

mixed with 1.2 g (0.03 mole) granulated sodium hydroxide for 40-50 min until a voluminous precipitate of the salt IIa formed, after which mixing was continued for another 10-15 min. The reaction mixture was removed by decanting from the alkali granules, the salt was filtered off and dried under vacuum (1-2 mm Hg, 100°C) over 3 Å molecular sieves to constant weight. Yield 0.54 g (50%), t. decomp. 250-252°C. UV spectrum, λ_{\max} (log ϵ): 265 nm (4.22). IR spectrum: 1645 (C), 1620 (CN), 1530 cm^{-1} (CN). PMR spectrum, δ : 7.09-7.57 (m, Ph), 3.77 ppm (s, 5H). Found: C 51.0; H 3.4; N 13.0; S 14.8%. $\text{C}_9\text{H}_7\text{N}_2\text{NaOS}$. Calculated: C 50.5; H 3.3; N 13.1; S 15.0%.

Potassium Salt of 2-Phenylimino-4-thiazolidinone (Ib). Produced analogously to compound Ia. Yield 0.67 g (60%), t. decomp. 250-253°C. UV spectrum, λ_{\max} (log ϵ): 265 nm (4.22). IR spectrum: 1635 (CO, CN), 1545 (CN), 1520 cm^{-1} (CN). Found: C 47.2; H 3.5; N 11.8; S 13.6%. $\text{C}_9\text{H}_7\text{KN}_2\text{OS}$. Calculated: C 46.9; H 3.1; N 12.2; S 13.9%.

Cesium Salt of 2-Phenylimino-4-thiazolidinone (Ic). Produced analogously to compound Ia. Yield 0.67 g (40%), t. decomp. 220-230°C. IR spectrum, λ_{\max} (log ϵ): 265 nm (4.20). IR spectrum: 1640 (CO), 1610 (CN), 1550 (CN), 1540 cm^{-1} (CN). Found: C 33.1; H 2.6; N 8.6; S 9.9%. $\text{C}_9\text{H}_7\text{CsN}_2\text{OS}$. Calculated: C 33.4; H 2.2; N 8.6; S 9.9%.

LITERATURE CITED

1. Yu. G. Basova, S. M. Ramsh, and A. I. Ginak, *Zh. Org. Khim.*, **18**, 2200 (1982).
2. F. B. Dains, L. M. Kinsett, C. O. Holmberg, and C. C. Robinson, *Univ. Kansas Sci. Bull.*, **24**, No. 2, 15 (1936).
3. F. C. Brown, *Chem. Rev.*, **61**, 463 (1961).

SYNTHESIS AND STRUCTURE OF 1,1-DIOXIDES OF 3-ALLYL(STYRYL)-4H-1,2,4-BENZOTHIADIAZINE

V. S. Fedenko, Z. F. Solomko,
and V. I. Avramenko

UDC 547.876:542.953.2:
541.62:543:422.4

The reaction of o-aminobenzenesulfonamides with acids of crotonic and cinnamic acids in dioxane yielded the corresponding anilides, which were cyclized to derivatives of 1,2,4-benzothiadiazine 1,1-dioxide. The structure of the end products is discussed in connection with the possibility of tautomeric equilibrium of the 2H- and 4H-forms on the basis of the spectral data.

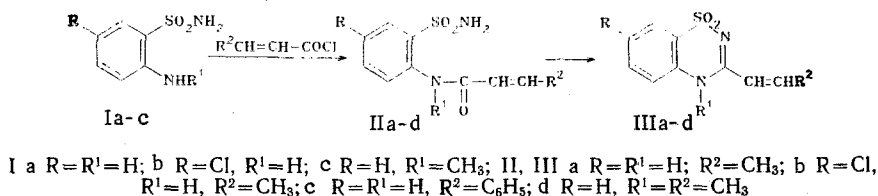
Derivatives of benzothiadiazine, which contain an alkenyl substituent in the 3-position of the heterocyclic ring, possess pronounced hypotensive activity [1, 2], comparable with the action of diazoxide in clinical use [3]. According to the spectral data [4, 5], and quantum chemical calculations [6], 1,1-dioxides of 1,2,4-benzothiadiazine exist primarily in the 4H-form. In view of this it is of interest to evaluate the influence of a substituent with a multiple bond on the state of the tautomeric equilibrium.

