125. Structure and Reactivity of Xanthocorrinoids

Part V[1])

Formation of *trans*-Diol Derivatives of 5,6-Dihydrocobyrinic Acid from Xanthocorrinoids under Acidic Conditions

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On treatment with H_2SO_4/MeOH, epimerization of hexamethyl *cis*-5,6-dihydroxycobyrinate *c*,8-lactam (**3**) takes place quantitatively at C(6), yielding the corresponding *trans*-diol **4**. The corresponding lactone **7**, whose structure has been established by X-ray analysis, is obtained from xanthocorrinoids **5** and **6** under similar conditions.

Some years ago, *Bonnett* [2] suggested that coordination of H_2O_2 to the Co-ion of cobyrinic-acid derivatives may be the first step of their transformation into xanthocorrinoids with the *Udenfriend* reagent (ascorbic acid and O_2 in MeOH at pH 7.2) [3]. This mechanism is not only consistent with the observed stereoselectivity of the reaction, which takes place on the more accessible β-face of the Co-complex, but also with the experimental evidence accumulated in our laboratory during the investigation of the influence of the substituent present at C(7) on the structure of the reaction product [4]. Particularly revealing proved to be the reactions of hexamethyl dicyanocob(III)yrinate *c*,8-lactone (**1a**) and hexamethyl dicyanocob(III)yrinate *c*,8-lactam (**1b**) with O_2 in the presence of ascorbic acid. Actually, whereas a *cis*-5,6-diol **3** could be isolated as a reaction product of the latter, **1a** yielded a spirolactone **2** instead of the diol corresponding to **3**. These results were interpreted as a consequence of the fact, that lactams are, in general, less prone to nucleophilic cleavage than lactones [4]. Moreover, the low yield of **3** (*ca.* 8%) may be explained by the loss of a considerable part of the product in the polar fractions of the reaction mixture, provided that during the reaction hydrolysis of the ester

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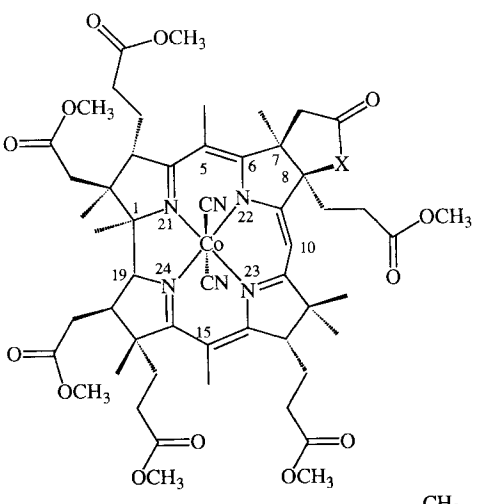
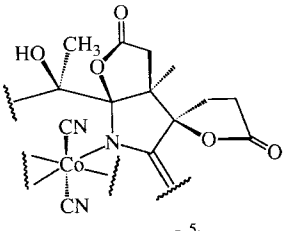


1a X = O
b X = NH



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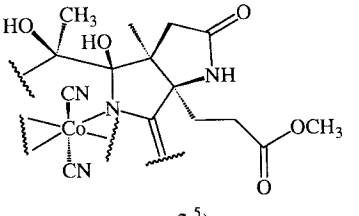

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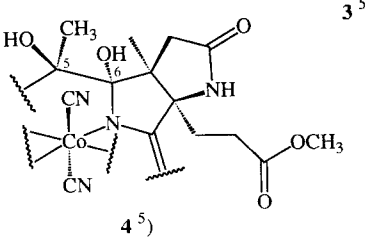


4 [5])

groups occurred to some extent. As a matter of fact, the yield of the 5,6-diol could be improved to 23% by treatment of the reaction mixture with 2% H_2SO_4/MeOH prior to chromatographic separation; surprisingly, however, the yellow corrinoid thus isolated was not identical with **3**. This new corrinoid **4** was also obtained in quantitative yield from **3** under the above esterification conditions. As shown by differential ^1H,^1H-NOE experiments with **4**, its OH groups at C(5) and C(6) are *trans* to each other.

On the basis of the assignments made for the ^1H- and ^{13}C-NMR spectra of heptamethyl dicyanocobyrinate [5–8], only a few ^1H- and ^{13}C-signals of **4** can be assigned unequivocally (*cf. Table 1*). Additional assignments were possible through differential homonuclear NOE experiments [9] (see *Table 2*) and two-dimensional ^1H,^1H-shift correlation spectroscopy (COSY) [10]. Complementary assignments of both ^1H- and ^{13}C signals were achieved by selective ^1H decoupling (^1J(CH) and ^nJ(CH)) in the ^{13}C-NMR spectrum (see *Exper. Part*).

