# Steroids. Part 4.[1] Carbon–Carbon Bond Cleavage of α-Azido Steroidal Ketoximes

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α-Azido steroidal oximes have been cleaved to provide mono- and di-cyano derivatives under standard Beckmann conditions. The structures, reactions, and spectral characteristics of these products are discussed.

Our interest in new synthetic approaches to biologically active steroids possessing nitrogen atoms led us to investigate the C–C bond cleavage of various α-azido steroidal oximes.

Earlier we reported that α-azido steroidal ketones were cleaved with bromine in acetic acid at room temperature to furnish cyano carboxylic acids.[2] Thus far, C–C bond cleavage reactions giving ω-cyano carbonyl derivatives have been studied using the Beckmann fragmentation of α-substituted oximes,[3] such as those of α-diketones,[3c] α-oxo acids,[3a] α-hydroxy ketones,[3d] and α-oxo ethers.[3a] Until our recent report of the transformation of 2α-azido-5α-cholestan-3-one oxime into 2,3-seco-5α-cholestane-2,3-dinitrile,[4] the C–C bond cleavage of an α-azido oxime to give a cyano derivative had not been reported. We describe here the details of this cleavage reaction.

## Results and Discussion

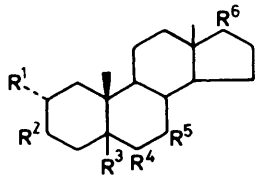
Treatment of the α-azido oxime (**1**) with typical reagents for Beckmann fragmentation, *e.g.* phosphorus trichloride oxide, tosyl chloride, thionyl chloride, and methanesulphonyl chloride in dry pyridine, led to evolution of $N_2$ and isolation of the dicyano derivative (**10**) in 65—94% yield after a short reaction time (Table 1). The best yield was achieved by heating (**1**) at 110 °C for 20 min in the presence of $POCl_3$, with dry pyridine as solvent.

Treatment of the α-azido oxime (**1**) with phosphorus pentaoxide in benzene gave an α,β-unsaturated ketone (**11**) (23%) together with the cleavage product (**10**) (39%).

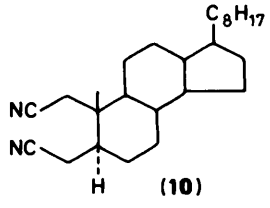
Kobayashi *et al.*[5] reported that treatment of 5α-cholestan-3-one oxime with polyphosphoric acid gave 5α-cholest-1-en-3-one, together with lactams. Their mechanism for the reaction involves fragmentation of the oxime to give an unsaturated nitrile, hydrolysis of this to an amide and then recyclization of the latter to form an α,β-unsaturated ketone. Our reactions however proceeded under anhydrous conditions ($P_2O_5$–benzene), a fact which implies that the formation of (**11**) in the presence of $P_2O_5$ is by direct cyclization of unsaturated nitrile (**A**) and not by the cyclization of the amide intermediate, the sensitive imine (**C**) being rapidly hydrolysed to the α,β-unsaturated ketone (**11**) during the period of extraction.

Fragmentation of the ring B α-azido oxime (**2a**) also gave a dicyano derivative, compound (**12**).

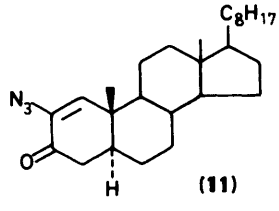
The $^{13}C$ n.m.r. spectra of the dicyano compounds (**10**) and (**12**) displayed singlets at δ 116.86, 118.89 (**10**) and 119.65, 122.30 p.p.m. (**12**), assigned to the cyano groups. The $^1H$ n.m.r. spectra displayed a four-proton multiplet at δ 2.35 (**10**) assigned to the 1- and 4-methylene groups, and a one-proton double doublet at δ 3.02 p.p.m. (**12**), assigned to the 5α-methine proton. The i.r. spectra confirmed the presence of the nitrile groups ($\nu_{max.}$ 2 240 $cm^{-1}$) (**10**) and ($\nu_{max.}$ 2 240 and 2 250 $cm^{-1}$) (**12**).



