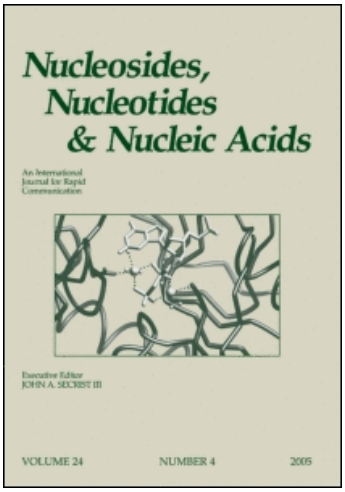

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Synthesis of Acyclo C-Nucleosides OF Phenanthro[9,10-e][1,2,4]Triazino[3,4-c]-[1,2,4] Triazoles, and Their Precursors

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SYNTHESIS OF ACYCLO *C*-NUCLEOSIDES OF PHENANTHRO[9,10-*e*][1,2,4]TRIAZINO[3,4-*c*]-[1,2,4]TRIAZOLES, AND THEIR PRECURSORS

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ABSTRACT

Reaction of 3-hydrazinophenanthro[9,10-*e*][1,2,4]triazine (**1**) with aliphatic and aromatic aldehydes as well as monosaccharides gave the corresponding hydrazones **2a-g**. The **D**-glucose analogue exists in the cyclic pyranosyl structure **5**. Acetylation and partial acetylation of the sugar hydrazones were carried out. Cyclization of a number of hydrazones including the partially acetylated sugar hydrazones by thionyl chloride gave regioselectively the respective angular isomer 1-substituted phenanthro[9,10-*e*][1,2,4]triazino[3,4-*c*][1,2,4]triazoles **16i-l**, and not the linear isomer. The cyclization of **1** with acetic acid, however, gave regioselectively the linear isomer **19**. The structural assignments were based on a model study whereby the angular **16a** was found to be different from the linear isomer **19a** obtained by the condensation of 4,5-diamino-3-methyl-1,2,4-triazole with 9,10-phenanthraquinone. Periodate oxidation of **2d** gave **20** whose reaction with **1** gave **21**.

INTRODUCTION

Considerable attention has been drawn to the synthesis of several condensed heterocyclic systems derived from triazoles and triazines owing to their great biological significance. Compounds containing the 1,2,4-triazine moiety are in use as pharmaceuticals, dyes, pesticides, herbicides, etc.[1-4]. Some triazolo-1,2,4-triazines, show antiviral and antibacterial properties[5], antihypertensive activity[6], blood platelet aggregation inhibition[7-10], herbicidal and anti-asthmatic[11,12], analgesic, antiinflammatory[13-15], and anticonvulsants activities as well as carrageenan-induced edema inhibition[16,17].

The discovery of *C*-nucleosides[18-23] and acyclonucleosides[22,23] as well as the rapid growth in literature on their biological activity led us to construct acyclo *C*-nucleoside analogues[22-31], which might have useful biological properties. The acyclo *C*-nucleoside analogues of phenanthro[9,10-*e*][1,2,4]triazino[3,4-*c*][1,2,4]triazole and their hydrazone precursors are the target molecules. The structures of the respective hydrazones have been found to be dependent on the sugar. This investigation may shed some light on the versatility of the annulation of a triazole ring onto the phenanthro[9,10-*e*][1,2,4]triazine as well as the regioselectivity of the angular versus the linear formation of phenanthrotriazinotriazole.

RESULTS AND DISCUSSION

The starting 3-hydrazinophenanthro[9,10-*e*][1,2,4]triazine (**1**) was prepared as described[32], by the action of hydrazine hydrate on 3-

mercaptophenanthro[9,10-*e*][1,2,4]triazine. Reaction of **1** with aliphatic or aromatic aldehydes as well as monosaccharides in an aqueous alcoholic solution and in the presence of a catalytic amount of acetic acid gave the corresponding hydrazones **2**. Thus, the hydrazones **2**a-g can be prepared from acetaldehyde, benzaldehyde, anisaldehyde as well as the monosaccharides, **D**-arabinose, **D**-xylose, **D**-galactose, and **D**-mannose. The corresponding derivative of **D**-glucose was similarly prepared, but it has been assigned the pyranosyl structure **5**.

The ^{1}H NMR spectra of the sugar hydrazones did not lead to conclusive results about their structures. The HC=N was hidden under the signal of the aromatic protons at ca. 7.7 ppm for **2**d-**2**f. The signals of the NH of **2**d-**2**f appeared at ca. 11.9 ppm whereas that of **5** appeared at 9.54 ppm. However, the rest of the sugar and hydroxyl protons appeared as multiplets in the range 3.5-5.3 ppm (Table 1).

The ^{13}C NMR (DMSO-d_6) spectra (Table 1) of the sugar hydrazones **2**d-g showed twelve C=C signals between 122.2-133.5 ppm and four C=N signals in the range 140.0-159.2 ppm, in addition to the signals of the sugar residue. The assignments of the heterocyclic ring carbons were based on a comparison with the data for other 1,2,4-triazine derivatives[25,26]. These carbons are non-protonated and highly deshielded, leading to the assignment of C-3 to the resonance at ca 159 ppm. The other two carbons are also relatively deshielded and appeared at ca 140 and 143 ppm.

