% and is markedly lower than that of compound **12d**. This large difference may be the steric hindrance of ethyl group of the reactant, ethyl methyl ketone. Each step of the reaction forming the intermediate C and intramolecular cyclization of the intermediate C by losing water would be, therefore, slow and this may lead to lowering the yield of compound **12e**.

These benzothiazine-4-thione derivatives **12a-e** may have been yielded via intermediates **C**, which were formed by the hydrolysis of methyl dithioanthranilate with sodium hydrogensulfide (**Scheme 6**).



	R^1	R^2	yields(%)
12a	H	Ph	76
12b	H	*p*-MeC_6H_4	69
12c	H	*p*-$MeOC_6H_4$	59
12d	Me	Me	90
12e	Me	Et	47

Scheme 6

The ^{1}H- and ^{13}C NMR and IR spectra of the 4*H*-3,1-benzoxazinethiones **10a-m,** *N*-(methylthio)methyl-1,2-dihydro-4*H*-3,1-benzoxazinethione **11,** and -benzothiazinethiones **12a-e** were all in good agreement with the proposed structures (**See EXPERIMENTAL**).

EXPERIMENTAL

Melting points were determined on a Mettler FP62 and a Yanagimoto MP-J melting point apparatuses and are uncorrected. NMR spectra were taken on a Nihondenshi model JEOL EX270 spectrometer and IR spectra were obtained with a Nihonbunko (JASCO) FT/IR-5000 spectrometer.

Low-pressure chromatographic separations were achieved by utilizing Oyobunko UVLOG/ALPC-100. Pure anhydrous sodium hydrogensulfide was obtained by recrystallizing reagent grade NaSH・nH_2O (Wako) from ethanol and diethyl ether and then by drying the resulting pure NaSH・nH_2O crystals over silica gel in vacuo.

Diphosphorus pentasulfide (Aldrich) was used as purchased. All solvents such as benzene, Et_2O, THF, and CH_2Cl_2 were distilled just before use.

Ethyl *N*-benzyloxycarbonylanthranilate (1). To a stirred solution of ethyl anthranilate (1.652 g, 10 mmol) and ethyldi- isopropylamine (3.87 g, 30 mmol) dissolved in 50 mL of CH_2Cl_2, was added benzyl chloroformate (2.56 g, 15 mmol) dropwise at 0 °C. The resulting mixture was continued to warm at 30 °C for 19 h. After 100 mL of saturated aqueous NH_4Cl solution was added to the cooled reaction mixture, the solution was extracted three times with each 30 mL of CH_2Cl_2. The combined CH_2Cl_2 extract was dried

($MgSO_4$), and evaporated in vacuo to give reddish viscous residue. Ethyl anthranilate remaining in the viscous residue was removed in vacuo at 130 °C. The solidified residue (2.95 g, 98.6%) was washed with cooled EtOH, then was recrystallized from hot EtOH to give white crystals of compound **1**; mp 25.5-28.0 °C ; IR (KBr) : 3297 (NH), 1738 (Ph-COO), 1690 (NHCOO) cm^{-1}. ^1H NMR ($CDCl_3$) : δ 10.64 (br. s, NH), 8.47 (d,1H, *J*=7.5 Hz, 6-H), 8.01 (d, *J*=7.5 Hz, 1H, 3-H), 7.35 (m, 5H, phenyl protons), 7.02 (t, 1H, *J*=7.5 Hz, 4-H), 5.20 (s, 2H, N-CH_2), 4.34 (q, 3H, *J*=7.3 Hz, OCH_2), 1.37 ppm (t, 3H, *J*=7.3 Hz, CH_3). Anal. Calcd for $C_{17}H_{17}N\,O_4$: C, 68.21; H, 5.73; N, 4.68. Found: C, 68.50; H, 5.64; N, 4.50.

***N*-Benzyloxycarbonylanthraniloyl piperidine (2).** To ice-cooled solution of butyllithium (4.48 g, 70 mmol) in THF (120 mL), was added dropwize piperidine (6.13 g, 72 mmol) diluted with THF (20 mL), and to this mixture was added ethyl *N*-benzyloxycarbonylanthranilate (5.99 g, 20 mmol) in THF (40 mL) at -15 °C. The mixture was kept for 2 h at -15 °C and kept for an additional 1 h at 0 °C under Ar, then MeOH (20 mL) was added to this reaction mixture. After adding saturated aqueous NH_4Cl solution (400 mL) to the subsequent mixture at 0 °C, the water layer, which was separated, was extracted with Et_2O (120 mL×3). The combined Et_2O extract was dried ($MgSO_4$), evaporated in vacuo to give yellow oil, which was column-chromatographed [silica gel (Fuji-Davison, BW-350), EtOAc-hexane:1:4] to give 5.46 g (91.2%) of pale yellow crystals of **2**. Recrystallization from CH_2Cl_2-hexane gave white crystals of Z-protected anthraniloyl piperidine (2); mp 71.8-74.6 °C.

