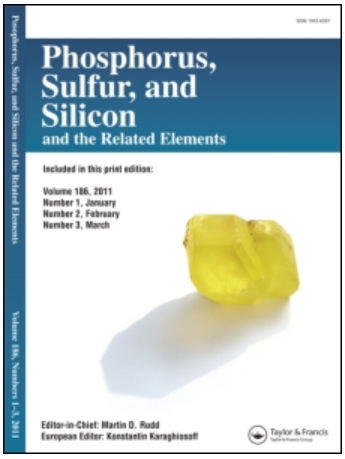

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THE REACTIONS OF 9,10-DIHYDROPYRROLO-[3,4-b][1,4]BENZOXAZEPINES WITH PHOSPHORIC NUCLEOPHILIC REAGENTS

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In the reaction with phosphoric nucleophilic reagents 9,10-dihydropyrrolo[3,4-b][1,4]benzoxazepine yield derivatives of the betaine salt type.

Key words: 9,10-dihydropyrrolo[3,4-b][1,4]benzoxazepine; reaction with nucleophiles.

In our previous investigations we obtained a new group of compounds, the derivatives of 9,10-dihydropyrrolo[3,4-b][1,4]benzoxazepine.[1] We have shown that these compounds react very easily with primary and secondary amines of sufficient nucleophilic properties to 2,3-substituted maleic acid imide derivatives.[2] The site of the amine attack is carbon C-3a and the attack results in the opening of the oxazepine ring.

The results of the investigation of the reactivity of the obtained pyrrolobenzoxazepines with nucleophilic reagents containing nitrogen made us deal with the reactivity of these compounds in relation with phosphoric nucleophilic reagents. We expected a similar reaction course as with amines, i.e., the opening of oxazepine ring. Trialkyl phosphites were chosen for preliminary investigations. As can be seen from the literature these compounds are known also for their alkylating properties.[3–8] Thus, in the case of oxazepine ring opening, alkylation of the formed phenolic group could follow.

In the first stage of the studies the reaction of 10-methyl-2-phenyl-1H, 2, 3, 9, 10-tetrahydropyrrolo [3,4-b][1,4]benzoxazepine-1,3,9-trion (**1**) with triethyl phosphite was dealt with. Reactions were carried out with the use of various solvents (ethanol, methanol, benzene) and varying molar ratio of the reagents (1:2, 1:3, 1:5). In each case one product was obtained with similar yield, the highest however in the case of the low concentration in benzene solution, with 5-molar excess of triethyl phosphite.

In order to show the general reaction course two other pyrrolobenzoxazepines were additionally studied with triethyl phosphite. The reactions were carried out with the same conditions as for pyrrolobenzoxazepine **1** so that comparable results could be obtained.

All the obtained derivatives were crystalline compounds. Elemental analysis has shown that in these reactions, the nucleophilic reagent was attached to pyrrolobenzoxazepine, similarly as in the reactions with amines. However, "amine" derivatives were coloured compounds, while phosphoric derivatives are colourless. Yet, spectroscopic studies did not confirm the expected structure. In the IR (KBr) spectra the signals of three carbonyl groups appear in the range 1730–1640 cm^{-1}, similarly as for starting pyrrolobenzoxazepines. In the range 1050–1080 cm^{-1} a

strong band of bonds appears, ascribed to ester group P—O—C, and at ~1100 cm^{-1}-ether group C—O—C, not observed for the products of pyrrolobenzoxazepines reactions with amines. The data point to the fact that the oxazepine ring has been preserved.

In the ^1H NMR spectra for all the compounds a triplet with δ = ~1.30 ppm was observed, ascribed to the protons of methyl groups of the ester group, as well as a doublet of quartets (quintet) with δ = ~4.2 ppm, ascribed to the protons of methylene groups in the ester. The above range of shifts and multiplicity of the signals point to the fact that all ethoxyl groups are bound to a phosphorus atom, as in triethyl phosphite. If the opening of the ring with simultaneous alkylation of the phenolic group occurred, the shift values for ester and ether groups would then be different.

For the derivative, with benzyl group at N-10 of the system position, a spectrum in the form of a quartet AB ($^2J_{HH}$ = 14 Hz $\Delta\nu$ = ~36 Hz) was observed characteristic for the geminal protons of the group. The benzyl rest, because of its character,[9,10] "monitors" very well all the symmetry changes in the molecule. Benzyl protons show enantiotopic character (singlet) when a symmetry element is present in the molecule (as it is the case in the starting pyrrolobenzoxazepine **3** and **6**) or show diastereotopic character (quartet AB) in the case of asymmetric molecule. The last effect occurs in our case after the addition of phosphoric reagents without the opening of oxazepine ring.

