BULLETIN OF THE CHEMICAL SOCIETY OF JAPAN VOL. 43 509—514 (1970)

# The Thermal Reaction of 3-Acetylguaiazulene with Sulfur

Shinji KUROKAWA

*Department of Chemistry, Faculty of Education, Saga University, Honjyô-machi, Saga*

(Received August 9, 1969)

When 3-acetylguaiazulene was heated with sulfur at 200°C, three new azulenoids were obtained, in addition to the S-guaiazulene formed by the loss of the acetyl group; the structures were established as 2-acetylguaiazulene, 6-acetyl-, and 7-acetyl-3,5,8-trimethylazuleno[6,5-*b*]thiophenes. From the experimental results it became obvious that a sulfur atom linked one methyl carbon atom of the isopropyl group with the $C_6$-azulene-ring carbon atom in 3-acetylguaiazulene, resulting in the formation of a thiophene ring, and also that the loss and the migration of the acetyl group took place in 3-acetylguaiazulene as well. The acetyl migration in this compound was ascertained to be a simple thermal reaction and to occur in one direction, from $C_3$ to $C_2$.

In the previous works on the thermal reaction of S-guaiazulene or vetivazulene with sulfur, the formations of 3,5,8-trimethylazuleno[6,5-*b*]thiophene[1,2] and 3,5,9-trimethylazuleno[1,2-*b*]thiophene[3] have been reported. The present investigation will be concerned with the thermal reaction between sulfur and 3-acetylguaiazulene (I), which contains both alkyl and acetyl substituents.

## Results and Discussion

**Structural Elucidation of the Reaction Products.** 3-Acetylguaiazulene (I) was heated with sulfur powder at 200°C. When the reaction mixture was subjected to step-by-step elution chromatography, three new compounds were isolated in addition to a small amount of S-guaiazulene (II), as is shown in Table 1. On these compounds, structural elucidation was carried out as follows.

*a) 2-Acetylguaiazulene (III).* The green crystalline substance, mp 80—81°C, which was isolated as the major product in this reaction had the same molecular formula, $C_{17}H_{20}O$, as the 3-acetylguaiazulene used as the starting material, but it was different in that is easily formed 2,4-dinitrophenylhydrazone, mp 246—247°C. The carbonyl group of this compound was an acetyl group from a methyl singlet (2.72 ppm) which can be assigned to an acetyl group in the NMR spectrum (Fig. 1-B), and from prominent peaks at *m/e* 43 and 197 ($m^*=161.7$) in the mass spectrum which may, respec-

---

[1] S. Hayashi, S. Kurokawa, M. Okano and T. Matsuura, *Tetrahedron Lett.*, **1967**, 3443.

[2] S. Hayashi, M. Okano, S. Kurokawa and T. Matsuura, *J. Sci. Hiroshima Univ., Ser. A-II*, **31**, 79 (1967).

[3] S. Hayashi, S. Kurokawa and T. Matsuura, This Bulletin, **42**, 1404 (1969).

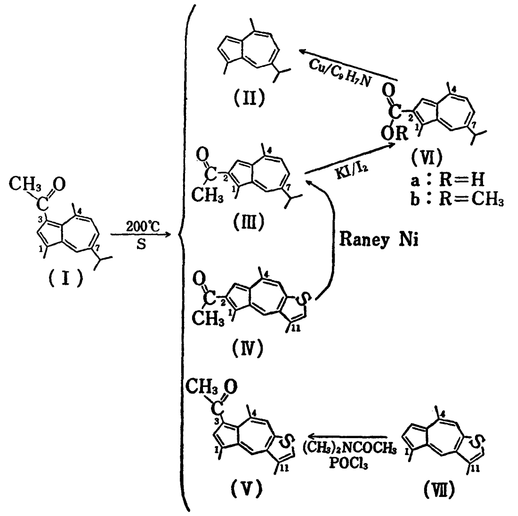


Chart 1*1

tively, be ascribed to $CH_3CO^+$ and $(M-CH_3CO)^+$ ions.4)

When the compound was oxidized by hypoiodite and the resulting acid (VIa) of green plates, mp 150—161°C, was subsequently decarboxylated by heating it with copper powder in quinoline, S-guaiazulene (II) was obtained in a good yield. Thus, the compound is thought to be a monoacetyl derivative of S-guaiazulene, which differs from 3-acetylguaiazulene in the position of the acetyl group. This deduction was, furthermore, supported by the fact that the signals of an isopropyl group (1.33 and 3.08 ppm) and a signal of two methyl groups attached to an aromatic ring system (2.83 ppm) were seen in the NMR spectrum of the compound.