***N*-Benzyloxycarbonylthioanthraniloyl piperidine (3).** A mixture of *N*-benzyloxycarbonylanthraniloyl piperidine (**2**) (1.69 g, 5 mmol) and diphosphorus pentasulfide (2.23 g, 5 mmol) in 1,4-dioxane (50 mL) was mechanically stirred under Ar and ultrasonic irradiation (24 kHz) at room temperature for 1 h. The resulting reaction mixture was continued to stir at 60 °C for 2 h under Ar. To a clear orange solution after removing the insoluble matters from the reaction mixture by filtration, was added water (100 mL) and the resulting aqueous solution was extracted with Et_2O (30 mL×3). The combined Et_2O extract was washed with water (100 mL), dried ($MgSO_4$), and evaporated in vacuo to give an oily matter**,** which was column-chromatographed [silica gel, (Fuji-Davison, BW-350), CH_2Cl_2] to give 4.75 g (89.4%) of greenish yellow crystals of compound **3**. Recrystallization from acetone-hexane gave white crystals of compound **3**; mp 101.5-102.0 °C ; IR (KBr): 3335 (NH), 3063, 2942, 2859, 1736 (C=O), 1584 and 1518 (aromatic ring conjugated with $R_2NC{=}S$), 1447, 1290, 1244, 1215, 980, 855, 745 cm^{-1}. Both CH_2 bonded to N-atom and neighboring CH_2 to it in piperidino group of compound **3** showed magnetic anisotropy by the restricted rotation of piperidino group in both ^1H- and ^{13}C NMR spectra. ^1H NMR ($CDCl_3$) : δ 7.95 (d, 1H, *J*=7.5 Hz, 6-H), 7.53 (br. s., 1H, NH), 7.33 (m, 6H, phenyl protons and 3-H), 6.98 (t, 1H, *J*=7.5 Hz,

4-H), 7.05 (t, 1H, *J*=7.5 Hz, 5-H), 5.20 and 5.15 (each d, *J*=9.5 Hz, CH_2Ph), 4.30 and 3.45 (m, 4H, N-CH_2×2), 1.74 and 1.63 (m, 4H, $NCH_2C\underline{H_2}$), 1.40 ppm (m, 2H, $NCH_2CH_2C\underline{H_2}$); ^{13}C NMR ($CDCl_3$) : δ 194.9 (C=S), 153.5 (C=O), 136.1-122.0 (9 peaks, phenyl carbons), 66.9, 53.0, 49.9, 26.8, 25.6, 24.0 ppm. Anal. Calcd for $C_{20}H_{22}O_2N_2S$: C, 67.76; H, 6.26; N, 7.90. Found: C, 67.63; H, 6.61; N, 8.07.

2-Benzyloxycarbonylamino-(α-methylthio)benzylidenepiperidinium iodide (4). *N*-Benzyloxy-carbonylthioanthraniloyl piperidine (1.77 g, 5 mmol) was dissolved in iodomethane (10 mL) and the solution was allowed to stand overnight at room temperature. The resulting solution did not show any other components than the iminium salt **4** by TLC check. Excess iodomethane was removed thoroughly in vacuo to give α-methylthiobenzylidene-piperidinium iodide **4** as yellow glassy solid in quantitative yield; mp 223 °C (decomposition). This compound could not be recrystallized from any solvents, but always separated as an oily matter); IR (KBr): 3433 (NH), 3150, 2944, 2863, 1722 (C=O), 1601, 1578, and 1516 cm^{-1}. Anal. Calcd for $C_{21}H_{25}O_2N_2SI$: C, 50.81; H, 5.08; N, 5.64; S, 6.46. Found: C, 50.38; H, 5.01; N, 5.65; S, 6.47.

Methyl *N*-benzyloxycarbonyldithioanthranilate (5). To a solution of 2-benzyloxycarbonylamino-α-methylthiobenzylidenepiperidinium iodide **4** (2.48 g, 5 mmol) in iodomethane (20 mL), was added pyridine (20 mL) and then hydrogen sulfide was babbled to this solution for 1 h at -15 °C, followed by stirring for an additional 1 h. After removing pyridine under reduced pressure, CH_2Cl_2 (100 mL) was added to the residue and the insoluble matter was filtered off. This CH_2Cl_2 extract was washed with water (50 mL×2), dried ($MgSO_4$), and evaporated in vacuo to yield orange to red oily matter, which was purified by flash column chromatography [silica gel (Fuji-Davison, BW-350), eluent; EtOAc-hexane: 1: 4] to give 1.02 g (64.3%) of orange oil of **5** and 0.49 g (25.5%) of Z-protected thioanthraniloyl piperidine (**3**). Fractional distillation with Kugelrohl in vacuo gave pure compound **5**; bp 186 °C (2.67 hPa); IR (potassium bromide) 3328 (NH), 3065 ,3032, 1736 (C=O), 1599, 1520, 1442, 1373, 1305, 1207, 1165, 1121, 1069, 1028, 889, 839, 756, 698 cm^{-1}; ^1H NMR ($CDCl_3$) : δ 8.95 (br. s, 1H, NH), 8.18 (d, 1H, *J*=7.5 Hz, 3-H), 7.55 (d, 1H, *J*=7.5 Hz, 6-H), 7.35 (m, 6H, phenyl protons and 4-H), 7.05 (t, 1H, *J*=7.5 Hz, 5-H), 5.15 (s, 2H, CH_2), 2.73 ppm (s, 3H, CH_3); ^{13}C NMR ($CDCl_3$) : δ 230.3 (C=S), 153.5 (C=O), 136.0-121.2 (9 peaks; phenyl carbons), 67.0, 20.9 ppm. Anal. Calcd for $C_{16}H_{15}NO_2S_2$: C, 60.54; H, 4.76; N, 4.41. Found: C, 60.27; H, 4.84; N, 4.47.