Chemical shift values for phosphorus atoms in ^{31}P NMR ($CDCl_3$) are approximately δ = ~40 ppm, which may point to the ionic character of the phosphorus atom.[11]

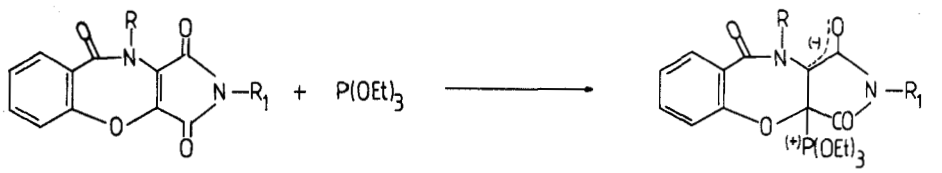
In the ^{13}C NMR ($CDCl_3$) spectra new signals, absent in the spectrum of the starting pyrrolobenzoxazepines, appear. C-3a carbon, which in the pyrrolobenzoxazepine substrate was in the range ~123 ppm was shifted to the region with higher field intensity and had the form of a doublet with chemical shift δ = ~50 ppm and coupling constant $^1J_{PC}$ = ~240 Hz, which points to the combination of C-3a carbon with a phosphorus atom, hence the high coupling constant by one bond.

The signal of the C-10a carbon shifted towards higher field intensity, viz., to δ = ~95 ppm. Signals in this range are common for hybridization of sp^3 and sp^2 carbon. Chemical shift of that order can be observed for olefin carbon atoms, which are in position to the atom which a free electron couple, and therefore the participation of ionic resonance structure is high.[12] The above mentioned signal appears in the form of a doublet with $^2J_{PC}$ = ~4 Hz, which points to the carboanionic character of C-10a carbon.[13]

In the ^{13}C NMR spectra for the derivatives in question three clear signals of carbonyl groups were also observed, two of them as a doublet of various coupling constant values $^2J_{PC}$ = ~18 Hz and $^3J_{PC}$ = ~22 Hz, and one signal in the form of a singlet.

The higher carbon-phosphorus coupling constant value by three bonds than by two bonds is typical of that kind of coupling.[14]

On the basis of the performed spectroscopic analysis of substrates and products the following structure of compounds **7–9** can be suggested and the following reaction course can be assumed.



1–3 **7–9**

1, 7 $R=CH_3$ $R_1=Ph$

2, 8 $R=Ph$ $R_1=Ph$

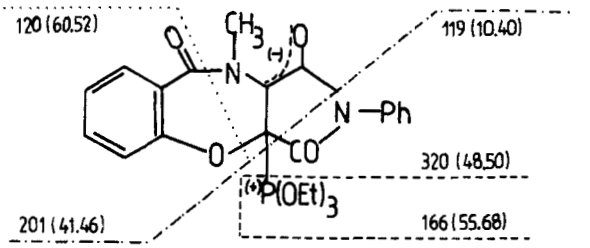
3, 9 $R=CH_2Ph$ $R_1=Ph$

SCHEME 1

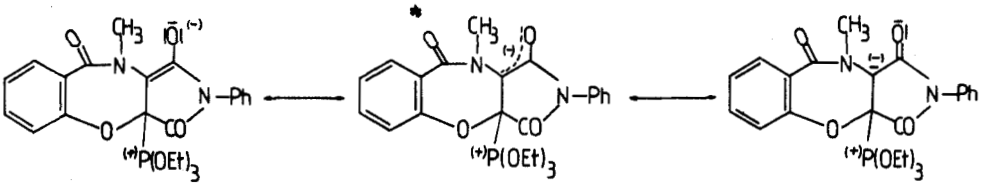
A similar structure is suggested by Winkler and Bencze for the products of reactions of α, β-unsaturated acidic chlorides with trimethyl phosphite.[15] In the mass spectrum (70 eV) for derivative **7** a molecular ion peak with m/z = 486 (100%) was observed. It can be assumed that fragmentation first aims at the cleavage of C—P bond and then the cleavage of the bond in the pyrrole ring follows. Fragmentation is shown in the scheme below. The second value is the percentage of the particular ions.

In the reaction with $FeCl_3$ (ethanol solution) derivatives **7–9** give a coloured reaction only after several hours. It can be assumed that derivative **7** is a resultant of mesomeric structures A and B.