The compound exhibited two visible absorption maxima of nearly equal intensities at 637 and 692 m$\mu$. When those hypsochromic shifts from the maximum of S-guaiazulene (607 m$\mu$) are analyzed according to the Plattner rule,5) three positions of the azulene nucleus, $C_2$, $C_6$, and $C_8$, are possible for the acetyl group.

On the other hand, the aromatic-proton region of the NMR spectrum (Fig. 1-B) held four-proton signals. In comparison with the spectra of S-guaiazulene (Fig. 1-A)6) and 3-acetylguaiazulene (Fig. 1-C), two doublets (2H) at 7.00 and 8.36 ppm can reasonably be assigned to $H_5$ and $H_8$, and the remaining signals (2H) from 7.31 to 7.58 ppm, to $H_6$ and $H_3$. As for the latter signals, it is thought that a part of a double doublet*2 ($J$=11.0, 2.0 Hz, 1H) centered at 7.47 ppm, to which $H_6$ is assigned, overlaps on the foot of the singlet of 7.58 ppm attributed to $H_3$. By such assignments, the coupling constants, $J_{5,6}=11.0$ Hz and $J_{6,8}=2.0$ Hz, are found to be in good agreement with those of 7-substituted azulene.

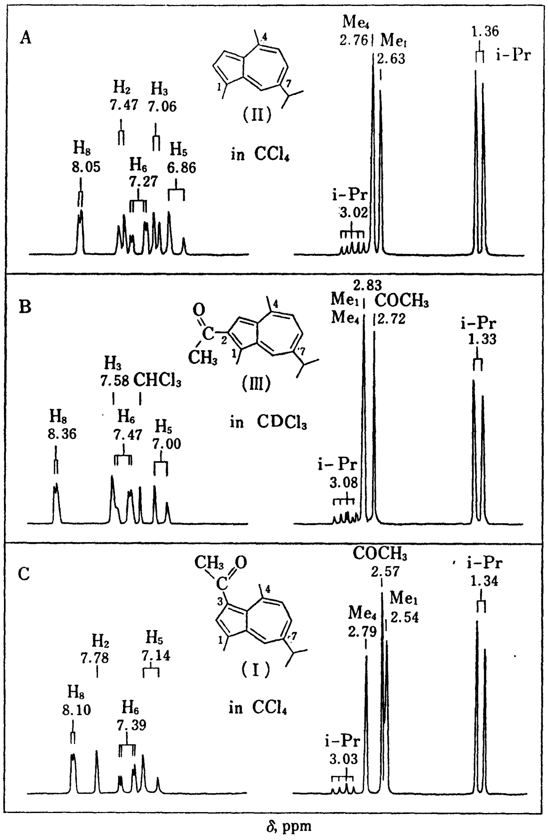
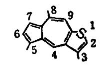


Fig. 1. NMR spectra of S-guaiazulene (A), 2-acetylguaiazulene (B) and 3-acetylguaiazulene (C).

From the three positions, $C_2$, $C_6$, and $C_8$, shown to be possible by the visible absorption spectrum, $C_6$ and $C_8$ were thus excluded, and the structure of this compound was determined to be 2-acetylguaiazulene (III).

---

[*1] The skeleton numbering of the azulenothiophenes according to the IUPAC nomenclature, used only for the name of the compound, is as follows:



For convenience in comparing these substances with the acetylguaiazulenes in terms of the NMR data, the numbering system in the azulene compounds was generally adopted for the azulenothiophenes in this paper.

4) H. Budjikiewicz, C. Djerassi and D. H. Williams, "Interpretation of Mass Spectra of Organic Compounds," Holden-Day, San Francisco (1964), p. 191.

5) E. Heilbronner, "Non-Benzenoid. Aromatic Compounds," ed. by D. Ginsburg, Interscience Publishers, New York, N. Y. (1959), p. 171.

6) D. Meuche, B. B. Molloy, D. H. Reid and E. Heilbronner, *Helv. Chim. Acta*, **46**, 2483 (1963).

[*2] The appearance of the double doublet due to $H_6$ can be expected from the signals of $H_5$ and $H_8$ observed as doublets.