Methyl dithioanthranilate hydrobromide (6). To a solution of methyl *N*-benzyloxycarbonyl-dithioanthranilate (**5**) (1.60 g, 5 mmol) in acetic acid (25 mL), was added HBr in acetic acid (47%, 25 mL) dropwise at room temperature under mechanical stirring and the solution was stirred for additional

30 min. The solvent of the reaction mixture was evaporated in vacuo at 40 °C to leave crude solid, which was washed 3 times with Et_2O, dried (silica gel) to give 1.30 g (98.5%) of methyl dithioanthranilate hydrobromide (**6**) as orange solid (chromatographically pure). Recrystallization from 1-propanol and hexane gave orange crystals; mp 191.6 °C; IR (KBr): 3440 and 3325 (NH_2), 3063, 2990, 2821, 2724, 2535, 1555, 1483, 1252 1073, 1022, 905, 891, 760 cm^{-1}; ^1H NMR (DMF-d_6) : δ 7.77-7.49 (m, 4H, aromatic protons), 7.12 (s, 3H, NH_3^+), 2.85 ppm (s, 3H, SCH_3); ^{13}C NMR (DMF-d_6) : δ225 (C=S), 162, 161, 136, 134, 131, 122, 29 ppm. Anal. Calcd for $C_8H_{10}NS_2Br$: C, 36.37; H, 3.82; N, 5.30. Found: C, 36.32; H, 3.75; N, 5.18.

Methyl dithioanthranilate (7). An aqueous solution (15 mL) of pure methyl dithioanthranilate hydrobromide **(6)** (0.793 g, 3 mmol) was neutralized with aqueous sodium hydrogensulfide (ca. 1*M*), then extracted with Et_2O (20 mL×2). The combined Et_2O extract was dried ($MgSO_4$) and evaporated to dryness in vacuo to afford red viscous oil (chromatographically pure), yield 0.35 g (64%); IR (KBr) 3445 and 3325 (NH_2), 3063, 2938, 2855, 1612, 1586, 1480, 1451, 1213, 1163, 1015, 905, 889 and 750 cm^{-1}; ^1H NMR ($CDCl_3$) : δ 7.81 (dd, 1H, *J*=1 Hz and 7.6 Hz, 6-H), 7.19 (dt, 1H, *J*=1 Hz and 7.6 Hz, 4-H), 6.69 (d, 1H, *J*=7.6 Hz, 3-H), 6.67 (t, 1H, *J*=7.6 Hz, 5-H), 5.83 (br. s, 2H, NH_2), and 2.69 ppm (s, 3H, SCH_3); ^{13}C NMR ($CDCl_3$) : δ 227.9 (C=S), 145.9, 132.5, 128.9, 128.1, 117.9, 116.7, and 20.0 ppm.

Confirmation of Formation of Sodium dithioanthranilate (8). Methyl dithioanthranilate hydrobromide **(6)** (0.186 g, 1 mmol) was dissolved in DMF (10 mL) and to this was added sodium hydrogensulfide (0.19 g, 3.3 mmol) in DMF (10 mL) dropwise at 0 °C to give a black solution, which was warmed gradually to 40 °C. After 1 h, a drop of the solution was highly diluted with acetone and to this was added one drop of 0.1% aqueous $NiCl_2$. The solution was colored immediately to thick deep bluish purple, indicating the formation of a complex between Ni(II) ion and sodium dithioanthranilate **(8)**.

2-(2-Aminophenyl)-4*H*-3,1-benzothiazine-4-thione (9). After dilution of above reaction mixture with water (20 mL), the aqueous solution was washed with Et_2O (20 mL×5) to remove DMF thoroughly, and the aqueous layer was acidified (pH ca. 5) with 1*M*-HCl to separate red oily matter, which was extracted with Et_2O (20 mL×2). The combined Et_2O extract was dried ($MgSO_4$), evaporated in vacuo to afford red oil, which solidified on standing overnight, yield 0.145 g (49%). Recrystallization from hot EtOH gave red crystals of compound **9**; mp 152-153 °C; the δ values of ^1H NMR of compound **9** were in good agreement with those reported by Jourdan *et al.* ; ^{13}C NMR ($CDCl_3$) : δ 211 (C=S), 164, 148, 141, 136, 132, 130, 129, 128, 127, 126, 118, 117, 116 ppm; IR (KBr): 3420 and 3275 (NH_2), 1616, 1578, 1522, 1454, 1236, 1197, 1153, and 1013 cm^{-1}. Anal. Calcd for $C_{14}H_{10}N_2S_2$: C, 62.19; H,3.73; N, 10.36.

Found: C, 62.19; H, 3.75; N, 10.39.