The reaction course of compounds **1–3** with nucleophilic phosphoric reagent was unexpected, i.e., different from that for the reaction with nitrogen nucleophilic reagents. This made us perform more detailed investigations of the problem.



SCHEME 2



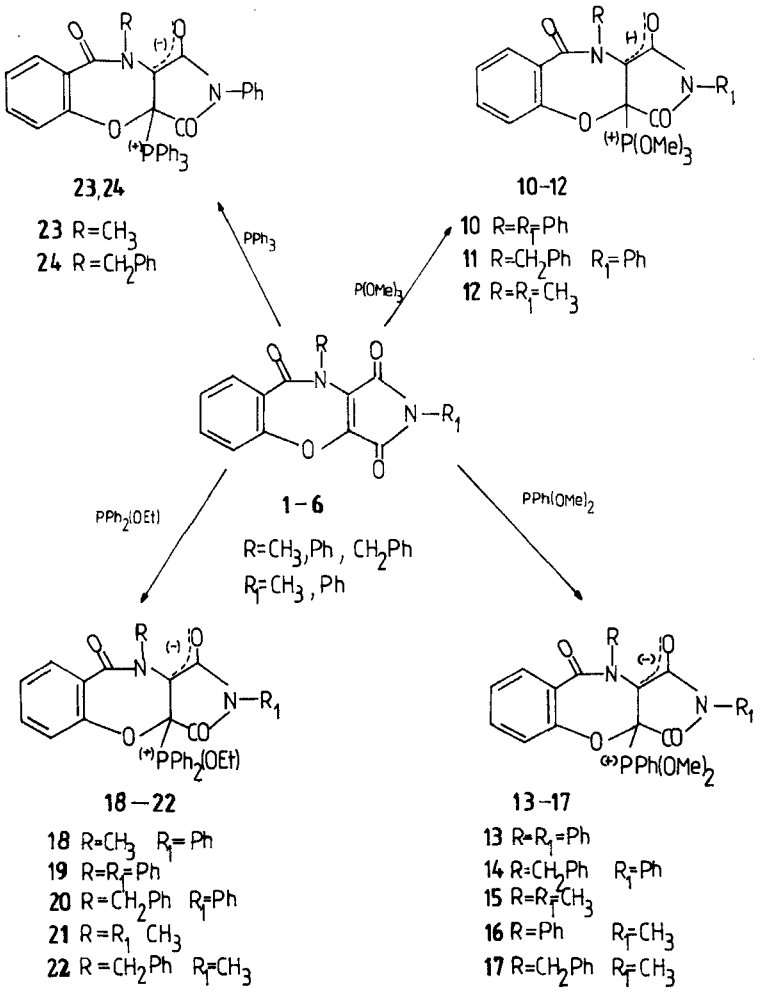
"A" "B"

SCHEME 3

Various pyrrolobenzoxazepines with C=O group, CH_2 group, and $CHP(O)(OR)_2$ group at C-9 position were used for reaction, as well as the following nucleophilic reagents: $P(OMe)_3$, $P(OMe)_2Ph$, $P(OEt)Ph_2$, PPh_3.

The reactions were carried out under the same conditions as those described for carbonyl group at C-9 position undergo the reaction, while others do not yield addition products.

An important factor affecting the reaction course are the nucleophilic properties of phosphoric reagents, similarly as in reactions with amines. An approximate measure of nucleophilic properties is the basicity constant. Literature gives basicity constant pK = 9.89[16,17] only for triphenyl phosphine. For the remaining nucleophilic reagents the values could not be found. It may be supposed that they are close to those of aniline or *o*-phenylenediamine, which also reacted only with the pyrrolobenzoxazepines with the carbonyl group at C-9 position. The reaction course and the list of obtained compounds is shown in Scheme 4.



SCHEME 4

The new structure of phosphoric derivatives of pyrrolobenzoxazepines encouraged us to perform the biological screening studies. For compound **7** antineoplastic effect has been found in mice with L-1210 leucaemia.[18]

Some of them show activity on central nervous system (CNS).†

EXPERIMENTAL

Melting points were determined in an electric cryometer and left uncorrected. IR spectra were made using Pye-Unicam 200G Spectrometer, in KBr (tablets), ν_{max} in cm^{-1}.

^1H NMR spectra were performed with a VARIAN EM-360 (60 MHz) spectrometer, and TESLA BS 567A (100 MHz) spectrometer.

^{13}C NMR at 25.2 MHz on a TESLA BS 567A and ^{31}P NMR at 24.3 MHz on a FT Joel FX-60 (external standard H_3PO_4). Mass spectra were measured on a LKB 2091 Mass Spectrometer (at 70 eV ionizing energy).