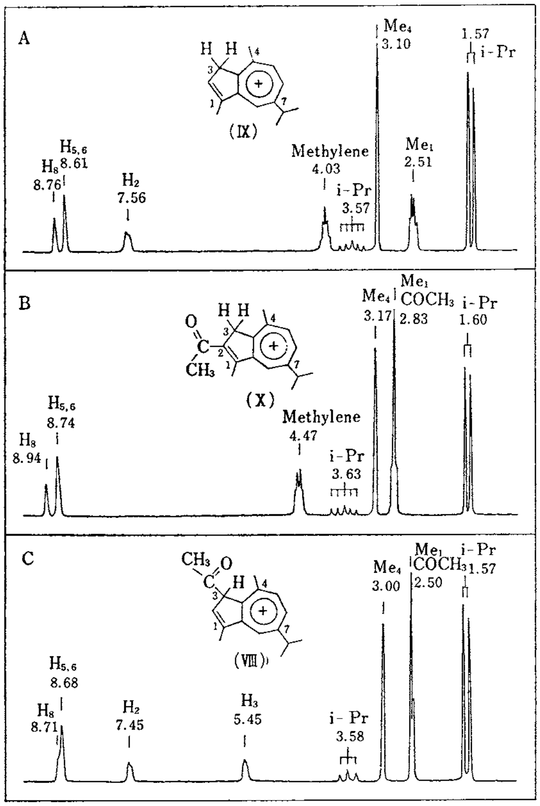


Fig. 2. NMR spectra of conjugate acids of S-guaiazulene (A), 2-acetylguaiazulene (B) and 3-acetylguaiazulene (C) (in $CF_3COOH$).

In addition, the NMR spectrum (Fig. 2-B) taken in a trifluoroacetic acid solution had no signal to be assigned to an olefinic proton, $H_2$ (*cf.* Fig. 2-A and 2-C). This fact can be well explained by the structure of the conjugate acid of 2-acetylguaiazulene (III).

*b) 6-Acetyl-3,5,8-trimethylazuleno[6,5-b]thiophene (IV).* Dark brown needles (mp 162—163°C) with a molecular formula of $C_{17}H_{16}OS$ were isolated from a benzene-eluted fraction in the elution chromatography of the reaction products. This compound gave a green oxime, mp 223—224°C, and exhibited prominent fragment ions of *m/e* 225 (base peak, $m^* = 188.8$, $(M-CH_3CO)^+$) and *m/e* 43 ($CH_3CO^+$) in the mass spectrum. Thus, it is certain that the compound also contains an acetyl group.

When the compound was subjected to reductive desulfurization by heating it with a Raney nickel catalyst, the 2-acetylguaiazulene (III) described in the preceding section was obtained. In the NMR spectrum of this sulfur-containing compound (Fig. 3-B), moreover, there is a singlet (8.34 ppm, 1H) corresponding to the $H_8$ of 2-acetylguaiazulene, but there are no signals which can be attributed to the isopropyl group or to $H_6$, which are both present in the spectrum of the original compound. The result of the reductive desulfurization and the NMR evidence lead to the conclusion that the compound is 6-acetyl-3,5,8-trimethylazuleno[6,5-*b*] thiophene (IV), which may be derived from 2-acetylguaiazulene through the formation of a sulfur bond between one methyl carbon atom of the isopropyl group and the $C_6$ of the azulene nucleus.

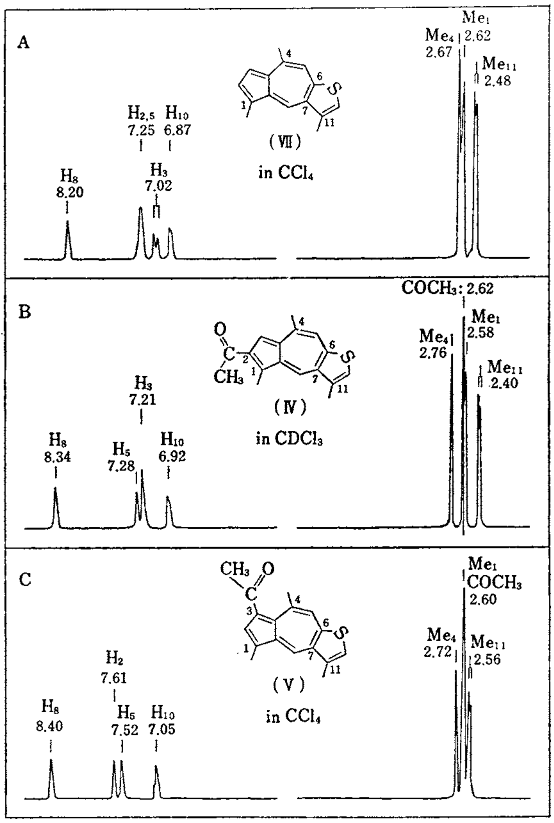


Fig. 3. NMR spectra of 3,5,8-trimethylazuleno-[6,5-*b*]thiophene (A), and its 6-acetyl- (B) and 7-acetyl derivatives (C).