The signals of the sugar residues of **2**d-g appeared in the range 63.03-73.58 ppm. The assignments of the sugar carbons has been based

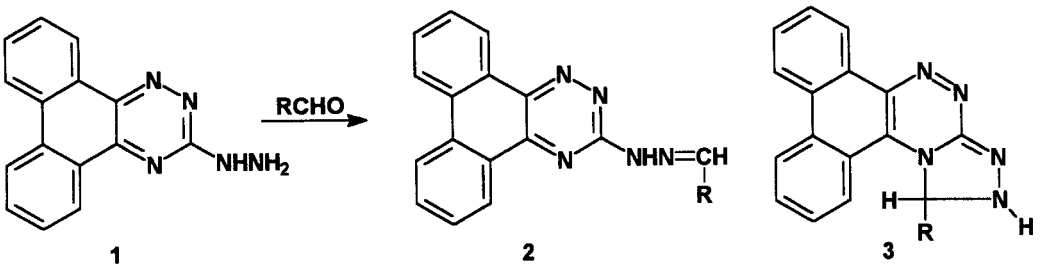
Table 1 **^{1}H and ^{13}C NMR Spectral Data for Compounds 2 and 5 in DMSO-d_6.**

Assignment	Chemical Shift (multiplicity) Compd No.					
	2d	2e		2f	2g	5
Sugar protons						
H-1	7.76[a]	7.74[a]		7.78[a]	7.73[a]	4.43 t
OH	5.08 d	5.27 d		5.00 d	5.32 d	5.20 d
2 H	4.67 m	4.58 m		4.54 m	4.50 m	4.96 2d
1 H	4.51 m	4.48 m		4.45 m	4.37 m	
1 H	4.39 m	4.37 m		4.27 m	4.27 m	4.12 m
2 H	3.39 m	3.68 m		4.20 m	3.77 m	3.76 m
2 H	3.50 m	3.52 m		3.79 m	3.64 m	3.54 m
2 H				3.63 m		3.28 m
2 H				3.46 m	3.52 m	3.22 m
NH	11.87 bs	11.88 bs		11.87 bs	11.90 bs	9.54 bs, 6.06 s
Aromatic Protons (4 m)						
2 H	9.10	9.10		9.10	9.10	9.27
2 H	8.77	8.76		8.78	8.77	8.73
1 H	7.94	7.94		7.90	7.91	7.93
3 H	7.80	7.80		7.80	7.76	7.77
Carbons of the sugar moieties						
C-1	150.21	149.18	C-1	150.56	150.31	90.45
C-4	73.58	72.29	C-5	72.39	71.18	77.76
C-2	71.04	71.85	C-2	70.31	70.83	76.67
C-3	70.35	71.56	C-3	69.77	70.56	71.15
C-5	63.43	62.56	C-4	69.12	69.47	70.28
			C-6	63.03	63.80	61.39
Carbons of the aromatic rings[b]						
Carbons of the heterocyclic rings						
	40.02	140.06		39.98	139.98	139.14
	143.17	143.16		143.16	143.18	142.91
	159.22	159.16		159.23	159.22	162.15

[a] Hidden under the aromatic region

[b] Supplemental Data available from the author.

on their chemical shift equivalences to the assigned open structure of other sugar hydrazones[25-27]. Thus, the highest field signal was assigned to C-6, and the lowest field signals may be assigned to C-4 or C-5. The resonance around 70.5 ppm was assigned to C-2. The C-1 of the sugar residue appeared in the range 149.18-150.31 ppm. These data confirmed the open chain nature of the sugar residues of the hydrazones **2**d-g. On the other hand, doubts concerning the structural assignment of **D**-glucose derivative as **2**h resulted from an examination of its ^{13}C NMR spectrum, which showed a resonance at 90.45 ppm in addition to the five signals between 61.37-77.76 ppm for the sugar carbons and fifteen signals in the range 122.15-162.15 ppm for the sp^2 carbon atoms. The appearance of a signal for a saturated carbon atom at 90.4 ppm accompanied by the disappearance of the signal around 150.0 ppm indicated that the open chain structure **2**h is not correct for the **D**-glucose analogue, but it is better presented in the cyclic structures **3-5**. That the correct structure is the pyranosyl form **5** was deduced by comparing its ^{13}C NMR spectrum with the spectra of α- and β-**D**-glucopyranose[33] (**6** and **7**) as well as 2'-(β-**D**-glucopyranosyl)-isonicotino-hydrazide[34,35] (**8**). Substitution of the hydrazine residue for the hydroxyl group at C-1 in **6** has a minimal effects on the chemical shifts of C-4 and C-6 of **8** and consequently the C-4 can be readily identified in our product at 70.28 ppm and the C-6 to the highest field resonance at 61.37 ppm. On the other hand, C-3 and C-5 experienced a similar magnitude in their chemical shifts[35], upon the formation of the hydrazine **8**, since they bear the same stereochemical