9,10-dihydropyrrolo[3,4-b][1,4]benzoxazepines (**1–6**) *obtained according to Reference 2.*

Reactions of pyrrolobenzoxazepines with phosphoric nucleophilic reagents.

10-alkyl(aryl)-2-phenyl(methyl)-3a-triethoxyphosphonio-1H,2,3,9,10-tetrahydropyrrolo[3,4-b][1,4]benzoxazepine-1,3,9-trionian (**7–9**). Into a solution of 0.001 mol of a pyrrolobenzoxazepine **1–3** in 15 cm^3 of anhydrous benzene 0.005 mol of triethyl phosphite were added. The reagents were left at room temperature for four days. Then the solvent was evaporated. To the obtained light yellow oil 10 cm^3 anhydrous ethyl ether were added and the mixture was left in a freezer to crystallize. The formed precipitate was filtered, dried at room temperature and recrystallized from benezene:ethyl ether (1:1).

Thus were obtained:

2-phenyl - 10 - methyl - 3a - triethoxyphosphino - 1H,2,3,9,10-tetrahydropyrrolo[3,4-b][1,4]benzoxazepine-1,3,9-trionian(**7**)

2,10 - diphenyl - 3a - triethoxyphosphonio - 1H,2,3,9,10 - tetrahydropyrrolo[3,4-b][1,4]benzoxazepine - 1,3,9-trionian(**8**)

10 - benzyl - 2 - phenyl - 3a - triethoxyphosphonio - 1H,2,3,9,10 - tetrahydropyrrolo[3,4-b][1,4]benzoxazepine-1,3,9-trionian(**9**)

2 - Phenyl(methyl) - 10 - alkyl(aryl) - 3a - trimethoxyphosphonio - 1H,2,3,9,10 - tetrahydropyrrolo[3,4-b][1,4]benzoxazepine-1,3,9-trionian (**10–12**). Into a solution of 0.001 mol of a given pyrrolobenzoxazepine **1–3** in 20 cm^3 of anhydrous benzene 0.003 mol of trimethyl phosphite were added. The reagents were left at room temperature for three days. Then the obtained precipitate was filtered and crystallized.

Obtained:

2,10-diphenyl-3a-trimethoxyphosphonio-1H,2,3,9,10-tetrahydropyrrolo[3,4-b][1,4]benzoxazepine-1,3,9-trionian(**10**)

10 - benzyl - 2 - phenyl - 3a - trimethoxyphosphonio - 1H,2,3,9,10 - tetrahydropyrrolo[3,4-b][1,4]benzoxazepine-1,3,9-trionian(**11**)

2,10 - dimethyl - 3a - trimethoxyphosphonio - 1H,2,3,9,10 - tetrahydropyrrolo[3,4-b][1,4]benzoxazepine - 1,3,9-trionian(**12**)

10 - Alkyl(aryl) - 2 - phenyl(methyl) - 3a - dimethoxy(ethoxy)phenyl(diphenyl)phosphonio - 1H,2,3,9,10-tetrahydropyrrolo[3,4-b][1,4]benzoxazepine-1,3,9-trionian (**13–22**). Into a solution of 0.001 mol of a pyrrolobenzoxazepine in 30 cm^3 of anhydrous benzene 0.003 mol of a proper phosphite were added ($PPh_2(OEt)$ or $PPh(OMe)_2$). The reaction mixture was left at room temperature for four days. Then the solvent was evaporated under reduced pressure, and anhydrous ethyl ether was added to the residue. The mixture was left to crystallize. The obtained precipitative was filtered off and recrystallized.

Obtained:

2,10 - diphenyl - 3a - dimethoxyphenylphosphonio - 1H,2,3,9,10 - tetrahydropyrrolo[3,4-b][1,4]benzoxazepine-1,3,9-trionian(**13**)

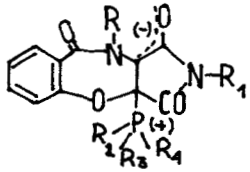
10-benzyl - 2 - phenyl-3a-dimethyoxyphenylphosphonio - 1H,2,3,9,10-tetrahydropyrrolo[3,4-b][1,4]-benzoxazepine-1,3,9-trionian(**14**)

2,10 - dimethyl - 3a - dimethoxyphenylphosphonio - 1H,2,3,9,10 - tetrahydropyrrol[3,4-b][1,4]benzoxazepine-1,3,9-trionian(**15**)

†Unpublished results.