For this purpose we synthesized some 1,1-dioxides of 3-allyl(styryl)-4H-1,2,4-benzothiadiazine (IIa-d) by heterocyclization of o-sulfamoylanilides of crotonic and cinnamic acids (IIa-c) under the action of alkali (Table 1). The anilides II in turn were produced from o-aminobenzenesulfamides (Ia-d) and chlorides of crotonic and cinnamic acids in dioxane. Since the N-methylcrotonanilide IIc is hydrolyzed in alkaline medium to the initial o-N-methylaminobenzenesulfamide (Id), thermal cyclization of the anilide IIc was used to synthesize the dioxide IIId.

The structure of compounds IIa-d was confirmed by spectral data. It should be noted that the frequencies of the stretching vibrations of the C=C and C=O bonds in the IR spectrum of compound IIc are shifted in the low-frequency direction in comparison with croton-

Dnepropetrovsk State University, Dnepropetrovsk 320625. Translated from *Khimiya Geterotsiklicheskikh Soedinenii*, No. 7, pp. 907-911, July, 1984. Original article submitted September 30, 1983.

anilides IIa, b, and d as a result of conjugation (Table 1). The absence of a band in the region of 1520-1540 cm^{-1} in the spectrum of the N-methylanilide IIc permits this band in the spectra of other anilides to be assigned to the deformational vibrations of N-H.



The observed UV absorption of compounds IIa-d (Fig. 1) is the result of superposition of two conjugated chromophores — $>\text{N}-\text{C}_6\text{H}_4\text{SO}_2\text{NH}_2$ and $\text{R}-\text{CH}=\text{CH}-\text{C}=\text{O}$. The latter chromophore (for

example, in crotonic acid [7]) has a band at 205 nm; therefore its influence on the general nature of the spectrum will be negligible. As a result of this, three bands are observed in the electronic spectra of the anilides Ia and b, just as for orthanilamide [8]. The introduction of a chlorine atom into the ring causes a bathochromic shift of the indicated bands, which agrees with the influence of electron acceptor substituents on the absorption of the aromatic chromophore [9]. The sharp difference of the spectrum of the N-methylcrotonanilide IIc is evidently due to a disruption of the coplanarity of the π -electrons of the phenyl ring and the p-electrons of the unshared pair of the nitrogen atom, which is associated with the presence of a voluminous ortho-sulfamoyl group. Therefore, the spectrum of compound IIc becomes close to the absorption of benzenesulfamide [10]: λ_{max} (log ϵ): 218 (3.99), 265 nm (2.87). The strong hyperchromic effect of the long-wave band in the electronic spectrum of the anilide IIc is evidence of the realization of an extended chromophore system.

In the PMR spectrum of the crotonanilide IIa (acetone- D_6), the protons of the CH_3 and CH groups form an ABX_3 -spin system. The signal of the methyl protons is represented in the form of a quartet at 1.83 ppm ($J_1 = 3.5$ and $J_2 = 1.5$ Hz). The signal of the methine proton in the allyl position appears in the form of two quartets with a center at 5.93 ppm. This assignment is supported [11] by the value of the allyl constant J_2 (1.5 Hz), while the value of the constant J_3 (16 Hz) permits a transconfiguration to be ascribed to the anilide IIa, by analogy with crotonic acid [12]. The signal of the other methine proton forms a complex multiplet with sulfamide and aromatic protons in the region of 6.57-8.70 ppm, while the broadened signal (9.53 ppm) indicates the presence of an amide NH group in the structure.