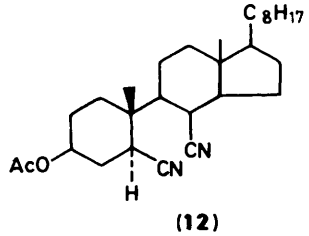
| | $R^1$ | $R^2$ | $R^3$ | $R^4$ | $R^5$ | $R^6$ |
|---|---|---|---|---|---|---|
| (**1**) | $N_3$ | (E)-NOH | α-H | $H_2$ | H | $C_8H_{17}$ |
| (**2a**) | H | β-OAc, α-H | α-H | (*E*)-NOH | $N_3$ | $C_8H_{17}$ |
| (**2b**) | H | β-OAc, α-H | α-H | (*Z*)-NOH | $N_3$ | $C_8H_{17}$ |
| (**3**) | H | β-OAc, α-H | α-H | $H_2$ | H | (*Z*)-C(:NOH)$CH_2N_3$ |
| (**4**) | H | β-OAc, α-H | $\Delta^{5,6}$ | H | H | $COCH_2N_3$ |
| (**5**) | H | β-OAc, α-H | $\Delta^{5,6}$ | H | H | (*Z*)-C(:NOH)$CH_2N_3$ |
| (**6**) | H | β-OAc, α-H | H | $H_2$ | H | CN |
| (**7**) | H | β-OAc, α-H | $\Delta^{5,6}$ | H | H | CN |
| (**8**) | H | β-OAc, α-H | H | $H_2$ | H | $NHCOCH_2N_3$ |
| (**9**) | H | β-OAc, α-H | $\Delta^{5,6}$ | H | H | $NHCOCH_2N_3$ |



(**10**)



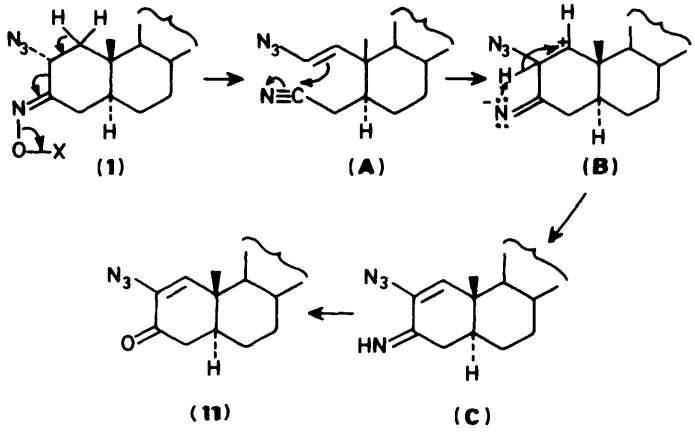
(**11**)



(**12**)

The mass spectrum of (**10**) had peaks at *m/z* 396 ($M^+$), 356 [fission of the C(1)–C(10) bond], and 316 [fission of the C(1)–C(10) bond and C(4)–C(5) bond]. The spectrum of (**12**) displayed peaks at *m/z* 274 and 180 due to fragments arising from fission of the C(9)–C(10) bond. These data clearly support the structures (**10**) and (**12**).

This method was also found to be applicable to the straight-chain α-azido oximes (**3**) and (**5**). Thus, when compounds (**3**) and (**5**) were allowed to react with phosphorus trichloride oxide, they gave approximately equal amounts (t.l.c.) of the Beckmann fragmentation products (**6**) and (**7**) and the normal re-



Scheme 1.

**Table 1.** Reactions of α-azido oximes under Beckmann conditions

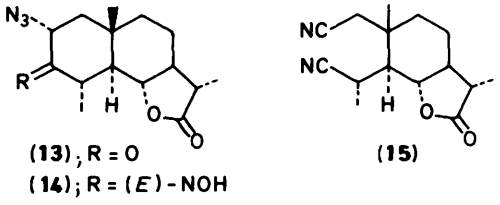
| Reactant | Reagent[a] | Solvent | Conditions (*t*/°C; min) | Product (% yield)[b] |
|---|---|---|---|---|
| (1) | TsCl | Pyridine | 110; 30 | (10) (85) |
| (1) | $POCl_3$ | Pyridine | 110; 20 | (10) (94) |
| (1) | $SOCl_2$ | Pyridine | 27; 60 | (10) (73) |
| (1) | MsCl | Pyridine | 110; 30 | (10) (65) |
| (1) | $PCl_5$ | Pyridine | 110; 20 | (10) (70) |
| (1) | $P_2O_5$ | Benzene | 80; 20 | (10) (39) + (11) (23) |
| (2a) | $POCl_3$ | Pyridine | 80; 15 | (12) (83) |
| (3) | $POCl_3$ | Pyridine | 70; 15 | (6) (20) + (8) (45) |
| (5) | $POCl_3$ | Pyridine | 70; 15 | (7) (32) + (9) (47) |
| (5) | $SOCl_2$ | Neat | 0; 30 | (7) (58) |
| (14) | $SOCl_2$ | Neat | 0; 10 | (15) (67) |

[a] Ts = *p*-$MeC_6H_4SO_2$; Ms = $MeSO_2$; [b] Isolated yield.

arrangement products (**8**) and (**9**). When (**5**) was allowed to react with thionyl chloride, the Beckmann fragmentation product (**7**) was the sole product (t.l.c.).