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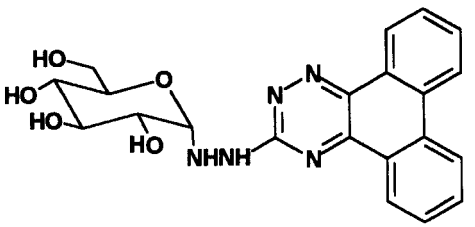

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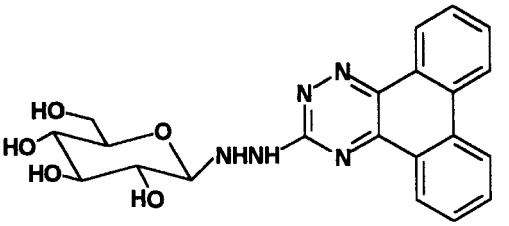

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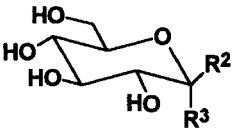
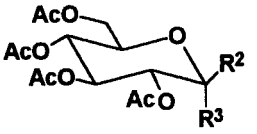
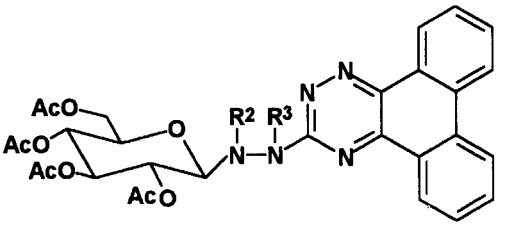
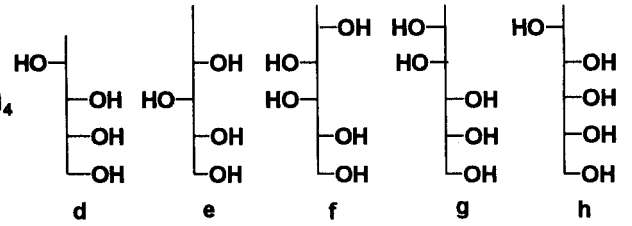






6 R^2 = OH, R^3 = H
7 R^2 = H, R^3 = OH
8 R^2 = $NHNHCOC_5H_4N$, R^3 = H
9 R^2 = OAc, R^3 = H
10 R^2 = H, R^3 = OAc
11 R^2 = OH, R^3 = H
12 R^2 = Ac, R^3 = H
13 R^2 = H, R^3 = Ac

R = Me Ph $MeOC_6H_4$
a b c



d e f g h

SCHEME 1

relationship to the anomeric C-1. The highest field signal, of the three remaining signals at 71.15 ppm was assigned to C-2. The remaining higher field signal at 76.67 ppm was assigned to C-3. The lowest field signal at 77.76 ppm was assigned to C-5. The identity of the product as either the α or the β anomer cannot be readily determined from the chemical shift of the anomeric carbon as it appeared at 90.45 ppm, when compared to the C-1 of **6** and **7**. However, it was similar to that of **8** indicating its likely β-configuration. Moreover, the shifts of C-3 and C-5 were much closer to those of the β-pyranoses **6** and **8** than the α-pyranose **7**. Consequently, the structure **5** was given for the **D**-glucose derivative and not **4**. The structure of **3** was ruled out based on the pronounced effects on the chemical shifts of the carbons of the sugar moiety when compared with those of compounds **2**.

Acetylation of **5** gave a product identified as **12** and not **13** based on analysis of its spectral data. Thus, its ^{13}C resonances are very close to those of **9** rather than to those of **11**, which would be expected if **13** was the product. Moreover, the C-3 of the triazine ring in **12** appeared at 160.22 ppm as compared to that of **5** which appeared at 162.15 ppm. if case of **13** was the correct structure, C-3 should be shift to lower field by about 4 ppm due to the acetylation of the nitrogen directly attached to the triazine ring.

Acetylation of **2**d-g with acetic anhydride in pyridine at room temperature for several hours afforded yellow crystalline products whose combustion analysis and spectral data indicated that five and four acetyl groups were introduced in the corresponding hexose and pentose

Table 2 **^{13}C Chemical shifts of the D-glucose derivatives***

Assignment	Compound no.							
	5	**6**[35]	**7**[35]	**8**[34]	**9**[33]	**10**[33]	**11**[33]	**12**
C-1	90.45	97.11	92.37	91.1	91.8	98.2	95.4	90.59
C-2	71.15	75.06	72.51	72.1	70.5	69.4	73.3	69.60
C-3	76.67	76.89	73.24	77.5	72.9	70.0	72.7	72.86
C-4	70.28	70.51	70.81	70.9	68.0	68.1	68.7	68.29
C-5	77.76	76.89	72.03	78.9	72.9	70.0	72.1	72.98
C-6	61.37	61.4	61.40	62.1	61.6	61.6	62.2	16.41

*DMSO-d_6 was used as a solvent for **5** and **8**, D_2O for **6** and **7**, and $CDCl_3$ for **9-12**.

derivatives, respectively. Consequently, the structure of these acetyl derivatives may be given as **14**d-g. Allowing the acetylation to proceed for a longer period of time led to a further introduction of an acetyl group on the hydrazone residue to give **15**i-l. A cyclic structure for these products as analogues of **12** was ruled out on the basis of their spectral data.