This structure is further supported by the facts that the UV ($\lambda_{max}$ 324 m$\mu$) and visible absorption spectra ($\lambda_{max}$ 625 m$\mu$ and 668 m$\mu$) show hypsochromic shifts[*3] as compared with those of azulenothiophene,[1,2] and that the NMR spectrum (Fig. 4-B) taken in a trifluoroacetic acid solution exhibits the signals assigned to $Me_1$ (2.95 ppm, 3H) and $C_3$-methylene (4.49 ppm, quartet, 2H), but has no peak corresponding to $H_2$ (*cf.* Fig. 4-A).

*c) 7-Acetyl-3,5,8-trimethylazuleno[6,5-b]thiophene (V).* The third product was brown needles (mp 141—142°C) whose molecular formula,

---

[*3] According to the Plattner rule,[5] this hypsochromic shift of the visible absorption maximum indicates that the acetyl group exists on the $C_2$ or $C_6$ of the azulenothiophene nucleus.

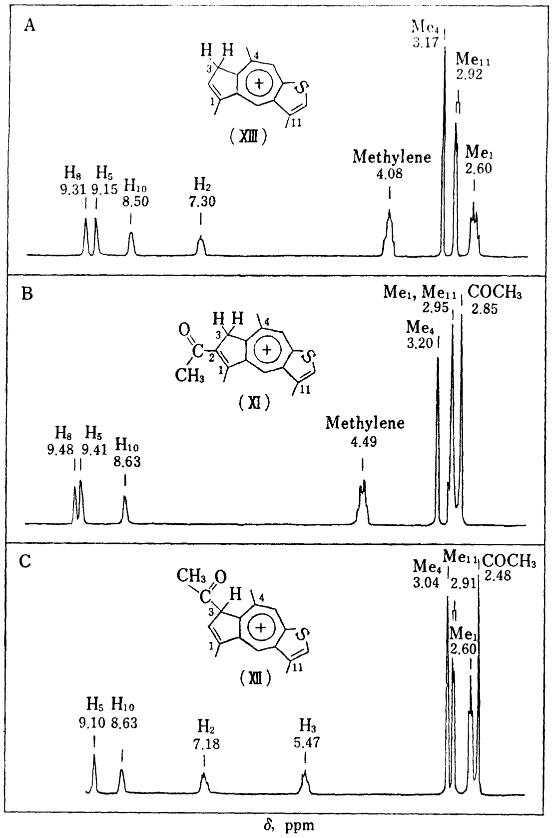


Fig. 4. NMR spectra of conjugate acids of 3,5,8-trimethylazuleno[6,5-*b*]thiophene (A), 6-acetyl-3,5,8-trimethylazuleno[6,5-*b*]thiophene (B) and 7-acetyl-3,5,8-trimethylazuleno[6,5-*b*]thiophene (C)*4 (in $CF_3COOH$).

$C_{17}H_{16}OS$, was the same as that of the foregoing compound, 6-acetyl-3,5,8-trimethylazuleno[6,5-*b*]thiophene. This compound also had an acetyl group, as was indicated by the strong carbonyl band at 1650 $cm^{-1}$ and by the fragment ions at $m/e$ 253 (base peak, $m^*=238.8$) and at $m/e$ 225 ($m^*=200.0$), which were correlated with, respectively, $(M-CH_3)^+$ and $(M-CH_3-CO)^+$. Besides, the NMR spectrum of the compound has a remarkable resemblance to that of 6-acetyl-3,5,8-trimethylazuleno[6,5-*b*]thiophene, as is shown in Fig. 3-C and 3-B. The evidence presented above suggests that the compound has a structure closely related to that of the 6-acetyl derivative.

However, the NMR spectrum (Fig. 4-C) taken in trifluoroacetic acid is extremely different from that of the 6-acetyl derivative (Fig. 4-B); two multiplets similar to those of the 3-acetylguaiazulenium cation (Fig. 2-C) and which can be assigned to $H_3$ and $H_2$ appear at 5.47 (1H) and 7.18 ppm (1H) respectively, but a methylene signal seen in the spectra of conjugate acids of azulenothiophene and 6-acetylazulenothiophene (Fig. 4-A and 4-B) is absent. This evidence indicates that this compound is 7-acetyl-3,5,8-trimethylazuleno[6,5-*b*]thiophene (V).

Furthermore, this structure was proved by its synthesis through the Vilsmeier acetylation[7] of 3,5,8-trimethylazuleno[6,5-*b*]thiophene.