TABLE I

Products of the reactions of pyrrolobenzoxazepines with phosphoric nucleophilic reagents



Comp. No	R	R_1	R_2	R_3	R_4	Yield (%)	mp. (^{o}C)	Solvent for crystallization
7	CH_3	Ph	OC_2H_5	OC_2H_5	OC_2H_5	95.0	101.5-103.0	benzene/ether ethyl
8	Ph	Ph	OC_2H_5	OC_2H_5	OC_2H_5	80.0	178-180	benzene
9	CH_2Ph	Ph	OC_2H_5	OC_2H_5	OC_2H_5	79.0	149-150	benzene/ethyl ether
10	Ph	Ph	OCH_3	OCH_3	OCH_3	76.0	196-198	methanol
11	CH_2Ph	Ph	OCH_3	OCH_3	OCH_3	96.0	221-222	methanol
12	CH_3	CH_3	OCH_3	OCH_3	OCH_3	83.4	176-178	benzene
13	Ph	Ph	OCH_3	OCH_3	Ph	78.0	199-201	benzene
14	CH_2Ph	Ph	OCH_3	OCH_3	Ph	90.0	204-206	benzene
15	CH_3	CH_3	OCH_3	OCH_3	Ph	50.0	145-147	benzene
16	Ph	CH_3	OCH_3	OCH_3	Ph	80.0	210-212	benzene
17	CH_2Ph	CH_3	OCH_3	OCH_3	Ph	91.0	202-204	benzene
18	CH_3	Ph	OC_2H_5	Ph	Ph	94.0	194-196	benzene/petrol
19	Ph	Ph	OC_2H_5	Ph	Ph	75.0	251-253	benzene/petrol
20	CH_2Ph	Ph	OC_2H_5	Ph	Ph	78.0	230-232	benzene/petrol
21	CH_3	CH_3	OC_2H_5	Ph	Ph	90.0	220-222.5	benzene/petrol
22	CH_2Ph	CH_3	OC_2H_5	Ph	Ph	76.0	225-227	benzene/petrol

TABLE II

Elemental analysis of derivatives 7–22

Comp. No	Molecular formula	Molar mass	Elemental analysis (%)							
			Calculated				Obtained			
			C	H	N	P	C	H	N	P
7	$C_{24}H_{12}N_2O_7P$	486.5	59.3	5.6	5.8	6.4	59.3	5.7	5.8	6.4
8	$C_{29}H_{29}N_2O_7P$	548.5	63.5	5.3	5.1	5.7	63.2	5.3	5.3	5.7
9	$C_{30}H_{31}N_2O_7P$	562.5	64.1	5.6	5.0	5.5	64.1	5.5	4.9	5.5
10	$C_{26}H_{23}N_2O_7P$	506.4	61.7	4.6	5.5	6.1	61.7	4.7	5.2	6.1
11	$C_{27}H_{25}N_2O_7P$	520.5	62.3	4.8	5.4	6.0	61.9	4.8	5.5	6.3
12	$C_{16}H_{19}N_2O_7P$	382.3	50.3	5.0	7.3	8.1	50.2	5.0	7.1	8.0
13	$C_{31}H_{25}N_2O_6P$	552.5	67.9	4.6	5.1	5.6	68.1	4.4	5.3	5.2
14	$C_{32}H_{27}N_2O_6P$	566.5	67.8	4.8	5.0	5.5	67.4	5.1	4.8	5.3
15	$C_{21}H_{21}N_2O_6P$	428.4	58.9	4.9	6.5	7.2	59.1	5.0	6.3	7.5
16	$C_{26}H_{23}N_2O_6P$	490.4	63.7	4.7	5.7	6.3	63.7	4.6	5.5	6.1
17	$C_{27}H_{25}N_2O_6P$	504.5	64.3	5.0	5.6	6.1	64.4	5.1	5.7	6.0
18	$C_{32}H_{27}N_2O_5P$	550.5	69.8	4.9	5.1	5.6	70.3	5.0	5.1	5.6
19	$C_{37}H_{29}N_2O_5P$	612.6	72.5	4.8	4.6	5.1	72.5	4.7	4.6	4.9
20	$C_{38}H_{31}N_2O_5P$	626.6	72.8	5.0	4.5	5.0	73.0	5.3	4.6	5.3
21	$C_{27}H_{25}N_2O_5P$	488.5	66.4	5.2	5.7	6.3	66.6	5.3	5.7	6.4
22	$C_{33}H_{29}N_2O_5P$	564.6	70.2	5.2	5.0	5.5	70.0	5.0	5.2	5.4

