4. E. S. A. Ibrahim, D. S. A. Shamsel, and F. S. G. Solinan, Pharmazie, 34, 392 (1979).
5. D. L. Trepanier and P. E. Krieger, US Patent No. 3,641,019; Chem. Abstr., 76, 127024k (1972).
6. S. S. Smagin, V. E. Bogachev, A. K. Yakubovskii, S. E. Metkalova, G. P. Privol'neva, V. V. Chugunov, and E. F. Lavretskaya, Khim.-farm. Zh., 9, 11 (1975).
7. J. Korosi, West German Patent No. 1,934,809; Chem. Abstr., 72, 100334s (1970).
8. E. K. Mikitenko and N. N. Romanov, Khim. Geterotsikl. Soedin., No. 5, 634 (1982).
9. C. Alberti, L. Bernardi, and B. Camerio, Gazz. Chim. Ital., 84, 489 (1954).
10. R. Metze, Chem. Ber., 88, 772 (1955).
11. Yu. P. Kitaev and B. I. Buzykin, in: Hydrazones [in Russian], Nauka, Moscow (1974), p. 56.
12. K. N. Zelenin, V. V. Alekseev, and V. A. Khrustalev, Khim. Geterotsikl. Soedin., No. 6, 769 (1983).
13. R. Hull, J. Chem. Soc., 2959 (1952).
14. M. Forster and B. Day, J. Chem. Soc., 101, 2234 (1912).

MESOIONIC COMPOUNDS WITH A BRIDGED NITROGEN ATOM.

13.* THIAZOLOPYRIMIDOINDOLES

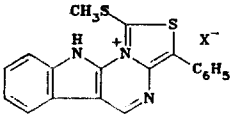
E. K. Mikitenko and N. N. Romanov

UDC 547.853.3'785.5'789.6

Derivatives of a new heterocyclic system, viz., thiazolo[3',4':3,2]pyrimido-[4,5-b]indole, are formed when 4-amino-2-methylthio-5-phenylthiazolium benzenesulfonate is heated with 3-formyloxindole in phosphorus oxychloride.

It is known that a number of compounds of the indole series, including condensed heterocycles with an indole ring [2], display high physiological activity. In this connection, it seems of interest to search for derivatives of new heterocyclic systems that contain an indole ring.

With this end in mind, we studied the reaction of 4-amino-2-methylthio-5-phenylthiazolium benzenesulfonate (I) with 3-formyloxindole (II). We found that condensation to give thiazopyrimidoindolium salts III and IV occurs upon prolonged heating of a mixture of the starting components in phosphorus oxychloride.



III,IV

III X=ClO_4; IV X=BF_4

The structures of the synthesized compounds were confirmed by IR and PMR spectral data, their chemical transformations, and alternative synthesis. Thus, for example, the IR spectrum of perchlorate III does not contain bands of the stretching vibrations of a C=O bond, but one does observe bands of the vibrations of C=N and N–H bonds (1525-1590 cm^{-1} and 3270 cm^{-1}); the PMR spectrum contains signals of protons of a methylthio group and aromatic protons with chemical shifts of 2.77 and 7.1-8.0 ppm, respectively. It should be noted that the molecules of the synthesized thiazolopyrimidoindolium salts can exist in the form of the 4H or 10H isomer.

*See [1] for communication 12.

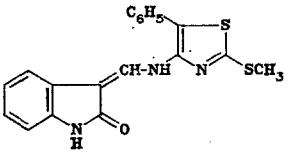
Institute of Organic Chemistry, Academy of Sciences of the Ukrainian SSR, Kiev 252660.
Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 4, pp. 502-504, April, 1985. Original article submitted June 20, 1984.

0009-3122/85/2104-0417$09.50

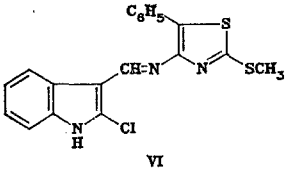
In our opinion, they exist in the latter form since, in it, the largest number of rings retains aromatic character.

The reaction of aldehyde II and benzenesulfonate I in alcohol readily gives aminomethyleneoxindole V, in the IR spectrum of which one observes bands of stretching vibrations of C=O and N–H bonds (1675 and 3150 cm^{-1}); the PMR spectrum contains signals of protons of methylthio, phenyl, and methylidyne groups with chemical shifts of 2.31, 6.4-7.2, and 8.77 ppm, respectively.