The nitrile groups of compounds (**6**) and (**7**) were characterized by their i.r. ($\nu_{max.}$ 2 240 $cm^{-1}$) and $^{13}C$ n.m.r. spectra [δ 121.45 (**6**) and 121.27 p.p.m. (**7**)]. The i.r. spectra of the normal rearrangement products (**8**) and (**9**) confirmed the presence of the azido groups [$\nu_{max.}$ 2 100 (**8**) and 2 120 $cm^{-1}$ (**9**)] and amide groups ($\nu_{max.}$ 3 380 $cm^{-1}$). The $^{13}C$ n.m.r. spectra displayed peaks at δ 52.90 p.p.m., assigned to the $CH_2N_3$ group, and at δ 166.31 p.p.m. (**8**) and 166.49 p.p.m. (**9**), assigned to the carbonyl carbon (C-20).

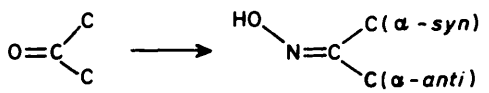
The new method is also useful in cases where a sensitive unit (lactone) is present in the substrate. When 2α-azido-3-hydroxyimino-5αH,4,6,11βH-eudesman-6,13-olide (**14**) was allowed to react with neat thionyl chloride, the fragmentation product (**15**)



was formed. However, treatement of (**14**) with $POCl_3$–pyridine gave an inseparable mixture. The i.r. and $^{13}C$ n.m.r. spectra confirmed the presence of the nitrile groups ($\nu_{max.}$ 2 250 $cm^{-1}$; δ 117.13 and 122.21 p.p.m.) and the lactone group ($\nu_{max.}$ 1 770 $cm^{-1}$; δ 177.99 p.p.m.).

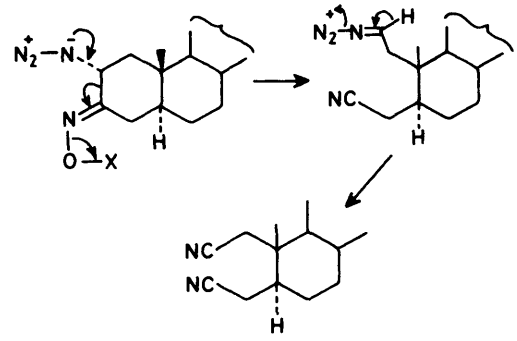
We then turned our attention to assignment of the two geometrical isomers (*E* and *Z*) of the starting oximes. Differentiation between the two geometrical isomers of α-azido oximes is possible by means of $^1H$ and $^{13}C$ n.m.r. spectral anlaysis of protons attached to the α-carbon atoms.

The $^1H$ n.m.r. spectrum of (**1**) showed a broad doublet at δ 3.17 p.p.m. which was assigned to 4α-H, suggesting that the oxime has the stereochemistry shown in (**1**).[6] In the case of the $^{13}C$ n.m.r. spectra, it is known that a consistent pattern of α-*anti* and α-*syn* carbon shift changes is observed when a ketone is converted into an oxime.[7] The resonances of both α-carbons all



shift upfield on oxime formation, with the effect for the α-*syn* carbon to the hydroxy group being greater than that for the α-*anti* carbon. The α-azido oximes (**1**), (**2a**), (**2b**), (**3**), (**5**), and (**14**) show this greater shift for the α-*syn* carbon than for the α-*anti* carbon (Table 2). On the basis of these results, the α-azido oximes (**1**), (**2a**), and (**14**) are assigned the *E* configuration and others (**2b**), (**3**), and (**5**) are assigned the *Z* configuration.

In the Beckmann fragmentation and rearrangement, the bond which migrates is generally the one *anti* to the hydroxy group. However, it is known that in some oximes the syn bond migrates.[8] In these experiments, however, the formation of (**6**) and (**7**) from the α-azido oximes (**3**) and (**5**) was due to fragmentation of the *syn* bond. However, this behaviour does not necessarily mean that the *syn* bond is actually undergoing the fragmentation. It may be that the azido oximes (**3**) and (**5**) undergo isomerization under these reaction conditions, before the fragmentation takes place.



Scheme 2.

We propose the mechanism in Scheme 2 for this interesting cleavage: Beckmann fragmentation is followed by elimination of $N_2$ from an iminodiazonium intermediate.