The ^{1}H NMR spectra (Table 3) of the acetyl derivatives **14**i and **14**j showed the presence of singlets corresponding to the acetyl groups and a downfield singlet due to the NH whereas those of **15**i-l showed an additional singlet due to the acetyl group on the nitrogen atom instead of that for the NH. The H-1 of the sugar residue was hidden under the aromatic protons in compounds **14**, whereas it appeared at around 6.6 ppm for compound **15**.

Table 3 **^{1}H NMR Spectral Data of the Acetyl Derivatives.**

Assignment	Chemical Shift (multiplicity)/ coupling constants (Hz) Compd No.								
	12	14i	14j	15i	15j	15k	15l	16j	16l
Sugar protons									
H-1	6.39bd	7.67d	7.61d	6.58d	6.67d	6.58d	6.67d	6.87d	6.59d
$J_{1,2}$	7.6	4.2	5.3	3.8	2.4	3.7	5.6	7.1	8.2
H-2		6.08t	5.71t	5.75t	5.66bs	5.63bd		6.17dd	6.13d
$J_{2,3}$		3.4	5.9	7.1				3.4	8.3
H-3	4.00-5.50m	5.87dd	5.63t	5.54dd	5.53bs	5.43	5.10m	5.24bd	5.77d
$J_{3,4}$		8.3	4.4	3.3				3.3	8.4
H-4		5.44m	5.37m	5.26m	5.41bs			4.18m	5.14bd
H-5		4.41	4.29dd	4.25	4.32bq	5.35m	5.11m		
$J_{4,5}$		2.8	4.5	2.7					4.20m
H-5'		4.30	4.12dd	4.14	4.03bq				
$J_{4,5'}$		5.5	6.7	5.1					
$J_{5,5'}$		12.4	11.9	12.5					
H-6	3.5m					4.21dd			
$J_{5,6}$						5.0	4.14 m		
H-6'						3.88dd			
$J_{5,6'}$						7.2			
$J_{6,6'}$						11.6			
NH		12.0s	12.12s						
NAc	2.53s			2.62s	2.62s	2.59s	2.65s		
xOAc	2.18s	2.25s	2.17s	2.09s	2.15s	2.11s	2.15s	2.14s	2.17s
	2.01s	2.16s	2.13s	2.06s	2.09s	2.09s	2.08s	2.12s	2.12s
		2.09s	2.12s	2.01s	2.06s	1.99s	2.03s	1.97s	2.03s
		2.05s	2.01s		2.01s	1.98s	2.03s		1.99s
							2.03s		1.78s
Aromatic protons[a]									

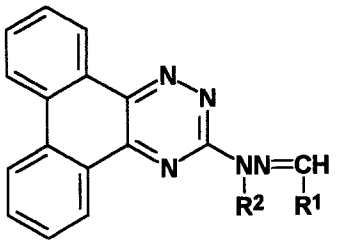
[a] Supplemental Data available from the author

The ^{13}C-NMR resonances of the acetyl derivatives were in good agreement with the acyclic structures, appearing at comparable chemical shifts with those reported for other hydrazones with acyclic side chains. The C-1 resonance of the sugar azomethine carbon appears at a higher magnetic field (139 ppm) than that of its precursor **2.** The highest field signal of 15k for example was assigned to the terminal methylene carbon, C-6. The lowest field signal (72.39 ppm) was assigned to C-5, which is shifted to lower field compared with that of **2**f as a consequence of the summation of the acetyl group effects. The signal at 70.31 ppm was assigned to C-2 and it was the one most affected by acetylation. The C-3 and C-4 were assigned to the two resonances at 69.77 and 69.12 ppm, and they were effected by the acetylations. The C-3 resonances of the triazine ring in **14** were not affected by the acetylation of the sugar residues, but they were shifted to higher field in **15** upon acetylation of the hydrazone residues.

The IR spectra, of the hydrazones **2**a-g showed bands around 3402-3269 cm^{-1} for OH and NH groups and double bond vibrations for C=N and C=C in the region 1608-1588 cm^{-1}, respectively. The spectra of the acetyl derivatives **14**i-l showed the presence of OAc groups (1743-1749 cm^{-1}) whereas the **12** and **15** showed the presence of OAc and NAc groups at 1751-1756 cm^{-1}, 1702-1708 cm^{-1}, respectively.

An alcoholic solution of iron(III) chloride has been found to be an effective reagent for cyclodehydrogenation of hydrazones derived from hydrazines linked at the α-position of heterocycles[25,26] or