Brief heating of oxindole V in $POCl_3$ or similar treatment of a mixture of I and II gives 2-chloroindole VI, which can also be isolated in the form of perchlorate VII. Further heating of azomethines VI and VII in phosphorus oxychloride leads to their cyclization to thiazolopyrimidoindole.



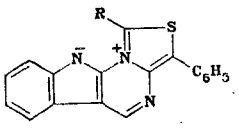
V



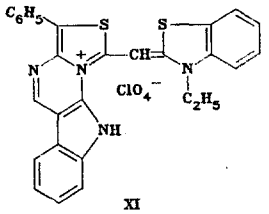
VI

It is interesting to note that the action of bases on salts III and IV readily gives mesoionic thiazolopyrimidoindole VIII, the IR spectrum of which does not contain a band of stretching vibrations of an N–H bond; the band of vibrations of the C=N bond is shifted to the low-frequency side (1540-1580 cm^{-1}) as compared with starting salts III and IV.

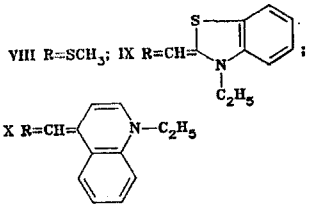
Thiazolopyrimidoindoles III, IV, and VIII react readily with nucleophilic intermediates used for the synthesis of polymethine dyes. Thus, for example, mesoionic monomethylidynecyanines IX and X are formed with 2-methyl-3-ethylbenzothiazolium tosylate or with 4-methyl-1-ethylquinolinium perchlorate. The corresponding simple salts III and XI are formed by the action of perchloric acid on mesoionic compounds VIII and IX.



VIII–X



XI



As expected, in conformity with the theoretical concepts [3], solutions of the mesoionic thiazolopyrimidoindoles absorb in the longer-wave part of the spectrum as compared with the salt forms.

EXPERIMENTAL

The electronic spectra of the compounds were obtained with an SF-8 spectrophotometer. The IR spectra were recorded with a UR-10 spectrometer. The PMR spectra of solutions in CF_3•COOH were recorded with a BS-467 spectrometer (60 MHz) with hexamethyldisiloxane (HMDS) as the internal standard.

The characteristics of the synthesized compounds are presented in Table 1.

1-Methylthio-3-phenyl-10H-thiazolo[3',4' 3,2]pyrimido[4,5-b]indolium Salts (III, IV). A mixture of 0.38 g (1 mmole) of benzenesulfonate I, 0.16 g (1 mmole) of 3-formyloxindole (II), and 3 ml of phosphorus oxychloride was heated at 80°C for 18 h, after which the excess $POCl_3$ was evaporated *in vacuo*, and the residual mass was triturated with petroleum ether. The precipitate was dissolved in alcohol, and 0.5 ml of 58% $HClO_4$ or HBF_4, respectively, was added. The resulting precipitate was removed by filtration and crystallized from acetonitrile–DMF (1:2 in the case of III and 1:1 in the case of IV).

2,3-Dihydro-3-[4-(2-methylthio-5-phenylthiazolyl)aminomethylen]-1H-indol-2-one (V). A mixture of 0.76 g (2 mmole) of benzenesulfonate I and 0.32 g (2 mmole) of oxindole II was refluxed in 12 ml of absolute alcohol. The precipitated product was removed by filtration, washed with alcohol, and crystallized from alcohol–DMF (1:3) to give 0.67 g of V.

TABLE 1. Characteristics of the Synthesized Compounds

Compound	mp, °C	λ_{max}*, nm (lg ε)	Found, %		Empirical formula	Calc., %		Yield, %
			Cl(N)	S		Cl(N)	S	
III	254—255	323 (4,48), 380 (4,08), 432 (4,09)	8,1	13,9	$C_{19}H_{14}ClN_3O_4S_2$	7,9	14,3	63
IV	246—247	323 (4,96), 378 (4,10), 432 (4,09)	(10,0)	15,0	$C_{19}H_{14}BF_4N_3S_2$	(9,7)	14,7	72
V	258—260	275 (4,29), 392 (4,46)	(11,1)	17,5	$C_{19}H_{15}N_3OS_2$	(11,5)	18,0	94
VI	265—266	275 (4,28), 390 (4,43)	8,9	16,5	$C_{19}H_{14}ClN_3S_2$	9,2	16,7	85
VII	284—285	305 (4,24)	14,2	13,4	$C_{19}H_{15}Cl_2N_3O_4S_2$	14,7	13,2	75
VIII	262—263	330 (4,49), 416 (4,09), 486 (4,16)	(12,5)	18,1	$C_{19}H_{13}N_3S_2$	(12,1)	18,4	80
IX	290—292	322 (4,26), 438 (4,35), 465 (4,35), 580 (4,54)	(11,6)	13,4	$C_{28}H_{20}N_4S_2$	(11,8)	13,5	59
X	278—280	358 (4,40), 450 (4,40), 660 (4,56), 700 (4,54)	(12,3)	6,4	$C_{30}H_{22}N_4S$	(11,9)	6,8	69
XI	218—220	300 (4,46), 430 (4,20), 450 (4,19), 542 (4,48)	5,9	11,5	$C_{28}H_{21}ClN_4O_4S_2$	6,1	11,5	71

