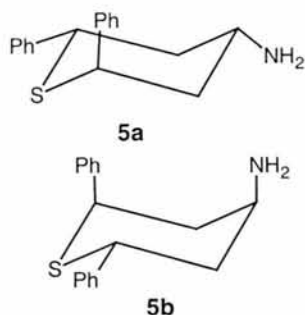


However, **1** should give only one amine **5** on reduction, since the amino group will be *cis* to one phenyl group and *trans* to the other phenyl group.

Stereochemistry of aminothiane **5**

Two chair conformations **5a** and **5b** are possible for **5**. Actually, **5a** and **5b** are interconvertible by chair flipping. In the ¹H NMR spectrum of **5** separate signals were observed for the seven protons in the heterocyclic ring. The vicinal coupling constants could be readily obtained by first-order analysis. The various coupling constants are given in **Table I**. The various proton chemical shifts are given in **Table II**. The observed vicinal coupling constants of **5** are consistent with chair conformation **5a** with an equatorial amino group.



Stereochemistry of aminothianes **6a-8a** and **6b-8b**

The vicinal coupling constants and proton chemical shifts could be obtained by first-order analysis in the cases of **6a**, **7a** and **8a** since the difference between the chemical shifts of the methylene protons is

considerably higher, so that $\frac{\Delta\nu}{J}$ is larger than 6.

However, in the cases of **6b** and **7b** the vicinal coupling constants and proton chemical shifts were obtained by second-order analysis¹², since the difference between the chemical shifts of the methylene protons is small, so that $\frac{\Delta\nu}{J}$ is less than 6.

In the case of **8b**, the chemical shifts of methylene protons are very nearly the same and the coupling constants could not be determined even by second-order analysis. In this case only the sum of the vicinal coupling constants could be determined. The calculated coupling constants and chemical shifts are given in **Table I** and **II**, respectively.

The observed vicinal coupling constants of **6a-8a** are consistent with chair conformation with equatorial orientations of all the substituents. The observed vicinal coupling constants of **6b** and **7b** suggest that these compounds exist largely in chair conformation with equatorial orientations of the aryl groups and axial orientation of the amino group. The observed sum of the vicinal coupling constants of **8b** could be accounted by chair conformation with equatorial orientations of the aryl group and axial orientation of the amino group.

It is seen from **Table II** that the benzylic protons resonate at a higher frequency in the axial aminothianes **6b-8b** compared to the equatorial aminothianes **6a-8a** and this can be attributed to the *syn*-1,3-diaxial interaction of the axial amino group with the axial benzylic hydrogens. Moreover, H(4)