Special care was taken to completely assign the eight *C*-methyl *s* in the ^1H-NMR spectrum. The signals at 1.18 and 1.28 ppm are easily assigned to the two geminal CH_3–C(12) since saturation of either peak enhances the signal corresponding to H–C(10). Similarly, CH_3–C(17) (1.23 ppm) and CH_3–C(1) (1.59 ppm) correlate with CH_3–C(15) and H–C(18), respectively, which, in turn, are recognized by their chemical shifts. Both CH_3–C(2) (1.33 ppm) and CH_3–C(7) (1.44 ppm) display a long-range (^4J(H,H)) coupling with one of the methylene protons of their geminal acetic-ester chain. The latter are easily discriminated by their unique coupling pattern and chemical shifts. The remaining peak (1.67 ppm) is, therefore, attributed to CH_3–C(5). This assignment is confirmed by the enhancements of the signals of OH–C(5), OH–C(6), and CH_3–C(7) which are observed when the peak at 1.67 ppm is saturated. Thereby, a first hint concerning the configuration of C(5) and C(6) is obtained. In order to establish the absolute configurations at these chiral centers, the assignment of the two OH protons is important. One of the peaks (4.02 ppm) is correlated through mutual NOE's to CH_3–C(7), the other one (4.96 ppm) to

[5]) For the sake of clarity, only the part of the molecule which is modified during the reaction is represented in the partial structure, remainder as in **1**.

Table 1. *^{1}H-NMR Data of* **4**[a])

δ [ppm]		Assignment	Method[b])
8.10	(br. *s*)	NH	A, B
5.21	(*s*)	H–C(10)	A, E
4.96	(br. *s*)	OH–C(5)	B, D
4.02	(*s*)	OH–C(6)	B, D
3.93	(*d*, J = 10.4 Hz)	H–C(19)	A, E
3.91	(*d*, J = 17.5 Hz)	$H_{pro\text{-}R}$–C(7^1)	C, D, E
3.8–3.7	[c])	H–C(3)	A
3.76, 3.72, 3.71, 3.70, 3.65, 3.61	(6*s*)	CH_3O	A
2.91	(*dd*, J = 5.5, 4.5 Hz)	H–C(13)	A, C, D
2.81	(*m*)	H–C(18)	A, C
2.54	[c])	2 H–C(18^1)	C
2.53	(*d*, $J \approx$ 17 Hz)[d])	H–C(2^1)	C
2.25	(*d*, $J \approx$ 17 Hz)[d])	H′–C(2^1)	C
2.16	(*s*)	CH_3–C(15)	A
2.13	(*d*, J = 17.5 Hz)[d])	$H_{pro\text{-}S}$–C(7^1)	C
2.03	[c])	H–C(13^1)	C
1.83	[c])	H′–C(13^1)	C
1.60 2.70	(*m*)	CH_2(3^1), CH_2(3^2), CH_2(8^1), CH_2(8^2), CH_2(13^2), CH_2(17^1), CH_2(17^2)	
1.67	(br. *s*)	CH_3–C(5)	D, E
1.59	(br. *s*)	CH_3–C(1)	D
1.44	(*s*)	CH_3–C(7)	C, D
1.33	(*s*)	CH_3–C(2)	C, E
1.28	(*s*)	α-CH_3–C(12)	D
1.23	(*s*)	CH_3–C(17)	D
1.18	(*s*)	β-CH_3–C(12)	D, E

[a]) In $CDCl_3$ solution at 300.13 MHz.
[b]) A: chemical-shift arguments (*cf.* [14]); B: H/D exchange; C: 2D-shift correlation COSY; D: ^{1}H,^{1}H-NOE; E: selective ^{13}C,^{1}H decoupling.
[c]) Resonance hidden in normal spectrum.
[d]) Extracted from COSY spectrum.

Table 2. *^{1}H-NMR Signals* (in ppm) *of* **4** *Assigned by Differential ^{1}H,^{1}H-NOE Experiments*[a])

Irradiated resonance	Enhanced signals[b])
4.96 (OH–C(5))	3.91 ($H_{pro\text{-}R}$–C(7^1)), 1.67 (CH_3–C(5))
4.02 (OH–C(6))	1.44 (CH_3–C(7))
3.91 ($H_{pro\text{-}R}$–C(7^1))	4.96 (OH–C(5)), 2.13 ($H_{pro\text{-}S}$–C(7^1))
2.16 (CH_3–C(15))	1.23 (CH_3–C(17))
1.67 (CH_3–C(5))	4.96 (OH–C(5)), 4.02 (OH–C(6)), 1.44 (CH_3–C(7))
1.59 (CH_3–C(1))	2.81 (H–C(18))
1.44 (CH_3–C(7))	4.02 (OH–C(6)), 2.13 ($H_{pro\text{-}S}$–C(7^1)), 1.67 (CH_3–C(5))
1.33 (CH_3–C(2))	1.59 (CH_3–C(1))
1.28 (α-CH_3–C(12))	5.21 (H–C(10))
1.23 (CH_3–C(17))	2.16 (CH_3–C(15)), 3.93 (H–C(19))
1.18 (β-CH_3–C(12))	5.21 (H–C(10)), 2.91 (H–C(13))

[a]) In $CDCl_3$ solution at 400.13 and 360.13 MHz.
[b]) Effects on unassigned protons in the region 1.6–2.7 ppm are omitted.