**Sequence of the Reaction.** As is shown in Table 1, the main product of this reaction was 2-acetylguaiazulene, formed through the migration of the acetyl group in the starting material; the second product was 6-acetyl-3,5,8-trimethylazuleno[6,5-*b*]thiophene, formed by the reaction of the 2-acetylguaiazulene with sulfur. S-Guaiazulene and 7-acetyl-3,5,8-trimethylazuleno[6,5-*b*]thiophene were obtained as minor products.

In order to clarify the effect of sulfur on the migration and the loss of the acetyl group, 3-acetylguaiazulene was heated at 200°C for 2 hr without sulfur. In this reaction, 2-acetylguaiazulene (16.4%) and S-guaiazulene (1.4%) (*cf.* Experimental section) were obtained in yields similar to those of the thermal reaction of 3-acetylguaiazulene with sulfur. Hence, the migration and the loss of the acetyl group in 3-acetylguaiazulene seem to depend upon the reaction temperature and to be hardly affected at all by sulfur.

On the other hand, when 2-acetylguaiazulene was heated at 200°C in a nitrogen atmosphere or at 300°C in a sealed tube, no appreciable isomerized product was obtained; only the original material was recovered.

Thus, the migration of the acetyl group in the thermal reaction of 3-acetylguaiazulene is not such a reversible reaction as that observed between 1-phenyl and 2-phenylazulenes,[8] but an irreversible reaction proceeding from 3-acetylguaiazulene to 2-acetylguaiazulene. This difference between acetylguaiazulenes and phenylazulenes may result from the fact that the difference in the potential energy between 2-acetyl- and 3-acetylguaiazulenes is much greater than that between phenylazulenes. Further investigation into this point is presently in progress in this laboratory.

## Experimental

All the melting points in this paper are uncorrected. The IR spectra were measured using KBr disks. The NMR spectra were obtained at 60 M Hz. The mass spectra were taken at 70 eV. Thin-layer chromatography (TLC) was conducted by the use of silica gel G (Merck), while vapor-phase chromatography (VPC) was carried out by using a stainless steel column (1 m ×

---

*4 The concentration of this sample was so small that the $H_8$ signal, being covered with the peaks originating from $CF_3COOH$ (spin side band, impurities, *etc.*), could not be identified.

7) K. Hafner and C. Bernhard, *Ann.*, **625**, 108 (1959).

8) Pl. A. Plattner, A. Fürst, M. Gordon and K. Zimmermann, *Helv. Chim. Acta*, **33**, 1910 (1950).

Table 1. The reaction products in the thermal reaction of 3-acetylguaiazulene with sulfur (200°C)

| Fr. | Solvent | Compound | Yield | |
|---|---|---|---|---|
| | | | mg | % |
| 1 | *n*-Hexane | S-Guaiazulene (II) | 2.1 | 1.1 |
| 2 | Benzene - *n*-hexane (1 : 1) | 2-Acetylguaiazulene (III) | 52.6 | 26.4 |
| 3 | Benzene | 6-Acetyl-3,5,8-trimethylazuleno-[6,5-*b*]thiophene (IV) | 23.3 | 11.7 |
| | | 3-Acetylguaiazulene (I) (unchanged) | 117.9 | 59.3 |
| 4 | Chloroform | 7-Acetyl-3,5,8-trimethylazuleno-[6,5-*b*]thiophene (V) | 3.0 | 1.5 |

3 mm) packed with 10% NGS on Diasolid L.

**3-Acetylguaiazulene (I).** This compound was synthesized from S-guaiazulene (II) and acetyl bromide according to the method of Reid *et al.*[9] It was obtained as purple plates (mp 88.2—88.8°C) after being recrystallized from a mixed solvent of petroleum ether and methanol, which showed a single brown spot ($R_f$, 0.17) in TLC using benzene.

**Thermal Reaction of 3-Acetylguaiazulene (I) with Sulfur.** 3-Acetylguaiazulene (1.00 g) was heated with half as much powdered sulfur at 200°C on an oil bath for 4 hr under a nitrogen atmosphere. The reaction mixture, which solidified at room temperature, was crushed into small fragments in the reaction vessel; then it was taken out, ground to powder in a mortar, and extracted with benzene. A black oil (320 mg) thus obtained was chromatographed on activated alumina (Merck II—III); after the non-azulenic components had been eluted out with *n*-hexane, the solvents being changed step by step, the four fractions shown in Table 1 were separated depending upon the color.