Table I—Coupling constants (Hz) of 4-aminothianes **5-8**

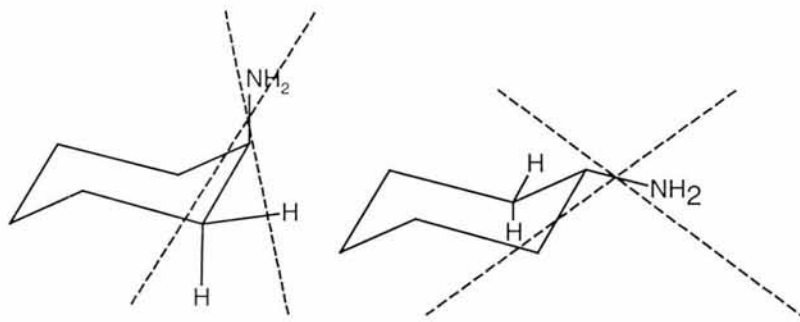
| Compd | $J_{2,3}$ | $J_{3,4}$ | $J_{4,5}$ | $J_{5,6}$ | J_{gem} |
|-----------|--------------------|-------------------|-------------------|--------------------|-----------------------|
| 6a | 11.79 (a, a) | 10.99 (a, a) | 10.99 (a, a) | 11.79 (a, a) | 13.18 |
| | 1.47 (a, e) | 3.09 (e, a) | 3.09 (e, a) | 1.47 (a, e) | 13.18 |
| 7a | 12.05 (a, a) | 1.09 (a, a) | 11.09 (a, a) | 12.05 (a, a) | 12.99 |
| | 2.02 (a, e) | 3.47 (e, a) | 3.47 (e, a) | 2.02 (a, e) | 12.99 |
| 8a | 11.87 (a, a) | 11.05 (a, a) | 11.05 (a, a) | 11.87 (a, a) | 13.09 |
| | 2.15 (a, e) | 3.51 (e, a) | 3.51 (e, a) | 2.15 (a, e) | 13.09 |
| 6b | 12.54 (a, a) | 3.76 (e, e) | 3.76 (e, e) | 12.54 (a, a) | 13.79 |
| | 2.20 (a, e) | 2.86 (e, a) | 2.86 (e, a) | 2.20 (a, e) | 13.79 |
| 7b | 12.53 (a, a) | 3.63 (e, e) | 3.63 (e, e) | 12.53 (a, a) | 13.79 |
| | 2.11 (a, e) | 2.66 (e, a) | 2.66 (e, a) | 2.11 (a, e) | 13.79 |
| 8b | 14.66 [*] | 6.52 [*] | 6.52 [*] | 14.66 [*] | - |
| 5* | 4.58 (e, a) | 11.43 (a, a) | 11.17 (a, a) | 12.00 (a, a) | 12.59 ($J_{5a,5c}$) |
| | 2.10 (e, e) | 3.49 (e, a) | 2.91 (a, e) | 2.29 (e, a) | 13.41 ($J_{3a,3e}$) |

^{*}Sum of the two vicinal coupling constants; ^{*}Carbon with axial phenyl group is designated as C-2

Table II—Chemical shifts (ppm) of 4-aminothianes **5-8**

| Compd | H(2) | H(3) | H(4) | H(5) | H(6) | Others | |
|-----------|---|-------------------------------------|-------------------|------------------------|------|---|------------|
| 6a | 4.13 | 2.28 (eq) 1.73 (ax) | 2.91 | 2.28 (ax) 1.73 (ax) | 4.13 | 7.37 - 7.21 1.47 (NH ₂) | (aromatic) |
| 7a | 4.07 | 2.32 (eq) 1.78 (ax) | 2.93 | 2.32 (eq) 1.78 (ax) | 4.07 | 7.37 - 7.26 6.86 - 6.83 3.79 (OCH ₃) 1.58 (NH ₂) | (aromatic) |
| 8a | 4.66 | 2.35 (eq) 1.67 (ax) | 3.07 | 2.35 (eq) 1.67 (ax) | 4.66 | 7.55 - 7.51 7.39 - 7.38 7.36 - 7.16 1.16 (NH ₂) | (aromatic) |
| 6b | 4.56 | 2.07 (eq) 2.22 (ax) | 3.75 | 2.07 (eq) 2.22 (ax) | 4.56 | 7.50 - 7.04 1.12 (NH ₂) | (aromatic) |
| 7b | 4.56 | 2.07 (eq) 2.21 (ax) | 3.78 | 2.07 (eq) 2.21 (ax) | 4.56 | 7.36 - 7.26 6.88 - 6.82 3.78 (OCH ₃) 1.48 (NH ₂) | (aromatic) |
| 8b | 5.21 (t) (Total width = 14.66 Hz) | 2.11 (Total width = 10.66 Hz) | 3.77 (quintet) | 2.11 (eq & ax) | 5.21 | 7.56 - 7.52 7.39 - 7.38 7.36 - 7.15 1.48 (NH ₂) | (aromatic) |
| 5* | 4.33 | 2.71 (eq) 2.07 (ax) | 2.91 | 2.25 (eq) 1.84 (ax) | 4.02 | 7.68 - 7.63 7.41 - 7.23 1.60 (NH ₂) | (aromatic) |

*Carbon bearing axial phenyl group is designated as C-2

**Figure 1**

resonates at a higher frequency in the axial epimers relative to the equatorial epimers since in the axial epimers H(4) is in equatorial orientation, whereas in equatorial epimers H(4) is in axial orientation. It is also seen that equatorial methylene protons at C-3/C-5 absorb considerably at a higher frequency compared to axial methylene protons in the equatorial aminothianes **6a-8a** which is in contrast to the observation seen in the axial aminothianes **6b** and **7b** in which axial protons resonate at higher frequency compared to equatorial protons. This can be attributed to the magnetic anisotropic effect⁴ of the C-N bond as shown in **Figure 1**. Axial proton lies in the deshielding region of the nearby axial C-N bond and shielding region of the nearby equatorial C-N bond.