$H_{pro\text{-}R}$–C(7^1). These effects clearly show that the two vicinal OH groups at C(5) and C(6) are *trans* to each other, *i.e.* either α-OH–C(5)/β-OH–C(6) or β-OH–C(5)/α-OH–C(6). Moreover, as a reciprocal NOE between CH_3–C(5) and CH_3–C(7) is observed, both CH_3 groups must be *cis* to each other and, therefore, OH–C(5) must be situated above the plane of the molecule (*i.e.* β). Consequently, the absolute configurations at C(5) and C(6) in **4** are *R* and *S*, respectively.

Further confirmation of the correct structure of **4** was obtained accidentally in the course of our attempts to correlate xanthocorrinoid **5**, which was obtained some time ago by oxidation of cyanocob(III)alamin with *Udenfriend*'s reagent in the presence of Cu^{II} ions [11], with xanthocorrinoid **6** whose structure has been established unequivocally by X-ray diffraction analysis [4]. Attempted esterification of **5** by reaction with 10% H_2SO_4/MeOH did not lead, however, to **6** but to a new xanthocorrinoid **7**, which was isolated in 24% yield. Remarkably, the same xanthocorrinoid was obtained from **6** in 48% yield, under the foregoing esterification conditions. Reduction of **7** with Zn in AcOH afforded a mixture of hexamethyl dicyanocob(III)yrinate *c*,8-lactone (**1a**) and hexamethyl *c*-hydrogen dicyanocobyrinate in 20 and 62% yield, respectively (*cf. Exper. Part*). Structure **7** was elucidated by X-ray diffraction (see *Fig. 1*)[6]) which confirmed, moreover, the results of a detailed analysis of a series of differential homonuclear NOE experiments.

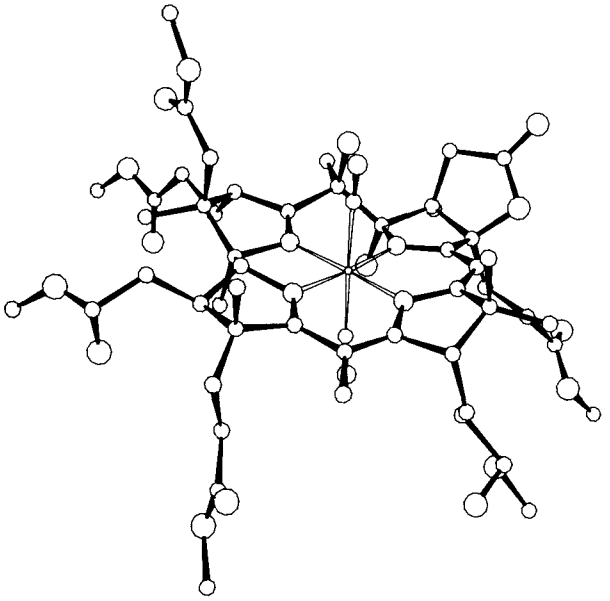
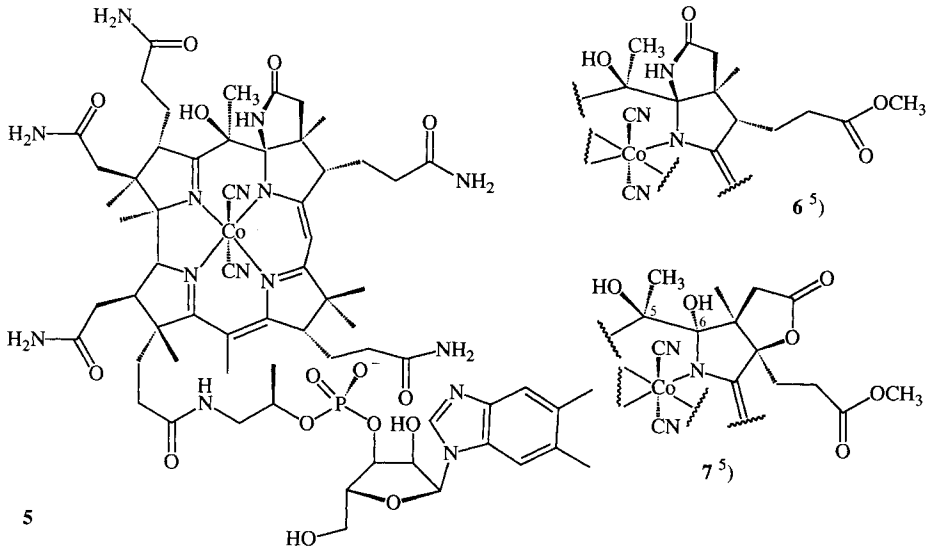


Fig. 1. *Molecular structure of hexamethyl (5R,6S)-Coα,Coβ-dicyano-5,6-dihydro-5,6-dihydroxycobyrinate c,8-lactone* (**7**)