*The spectra of III, IV, VII, and XI were obtained from solutions in CH_3COOH, the spectra of V and VI were obtained from solutions in CH_3CN, and the spectra of VIII-X were obtained from solutions in dimethylformamide (DMF).

3-[4-(2-Methylthio-5-phenylthiazolyl)iminomethyl]-2-chloroindole (VI). A) A mixture of 0.38 g (1 mmole) of benzenesulfonate I, 0.16 g (1 mmole) of formyloxindole (II), and 2 ml of $POCl_3$ was heated at 80°C for 1 h, after which the excess phosphorus oxychloride was washed away with petroleum ether, and the residue was dissolved in alcohol. The alcohol solution was treated with 0.2 g (2 mmole) of triethylamine, and the product was removed by filtration and crystallized from alcohol to give 0.33 g of VI.

B) A mixture of 0.73 g (2 mmole) of indolone V and 3 ml of $POCl_3$ was heated at 80°C for 1 h, after which the excess $POCl_3$ was washed away with petroleum ether, and the residue was triturated with acetone and dissolved in alcohol. The alcohol solution was treated with 0.2 g (2 mmole) of triethylamine, and the product was removed by filtration and crystallized from alcohol to give 0.44 g (58%) of VI. The preparation was identical to the product obtained by method A.

3-[4-(2-Methylthio-5-phenylthiazolyl)iminomethyl]-2-chloroindole (VII). A mixture of 0.38 g (1 mmole) of benzenesulfonate I, 0.16 g (1 mmole) of formyloxindole (II), and 2 ml of $POCl_3$ was heated at 80°C for 1 h, after which the excess $POCl_3$ was washed away with petroleum ether, and the residue was triturated with acetone and dissolved in alcohol. The alcohol solution was treated with 0.5 ml of 58% perchloric acid, and the product was removed by filtration and crystallized from alcohol to give 0.36 g of VII.

1-Methylthio-3-phenyl-10H-thiazolo[3',4':3,2]pyrimido[4,5-b]indol-11-ylium-10-ide (VIII). A 1-mmole sample of salt III or IV was dissolved in 5 ml of absolute alcohol, and 0.1 g (1 mmole) of triethylamine was added. The precipitated product was removed by filtration and crystallized from alcohol—DMF (1:3) to give 0.28 g of VIII.

1-[(3-Ethyl-2(3H)-benzothiazolylidene)methyl]-3-phenyl-10H-thiazolo[3',4':3,2]pyrimido-[b]indol-11-ylium-10-ide (IX). A mixture of 0.18 g (0.5 mmole) of thiazolopyrimidoindole VIII, 0.17 g (0.5 mmole) of 2-methyl-3-ethylbenzothiazolium tosylate, 2 ml of alcohol, and 2 ml of DMF was heated until the components had dissolved, after which 0.05 g (0.5 mmole) of triethylamine was added. The dye was removed by filtration and crystallized from alcohol—DMF (1:4). The yield was 0.14 g.

1-[(1-Ethyl-4(1H)-quinolinylidene)methyl]-3-phenyl-10H-thiazolo[3',4':3,2]pyrimido[4,5-b]-indol-11-ylium-10-ide (X). A mixture of 0.18 g (0.5 mmole) of thiazolpyrimidoindole VIII, 0.15 g (0.5 mmole) of 4-methyl-1-ethylquinolinium perchlorate, 2 ml of alcohol, and 2 ml of DMF was heated until the components had dissolved, after which 0.05 g (0.5 mmole) of triethylamine was added. The precipitated dye was removed by filtration and crystallized from alcohol—DMF (1:2). The yield was 0.16 g.