**2-Acetylguaiazulene (III).** Green crystals of Fr. 2 (170 mg), which had been collected by repeating the thermal reaction, were developed on a silica-gel column with a mixed solvent of ether and *n*-hexane (1 : 19). The part of a blue-colored main adsorption band was cut off and extracted with the same mixed solvent to yield green crystals (130 mg), which gave green needles (mp 80.0—81.0°C) after being recrystallized twice from methanol. This compound showed a single green spot ($R_f$, 0.36) in TLC with an ether-*n*-hexane (1 : 19) mixture. IR: 1666 cm$^{-1}$ (C=O). UV: $\lambda_{\max}^{\text{cyclohexane}}$ m$\mu$ (log $\varepsilon$) 250 (4.40), 301.5 (4.63), 345 (3.74), 360 (3.76), 370 sh (3.30). Visible absorption spectrum: $\lambda_{\max}^{\text{cyclohexane}}$ m$\mu$ ($\varepsilon$) 637 (656), 692 (650).

Found: C, 84.83; H, 8.15%. Calcd for $C_{17}H_{20}O$: C, 84.96; H, 8.39%.

The 2,4-dinitrophenylhydrazone of this compound was obtained by using a mixed solvent of ethanol and phosphoric acid[10] as a reddish-brown powder. After being recrystallized twice from benzene, it showed a mp of 246.0—247.0°C. IR: 1526, 1328 cm$^{-1}$ ($NO_2$).

**Hypoiodite Oxidation of 2-Acetylguaiazulene (III).** A solution of 2-acetylguaiazulene (III) (170 mg) in dioxane (22 m*l*) was gradually mixed with a 10% aqueous sodium hydroxide solution (23 m*l*). To this mixture, kept at 60°C, an aqueous solution (8.2 m*l*) containing iodine (820 mg) and potassium iodide (1.64 g) was stirred in, drop by drop, over a 10-min period; the stirring was then continued for an additional 20 min at 60°C. At the end of this period, the excess iodine was reduced with a saturated aqueous solution of sodium hydrogen sulfite. The reaction mixture was chilled to 0°C and filtered to remove the precipitate of the iodoform. When the filtrate, from which unchanged 2-acetylguaiazulene was removed by dilution with water (30 m*l*) and subsequent extraction with chloroform, was acidified with 2 N hydrochloric acid, S-guaiazulene-2-carboxylic acid (VIa) (120 mg) was obtained as a green crystalline substance, mp *ca.* 145°C. This crude substance was further purified by sublimation at 220—250°C and 1.5 mmHg to give green prisms, mp 150—161°C. These crystals showed a dispersed blue spot ($R_f$, 0—0.18) in TLC with benzene; the spot turned yellow when sprayed with a solution of bromocresol green. IR: 1670 (C=O), 1260 (coupled C–O and O–H), 952 cm$^{-1}$ (O–H, out-of-plane deformation). NMR: $\delta_{\text{TMS}}^{\text{CDCl}_3}$ 2.82 (s, 3H; $Me_1$), 7.78 (s, 1H; $H_3$), 2.90 (s, 3H; $M_4$), 7.03 (d, 1H; $H_5$), 7.47 (q, 1H; $H_6$), 1.36/3.08 (d, 6H/m, 1H; *i*-Pr), 8.38 (d, 1H; $H_8$). $\delta_{\text{TMS}}^{\text{CF}_3\text{COOH}}$ 2.68 (t, 3H; $Me_1$), 4.23 (q, 1H; $H_3$), 2.97 (s, 3H; $Me_4$), 8.66 (s, 2H; $H_{5,6}$), 1.41/3.43 (d, 6H/m, 1H; *i*-Pr), 8.85 (s, 1H; $H_8$). MS: *m/e* 242 ($M^+$, $C_{16}H_{18}O_2$), 39.3%; *m/e* 227 $(M-CH_3)^+$ ($m^* = 212.9$), 42.3%; *m/e* 197 $(M-COOH)^+$, 11.0%; *m/e* 28 ($CO^+$), base peak.