[6]) Xanthocorrinoid **7** crystallizes in the space group $P4_12_12$ with the following cell constants: $a = b = 15.847$ (4) and $c = 44.160$ (1) Å, $V = 11090$ (1) Å^3, $Z = 8$, $d_c = 1.326$ g/cm^3. Data were collected on a modified *Stoe*-4-circle diffractometer (MoK_α radiation, $\lambda = 71.069$ pm) at 100 K. The structure was solved with direct methods and tangent expansion (SHELX 86 [12]), and refined (SHELX 76 [13]) for all but H-atoms to $R_w = 11.77\%$ from 5017 reflexions with $F > 4\sigma(F_o)$ in the range $4 \leq 2\theta \leq 45°$. Several of the ester side chains are partially disordered, resulting in large and anisotropic atomic displacement parameters for the corresponding atoms. Atomic coordinates and experimental details have been deposited at the *Cambridge Crystallographic Data Centre*.



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6 [5])

7 [5])

As in the case of xanthocorrinoid **4**, the assignment of the ^{1}H-signals corresponding to the eight *C*-methyl groups was necessary in order to determine the structure of **7** (*cf. Table 3*). Thus, saturation of the resonance of H–C(10) at 5.33 ppm gives rise to an enhancement of the signal intensity of both CH_3 groups at C(12) which is more pronounced for the *pro-R* (1.32 ppm) than for the *pro-S* group (1.17 ppm; *cf.* [6]). As, on the other hand, the intensity of the signals of H–C(18) and of CH_3–C(2) at 2.82 and 1.33 ppm, respectively, are enhanced on saturation at 1.59 ppm, the latter resonance corresponds to CH_3–C(1). By analogy to other xanthocorrinoids, the peaks at 2.17 and 1.23 ppm are assigned to CH_3–C(15) and CH_3–C(17), respectively. The assignment of the remaining CH_3–C(5) and CH_3–C(7) followed from the fact, that irradiation at 1.67 ppm enhances the intensities of a *d* at 2.40 and of a *m* at 3.79 ppm, as well as those of a CH_3 peak at 1.48 ppm and of both OH groups at 4.05 and 5.02 ppm. Inspection of molecular models shows that in a xanthocorrinoid structure in which OH–C(6) is below the plane of the molecule, CH_3–C(5) is close to $H_{pro\text{-}R}$–C(7^1), H–C(3), OH–C(6), and CH_3–C(7), an arrangement which agrees with the above NOE correlations and which allows to assign the peaks at 1.67 and 1.48 ppm to CH_3–C(5) and CH_3–C(7), respectively. Accordingly, saturation of the CH_3 signal at 1.48 ppm enhances the intensity of the signals corresponding to 1 OH group (4.05 ppm), as well as those of the *s* at 1.67 and of the *d* at 2.40 ppm. As mentioned before, CH_3–C(5) and CH_3–C(7) display reciprocal NOE's, hence they are *cis* to each other. Consequently, OH–C(5) is located above the plane of the molecule. In agreement with a *trans* relative configuration of both OH groups, irradiation at the resonance of OH–C(5) (5.02 ppm) enhances the intensity of the $H_{pro\text{-}S}$–C(7^1) signal but not that of OH–C(6). Irradiation at the resonance of the latter (4.05 ppm) enhances only the intensities of the peaks corresponding to CH_3–C(5) and CH_3–C(7). Hence, the absolute configuration of C(6) is *S*.

Table 3. *^{1}H-NMR Signals* (in ppm) *of* **7** *Assigned by Differential ^{1}H,^{1}H-NOE Experiments*[a])

Irradiated resonance	Enhanced signals
5.33 (H–C(10))	1.32 (α-CH_3–C(12)), 1.17 (β-CH_3–C(12))
5.02 (OH–C(5))	4.11 (H′–C(7^1), J = 18 Hz)
4.05 (OH–C(6))	1.67 (CH_3–C(5)), 1.48 (CH_3–C(7))
1.67 (CH_3–C(5))	1.48 (CH_3–C(7)), 3.79 (H–C(3)), 5.02 (OH–C(5)), 4.05 (OH–C(6)), 2.40 (H–C(7^1), J = 18 Hz)
1.59 (CH_3–C(1))	2.82 (H–C(18)), 1.33 (CH_3–C(2))
1.48 (CH_3–C(7))	1.67 (CH_3–C(5)), 4.05 (OH–C(6)), 2.40 (H–C(7^1), J = 18 Hz)

[a]) In $CDCl_3$ solution at 360.13 MHz.