General procedure for the synthesis of 2-substituted or 2,2-disubstituted 1,2-dihydro-4*H*-3,1-benzoxazine-4-thiones (10a-m). A mixture of 1 mmol of methyl dithioanthranilate hydrobromide (**6**), 1 to 2 mmol of appropriate aldehyde or ketone, and 10 mL of THF (for **10a-c,10e**) or MeOH (for **10f-g, 10k-l**) was refluxed at 66 °C for 24 h. The reaction mixture was cooled and then diluted with water (30 mL) and extracted with Et_2O (50 mL×3). The combined Et_2O extract was washed once with water (50 mL), dried ($MgSO_4$), evaporated, and the residue obtained was separated by chromatography (the residue was pre-absorbed on silica gel, eluent:1:10 C_6H_6-C_5H_{12}). Orange to yellow crystals of crude compounds **10** were recrystallized from benzene-pentane (**10c,e, h-m**) or -hexane (**10a,b,f,g**). For the synthesis of compound **10d**, EtOH was used as solvent and refluxed at 80 °C for 24 h. For the syntheses of 1,2-dihydro-4*H*-3,1-benzoxazine-4-thiones, **10h-j** and **10m,** each large excess of the corresponding ketone was used under refluxing at 60 to 80 °C for 24 h.

2-Methyl-l,2-dihydro-4*H*-3,1-benzoxazine-4-thione (10a). Paraldehyde was used in place of MeCHO for the synthesis of compound **10a**. Yellow crystals: yield 0.13 g (74%); mp 90.5-92 °C; IR (KBr) 3312 (NH), 3067, 2979, 2965, 2881, 1616, 1505 (hetero ring), 1481, 1280, 1119, 930, 760 cm^{-1}; ^1H NMR ($CDCl_3$): δ 7.92 (quasi d, 1H, *J*=6.8 Hz, 5-H), 7.40 (dd, 1H, *J*=1 Hz and 8.1Hz, 7-H), 6.85 (t, 1H, *J*=7.3 Hz, 6-H), 6.75 (dd, 1H, *J*=1 Hz and 8 Hz, 8-H), 5.22 (q, 1H, *J*=6.5 Hz, 2-H), 4.30（br s, 1H, NH, 1.65 ppm (d, 3H, *J*=6.5 Hz, CH_3); ^{13}C NMR ($CDCl_3$): δ 188 (C=S), 148.7, 134.8, 127.9, 120.6, 119.4, 117.6, 55.1, 20.9 ppm. Anal. Calcd for C_9H_9NOS: C, 60.31; H, 5.06; N, 7.82; S, 17.87. Found: C, 60.06; H, 4.79; N, 7.91; S,17.65.

2-Ethyl-l,2-dihydro-4*H*-3,1-benzoxazine-4-thione (10b). Orange viscous oil: yield 0.12 g (61%); IR (KBr) 3323 (NH), 3065, 2968, 2933, 2875, 1614, 1504, 1484, 1269, 1192, 1157, 1126, 932, 764 cm^{-1}; ^1H NMR ($CDCl_3$): δ 7.90 (dd, 1H, *J*=1.6Hz and 8.1Hz, 5-H), 7.31 (t, 1H, *J*= 8.1 Hz , 7-H), 6.80 (m, 2H, 6-H and 8-H), 5.01 (t, 1H, *J*=6.75 Hz, 2-H), 4.80 (br. s, 1H, NH), 2.02 (q, 2H, *J*=6.75 Hz, -CH_2-), 1.09 ppm (t, 3H, *J*=6.75Hz, CH_3); ^{13}C NMR ($CDCl_3$): δ 188.2 (C=S), 48.7, 134.9, 127.7, 120.6, 119.2, 117.7, 61.0, 28.2, 9.91 ppm. Anal. Calcd for $C_{10}H_{11}NOS$: C, 62.15, H,5.74; N,7.25: S,16.59. Found: C, 61.81; H,5.95, N,7.54, S,16.20.

2-Phenyl-l,2-dihydro-4*H*-3,1-benzoxazine-4-thione (10c). Yellow crystals: yield 0.16 g (65%); mp 163.5-164 °C; IR (KBr): 3310 (NH), 1615, 1599, 1481, 1275, 1155, 1103, 934, 770 cm^{-1}; ^1H NMR ($CDCl_3$): δ 7.92 (d,1H, *J*=8.1 Hz, 5-H), 7.60 (dd, *J*=1 Hz and 7.0 Hz, 7-H), 7.43-7.25 (m,5H, phenyl protons), 6.875 (t, 1H, *J*=7.6Hz, 6-H), 6.75 (d, 1H, *J*=8.1 Hz, 8-H), 6.18 (s, 1H, 2-H), 4.82 ppm (br. s, 1H,

NH); ^{13}C NMR ($CDCl_3$): δ 187.7 (C=S) 148.7, 136.5, 135.1, 129.9, 129.2, 128.3, 128.0, 127.6, 120.2, 119.7, 63.3 ppm. Anal. Calcd for $C_{14}H_{11}NOS$: C, 69.68; H, 4.59; N, 5.80; S, 13.29. Found: C, 69.70; H, 4.52; N, 5.70; S, 13.24.