Equatorial proton lies in the shielding region of both the nearby axial C-N and equatorial C-N bonds.

For the amines obtained by reducing *r*(2), *c*(6)-diarylthian-4-one oximes **2-4**, configuration of the amino group can be assigned using the vicinal coupling constants about C(3)-C(4) and C(4)-C(5) bonds as well as the chemical shift of H-4. However, the configuration can be assigned using the vicinal coupling constants even from the data of any one epimer, whereas use of the chemical shift of H-4 needs the data for both the epimers. This demonstrates the superiority of proton-proton vicinal coupling constants over proton chemical shifts, in assigning the configuration of a substituent in cyclic compounds.

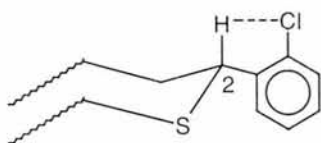
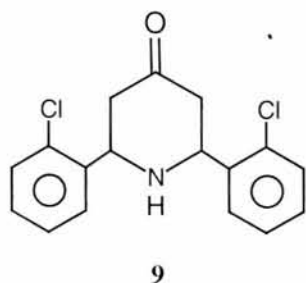


Figure 2

It is inferred from **Table II** that there is no appreciable difference in the chemical shifts of the heterocyclic ring protons due to the introduction of a substituent in the *para* position of the phenyl ring. However, the introduction of chloro substituent in the *ortho* position deshields the nearby benzylic protons ($\approx + 0.5$ ppm). This can be explained based on the conformation of the aryl ring shown in **Figure 2** in which the chlorine atom prefers to be *syn* to the benzylic protons in order to avoid dipole-dipole interaction between C-S and C-Cl bonds. In this conformation the benzylic protons experience severe van der Waals' interaction with the benzylic hydrogens and hence these hydrogens are deshielded. Similar explanation has already been offered in 2,6-bis(*o*-chlorophenyl)piperidin-4-one **9** for the deshielding of benzylic protons due to the presence of *o*-chloro substituent.



9

Comparison of **6a** and **8a** shows that the *o*-chloro substituent in **8a** deshields the equatorial methylene proton by 0.07 ppm but shields the axial methylene proton by 0.06 ppm. These effects are similar to those observed in piperidin-4-ones². It is also seen that the *o*-chloro substituent deshields H-4 by 0.16 ppm. This can be explained as follows: The *o*-chloro substituent should be expected to push the benzylic hydrogen inside the heterocyclic ring. This should increase the 1,3-diaxial interaction of H-4 with benzylic hydrogens. This causes a deshielding on H-4.

Taking the effects of the *o*-chloro substituent on the benzylic proton and the methylene proton in **8b** to the same as those in **8a** the chemical shifts of the benzylic

proton, equatorial methylene proton and axial methylene proton in **8b** were calculated as 5.09, 2.14 and 2.16 ppm, respectively. The observed values are in good agreement with these calculated values.

Experimental Section

4-Amino-*r*(2),*t*(6)-diphenylthiane **5** and the epimeric aminothianes **6a-8a** and **6b-8b** were prepared according to the procedure described in literature¹⁰. The melting points are 76° (**5**), 87° (**6a**), 121° (**6b**), 158° (**7a**), 125° (**7b**), 81° (**8a**) and 156°C (**8b**). These melting points are in excellent agreement with those reported already.

Spectra

¹H NMR spectra at 270 MHz were recorded on a Bruker WH-270 NMR spectrometer operating at a field of 6.35 Tesla. Samples were prepared by dissolving about 10 mg of material in 0.5 ml of CDCl₃ containing 1% TMS. The experimental parameters were the following: data points, 32 K; number of transients, 10; spectrum width, 2700 Hz.

Acknowledgement

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