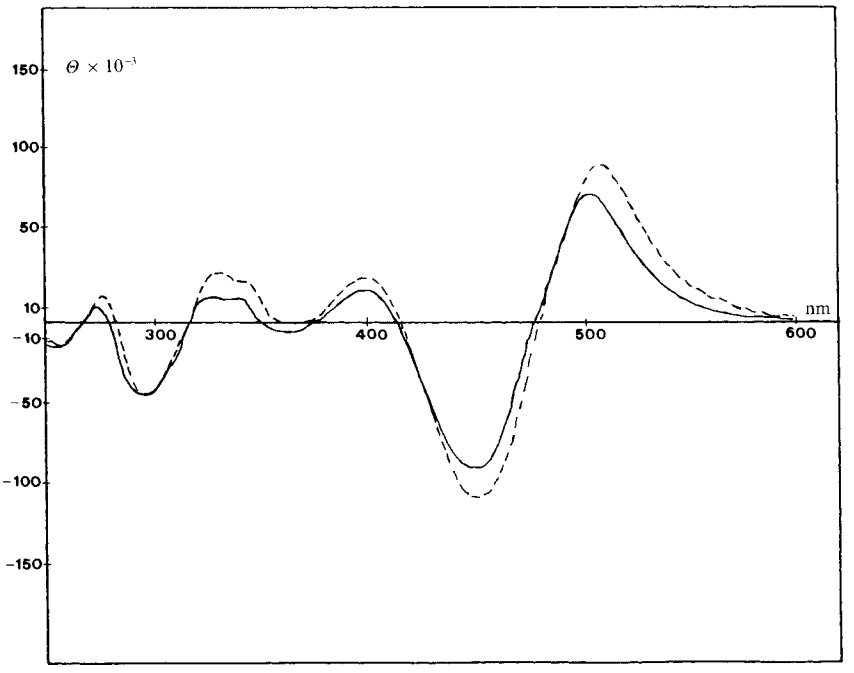


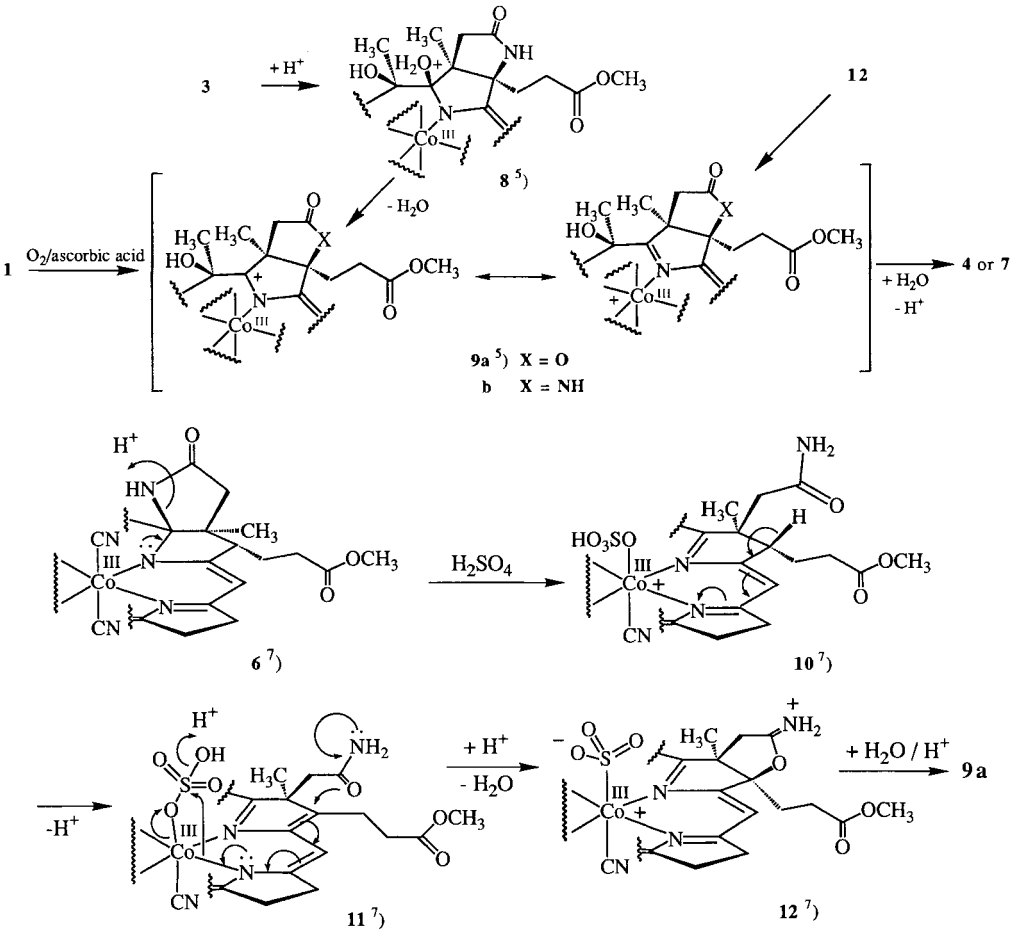
Fig. 2. *CD spectra of hexamethyl (5R,6S)-Coα,Coβ-dicyano-5,6-dihydro-5,6-dihydroxycobyrinate c,8-lactam* (**4**; ——) *and (5R,6S)-Coα,Coβ-dicyano-5,6-dihydro-5,6-dihydroxycobyrinate c,8-lactone* (**7**; – – –)

The identity of the absolute configurations at all asymmetric C-atoms in both xanthocorrinoids **4** and **7** is emphasized by the similarity of their CD spectra (*cf. Fig. 2*).