thiosemicarbazones[30,31]. Subjection of the hydrazone **2f** to the action of an alcoholic solution of $FeCl_3$ afforded a dark-colored iron complex, purification of which was found to be troublesome. On the other hand, various aromatic aldehyde hydrazones can be readily cyclized by boiling with thionyl chloride to give the corresponding triazolo derivatives[36]. The annelation of a triazole ring to the triazine ring in the present work was similarly achieved in the case of aromatic as well as aliphatic aldehyde hydrazones **2a-c** with thionyl chloride. For instance, heating the hydrazones **2a-c** in thionyl chloride on a water-bath for few hours produced yellow to reddish orange crystalline products **16a-c**. The selection of the angular isomer **16** for the products and not the isomeric linear structure **19** was based on a model experiment by which the synthesis of **19a** was achieved by the condensation of phenanthraquinone **17** with 4,5-diamino-3-methyl-1,2,4-triazole **18**. This reaction would give only one isomer, namely the linear one, due to the symmetric nature of the quinone **17**, regardless of which amino group in **18** is the reactive one. Compound **19a** was found to be different from that obtained by cyclisation of **2a** by thionyl chloride. On the other hand, the linear isomer **19a** could be prepared by the action of triethyl orthoacetate or acetic acid on the hydrazine **1**. The partially acetylated sugar hydrazones **14i-l** were found to be effectively cyclized with thionyl chloride in acetonitrile, furnishing the triazolo derivatives **16i-l**. The selection of the angular structure for these products was based on the previous model study. The formation of **16** may be result from the propensity of N-4 rather than N-2 of the triazine ring to attack the possibly formed nitrilium ion intermediate.



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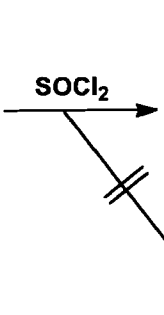
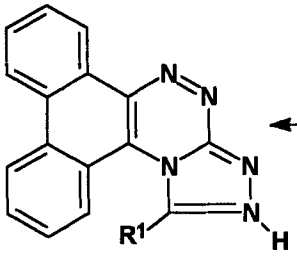
15 R^2 = Ac





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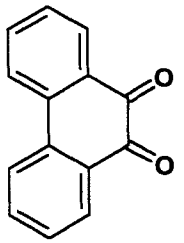

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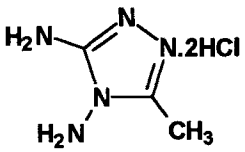

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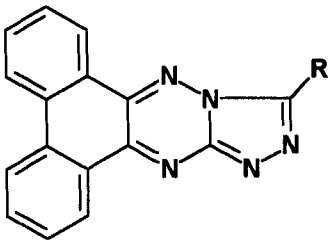

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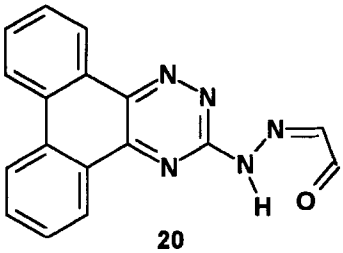

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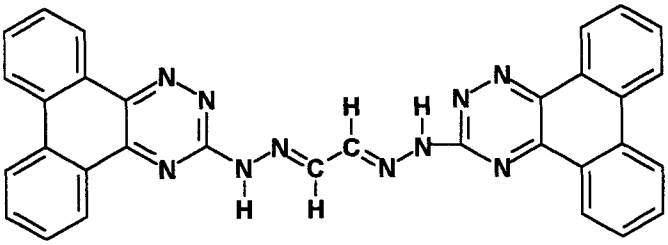

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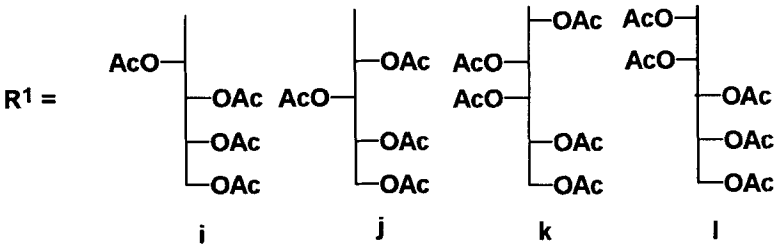

SCHEME 2

In the ^{13}C-NMR spectra (Table 4) of **16**i-l, the appearance of the triazole-carbon at a lower field (ca. 145 ppm) than the respective carbon (C-1) in **14** confirmed the cyclisation. The C-3 of the triazine ring of **16** is more shielded (appeared at ca. 147.6 ppm) than those of the respective carbons of **2** and **14** as a consequence of its presence at a junction of the triazole and triazine ring. The aromatic ring carbons are almost the same as those of **2** and **14**.

Periodate oxidation of **2**e with sodium metaperiodate gave the aldehyde **20**, whose structure was confirmed by its reaction with the hydrazine **1** to give **21**. This result indicated that the periodate did not cause any oxidative cyclization of the hydrazone residue and confirmed the acyclic nature of the polyhydroxy alkylidene residues of **2**. The structure of **21** was established by its identity with the product resulting from the reaction of two molecules of **1** with glyoxal. Moreover, its ^{1}H-NMR spectrum showed the presence of a resonance due to the NH as well as the aldehydic proton as a singlet and doublet, respectively.

EXPERIMENTAL

General procedures. Melting points were determined with a Kofler block apparatus and are uncorrected. IR spectra were recorded with a Perkin-Elmer model 1720 FTIR spectrometer for KBr discs. ^{1}H-NMR spectra were determined with a Varian EM-390 and Bruker AC-250 spectrometers. The chemical shifts are expressed in ppm in the δ scale using tetramethylsilane as internal standard; coupling constants are given in Hz. Microanalyses were performed at the unit of Micro-analyses at the University of Cairo.