1-[(3-Ethyl-2(3H)-benzothiazolylidene)methyl]-3-phenyl-10H-thiazolo[3',4':3,2]pyrimido-[4,5-b]indolium Perchlorate (XI). A 0.1-g (2 mmole) sample of monomethylidynecyanine IX was

dissolved in 5 ml of acetic acid, and 0.1 g of 58% perchloric acid was added. The precipitated salt was removed by filtration and crystallized from acetic acid. The yield was 0.08 g.

LITERATURE CITED

1. K. V. Fedotov, N. N. Romanov, and A. I. Tolmachev, Khim. Geterotsikl. Soedin., No. 7, 969 (1984).
2. French Patent Application No. 2,450,607; Ref. Zh. Khim., 30244P.
3. A. D. Kachkovskii, E. K. Mikitenko, and N. N. Romanov, Ukr. Khim. Zh., 49, 1088 (1983).

ALLYLIC MIGRATION OF THE AZIRIDINE RING IN 2-AZIRIDINO-3-TRIFLUOROMETHYL-4,4-DIFLUORO-3-BUTENOATES

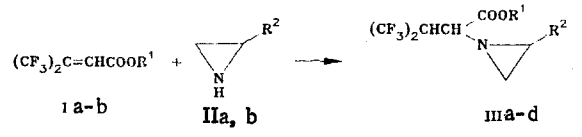
I. V. Solodin, A. V. Eremeev, É. É. Liepin'sh, and R. G. Kostyanovskii

UDC 547.717'722.3'413.5

Products of allylic rearrangement of 2-aziridino-3-trifluoromethyl-4,4-difluoro-3-butenoates, viz., 4-aziridino-3-trifluoromethyl-4,4-difluoro-2-butenoates, were obtained in the dehydrofluorination of 2-aziridino-3-trifluoromethyl-4,4,4-trifluorobutanoates.

Numerous examples of allylic rearrangements and reactions involving allylic substitution are known [1-4], whereas such reactions in N-allyl-substituted nitrogen heterocycles have been described only in [5, 6]. It was shown that 6-aryl-3-ethoxycarbonyl-4-pyrrolidino(piperidino)-4H-thiopyran readily undergoes rearrangement to 6-aryl-3-ethoxycarbonyl-2-pyrrolidino(piperidino)-2H-thiopyran [5] and that N-(α-methallyl)pyridinium tetrafluoroborates undergo thermal isomerization to N-(γ-methallyl) derivatives [6].

Reactions of this type are unknown for N-allyl-substituted aziridines. In the course of studies of the nucleophilic addition of amines to β,β-bis(trifluoromethyl)acrylates (Ib) [7] we obtained 2-aziridino-3-trifluoromethyl-4,4,4-trifluorobutenoates (IIIa-d) in high yields in the reaction of esters Ia,b with aziridine (IIa) and 2-methylaziridine (IIb) in ether:



Ia-b IIa, b IIIa-d

Ia, IIIa,b R^1=Me; Ib, IIIc,d R^1=Et; IIa, IIIa,c R^2=H; IIb, IIIb,d R^2=Me

In the dehydrofluorination of IIIa-d with powdered KOH by refluxing in o-xylene, instead of the expected 2-aziridine-3-butenoates (IVa-d), we isolated 4-aziridino-2-butenoates in 50% yield in the form of mixtures of E and Z isomers (Va-d and VIa-d, respectively) in a ratio of 3:1.

Isomers V and VI were separated by high-performance liquid chromatography (HPLC) and were identified from their ^{1}H and ^{19}F NMR spectra (Tables 1 and 2). Their formation can be explained by allylic rearrangement of esters of the IV type. In fact, ester IVa was isolated in 55% yield and identified in the dehydrofluorination of IIIa under mild interphase-catalysis conditions in the CCl_4—solid KOH—$Bu_3N^+CH_2Ph \cdot Cl^-$ system at 0°C. Ester IVa undergoes quantitative isomerization to ester Va when it is heated (100°C). Allylic rearrangement of IVa takes place not only when it is heated, but also under the influence of catalytic amounts of

Institute of Organic Synthesis, Academy of Sciences of the Latvian SSR, Riga 226006. Institute of Chemical Physics, Academy of Sciences of the USSR, Moscow 117334.

Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 4, pp. 505-508, April, 1985. Original article submitted March 28, 1984.

0009-3122/85/2104-0420$09.50