Although most rationales which attempt to explain the pathway of chemical transformations are oversimplifications of the 'true' reaction mechanism, some comment on the formation of the rather unexpected structures of xanthocorrinoids **4** and **7** cannot be evaded at this point. It is obvious, that protonation of OH–C(6) in **3** (→ **8**) and subsequent elimination of H_2O should afford the same cationic intermediate **9** (see *Scheme*) which has been suggested by *Bonnett* [2] and us [4] [14] as the common precursor of all different types of xanthocorrinoids which are known until now. Under the conditions of the *Udenfriend* reaction (pH 7.2), addition of an OH^- ion from the more accessible β-face of the corrin macrocycle may be the rate-determining step of the reaction, thus yielding a *cis*-diol, which can be isolated (see **3**) in the case of **1b** or which serves as intermediate in the formation of spirolactone **2** in the case of **1a**. Under strongly acidic conditions, on the other hand, cationic species such as **9** should be more stable, so that the *trans*-diol **4** may be the product of thermodynamic control of the reaction. It is noteworthy, that in less ionizing media, like CF_3COOH (or even conc. H_2SO_4), *trans*-diol **4** is partially reconverted to the *cis*-isomer **3** (*cf. Exper. Part*).

The formation of *trans*-diol **7** may be rationalized in a similar manner as that of xanthocorrinoid **4**, whereby, however, the rearrangement of the acetic-acid chain at C(7) must involve an additional oxidation step. It is possible that a cationic intermediate **10**, formed by protolytic cleavage of the lactam ring of **6**, loses H–C(8) yielding **11** (see *Scheme*). The further steps would parallel the pathway suggested for the closure of the

Scheme



c-lactone ring of 'dehydrovitamin B_{12}' [15], a process which appears to be quite common in corrin chemistry (*cf.* [14]). However, a still open but fundamental question related to the mechanism of corrinoid *c*-lactone formation concerns the oxidation step necessary in order to explain nucleophilic attack on C(8). Since abstraction of a hydride ion [2] is not likely under the employed esterification conditions, 'formal' transitory reduction of the Co^{III} to a Co^{I} complex seems to be more plausible [4]. In the present case, 'formal' means, that electron transfer from the corrinoid macrocycle to an axial hydrogen sulfate ligand on the Co-ion may take place, yielding a cobalt sulfonic acid complex **12** analogous to the known 'sulfitocobalamin' [16]. Both cationic intermediates **12** and the corresponding lactone **9a**, which results from hydrolysis of the iminio-ether group of the former, can react with a H_2O molecule, under acidic conditions, yielding **7** in the same way as **9b**

7) *Cf. Footnote 5.* For the sake of clarity, substituents at C(12) and C(13) have been omitted.

affords **4**. Thus, the results of the present work emphasize once more the possible key role of cationic intermediates of the type represented by **9** in reactions involving xanthocorrinoids.

Financial support from the *Swiss National Science Foundation* (Project No. 2.320-0.81) is gratefully acknowledged. We thank Mr. *J.-L. Clément, Ciba-Geigy AG,* Marly, for performing elemental analyses.

Experimental Part

General. See [4]. Fast atom bombardement mass spectra (FAB-MS) were measured by Mr. *F. Nydegger.*

*Hexamethyl (5*R*,6*R*)-*Coα*-*Coβ*-Dicyano-5,6-dihydro-5,6-dihydroxycob(III)yrinate c,8-Lactam* (**3**). A soln. of **4** (50 mg) in 2 ml of CF_3CO_2H was allowed to stand at r.t. for 15 h before it was diluted with 20 ml of CH_2Cl_2. Then, the mixture was repeatedly washed with H_2O and finally shaken with 1% aq. KCN soln. After evaporation of the solvent, 29 mg (58%) of **3**, which proved to be identical with the *cis*-diol prepared earlier from **1b** [4], and 20 mg (40%) of starting material were separated from the residue by chromatography (silica gel containing 1% acetone cyanohydrin, AcOEt/acetone 6:4).