**Preparation of the Methyl Ester of S-Guaiazulene-2-carboxylic Acid (VIb).** Crude S-guaiazulene-2-carboxylic acid (VIa) (70 mg) was dissolved into an ethereal solution of diazomethane prepared from nitrosomethylurea (4 g) in the usual manner; the solution was then allowed to stand at room temperature for 8 hr. After the excess diazomethane had been decomposed by adding a few drops of acetic acid, the solvent was distilled off under reduced pressure to give an oily residue (250 mg). The residue was then eluted through a silica-gel column with a mixed solvent of benzene and ether (1 : 1); the methyl ester of S-guaiazulene-2-carboxylic acid (VIb) (60 mg) was thus isolated as a blue oil. It showed a single blue spot ($R_f$, 0.47) in TLC using benzene-ether (1 : 1) mixture. IR: 1710 (C=O), 1230 and 1068 cm$^{-1}$ (C–O). UV: $\lambda_{\max}^{\text{cyclohexane}}$ m$\mu$ (log $\varepsilon$) 248.5 (4.29), 290 sh (4.47), 298.2 (4.52), 310 sh (4.33), 340 (3.59), 355.8 (3.69). Visible absorption spectrum: $\lambda_{\max}^{\text{cyclohexane}}$ m$\mu$ ($\varepsilon$) 631 (484), 680 (468). NMR: $\delta_{\text{TMS}}^{\text{CCl}_4}$ 2.75 (s, 3H; $Me_1$), 3.88 (s, 3H; COOMe),

---

9) D. H. Reid, W. H. Stafford and W. L. Stafford, *J. Chem. Soc.*, **1958**, 1118.

10) G. D. Johnson, *J. Amer. Chem. Soc.*, **73**, 5888 (1951).

7.52 (s, 1H; $H_3$), 2.80 (s, 1H; $H_4$), 6.86 (d, 1H; $H_5$), 7.29 (q, 1H; $H_6$), 1.33/3.02 (d, 6H/m, 1H; i-Pr), 8.22 (d, 1H; $H_8$). $\delta_{\mathrm{TMS}}^{\mathrm{CF_3COOH}}$ 2.85 (t, 3H; $Me_1$), 4.16 (s, 3H; COOMe), 4.41 (q, 1H; $H_3$), 3.16 (s, 3H; $Me_4$), 8.75 (s, 2H; $H_{5,6}$), 1.60/3.63 (d, 6H/m, 1H; *i*-Pr), 8.94 (s, 1H; $H_8$). MS: *m/e* 256 ($M^+$, $C_{17}H_{20}O_2$), 87.5%; *m/e* 241 $(M-CH_3)^+$($m^*=226.9$), base peak; *m/e* 225 $(M-OCH_3)^+$, 17.7%.

**Decarboxylation of S-Guaiazulene-2-carboxylic Acid (VIa).** A solution of crude S-guaiazulene-2-carboxylic acid (VIa) (30 mg) in quinoline (2 m*l*) was refluxed with copper powder (30 mg) for 1 hr on a sand bath. The reaction mixture was then diluted with *n*-hexane and subsequently filtered. The filtrate, after being washed with 1N hydrochloric acid and then with a 2N aqueous sodium carbonate solution to take quinoline and the unchanged acid away, was concentrated under reduced pressure to give a crude blue oil (30 mg). This oil was subsequently chromatographed on a silica-gel column with *n*-hexane; a blue oil (8.3 mg) was thus isolated in a pure state. The oil thus obtained was identical with an authentic specimen of S-guaiazulene (II) in TLC, VPC, and IR spectrometry.

**6-Acetyl-3,5,8-trimethylazuleno[6,5-*b*]thiophene (IV).** The purple oil (150 mg) of Fr. 3 (Table 1) was rechromatographed on a silica-gel column with a mixed solvent of ether and benzene (1 : 19), and then with an ether-*n*-hexane (1 : 3) mixed solvent. A green crystalline substance thus isolated was collected by repeating the above process. The substance (40 mg), after recrystallization from a mixed solvent of *n*-hexane and methanol (1 : 1) and again from methanol, gave dark brown needles (10.6 mg), mp 162.0—163.0°C, which exhibited a single blue spot ($R_f$, 0.37) in TLC with an ether-*n*-hexane (1 : 3) mixture. IR: 1655 $cm^{-1}$ (C=O). UV: $\lambda_{\max}^{\mathrm{cyclohexane}}$ m$\mu$ (log $\varepsilon$) 240.5 (4.10), 290 (4.41), 302 sh (4.60), 324 (4.80), 370 (3.77), 386 (3.82). Visible absorption spectrum: $\lambda_{\max}^{\mathrm{cyclohexane}}$ m$\mu$ ($\varepsilon$) 624.6 (595), 668 (578).

Found: S, 12.38%. Calcd for $C_{17}H_{16}OS$: S, 11.95%.

The oxime of this compound was prepared from a pyridine solution and was obtained as green needles, mp 223.0—224.0°C, after recrystallization from methanol. IR: *ca.* 3400 (O–H), 1638, 1620 and 1592 (C=C and/or C=N), 992 or 910 $cm^{-1}$ (N–O).