TABLE III

IR, ^{1}H NMR and MS spectroscopic data of derivatives **7–22**

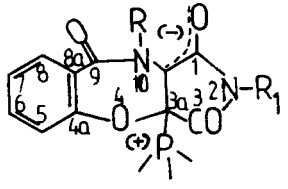
Comp.No	IR(KBr) ν (cm^{-1})	^{1}H NMR($CDCl_3$) δ(ppm)	MS:m/z (%)
1	2	3	4
7	1740,1670,1650(C=O); 1100(C-O-C); 1030(P-O-C)	1.33(t,9H,CH_3), 3.09(s,3H,N-CH_3), 4.28(dq,6H,CH_2), 6.70-8.00(m,9H,ar)	486(100), 320(66.62), 166(50.75), 120(23.18), 119(10.63), 81(13.59)
8	1710,1655,1640(C=O); 1090(C-O-C); 1050(P-O-C)	1.24(t,9H,CH_3), 3.97(dq,6H,CH_2), 6.69-8.00(m,14H, ar)	
9	1750,1675,1655(C=O); 1100(C-O-C); 1030(P-O-C)	1.39(t,9H,CH_3), 4.33(dq,7H,3xCH_2-CH_3,1H,CH_2Ph), 5.55(d,1H,CH_2Ph, $^2J_{HH}$=14Hz), 6.66-8.03(m,14H,ar)	
10	1725,1670,1650(C=O); 1110(C-O-C); 1060(P-O-C)	3.69(d,9H,O-CH_3, $^3J_{PCH}$=12Hz), 6.85-8.00(m,14H,ar)	506(63.6), 386(66.8), 382(13.8), 120(90.4)
11	1740,1680,1640(C=O); 1070(C-O-C); 1060(P-O-C)	3.97(d,9H,O-CH_3, $^3J_{PCH}$=12Hz), 4.39,5.48(AB quartet, 2H,CH_2Ph), 6.66-8.06(m,14H,ar)	520(11.8), 400(18.2), 120(48.8)
12	1725,1670,1630(C=O); 1100(C-O-C); 1050(P-O-C)	3.03(s,6H,2xN-CH_3), 3.78(d,9H,O-CH_3, $^3J_{PCH}$=12Hz), 6.66-8.00(m,4H,ar)	382(100), 262(27.4), 258(27.8), 124(28.63), 120(21.81)
13	1725,1665,1645(C=O); 1455(P-C_{ar}); 1120(C-O-C); 1050(P-O-C)	3.30, 3.48(2xd,6H,O-CH_3, $^3J_{PCH}$=20Hz), 6.66--7.94(m,19H,ar)	552(66.66), 432(78.34), 195(100), 170(20.09), 120(24.45), 77(95.63)
14	1730,1680,1650(C=O); 1455(P-C_{ar}); 1120(C-O-C); 1045(P-O-C)	3.38,3.42(2xd,6H,O-CH_3, $^3J_{PCH}$=14Hz), 4.41,5.51 (AB quartet, 2H,CH_2Ph, $^2J_{HH}$=14Hz), 6.66-7.93 (m,19H,ar)	

TABLE III (*Continued*)