2-(*p*-Tolyl)-l,2-dihydro-4*H*-3,1-benzoxazine-4-thione (10d). Yellow crystals: yield 0.095 g (37%); mp 137.5-138 °C; IR (KBr): 3267 (NH), 1599 (vs, phenyl and hetero ring), 1503, 1481, 1279, 1155, 1103, 936 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 7.90 (d, 1H, *J*=7.5 Hz, 5-H), 7.48 and 7.25 (each d, 4H, *J*=8.1 Hz, 2', 3' 5', 6'-protons), 7.35 (t, 1H, *J*=7.5 Hz, 7-H), 7.28 (d, 1H, *J*=7.5 Hz, 6-H), 6.86 (t, 1H, *J*=7.5 Hz, 8-H), 6.14 (s,1H, 2-H), 4.81 (br. s, 1H, NH), 2.40 ppm (s, 3H, CH_3); ^{13}C NMR ($CDCl_3$): δ 187.7 (C=S), 148.8, 140.0, 135.0, 129.8, 128.3, 128.0, 127.5, 120.2, 119.6, 117.5, 63.1, 21.3 ppm. Anal. Calcd for $C_{15}H_{13}NOS$: C, 70.56; H, 5.13; N, 5.49; S, 12.56. Found: C, 70.44; H, 5.05; N, 5.36; S, 12.84.

2-(*p*-Methoxyphenyl)-l,2-dihydro-4*H*-3,1-benzoxazine-4-thione (10e). Yellow crystals: yield 0.14 g (52%); mp 156.7-157.2 °C; IR (KBr): 3316 (NH), 1618, 1599, 1512, 1497, 1483, 1279, 1248, 1177, 1032, 936, 837, 768 cm^{-1}; ^{1}H NMR ($CDCl_3$): δ 7.75 (d, 2H, *J*=7.6 Hz, 2'-H and 6'-H); 7.59 (d, 2H, *J*=7.6 Hz, 5 and 8-H); 7.39 (t, 1H, *J*=7.6 Hz, 7-H); 7.03 (d, 3H, *J*=7.6.Hz, 3'-H, 5'-H, and NH)), 6.79 (t, 1H, *J*=7.6.Hz, 6-H), 6.35 (s, 1H, 2-H), 3.78 ppm (s, 3H, OCH_3); ^{13}C NMR ($CDCl_3$): δ 186.8 (C=S), 159.9, 150.1, 134.9, 129.0, 128.9, 126.7, 118.6, 117.9, 117.8, 114.0, 61.5, 55.2 ppm. Anal. Calcd for $C_{15}H_{13}NO_2S$: C, 66.40; H 4.83; N, 5.16: S, 11.82. Found: C, 66.38; H, 4.73; N, 5.13; S, 11.74.

2-(1-Naphthyl)-l,2-dihydro-4*H*-3,1-benzoxazine-4-thione (10f). Yellow crystals: **y**ield 0.16 g (54%); mp 210.5-212.4 °C; IR (KBr): 3280 (NH), 1623, 1597, 1499, 1481, 1277, 1193, 1109, 933, 782, 765 cm^{-1}; ^{1}H NMR (DMSO-d_6): δ 8.05-7.09 (m, 11H, aromatic protons), 6.85 (quasi s, 2-H), 6.17 ppm (br. s, 1H, NH); ^{13}C NMR (DMSO-d_6): δ 186.9 (C=S), 150.5, 135.0, 133.5, 132.2, 129.8, 129.7, 128.8, 128.2, 126.9, 126.4, 126.2, 125.3, 124.0, 118.7, 117.9, 59.8 ppm. Anal. Calcd for $C_{18}H_{13}NOS$: C, 74.20; H; 4.50; N, 4.81; S, 11.00. Found: C, 74.31; H, 4.63; N, 4.59; S, 10.96.

2-(2-Naphthyl)-l,2-dihydro-4*H*-3,1-benzoxazine-4-thione (10g). Yellow crystals: **y**ield 0.145 g (50%); mp 201.4-201.9 °C; IR (KBr): 3303 (NH), 1612, 1503, 1481, 1280, 1190, 1155, 1103, 934, 863, 826, 754 cm^{-1}; ^{1}H NMR (acetone-d_6): δ 8.01-6.83 (m, 11H, aromatic protons), 6.53 (s, 2-H), 6.17 ppm (s, 1H, 2-H). ^{13}C NMR (acetone-d_6): δ187.2 (C=S), 151.0, 135.9, 135.7, 134.6, 134.1, 129.6, 129.0, 128.6, 127.8, 127.7, 127.6, 125.7, 120.5, 119.5, 118.8, 63.8 ppm. Anal. Calcd for $C_{18}H_{13}NOS$: C, 74.20; H, 4.50; N, 4.81; S, 11.00. Found: C, 73.95; H, 4.55; N, 4.77; S, 10.78.

2,2-Dimethyl-l,2-dihydro-4*H*-3,1-benzoxazine-4-thione (10h). Orange crystals: yield 0.11 g (57%); mp 105.8-106.3 °C; IR (KBr): 3306 (NH), 1601, 1505, 1481, 1285, 1227, 1161, 934, 766 cm^{-1}; UV (EtOH)

λ_{max} 236.6 (log ε 4.30), 254 (sh, 3.87), 274.6 (sh, 3.54), 378.6 nm (3.48); ^{1}H NMR ($CDCl_3$): δ 7.80 (d ,1H, *J*=8.1 Hz, 5-H), 7.36 (t, 1H, *J*=7.0 Hz, 7-H), 6.79 (t, 1H, *J*=7.3 Hz, 6-H), 6.90 (d, 1H, *J*=8.1 Hz, 8-H), 6.50 (br. s, 1H, NH), 1.75 ppm (s, 6H, CH_3×2); ^{13}C NMR ($CDCl_3$): δ 187.3 (C=S), 149.1, 135.7, 127.5, 119.4, 118.9, 118.7, 64.1, 30.6 ppm. Anal. Calcd for $C_{10}H_{11}NOS$: C, 62.15, H,5.74; N,7.25: S,16.59. Found: C, 61.90; H,5.71, N,7.17, S,16.75.