Table 4 **^{13}C NMR Spectral Data in $CDCl_3$**

Assignment	Chemical shifts (ppm) Compd.No.								
	12[a]	**14i**	**14j**	**15i**	**15j**	**15k**	**15l**	**16j**	**16l**
Carbons of sugar part									
C-1	90.59	145.50	143.20	139.77	139.08	139.38	139.47	63.49	63.50
C-2	72.98	70.49	71.31	70.41	70.71	70.01	70.55	68.27	67.87
C-3	72.86	69.90	70.01	69.44	69.72	68.24	68.57	68.78	67.34
C-4	69.60	68.61	68.69	68.30	68.91	67.59	67.96	61.29	67.95
C-5	68.29	62.14	61.68	61.77	61.70	67.52	67.31		61.49
C-6	61.41					61.98	61.79		
Carbons of the aromatic rings[b]									
Carbons of the heterocyclic rings									
	143.70	141.31	140.13	145.43	145.42	145.41	145.32	140.18	139.90
	144.12	141.67	140.63	145.79	145.81	145.80	145.74	142.19	142.41
	160.22	159.31	158.85	155.99	155.93	155.99	155.82	145.45	145.25
								147.59	147.69
Miscellaneous									
xOAc	19.87	20.75	20.39	20.57	20.52	20.52	20.56	20.12	20.05
	20.47	20.90	20.57	20.74	20.60	20.56	20.64	20.27	20.35
	20.57				20.67	20.64	20.74	20.27	20.43
	20.76				20.71	20.69		20.31	20.47
NAc	23.06			21.93	21.94	21.93	21.98		
OCO	169.35	169.82	169.35	169.47	169.38	169.42	169.21	169.17	69.02
	169.95	169.90	169.49	169.63	159.57	169.60	169.57	169.24	169.25
	170.02	169.93	169.56	169.70	169.67	169.77	169.64	169.46	169.48
	170.35	170.65	169.91	170.53	170.30	170.18	169.74	169.71	169.97
						170.43	170.53		
NCO	172.67			173.08	172.97	173.00	173.13		

[a]Assignment of the sugar part are shown in table 2.
[b] Supplemental Data available from the author.

3-Hydrazinophenanthro[9,10-e][1,2,4]triazine (1). 3-Mercapto-phenanthro[9,10][1,2,4]triazine (2.53 g, 10.0 mmol) was heated under reflux with 90% hydrazine hydrate (12 ml) for 2 h, until the evolution of hydrogen sulfide was complete. The reaction mixture was cooled to room temperature and the solid product that separated was filtered,

washed with water and recrystallized from pyridine to give yellowish brown crystals (2.38 g, 89%), m.p. 230-232°C [lit.[32] mp 233°C; lit.[37] mp 231°C].

Acetaldehyde (phenanthro[9,10-e][1,2,4]triazin-3-yl)hydrazone (2a). To a solution of **1** (2.61 g, 10.0 mmol) in ethanol (50 ml), and acetaldehyde (0.ml, 10.0 mmol), two drops of acetic acid were added. The reaction mixture was heated under reflux for 2 h. The product that separated out on cooling was filtered, washed with methanol and recrystallized from DMF/methanol as yellow crystals (87%), m.p. 248-250°C; IR (KBr): 3208 (NH) and 1612, 1608 cm^{-1} (C=N); ^1H NMR (DMSO-d_6) δ: 2.06 (d, 3 H, *J* 5.4 Hz, C-Me), 7.70-7.83, 7.90-7.96, 8.69-8.78, 9.03-9.16 (Ar-H), 11.72 (s, 1 H, NH).

Benzaldehyde(phenanthro[9,10-e][1,2,4]triazin-3-yl)hydrazone (2b). As for **2a**. The solid obtained was crystallized from DMF as yellow fibres (83%), m.p. > 300°C (Lit.[32] 320°C), IR (KBr): 3209 (NH), 1613 cm^{-1} (C=N); ^1H NMR (DMSO-d_6) δ: 7.40-7.54, 7.80-7.86, 7.95-8.00, 8.40, 8.67-8.84, 9.14-9.18 (Ar-H), 12.23 (s, 1 H, NH).

Anisaldehyde (phenathro[9,10-e][1,2,4]triazin-3-yl)hydrazone (2c).. As described for **2**a. The solid obtained was crystallized from DMF as orange fibres (80%), m.p. > 300°C (Lit.[32] 303°C), IR (KBr): 3216 (NH), 1610 cm^{-1} (C=N). ^1H NMR (DMSO-d_6) δ: 3.84 (s, 3 H, Me), 7.05 (d, 2 H, *J* 8.8 Hz, HC=N), 7.75-7.88, 7.94-8.00, 8.35, 8.76-8.84 and 9.13-9.17 (Ar-H), 12.08 (s, 1 H, NH).

Sugar (phenanthro[9,10-e][1,2,4]triazin-3-yl)hydrazones (2d-g) and (5). A solution of the respective sugar (10.0 mmol) in water (5.0 ml)

was treated with a solution of **2** (2.61 g, 10.0 mmol) in a mixture of ethanol (50 ml), DMF (20 ml) and few drops of acetic acid. The mixture was boiled under reflux for 2 h. The product that separated out on cooling was filtered, washed with water followed by ethanol and dried. The yellow product was recrystallized from *N,N*-dimethylformamide as yellow crystals (Table 5).