1	2	3	4
15	1720,1700,1660(C=O); 1455(P-C_{ar}); 1120 (C-O-C); 1055(P-O-C)	3.09(s,3H,N-CH_3-in pyrrole), 3.33(s,3H, N-CH_3-in oxazep.), 3.66,3.69(2xd,6H,O-CH_3, $^3J_{PCH}$=12Hz), 6.66-7.97(m,9H,ar)	
16	1720,1670,1645(C=O); 1460(P-C_{ar}); 1125 (C-O-C); 1055(P-O-C)	2.43(s,3H,N-CH_3), 3.69,3.76(2xd,6H,O-CH_3, $^3J_{PCH}$=12Hz), 6.75-8.00(m,14H,ar)	
17	1730,1660,1645(C=O); 1455(P-C_{ar}); 1110 (C-O-C); 1050(P-O-C)	2.39(s,3H,N-CH_3), 3.69, 3.72(2xd,6H,O-CH_3, $^3J_{PCH}$=12Hz), 4.33,5.33(AB quartet,2H,CH_2Ph, $^2J_{HH}$=14Hz), 6.66-8.00(m,14H,ar)	504(9.2), 384(35.43), 383(100), 170(28.45), 120(9.63), 91(85.14), 77(17.31)
18	1725,1675,1645(C=O); 1450(P-C_{ar}); 1120 (C-O-C); 1030(P-O-C)	1.50(t,3H,CH_3), 2.91(s,3H,N-CH_3), 4.40(q, 2H,CH_2), 6.56-7.91(m,19H,ar)	550(6.74), 230(100), 201(80.93), 120(11.65) 77(15.45)
19	1720,1670,1640(C=O); 1450(P-C_{ar}); 1090 (C-O-C); 1030(P-O-C)	1.33(t,3H,CH_3), 3.99(q,2H,CH_2), 6.60-7.82 (m,24H,ar)	612(19.82), 492(6.36), 230(100), 201(66,19), 120(10.73), 77(22.14)
20	1730,1660,1640(C=O); 1450(P-C_{ar}); 1110 (C-O-C); 1030(P-O-C)	1.50(t,3H,CH_3), 4.50(q,2H,CH_2), 4.15,5.22 (AB quartet, 2H,CH_2Ph), 6.56-8.00(m,24H,ar)	505(50.46), 477(13.14) 230(77.6), 201(100), 120(7.11), 91(58.84), 77(15.41)
21	1725,1660,1640(C=O); 1450(P-C_{ar}); 1120 (C-O-C); 1040(P-O-C)	1.42(t,3H,CH_3), 2.63(s,3H,N-CH_3-in pyrrole) 2.91(s,3H,N-CH_3-in oxazep.), 4.33(q,2H,CH_2) 6.50-7.91(m,18H,ar)	488(20.7), 367(11.78) 230(100), 201(89.85), 120(16.98), 92(23.51) 77(32.49)
22	1725,1650,1630(C=O); 1460(P-C_{ar}); 1120 (C-O-C); 1030(P-O-C)	1.56(t,3H,CH_3), 4.45(q,2H,CH_2), 4.12,5.33 (AB quartet, 2H,CH_2Ph,$^2J_{HH}$=14Hz), 6.60--8.09(m,19H, ar)	564(13.32), 464(49.88) 443(64.38), 230(82.60) 201(100), 120(6.83)

TABLE IV

^{13}C-Chemical shift values for pyrrolobenzoxazepine derivatives with phosphoric reagents ($CDCl_3$) δ (ppm)



Comp. No	R	R_1	^+P	C_1	C_3	C_{3a}	C_{4a}	C_{8a}	C_9	C_{10a}	C - R	C - R_1	C-O-P^+
7	CH_3	Ph	$P(OEt)_3$	168.42 ^3J=22.54Hz	170.39 ^2J=20.6Hz	50.5 ^1J=242Hz	155.06	121.86	162.37	95.67 ^2J=5.63Hz	N-CH_3 29.41	-	O-CH_2-CH_3:15.86, ^3J=5.63Hz O-CH_2-CH_3:65.88, ^2J=5.63Hz
9	CH_2Ph	Ph	$P(OEt)_3$	168.50 ^3J=22.53Hz	170.58 ^2J=18.8Hz	50.01 ^1J=240Hz	155.28	121.98	163.42	94.74	CH_2Ph 46.58	-	O-CH_2-CH_3:16.01, ^3J=5.63Hz O-CH_2-CH_3:65.99, ^2J=7.51Hz
17	CH_2Ph	CH_3	$PPh(OMe)_2$	171.89 ^3J=16.9Hz	170.51 ^2J=15.3Hz	51.47 ^1J=189Hz	156.61	123.31	158.21	95.41	CH_2Ph 46.66	N-CH_3 23.14	O-CH_3:54.5 ^2J=6.93Hz

TABLE V

^{31}P Chemical shift values for derivatives **7–22**

Comp. No	7	12	13	14	15	16	17	19	20	21	22
δ(ppm) $CDCl_3$	40.99	46.48	65.29	65.14	64.57	64.69	64.39	50.58	50.79	48.59	49.32

10 - phenyl-3a-dimethoxyphenylphosphonio - 2 - methyl - 1H,2,3,9,10-tetrahydropyrrolo[3,4-b][1,4]-benzoxazepine-1,3,9-trionian(**16**)

10-benzyl-3a-dimethoxyphenylphosphonio-2-methyl-1H,2,3,9,10-tetrahydropyrrolo[3,4-b][1,4]-benzoxazepine-1,3,9-trionian(**17**)

2-phenyl-3a-ethoxydiphenylphosphonio-10-methyl-1H,2,3,9,10-tetrahydropyrrolo[3,4-b][1,4]-benzoxazepine-1,3,9-trionian(**18**)

3a - ethoxydiphenylphosphonio - 2,10 - diphenyl - 1H,2,3,9,10 - tetrahydropyrrolo[3,4-b][1,4]benzoxazepine-1,3,9-trionian(**19**)