2-Ethyl-2-methyl-l,2-dihydro-4*H*-3,1-benzoxazine-4-thione (10i). Orange crystals: yield 0.18 g (88%); mp 66.6-67.1 °C; IR (KBr): 3326 (NH), 3065, 2971, 2934, 2878, 1598, 1482, 1285, 1155, 1106, 955, 855, 764 cm^{-1}; UV (EtOH) λ_{max} 238 (log ε 4.34), 258 (sh,3.91), 273 (sh,3.63), 383 nm (3.52); ^{1}H NMR ($CDCl_3$): δ 7.90 (d, 1H, *J*=8.1 Hz, 5-H), 7.33 (t, 1H, *J*=7.0 Hz, 7-H), 7.26 (d, 1H, *J*=8.1 Hz, 8-H), 6.815 (t, 1H, *J*=7.3 Hz, 6-H), 4.59 (br. s, 1H, NH), 2.03 (m, 2H, CH_2Me), 1.69 (s, 3H, CH_3), 1.02 ppm (t, 3H, $CH_2C\underline{H_3}$); ^{13}C NMR ($CDCl_3$): δ 188.0 (C=S), 147.0, 135.1, 127.5, 119.4, 118.9, 117.9, 67.1, 35.4, 27.8, 9.0 ppm. Anal. Calcd for $C_{11}H_{13}NOS$: C, 63.74, H, 6.32; N, 6.76: S, 15.47. Found: C, 63.79; H,6.32; N,6.73; S,15.31.

2,2-Diethyl-l,2-dihydro-4*H*-3,1-benzoxazine-4-thione (10j). Orange crystals: yield 0.125 g (57%); mp 77.5-78.0 °C; IR (KBr) 3287 (NH), 2972, 2938, 1595, 1516, 1481, 1380, 1290, 1253, 1147, 1106, 988, 942, 856, 765 cm^{-1}; UV(EtOH) λ_{max} 239 (log ε 4.38), 258 (sh, 3.95), 280 (sh, 3.58), 387 nm (3.53); ^{1}H NMR ($CDCl_3$) δ7.88 (d, 1H, *J*=7.8 Hz, 5-H), 7.32 (t, 1H, *J*=7.6 Hz, 7-H), 6.785 (t, 1H, *J*=7.6 Hz, 6-H), 7.75 (d, 1H, *J*=7.6 Hz, 8-H), 4.77 (s, 1H, NH), 2.03 (q, 4H, *J*=7.6 Hz, CH_2×2), 0.99 ppm (t, 6H, *J*=7.6 Hz, CH_3×2); ^{13}C NMR ($CDCl_3$) δ 188.2 (C=S), 147.2, 135.1, 127.2, 119.4, 118.6, 117.9, 71.0, 32.2, 8.7, 8.4 ppm. Anal. Calcd for $C_{12}H_{15}NOS$: C, 65.12; H, 6.83; N, 6.33; S, 14.49. Found: C, 64.96; H, 6.79; N, 6.29; S, 14.26.

2-Methyl-2-phenyl-l,2-dihydro-4*H*-3,1-benzoxazine-4-thione (10k). Orange crystals: yield 0.145 g (57%); mp 127.1-127.6 °C; IR (KBr): 3314 (NH), 3060, 3033, 2985, 2923, 1601, 1481, 1444, 1281, 1254, 1203, 1145, 956, 929, 762, 698 cm^{-1}; UV (EtOH): λ_{max} 236 (log ε 4.56), 258 (sh, 4.10), 282 (sh, 3.71), 378 nm (3.68). Anal. Calcd for $C_{15}H_{13}NOS$: C, 70.56; H, 5.13; N, 5.49; S,12.56. Found: C, 70.30; H, 5.14; N,5.50; S,12.45.

4-Thioxo-l,2-dihydro-4*H*-3,1-benzoxazine-2-spirocyclopentane (10l). Orange crystals: yield 0.015 g (7%); mp 84.6-85.1 °C; IR (KBr): 3299 (NH), 3069, 2925, 2850, 1611, 1590, 1508, 1480, 1282, 1144, 933, 769 cm^{-1}; UV (EtOH): λ_{max} 238 (logε 4.29), 258 (sh, 3.89), 281 (sh, 3.53), 306 (3.19), 382 nm (3.47); ^{1}H NMR ($CDCl_3$): δ7.83-6.75 (m, 4H, aromatic protons), 4.49 (br.s, 1H, NH), 2.23-1.475 ppm (m, 8H, C_4H_8). Anal. Calcd for $C_{12}H_{13}NOS$: C, 65.72; H, 5.97; N, 6.39 S, 14.62. Found: C, 64.81; H, 6.30; N,

6.30; S,14.59.