**Desulfurization of 6-Acetyl-3,5,8-trimethylazuleno[6,5-*b*]thiophene (IV).** A solution of 6-acetyl-3,5,8-trimethylazuleno[6,5-*b*]thiophene (IV) (11.3 mg) in methanol (10 m*l*) was stirred with a freshly-activated W-2 Raney nickel catalyst (500 mg) at 50—60°C for 30 min. The reaction mixture was filtered, and the filtrate was concentrated under reduced pressure to give a blue oil (10 mg). The oil was then submitted to elution chromatography using benzene; we separated a green crystalline substance (0.4 mg) which was found to be identical with 2-acetylguaiazulene (III) by TLC and UV spectrometry.

**7-Acetyl-3,5,8-trimethylazuleno[6,5-*b*]thiophene (V).** Brown crystals of Fr. 4 (15 mg), obtained from several repetitions of the reaction, were recrystallized from ethanol to give brown needles (10 mg; mp 141.0—142.0°C), which showed a single yellow spot ($R_f$, 0.37) in TLC with benzene. IR: 1650 $cm^{-1}$ (C=O). UV: $\lambda_{\max}^{\mathrm{cyclohexane}}$ m$\mu$ (log $\varepsilon$) 235.5 (4.19), 287 sh (4.28), 300 sh (4.43), 327.4 (4.62). Visible abosorption spectrum: $\lambda_{\max}^{\mathrm{cyclohexane}}$ m$\mu$ ($\varepsilon$) 518 sh (442), 554 (492), 600 sh (370), 660 sh (119).

**Acetylation of 3,5,8-Trimethylazuleno[6,5-*b*]-thiophene (VII).** 3,5,8-Trimethylazuleno[6,5-*b*]thiophene (VII) (80 mg; mp 116.0—116.5°C), prepared by the reaction of S-guaiazulene (II) with sulfur,[1,2] was dissolved in absolute tetrahydrofuran (1 m*l*) together with *N*,*N*-dimethylacetamide (90 mg). To the solution there was then added, drop by drop, another absolute terahydrofuran solution (1 m*l*) of phosphorus oxychloride (150 mg); the mixture was then refluxed on a water bath for 4 hr. The reaction mixture, after being diluted with water (100 m*l*), was made alkaline by adding ammonia water, and a dark brown oil separated was taken up into chloroform. The dark brown oil (140 mg) thus obtained was chromatographed on activated alumina (Merck II—III) with chloroform to afford brown crystals (20 mg). The recrystallization of these crystals from ethanol gave brown needles (12.5 mg; mp 141.5—142.5°C), which were identified as 7-acetyl-3,5,8-trimethylazuleno[6,5-*b*]thiophene by a mixed-melting-point determination and by TLC and IR spectrometry.

**Thermal Rearrangement of 3-Acetylguaiazulene (I).** In a slow stream of nitrogen, 3-acetylguaiazulene (1.0 g) was heated at 200°C for 2 hr. The reaction mixture was chromatographed on silica gel with benzene to separate it into the following three fractions.

Fr. 1: S-Guaiazulene (II), 10 mg (1.4%). Fr. 2: 2-Acetylguaiazulene (III), 120 mg (16.4%). Fr. 3: 3-Acetylguaiazulene (I), 600 mg (82.2%).

**Thermal Reaction of 2-Acetylguaiazulene (III).** 2-Acetylguaiazulene (III) (400 mg), which had been isolated from the reaction products of the above thermal isomerization of 3-acetylguaiazulene, was heated at 200°C for 2 hr in the same manner as has been described in the case of 3-acetylguaiazulene. The spots corresponding to 3-acetylguaiazulene and S-guaiazulene (II) were not observed in the TLC of the reaction mixture with benzene, and only the starting material (220 mg) was recovered when the reaction mixture was chromatographed on silica gel with benzene.

Next, 2-acetylguaiazulene (94 mg) was heated in a sealed glass tube at 300°C for 1 hr. In this case also, no spot corresponding to S-guaiazulene or 3-acetylguaiazulene was observed; only the starting material (48 mg) was recovered from the reaction mixture.

The author wishes to thank Professor Tamon Matsuura and Professor Shûichi Hayashi of Hiroshima University for their helpful guidance and advice on this work. Thanks are also due to Professor Shô Itô of Tohoku University for his kind measurement of the NMR and mass spectra and to Dr. Hitoshi Minato of Shionogi Research Laboratory of Shionogi & Co., Ltd., for his kind measurement of the NMR spectra.