The conversion of the anilides IIa-d to the dioxides IIIa-d is indicated by the disappearance of the "amide I" band in the IR spectra of the latter, the appearance of absorption of the $\text{C}=\text{N}$ bond [1, 13], at 1615-1618 cm^{-1} , a low-frequency shift (40-45 cm^{-1}) of the asymmetrical stretching vibrations of the SO_2 group, and changes in the region of the stretching vibrations NH. An unsaturated substituent in the 3-position does not change the nature of the absorption in the region of 1500-1620 cm^{-1} , which, just as for other 1,2,4-benzothiadiazines, is characterized by three strong bands [14]. The absorption in the region of 3150-3265 cm^{-1} is represented by a complex set of bands with different relative intensities. Earlier [1] the absorption at 3075-3290 cm^{-1} of 3R-1,2,4-benzothiadiazines was assigned to the stretching vibrations of N-H. For the 1,1-dioxide of 3-methylbenzothiadiazine, the interpretation of the short-wave band at 3260 cm^{-1} is confirmed by the method of deuteration [15]. Our investigation of a deuteroanalog of the dioxide IIIb permitted an experimental confirmation of the presence of three bands $\nu_{\text{N-H}}$ (Table 1): the calculated values of $\nu_{\text{N-H}}/\nu_{\text{N-D}}$ lie in the interval 1.35-1.38. The stretching vibrations of $=\text{C}-\text{H}$ in the region of 3065-3095 cm^{-1} differ appreciably from the absorption of $\text{C}-\text{H}$ of the methyl group (2848-2978 cm^{-1}). We should mention that the asymmetrical vibration $\nu_{\text{C}-\text{H}}$ is split into two bands with lower intensity as a result of the resonance effect [16] due to the presence of a neighboring double bond. The broad, low-intensity band in the spectra of the dioxides IIIa-c in the region of 2780-2795 cm^{-1} is characteristic of the strongly associated N-H bond [17].

Thus, the electronic spectra of compounds IIIa and the model 1,1-dioxide of 3-methyl-1,2,4-benzothiadiazine, which, according to the data of [4], is represented in alcohol solution by a 4H-form, differ substantially (Fig. 2), it might have been assumed that when the methyl group is replaced by an allyl group, the equilibrium will be shifted in the direction of the 2H-form.

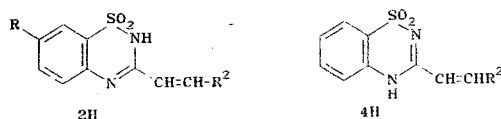
However, a comparison with the 4-methyl derivative IIIc, where the $\text{C}=\text{N}$ bond is rigidly fixed in the 2,3-position, supports a 4H form. The change in the nature of the UV absorption

TABLE 1. o-Sulfamoylanilides of Crotonic and Cinnamic Acids, 1,1-Dioxides of 3-Allyl(styryl)-4H-1,2,4-benzothiadiazine

| Compound | mp, °C | IR spectrum, ν , cm^{-1} | N found, % | Gross formula | N calc. % | Yield, % |
|----------|---------|---|------------|--|-----------|----------|
| IIa | 182—183 | 1152 (SO_2 , s); 1330 (SO_2 , as); 1630 ($\text{C}=\text{C}$); 1675 ($\text{C}=\text{O}$); 3285, 3350 (N—H) | 11,7 | $\text{C}_{10}\text{H}_{12}\text{N}_2\text{O}_3\text{S}$ | 11,7 | 75 |
| IIb | 194—195 | 1160 (SO_2 , s); 1335 (SO_2 , as); 1645 ($\text{C}=\text{C}$); 1685 ($\text{C}=\text{O}$); 3200, 3360, 3385 (N—H) | 10,1 | $\text{C}_{10}\text{H}_{11}\text{ClN}_2\text{O}_3\text{S}$ | 10,2 | 70 |
| IIc | 220—221 | 1140 (SO_2 , s); 1330 (SO_2 , as); 1605 ($\text{C}=\text{C}$); 1660 ($\text{C}=\text{O}$); 3270, 3295 (N—H) | 10,5 | $\text{C}_{15}\text{H}_{14}\text{N}_2\text{O}_3\text{S}$ | 10,6 | 88 |
| IId | 143—144 | 1165 (SO_2 , s); 1338 (SO_2 , as); 1625 ($\text{C}=\text{C}$) ^a ; 1665 ($\text{C}=\text{O}$); 3275, 3365 (N—H) | 11,1 | $\text{C}_{11}\text{H}_{13}\text{N}_2\text{O}_3\text{S}$ | 11,0 | 73 |
| IIIa | 254—255 | 1160 (SO_2 , s); 1285 (SO_2 , as); 1575, 1675 ($\text{C}=\text{C}$); 1615 ($\text{C}=\text{N}$); 2850, 2885, 2978 ($\text{C}-\text{H}$) ^b ; 3170, 3210, 3265 (N—H) | 12,4 | $\text{C}_{10}\text{H}_{10}\text{N}_2\text{O}_2\text{S}$ | 12,6 | 85 |
| IIIf | 282—283 | 1170 (SO_2 , s); 1290 (SO_2 , as); 1580, 1665 ($\text{C}=\text{C}$); 1618 ($\text{C}=\text{N}$); 2848, 2875, 2975 ($\text{C}-\text{H}$); 3150, 3200, 3250 (N—H) ^c | 10,9 | $\text{C}_{10}\text{H}_9\text{ClN}_2\text{O}_2\text{S}$ | 10,9 | 77 |
| IIIc | 337—338 | 1135 (SO_2 , s); 1265 (SO_2 , as); 1575, 1650 ($\text{C}=\text{C}$); 1615 ($\text{C}=\text{N}$); 3160, 3200, 3245 (N—H) | 9,8 | $\text{C}_{15}\text{H}_{12}\text{N}_2\text{O}_2\text{S}$ | 9,7 | 76 |