4-Thioxo-l,2-dihydro-4*H*-3,1-benzoxazine-2-spirocyclohexane (10m). Yellow crystals : yield 0.10 g (43%); mp 191.8-192.3 °C; IR (KBr): 3299 (NH), 3070, 2925, 2850, 1610, 1591, 1508, 1480, 1282, 1210, 1143, 933, 769 cm^{-1}; UV (EtOH): λ_{max} 238 (log ε 4.16) 258 (sh, 3.72), 277 (sh, 3.40), 384 nm (3.28); ^1H NMR ($CDCl_3$): δ 7.88 (d, 1H, *J*=7.6 Hz, 5-H), 7.33 (t, 1H, *J*=7.3 Hz, 7-H), 6.82 (t, 1H, *J*=7.6 Hz, 6-H), 6.74 (d, 1H, *J*=8.1 Hz, 8-H), 4.49 (br. s, 1H, NH), 2.20-1.44 ppm (m, 10H, cyclo-C_5H_{10}) ; ^{13}C NMR ($CDCl_3$): δ 187.7 (C=S), 146.6, 135.0, 127.4, 120.1, 119.1, 118.0, 66.9, 38.7, 25.0, 22.0 ppm. Anal. Calcd for $C_{13}H_{15}NOS$: C,66.92; H,6.48; N,6.00; S,13.74. Found: C,66.62; H,6.59; N,5.83; S,13.42.

***N*-Methylthiomethyl-1,2-dihydro-4*H*-3,1-benzoxazine-4-thione (11).** A mixture of methyl dithioanthranilate hydrobromide (**6**) (0.265g, 1 mmol), paraformaldehyde (0.88g, 6.7 mmol), THF (10 mL) was refluxed at 66 ℃ for 24 h. To the cooled reaction mixture, was added water (30 mL) and Et_2O (50 mL), and then was shaken vigorously. After separating organic layer, the water layer was extracted with Et_2O (50 mL×3). The combined Et_2O extract was dried ($MgSO_4$), evaporated in vacuo to give oily matter, which was chromatographed (silica gel, 400 mesh, 1:4 EtOAc-pentane) to give 0.13 g (74%) of crude yellow crystals of compound **11**. Recrystallization from benzene-hexane gave yellow crystals of compound **11**; mp 90.5-92 °C; IR (KBr): 3065, 2968, 2919, 2877, 2834, 1596, 1631, 1596, 1474, 1283, 1125, 984, 929, 892, 772 cm^-; ^1H NMR ($CDCl_3$): δ 8.01 (d, 1H, *J*=7.6 Hz, 5-H), 7.50 (t, 1H, *J*=7.6 Hz, 7-H), 6.99 (t, 2H, *J*=7.3 Hz, 6-H and 8-H), 4.94 (s, 2H, 2-H), 4.94 (s, 2H, NCH_2O), 4.58 (s, 2H, NCH_2S), 2.24 (s, 3H, CH_3); 2.24 ppm (s, 3H, CH_3); ^{13}C NMR ($CDCl_3$): δ 188.0 (C=S)., 148.7, 134.7, 128.4, 123.8, 120.9, 118.8, 57.2, 50.9, 15.0 ppm. Anal. Calcd for $C_{10}H_{11}NOS_2$: C, 53.30; H, 4.92; N, 6.22; S, 28.46. Found: C, 53.36; H, 4.96; N, 6.27; S, 28.44.

General procedure for the synthesis of 2-substituted or 2,2-disubstituted 1,2-dihydro-4*H*-3,1-benzothiazine-4-thiones (12a-e). To a three-necked flask containing EtOH (10 mL) and finely powdered pure NaSH (0.56 g, 10 mmol), was added 0.5 mmol of the appropriate aldehyde or ketone dissolved in THF (10 mL) and methyl dithioanthranilate (0.132 g, 0.5 mmol) in THF (10 mL), which was obtained by neutralizing methyl dithioanthranilate hydrobromide with ethyldiisopropylamine, and the resulting mixture was warmed to 40~50 °C for 18 h under Ar. The mixture turned deep red. Water (150 mL) was added to the reaction mixture, and the organic layer was separated. The water layer was extracted with Et_2O (60 mL×3). The organic layer and each Et_2O extract were combined, dried ($MgSO_4$), and evaporated in vacuo to remain deep red oily matter, which was chromatographed (silica gel, 400 mesh, 1:10 EtOAc-pentane) to give deep red crystals or oil which solidified under storage in a desiccator.

1,2-Dihydro-4*H*-3,1-benzothiazinethiones **12a-c** obtained as crude red crystals were recrystallized from benzene-pentane.

2-Phenyl-1,2-dihydro-4*H*-3,1-benzothiazine-4-thione (12a). Red crystals: yield 0.098 g (76%); mp 116.5-117.0 °C; IR (KBr): 3449 (NH), 1605, 1562, 1491, 1472 cm^{-1}; ^1H NMR ($CDCl_3$): δ 8.36 (dd, 1H, *J*=1.5 Hz and 7Hz, 5-H), 7.58 (quasi dt, 1H, *J*=7.3 Hz, 7-H), 7.45 - 7.41 (m, 5H, phenyl protons), 6.87 (t, 1H, *J*=8.1 Hz, 6-H), 6.73 (d, 1H, *J*=8.1 Hz, 8-H), 6.00 (s, 1H, 2-H), 4.96 ppm (br. s, 1H, NH); ^{13}C NMR ($CDCl_3$): δ 217.6 (C=S), 144.6, 135.4 135.3, 130.1, 130.0, 129.3, 128.0, 127.7, 120.0, 117.8, 63.7 ppm. Anal. Calcd for $C_{14}H_{11}NS_2$: C, 65.33; H, 4.31; N, 5.44; S, 24.92. Found: C, 65.32; H, 4.31; N, 5.15; S, 24.64.