10-benzyl-3a-ethoxydiphenylphosphonio-2-phenyl-1H,2,3,9,10-tetrahydropyrrolo[3,4-b][1,4]benzoxazepine-1,3,9-trionian(**20**)

3a-ethoxydiphenylphosphonio-2,10-dimethyl-1H,2,3,9,10-tetrahydropyrrolo[3,4-b][1,4]benzoxazepine-1,3,9-trionian(**21**)

10-benzyl-3a-ethoxydiphenylphosphonio-2-methyl-1H,2,3,9,10-tetrahydropyrrolo[3,4-b][1,4]benzoxazepine-1,3,9-trionian(**22**)

Analytic data for compounds **7–22** can be found in Table I, elemental analysis in Table II, spectroscopic data for ^1H NMR, IR, and MS in Table III, ^{13}C NMR in Table IV, and ^{31}P NMR in Table V.

2 - Phenyl-10-methyl(benzyl)-3a-triphenylphosphonio - 1H,2,3,9,10 - tetrahydropyrrolo[3,4-b][1,4]-benzoxazepine-1,3,9-trionian (**23, 24**). 0.001 mol of pyrrolobenzoxazepine **1** or **3** were dissolved in 10 cm^3 of anhydrous benzene, and then 0.002 mol (0.52 g) of triphenylphosphite was added. The reaction mixture was heated under reflux condenser for 2 hours. Then the solvent was distilled off. The obtained colourless oil was triturated with anhydrous ethyl ether. The precipitate was filtered and recrystallized from benzene: petrol ether (2:1).

Obtained:

2-phenyl-10-methyl-3a-triphenylphosphonio-1H,2,3,9,10-tetrahydropyrrolo[3,4-b][1,4]benzoxazepine-1,3,9-trionian (**23**) - 0.49 g (yield 86%), mp. 233–235°C.

Analysis for formula $C_{36}H_{27}N_2O_4P$ (582.6)

Calc.	C 74.2	H 4.7	N 4.8	P 5.3%
found	74.3	4.8	4.8	5.4%

IR (KBr) ν(cm^{-1}): 1720, 1660, 1630 (C=O), 1470 (P—$C_{aromat.}$), 1110 (C—O—C)

^1H NMR ($CDCl_3$) δ (ppm): 2.91 (s, 3H, NCH_3), 6.40–7.85 (m, 24H, aromat.)

^{31}P NMR ($CDCl_3$) δ (ppm): 13.204

^{13}C NMR ($CDCl_3$) δ (ppm): 29.6 (NCH_3), 46.29 (d, PC, $^1J_{PC}$ = 131.43 Hz), 96.6 (d, PC, $^2J_{PCC}$ = 3.76 Hz), 154.68, 162.0 (C=O), 168.86 (d, PC, $^2J_{PCC}$ = 15.0 Hz), 170.88 (d, PC, ^3J = 15.025 Hz).

MS m/z (%): 582 (M^+, 1.28), 262(100), 201(16.95), 120(27.31), 104(24.65)

10-benzyl-2-phenyl-3a-triphenylphosphonio-1H,2,3,9,10-tetrahydropyrrolo[3,4-b][1,4]benzoxazepine-1,3,9-trionian (**24**) - 0.62 g (yield 94.6%), mp. 250–252.5°C.

Analysis for formula $C_{42}H_{31}N_2O_4P$ (658.6)

Calc.	C 76.6	H 4.7	N 4.3	P 4.7
found	76.9	5.0	4.2	4.5

IR (KBr) ν(cm^{-1}): 1730, 1670, 1640 (C=O), 1460 (P—$C_{aromat.}$), 1100 (C—O—C)

^1H NMR ($CDCl_3$) δ(ppm): 4.33, 5.36 (AB quartet, 2H, CH_2, $^2J_{HH}$ = 14.0 Hz, $\Delta\nu$ = 62.0 Hz), 6.42–7.97 (m, 29H, aromat.)

^{13}C NMR ($CDCl_3$)δ(ppm): 46.73, 45.05 (d, PC, $^1J_{PC}$ = 129.58 Hz), 95.71, 154.76, 162.52, 170.88 (d, PC, $^3J_{PCC}$ = 15.024 Hz), 168.90 (d, PC, $^2J_{PC}$ = 13.15 Hz)

MS m/z (%): 658 (m^+, 0.67), 396 (21.31), 262 (86.72), 183 (70.77), 120(3.88), 108 (34.04), 91(100).

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