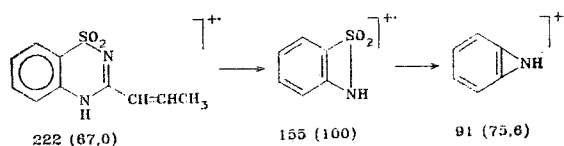
^aAppears in the form of a shoulder on the main band. ^b $\nu_{\text{C}-\text{H}}$ of the methyl group. ^cFor the deuterio analog of the dioxide IIIf 2295, 2375, 2440 ($\nu_{\text{N}-\text{D}}$).

for 3-allylbenzothiadiazines is evidently associated with the presence of a cross-conjugated chromophore, where p, π -conjugation of the free electron pair of the nitrogen atom in the 4-position with the 2,3-azomethine bond is weakened on account of the competing conjugation of the latter with the exocyclic $\text{C}=\text{C}$ bond. For 3-styrylbenzothiadiazine IIIc, the absorption maximum around 240 nm is absent, but the long-wave band undergoes a bathochromic shift, accompanied by a strong hyperchromic effect.



In the PMR spectrum of compound IIIa ($\text{DMSO}-d_6$) a quartet of methyl protons is observed at 1.90 ppm ($J_1 = 7$ and $J_2 = 1.5$ Ha). The signal at 6.12 ppm represented by two quartets ($J_2 = 1.5$, $J_3 = 16$ Hz), should be assigned to one of the methine protons, since the signal of the other forms a common multiplet with the aromatic protons (6.72–7.90 ppm). In the spectrum of compound IIIc ($\text{DMSO}-d_6$), two doublets of the methine protons should be noted (6.87 and 7.87 ppm).

The main direction of the decomposition of compound IIIa under the action of electron impact, according to the data of [18], proceeds according to the scheme



EXPERIMENTAL

The IR spectra of the investigated compounds were recorded on UR-20 and Specord 75 IR instruments in the region of 400–3700 cm^{-1} in KBr tablets. The UV spectra were obtained on a Specord UV-vis spectrophotometer in ethanol, concentration of the solution 10^{-4} M, thickness of the absorption layer 0.5 and 1 cm. The PMR spectra were recorded on a Tesla-467 instrument with working frequency 60 MHz; solvents: acetone- d_6 for the anilide IIa and $\text{DMSO}-d_6$ for compounds IIc, IIIa, and IIIc; external standard HMDS. The mass spectrum of compound IIIa

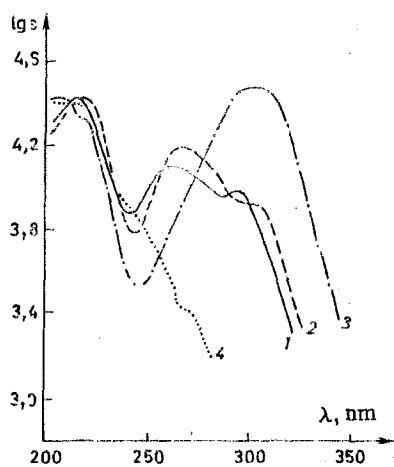


Fig. 1

Fig. 1. UV spectra of compounds IIa (1), IIb (2), IIc (3), and IIId (4).