2-(*p*-Tolyl)-1,2-dihydro-4*H*-3,1-benzothiazine-4-thione (12b). Red crystals: yield 0.094 g (69%); red viscous oil; IR (KBr): 3449 (NH), 1611, 1561, 1477 cm^{-1}; ^1H NMR ($CDCl_3$): 8.37 (d, 1H, *J*=7.5 Hz, 5-H), 7.47 (d, 2H, *J*=8.1 Hz, 2'-H and 6'-H), 7.36 (m, 1H, 7-H), 7.25 (d, 1H, *J*=8.1 Hz, 3'-H and 5'-H), 6.87 (t, 1H, *J*=7.5 Hz, 6-H), 6.715 (d, 1H, *J*=8.1 Hz), 5.98 (s, 1H, 2-H), 4.92 ppm (br. s, 1H, NH), 2.37(s, 3H, CH_3); ^{13}C NMR ($CDCl_3$): δ 217.9 (C=S), 144.6, 140.2, 135.2, 132.4, 130.2, 129.9, 128.1, 127.6, 120.0, 117.7, 63.5, 21.3 ppm. Anal. Calcd for $C_{15}H_{13}NS_2$: C, 66.38; H, 4.83; N, 5.16; S, 23.62. Found: C, 66.21; H, 4.95; N, 4.99; S, 23.32.

2-(*p*-Methoxyphenyl)-1,2-dihydro-4*H*-3,1-benzothiazine-4-thione (12c). Red crystals: yield 0.085 g (59%); mp 162.1-163.2 °C; IR (KBr): 3453 (NH), 1607, 1561, 1489, 1472 cm^{-1} ;^1H NMR ($CDCl_3$): δ 8.36 (d, 1H, *J*=8.1 Hz, 5-H), 7.51 (d, 2H, *J*=8.4 Hz, 3'-H and 5'-H), 7.38 (t, 1H, *J*=7.4 Hz, 7=H), 6.95 (d, 2H, *J*=8.4 Hz, 2'-H and 6'-H), 6.87 (t, 2H, *J*=7.6 Hz, 6-H), 6.72 (d, 2H, J=8.1 Hz, 8-H), 5.97 (s, 1H, 2-H), 4.90 (s, 1H, NH), 3.84 ppm (s, 3H, OCH_3); ^{13}C NMR ($CDCl_3$): δ 218.1 (C=S), 160.8, 144.7, 135.2, 130.2, 129.1, 128.1, 127.2, 120.0, 117.7, 114.6, 63.3, 55.4 ppm. Anal. Calcd for $C_{15}H_{13}NOS_2$: C,62.68; H,4.56; N,4.88; S,22.31. Found: C,62.35; H,4.38; N,4.64; S,22.08.

2,2-Dimethyl-1,2-dihydro-4*H*-3,1-benzothiazine-4-thione (12d). Deep red crystals: yield 0.094 g (90%); mp 163.2-163.4 °C; IR (KBr): 3279 (NH), 1605, 1561, 1495, 1474 cm^{-1}; ^1H NMR ($CDCl_3$): δ 8.37-6.70, (m, 4H, aromatic protons), 4.93 (s, 1H, NH), 1.68 ppm (s, 6H, CH_3×2); ^{13}C NMR ($CDCl_3$): δ 216.5 (C=S), 142.6, 130.0, 127.3, 119.7, 118.3, 117.9, 62.4, 29.1 ppm. Anal. Calcd for $C_{10}H_{11}NS_2$: C,57.38; H,5.30; N,6.69; S,30.64. Found: C, 57.48; H,5.31; N,6.58; S, 30.16.

2-Ethyl-2-methyl-1,2-dihydro-4*H*-3,1-benzothiazine-4-thione (12e). Orange crystals: yield 0.053 g (47%); mp 66.6-67.1 °C; IR (KBr): 3491(NH), 1607, 1564, 1497, 1474 cm^{-1}; ^1H NMR ($CDCl_3$): δ 8.36-6.69 (m, 4H, aromatic protons), 4.83 (s, 1H, NH), 1.95 (q, 2H, *J*=7.3 Hz, CH_2Me), 1.68 (s, 3H,

2-CH_3), 0.96 ppm (t, 3H, *J*=7.3 Hz, CH_3); ^{13}C NMR ($CDCl_3$): δ 217.9 (C=S), 142.5, 135.4, 130.9, 129.7, 127.4, 118.2, 68.2, 38.7, 26.2, 11.0 ppm. Anal. Calcd for $C_{11}H_{13}NS_2$: C, 59.14; H,5.87; N,6.28; S, 28.71. Found: C, 59.53; H, 5.69; N, 6.45; S, 28.30.

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