*Hexamethyl (5*R*,6*S*)-Coα, Coβ-Dicyano-5,6-dihydro-5,6-dihydroxycob(III)yrinate c,8-Lactam* (**4**). To a soln. of 1.073 g of hexamethyl *Coα,Coβ*-dicyanocob(III)yrinate *c*,8-lactam (**1b**) [4] in MeOH (150 ml) containing $KHCO_3$ (2.38 g), EDTA (4.7 mg), and 160 ml of phosphate buffer (pH 7.2), ascorbic acid (4.0 g) was added, and a gentle stream of air was passed through the mixture for 4 h at 65°. After cooling to r.t., 300 ml of sat. aq. NaCl soln. were added, and the mixture was extracted with CH_2Cl_2 (3 × 100 ml). The combined extracts were evaporated, and the residue was refluxed with 2% H_2SO_4 in MeOH (100 ml) for 3 h. Then H_2O (500 ml), $NaHCO_3$ (10 g), and KCN (0.1 g) were added, and the mixture was extracted with CH_2Cl_2 (3 × 100 ml). The combined org. phases were dried ($CaCl_2$) and evaporated, and the residue submitted to column chromatography (silica gel containing 0.5% KCN, CH_2Cl_2/MeOH 97:3). Recrystallization from MeOH/Et_2O yielded 0.16 g (26%) of **4**. M.p. 223–225° (dec.). UV/VIS (MeOH containing 0.01% KCN): 486 (4.03), 466 (4.04), 316 (4.07). CD ($5.74 \cdot 10^{-5}$ M, MeOH): 502 (82787), 476 (0), 448 (−100034), 413 (0), 398 (19547), 376 (0), 361 (−8049), 348 (0), 340 (13798), 326 (14948), 316 (0), 296 (−49442), 278 (0), 272 (6899), 266 (0), 258 (−17247), 243 (0). IR (CH_2Cl_2): 3440*w*, 2955*m*, 1735*s*, 1705*s*, 1590*w*, 1545*m*, 1437*m*, 1410*m*, 1390*m*, 1203*s*, 1175*s*. ^{1}H-NMR: *Table 1*. ^{13}C-NMR (100.61 MHz): 189.7 (*s*, C(4)); 175.7, 175.4, 175.3, 175.2 (4*s*, C(9), C(11), C(16), C(7^2)); 174.0, 173.6, 172.7, 172.3, 171.5, 171.2 (6*s*, ester-CO); 164.7 (*s*, C(14)); 133.8, 131.4 (2*s*, 2 CN); 98.4 (*s*, C(15)); 97.1 (*s*, C(6)); 86.4 (*d*, C(10)); 84.2 (*s*, C(1)); 77.5 (*s*, C(5)); 75.5 (*d*, C(19)); 75.4 (*s*, C(8)); 58.1 (*s*, C(17)); 56.8 (*d*, C(3)); 54.6 (*s*, C(7)); 54.1 (*d*, C(13)); 52.38, 51.83, 51.76, 51.74 (2 C), 51.44 (5*q*, 6 CH_3O); 46.6, 46.3 (2*s*, C(2), C(12)); 41.0 (*t*, C(7^1)); 40.3 (*t*, C(2^1)); 39.6 (*d*, C(18)); 30.4 (*q*, *β*-CH_3–C(12)); 33.5, 32.7, 31.5, 30.3, 30.1, 29.8, 29.7, 23.1 (8*t*, 8 CH_2); 25.2 (*t*, C(13^1)); 21.3 (*q*, CH_3–C(5)); 20.5 (*q*, CH_3–C(1)); 19.4 (*q*, α-CH_3–C(12)); 18.9 (*q*, CH_3–C(7)); 18.4 (*q*, CH_3–C(17)); 16.1 (*q*, CH_3–C(2)); 14.4 (*q*, CH_3–C(15)). FAB-MS (2-nitrophenyl octyl ether): 1106 (39, $[M + 1]^+$), 1080 (100, $[M + 1 - CN]^+$), 1052 (64, $[M - HCN - CN]^+$). Anal. calc. for $C_{53}H_{72}CoN_7O_{15}$ (1106.12): C 57.55, H 6.56, N 8.86; found: C 57.22, H 6.58, N 8.61.

The same xanthocorrinoid **4** was obtained, in quantitative yield, by reaction of **3** [4] with 2% H_2SO_4/MeOH under the above esterification conditions.

*Hexamethyl (5*R*,6*S*)-Coα, Coβ-Dicyano-5,6-dihydro-5,6-dihydroxycob(III)yrinate c,8-Lactone* (**7**). A soln. of *(5R,6S)-Coα,Coβ*-dicyano-7-de(carbamoylmethyl)-5,6,7^1,7^2-tetrahydro-5-hydroxy-7^2-oxopyrrolo[2,3-*f*]cob(III)alamin [1] (**5**; 250 mg) in 30 ml of 10% H_2SO_4/MeOH was heated under N_2 for 4 d at 80°. After cooling to r.t., the mixture was neutralized with 10% aq. $NaHCO_3$ soln., and extracted repeatedly with CH_2Cl_2. The combined extracts were shaken with 2% aq. KCN soln. (2 × 250 ml), then with H_2O, and finally dried by filtration through cotton. After evaporation, the yellow product was isolated by TLC (silica gel containing 0.1% KCN, CH_2Cl_2/MeOH 96:4). Recrystallization from MeOH/Et_2O yielded 47 mg (24%) of **7**. M.p. 223–225° (dec.). UV/VIS (MeOH containing 0.01% KCN): 494 (4.03), 475 (4.02), 339 (sh), 319 (4.09). IR ($CHCl_3$): 3450*m*, 3000*m*, 2960*m*, 2130*w*, 1785*m*, 1735*s*, 1585*m*, 1550*m*, 1440*m*, 1410*m*, 1385*m*. CD ($9.91 \cdot 10^{-5}$ M, MeOH): 506 (99869), 478 (0), 448 (−113184), 414 (0), 398 (30793), 374 (0), 364 (−2496), 356 (0), 339 (25799), 329 (29961), 316 (0), 292 (−46605), 280 (0), 275 (19974), 266 (0), 254 (−13316). ^{1}H-NMR (360.13 MHz): 5.33 (*s*, H–C(10)); 5.02, 4.05 (2*s*, exchangeable for D, OH–C(5) and OH–C(6), resp.); 4.11 (*d*, J = 18.4, H–C(7^1)); 3.92 (*d*, J = 10.5, H–C(19)); 3.79 (*dd*, J = 7.4, J < 1, H–C(3)); 3.76, 3.72, 3.71, 3.70, 3.66, 3.61 (6*s*, 6 CH_3O); 2.92 (*dd*, J = 9.5, 1.8, H–C(13)); 2.82 (*dt*, J = 11.2, 8.2, H–C(18)); 2.40 (*d*, J = 18.4, H′–C(7^1)); 2.17 (*s*, CH_3–C(15)); 1.67 (*s*, CH_3–C(5)); 1.59 (*s*, CH_3–C(1)); 1.48 (*s*,