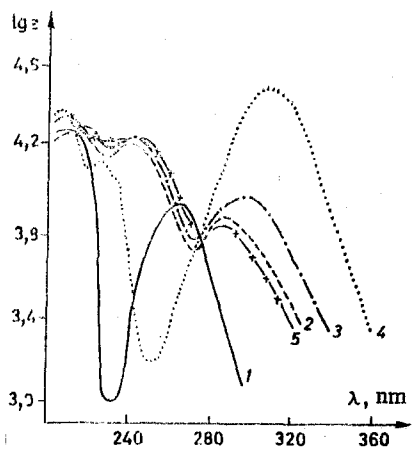


Fig. 2

Fig. 2. UV spectra of the 1,1-dioxide of 3-methyl-4H-1,2,4-benzothiadiazines (1), compound IIIa (2), IIIb (3), IIIc (4), and IIId (5).

was recorded on an MX-1303 instrument with system of evaporation of the substance in direct proximity to the region of ionization, at an energy of the ionizing electrons 70 eV, emission current 100 mA. The course of the reactions and the purity of the substances obtained were monitored chromatographically on Silufol UV-254 plates in the system benzene-ethyl acetate; development with iodine vapors or UV light.

The 1,1-dioxide of 3-methyl-2H-1,2,4-benzothiadiazine was produced by the method of [8].

o-Sulfamoylanilides of Crotonic and Cinnamic Acids (IIa-d). To a solution of 2.5 mmoles of the orthanilamide Ia-c in 10 ml of dioxane we added 3 mmoles of the chloride of crotonic or cinnamic acid and mixed for 2 h. The solvent was evaporated, the solid residue crystallized from aqueous isopropanol. The constants of the anilides IIa-d obtained are cited in Table 1.

PMR spectrum of the anilide IIc: 6.83 (1H, d, $J = 16$ Hz, $\text{CH}=\text{C}$), 7.08-8.02 ppm (6H, m, $\text{CH}=\text{C}$, C_6H_4 , NH).

1,1-Dioxides of 3-Allyl(styryl)-1,2-benzothiadiazine (IIIa-c). A solution of 0.001 mole of the anilides IIa-c in 6 ml of a 0.1 N solution of sodium hydroxide was heated on a water bath for 1 h. It was filtered, cooled, and neutralized with acetic acid to pH 6. The precipitate was removed and crystallized from aqueous isopropanol. The constants of the thiadiazines IIIa-c obtained are cited in Table 1.

Heating of the dioxide IIIc in a mixture of acetonitrile and D_2O yielded the corresponding deuteroanalogs.

In cyclization of 0.15 g (0.6 mmole) of the crotonanilide IIId according to this method, 0.07 g (64%) of the sulfamide Ic was obtained, mp 114-115°C (from water). According to the data of [19], mp 115-116.5°C.

1,1-Dioxide of 4-methyl-3-allyl-4H-1,2,4-benzothiadiazine (IIId). The crotonanilides IIId (0.2 g, 0.8 mmole) was heated at 250°C for 3 min. The reaction mixture was washed with ether and crystallized from aqueous isopropanol. Yield 0.05 g (30%), mp 236-237°C. Found: N 12.0%. $\text{C}_{11}\text{H}_{12}\text{N}_2\text{O}_2\text{S}$. Calculated: N 12.0%.

LITERATURE CITED

1. J. G. Topliss, M. H. Sherlock, H. Reimann, L. M. Konzelman, E. F. Shapiro, B. W. Petersen, H. Schneider, and N. Sperber, *J. Med. Chem.*, **6**, 122 (1963).
2. Scherico Ltd. Pat. 1333173 (GB); *Chem. Abstr.*, **70**, 28963 (1969).
3. G. Peters and L. Roch-Ramel, in: *Handbook of Experimental Pharmacology*, Springer-Verlag, Berlin, Heidelberg, New York (1969), p. 257.