Per-*O*-acetyl sugar (phenanthro[9,10-*e*][1,2,4]triazin-3-yl) hydrazones (14i-l). A cold solution of **2**d-g (2 mmol) in dry pyridine (5.0 ml) was treated with acetic anhydride (5.0 ml). The mixture was stirred for 8 h at room temperature. It was filtered and the filtrate was poured onto crushed ice and the product was collected by filtration, washed repeatedly with water, dried and recrystallized from methanol as pale yellow crystals (Table 5).

Per *O*-acetyl *N*-acetyl sugar (phenanthro[9,10-*e*][1,2,4]triazin-3-yl)-hydrazones (12) and (15i-l). A cold solution of **2** or **5** (2 mmol) in dry pyridine (5.0 ml) was treated with acetic anhydride (5.0 ml). The mixture was kept for 24 h at room temperature with occasional shaking. It was poured on crushed ice and the product was collected by filtration, washed repeatedly with water, dried and recrystallized from methanol as pale yellow crystals (Table 5).

3-Methyl phenanthro[9,10-*e*][1,2,4]triazino[2,3-*d*][1,2,4]triazole(19a).

Method a: A mixture of solutions of **18** (0.3 g, 2 mmol) in ethanol (5 ml), sodium acetate (0.34 g, 4 mmol) in water (2 ml), phenanthraquinone (0.42 g, 2 mmol) in ethanol (40 ml), and few drops of acetic acid was heated under reflux for 2 h. Washing the separated yellow solid with water and crystallisation from DMF gave yellowish brown crystals, m.p. > 300°C.

Method b: A solution of **1** (0.58 g, 2 mmol) in 10 ml acetic acid was boiled under reflux for 8 h. The mixture was cooled and diluted with H_2O. The solid

Table 5 Elemental Analysis and IR Spectral Data

Compd. No.	Yield (%)	M.p (°C)	Mol. Formula	Mol. wt.	Elemental Analyses						ν_{max}(KBr) cm^{-1}			
					Calcd.			Found						
					C	H	N	C	H	N	OH, NH	NCO,	OCO	C=C, C=N
2d	77	194-197	$C_{20}H_{19}N_5O_4$	393.4	61.1	4.9	17.8	61.0	5.0	17.7	3392			1607
2e	75	199-201	$C_{20}H_{19}N_5O_4$	393.4	61.1	4.9	17.8	61.2	5.0	17.5	3402			1607
2f	80	206-209	$C_{21}H_{21}N_5O_5$	423.4	60.0	5.0	16.5	59.2	5.0	16.1	3402			1608
2g	75	197-199	$C_{21}H_{21}N_5O_5$	423.4	60.0	5.0	16.5	60.0	5.2	16.1	3392			1607
5	78	205-208	$C_{21}H_{21}N_5O_5$	423.4	60.0	5.0	16.5	59.3	5.2	16.3	3269			1608
12	75	97-100	$C_{31}H_{31}N_5O_{10}$	633.6	58.8	4.9	11.1	58.7	5.2	10.4	3202	1704	1756	1609
14i	60	140-143	$C_{28}H_{27}N_5O_8$	561.5	59.9	4.9	12.5	59.6	4.8	12.2	3208		1743	1588
14j	62	136-139	$C_{28}H_{27}N_5O_8$	561.5	59.9	4.9	12.5	59.6	4.8	12.2	3205		1743	1597
14k	65	135-138	$C_{31}H_{31}N_5O_{10}$	633.6	58.8	4.9	11.1	58.6	4.9	11.1	3207		1744	1605
14l	68	120-122	$C_{31}H_{31}N_5O_{10}$	633.6	58.8	4.9	11.1	58.6	4.7	11.4			1747	1607
15i	82	129-131	$C_{30}H_{29}N_5O_9$	603.6	59.7	4.8	11.6	59.5	4.7	11.4		1702	1751	1608
15j	80	93-96	$C_{30}H_{29}N_5O_9$	603.6	59.7	4.8	11.6	59.6	4.9	11.2		1703	1752	1608
15k	72	199-201	$C_{33}H_{33}N_5O_{11}$	675.7	58.7	4.9	10.4	58.4	4.9	10.2		1703	1752	1608
15l	78	128-131	$C_{33}H_{33}N_5O_{11}$	675.7	58.7	4.9	10.4	58.5	4.8	10.1		1708	1752	1608
16i	63	135-138	$C_{28}H_{25}N_5O_8$	559.5	60.1	4.5	12.5	60.2	4.5	12.2			1751	1602
16j	60	140-142	$C_{28}H_{25}N_5O_8$	559.5	60.1	4.5	12.5	59.8	4.6	12.1			1751	1603
16k	68	112-115	$C_{31}H_{29}N_5O_{10}$	631.6	59.0	4.6	11.1	58.5	4.7	10.9			1752	1604
16l	63	141-144	$C_{31}H_{29}N_5O_{10}$	631.6	59.0	4.6	11.1	58.6	4.8	10.1			1752	1603

product that separated was filtered, washed with methanol/H_2O and crystallized from DMF/MeOH as yellow crystals (75%); m.p. > 300°C (Lit.[34] 282°C); the product is identical with that obtained from method a. ^{1}H NMR (DMSO-d_6) δ: 2.9 (s, 3 H, Me), 7.6-7.9 (m, 4 H), 8.50 (bs, 2 H), 8.7 (bs, 1 H), 8.8 (bd, 1 H).