CH_3–C(7)); 1.33 (*s*, α-CH_3–C(12)); 1.32 (*s*, CH_3–C(2)); 1.23 (*s*, CH_3–C(17)); 1.17 (*s*, β-CH_3–C(12)); 2.7–1.4 (*m*, remaining CH_2). ^{13}C-NMR (100.61 MHz): 189.46 (*s*, C(4)); 176.11, 175.99 (2*s*, C(11), C(16)); 173.53, 173.49, 172.66, 172.56, 172.30, 172.15, 171.45, 171.13 (8*s*, 6 ester-CO, C(7^2), C(9)); 164.54 (*s*, C(14)); 99.31 (*s*, C(15)); 96.59 (*s*, C(6)); 95.04 (*s*, C(8)); 86.29 (*d*, C(10)); 84.27 (*s*, C(1)); 77.51 (*s*, C(5)); 75.64 (*d*, C(19)); 58.33 (*s*, C(17)); 56.75 (*d*, C(3)); 54.04 (*s*, C(7)); 53.67 (*d*, C(13)); 52.40, 51.91 (2 C), 51.83, 51.72, 51.55 (5*q*, 6 CH_3O); 46.65 (2 C) (*s*, C(2), C(12)); 40.33 (*t*, C(2^1)); 39.54 (*d*, C(18)); 38.92 (*t*, C(7^1)); 33.47 (*t*, C(3^2)); 32.72 (*t*, C(17^1)); 31.50 (*t*, C(18^1)); 30.24 (*q*, β-CH_3–C(12)); 30.16 (*t*, C(13^2)); 30.06 (*t*, C(8^1)); 29.74 (*t*, C(17^2)); 29.18 (*t*, C(8^2)); 25.24 (*t*, C(13^1)); 23.04 (*t*, C(3^1)); 21.48 (*q*, CH_3–C(5)); 20.59 (*q*, CH_3–C(1)); 19.66 (*q*, α-CH_3–C(12)); 18.78 (*q*, CH_3–C(7)); 18.48 (*q*, CH_3–C(17)); 16.21 (*q*, CH_3–C(2)); 14.53 (*q*, CH_3–C(15)). FAB-MS: 1055 (66, $[M+1-2\ CN]^+$), 1054 (100, $[M+1-HCN-CN]^+$), 1040 (23), 1025 (13), 996 (16), 978 (10), 952 (9), 895 (6). Anal. calc. for $C_{53}H_{71}CoN_6O_{16}$ (1107.12): C 57.48, H 6.47, N 7.59; found: C 57.90, H 6.60, N 7.79.

The same xanthocorrinoid was obtained in 48% yield on refluxing a soln. of hexamethyl (5*R*,6*S*)-*Coα,Coβ*-dicyano-7-de(carboxymethyl)-5,6,7^1,7^2-tetrahydro-5-hydroxy-7^2-oxopyrrolo[2,3-*f*]cob(III)yrinate [4] (**6**; 25 mg) in 30 ml of 5% H_2SO_4/MeOH for 1 h.

Chemical Reduction of **7**. To a soln. of **7** (5 mg) in 10 ml of dry CH_2Cl_2, 60 mg of Zn dust[8]) and 0.5 ml of AcOH were added at once. After 150 min stirring under Ar, the Zn was filtered off and the filtrate neutralized with 10% aq. $NaHCO_3$ soln. The org. layer was shaken with 2% aq. KCN soln., washed with H_2O, and filtered through a cotton plug. After evaporation, 3 mg (62%) of hexamethyl *c*-hydrogen *Coα,Coβ*-dicyanocob(III)yrinate [18], 1 mg (20%) of the corresponding *c*,8-lactone **1a** [19], and 0.85 mg (17%) of the starting **7** were isolated by TLC (silica gel containing 0.1% KCN, CH_2Cl_2/MeOH 95:5). All products were identified by comparison with authentic compounds.

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