4. F. C. Novello, S. C. Bell, E. L. A. Abrams, C. Ziegler, and J. M. Sprague, *J. Org. Chem.*, **25**, 970 (1960).
5. P. Jakobsen and S. Treppendahl, *Tetrahedron*, **35**, 2151 (1970).
6. A. Wohl, *Mol. Pharmacol.*, **6**, 189 (1970).
7. A. T. Nielsen, *J. Org. Chem.*, **22**, 1539 (1957).
8. D. V. Parke and R. T. Williams, *J. Chem. Soc.*, No. 7, 1760 (1951).
9. L. A. Kazitsyna, N. B. Kupletskaya, *The Use of UV, IR, NMR, and Mass Spectroscopy in Organic Chemistry* [in Russian], Vysshaya Shkola, Moscow (1979), p. 26.
10. E. Stern and C. Timmons, *Electronic Absorption Spectroscopy in Organic Chemistry*, St. Martin's Press (1970).
11. M. Barfield, R. J. Spear, and S. Sternhell, *Chem. Rev.*, **76**, 593 (1976).
12. B. V. Ioffe, R. R. Kostikov, and V. V. Razin, *Physical Methods of Determining the Structure of Organic Molecules* [in Russian], Izd. LGU, Leningrad (1976), p. 304.
13. L. Raffa, R. Cameroni, and M. T. Bernabei, *Farmaco, Ed. Sci.*, **17**, 679 (1962); *Chem. Abstr.*, **58**, 4572 (1963).
14. H. L. Yale, K. Losee, and J. Bernstein, *J. Am. Chem. Soc.*, **82**, 2042 (1960).
15. R. Cameroni, A. Albasini, M. T. Bernabei, and V. Ferioli, *Atti Soc. Nat. Mat. Modena* **1970**, **101**, 59 (1971).
16. L. Bellamy, *Infrared Spectra of Complex Molecules* [Russian translation], IL, Moscow (1963), p. 25.
17. R. F. Branch, A. H. Bekket, and D. B. Cowell, *Tetrahedron*, **19**, 401 (1963).
18. A. M. Kirkien-Pzeszotarski, J. R. Plimmer, S. V. Krees, W. J. Pzeszotarski, *J. Heterocycl. Chem.*, **12**, 155 (1975).
19. L. Raffa, *Farmaco, Ed. Sci.*, **12**, 387 (1957); *Chem. Abstr.*, **53**, 18898 (1959).

1,3-DIARYL-2,2-DIHALOAZIRIDINES IN NITRATION AND BROMINATION REACTIONS

A. F. Khlebnikov and R. R. Kostikov

UDC 547.717'546'539:542.958:
1'944.2:543.422.25'27.4

In the nitration of 3-(4-nitrophenyl)-1-phenyl-2,2-dichloroaziridine in acetic acid, 1-(o- and p-nitrophenyl)-derivatives are formed in a 35:65 ratio. 1,3-Diphenyl-2,2-dichloroaziridine undergoes opening of the three-membered ring under the same conditions, forming a mixture of o- and p-nitroanilides and 2-nitro-4-chloroanilides of 2-acetoxy (or 2-chloro)-2-phenylacetic acids. The bromination of 3-(4-nitrophenyl)-1-phenyl-2,2-dichloroaziridine in aqueous acetic acid leads to 1-(4-bromophenyl)-3-(4-nitrophenyl)-2,2-dichloroaziridine, while in a mixture of acetic acid and acetic anhydride it leads to the anilide of 2-bromo-2-phenylacetic acid and 2-bromo-N-(2,4-dibromophenyl)-1-(4-nitrophenyl)-2,2-dichloroethylamine.

1,3-Diaryl-2,2-dihaloaziridines, formed in the interaction of dihalocarbenes with benzylidenanilines, can be used in the synthesis of amidines [1, 2], imidoesters [2, 3], heterocycles [4-6], and other compounds [2, 7-9].

We studied the reactions of nitration and bromination of the aziridines Ia and b. In the nitration of the aziridine Ia a mixture of aziridines Ic and Id is formed in a 65:35 ratio; their structure was confirmed by the PMR spectra (Table 1) and by hydrolysis in 20% sulfuric acid to o- and p-nitroanilines. Nitration of the aziridine Ib leads to a complex mixture of anilides IIa-f in the amounts indicated on the scheme. The structure of compounds IIa-f is confirmed by the data of the PMR and IR spectra (Table 1). In the IR spectra of the anilides, the bands of the amide group are observed at 1658-1715 (C=O) and 3295-3395 cm⁻¹ (NH); in the spectra of anilides of 2-acetoxy-2-arylacetic acids, in addition, there is the band of the C=O

A. A. Zhdanov Leningrad State University, Leningrad 199004. Translated from *Khimiya Geterotsiklicheskikh Soedinenii*, No. 7, pp. 912-916, July, 1984. Original article submitted December 5, 1983.