3-Methyl phenanthro[9,10-e][1,2,4]triazino[3,4-c][1,2,4]triazole (16a). A solution of **2**a (0.58 g, 2 mmol) in thionyl chloride (10 ml) was heated on a water-bath for 2 h. Excess $SOCl_2$ was removed by evaporation. The product washed several times with H_2O and crystallized from DMF/MeOH as yellow crystals (60%); m.p. > 279-281°C; IR (KBr): 1601 cm^{-1} (C=N); ^{1}H NMR (DMSO-d_6) δ: 2.85 (s, 3 H, Me), 7.73-7.82 (m, 4 H), 8.41-8.46 (m, 2 H), 8.57 (d, 1 H), 8.74 (d, 1 H).

3-Phenyl phenanthro[9,10-e][1,2,4]triazino[3,4-c][1,2,4]triazole (16b). A mixture of **2**b (2 mmol) and $SOCl_2$ (15 ml) was heated on a water bath for 8 h. The mixture was processed as above, and the product was crystallized from DMF as yellow crystals (72%); m.p. > 300°C; IR (KBr): 1612 cm^{-1} (C=N).

3-(4-Methoxyphenyl) phenanthro[9,10-e][1,2,4]triazino[3,4-c]-[1,2,4]triazole (16c). As described for **16**b. The solid obtained was crystallized from DMF as reddish orange crystals (70%); m.p. > 300°C, IR (KBr) 1610 cm^{-1} (C=N). ^{1}H NMR (DMSO-d_6) δ: 3.90 (s, 3 H, Me), 7.23 (d, 2 H, $J \approx 8.2$ Hz), 7.63-7.80 (m, 4 H), 8.43-8.47 (m, 4 H), 8.63 (t, 1 H, $J \approx 1.4$ Hz)), 8.81 (d, 1 H, $J \approx 5.7$ Hz).

3-(Polyacetoxyalkyl) phenanthro[9,10-e][1,2,4]triazino[3,4-c]-[1,2,4]triazole (16i-l). A solution of **14**i-l (2 mmol) in dry acetonitrile

(20 ml) was treated with $SOCl_2$ (10 ml). The mixture was heated on a water bath for 2 h. After cooling it was poured onto crushed ice and the product was collected by filtration, washed repeatedly with water, dried and recrystallized from methanol as pale yellow green crystals (Table 5).

Glyoxal mono(phenanthro[9,10-e][1,2,4]triazin-3-yl)hydrazone (20). A suspension of **2e** (1.97 g, 5 mmol) in distilled water (50 ml) was treated with a solution of sodium metaperiodate (1.59, 6.93 mmol) in distilled water (20 ml). The mixture was stirred for 1 h, and then left in the dark at room temperature for 24 h with occasional shaking. The yellow product was filtered off, washed repeatedly with water and recrystallized from DMF, (80%), m.p. 212-214°C. IR (KBr): 3211 (NH), 1690 (CO), 1597 (cm^{-1}) (C=N); ^1H NMR (DMSO-d_6) δ: 7.79-7.81, 7.91-7.97, 8.73-8.83, 8.98-9.05 (5 m, Ar-H and HC=N), 9.11-9.13 (5 m, Ar-H and HC=N), 9.70 (d, 1 H, *J* 7.7 Hz, CHO), 13.01 (s, 1 H, NH).

Anal. Calcd. for $C_{17}H_{11}N_5O$ (301.3): C, 67.8; H, 4.0; N, 23.0. Found: C, 68.0; H; 3.7; N; 23.3.

Glyoxal *bis*(phenanthro[9,10-e][1,2,4]triazin-3-yl)hydrazone (21).

Method a: To a solution of **20** (0.30 g, 1 mmol) in ethanol (50 ml) was added an ethanolic solution of **1** (0.26 g, 1 mmol) and piperidine (0.1 ml). The mixture was heated under reflux for 1 h. The solid which separated out on cooling was collected by filtration, washed with water followed by ethanol and dried. It was crystallized from DMF as yellow plates (75%), m.p. > 300°C. IR (KBr): 3210 (NH), 1608 cm^{-1} (C=N).

Anal. Calcd. for $C_{32}H_{20}N_{10}$ (544.6): C, 70.3; H, 4.0; N, 25.5. Found: C, 70.6; H; 3.7; N; 25.6.

Method b: To a solution of **1** (2.61 g, 10 mmol) in ethanol was added glyoxal (0.29 g, 5 mmol) and piperidine (0.1 ml) and the mixture was boiled under reflux for 1 h. The solid which separated out on cooling was collected. Working up as above gave yellow plates (70%) identical with that obtained by method a.

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