## Experimental

M.p.s were determined with a Yanagimoto apparatus and are uncorrected. I.r. spectra were recorded in KBr on a Hitachi Model 215 spectrophotometer. $^1H$ N.m.r. (90 MHz) and $^{13}C$ n.m.r. (22.6 MHz) spectra were recorded in $CDCl_3$ with tetramethylsilane as internal standard, on a Hitachi FT-NMR spectrometer. Mass spectra were measured with a direct inlet at 70 eV on a Hitachi M-80 instrument.

**Table 2.** α-Carbon shift changes (Δ/p.p.m.) in He $^{13}C$ n.m.r. spectra during the conversion of ketones into oximes

| | | | | | | |
|---|---|---|---|---|---|---|
| O=C(C)C(N$_3$) | 43.77 (C-4) | 52.99 (C-5) | | 60.68 (C-17) | 60.54 (C-17) | 44.49 (C-4) |
| | 63.95 (C-2) | 70.70 (C-7) | | 58.47 (C-21) | 58.47 (C-2) | 63.19 (C-2) |
| | **(1)** | **(2a)** | **(2b)** | **(3)** | **(5)** | **(14)** |
| HON=C(C)C(N$_3$) | 26.92 (C-4) | 31.10 (C-5) | 42.30 (C-5) | 54.02 (C-17) | 53.89 (C-17) | 31.73 (C-4) |
| | 58.47 (C-2) | 55.64 (C-7) | 50.97 (C-7) | 46.61 (C-21) | 46.65 (C-21) | 58.74 (C-2) |
| Δ Value | 16.85 (C-4) | 21.89 (C-5) | 10.69 (C-5) | 6.66 (C-17) | 6.65 (C-17) | 12.76 (C-4) |
| | 5.48 (C-2) | 15.06 (C-7) | 19.73 (C-7) | 11.86 (C-21) | 11.82 (C-21) | 4.45 (C-2) |

2α-Azido-5α-cholestan-3-one,[9] 3β-acetoxy-7β-azido-5α-cholestan-6-one,[9] and 3β-acetoxy-21-azido-5α-pregnan-20-one[2b] were synthesized according to the procedure of Zbiral.

3β-*Acetoxy*-21-*azidopregn*-5-*en*-20-*one* (**4**).—This was synthesized[9] from 3β-acetoxy-21-bromopregn-5-en-20-one[10] as needles, m.p. 149—151 °C (decomp.) [from ether–MeOH, 63.8% yield] (lit.,[11] 149—153 °C); $\nu_{max.}$ 3 050, 2 100, 1 730, 1 715, and 1 260 cm$^{-1}$; $\delta_H$ 2.03 (3 H, s, MeCO), 3.86 (2 H, s, 21-H$_2$), 4.56 (1 H, m, $w_{\frac{1}{2}}$ 18 Hz, 3α-H), and 5.36 (1 H, m, $w_{\frac{1}{2}}$ 6 Hz, 6-H); $\delta_C$ 58.47 (C-21), 60.54 (C-17), 73.80 (C-3), 122.26 (C-6), 139.79 C-5), 170.62 (CO-3β), and 204.92 (C-20).

2α-*Azido*-3-*oxo*-5αH,4,6,11βH-*eudesman*-6,13-*olide* (**13**).—This was synthesized[9] from 2α-bromo-3-oxo-5αH,4,6,11βH-eudesman-6,13-olide[12] as needles, m.p. 175—176 °C (decomp.) (from benzene–EtOH, 70.6% yield); $\nu_{max.}$ 2 110, 1 770, and 1 715 cm$^{-1}$; $\delta_H$ 2.70 (1 H, dq, *J* 12 and 7 Hz, 4β-H), 3.93 (1 H, t, *J* 10 Hz, 6β-H), and 4.13 (1 H, dd, *J* 7 and 13 Hz, 2β-H); $\delta_C$ 44.49 (C-4), 63.19 (C-2), 82.16 (C-6), 178.76 (C-13), and 205.50 (C-3) (Found: C, 62.1; H, 7.35; N, 14.4. $C_{15}H_{21}N_3O_3$ requires C, 61.83; H, 7.26; N, 14.42%).

*Typical Procedure for Preparation of Oximes.*—A mixture of the α-azido ketone (2.34 mmol), methanol (100 ml), hydroxylamine hydrochloride (33.1 mmol), and sodium acetate (25.0 mmol) was heated under reflux for 2 h with stirring. After work-up, the resulting residue was purified either by recrystallization or by silica-gel column chromatography.

2α-*Azido*-5α-*cholestan*-3-*one oxime* (**1**). Elution with benzene gave (**1**) (97.1% yield), m.p. 135—136 °C (decomp.) (from MeOH); $\nu_{max.}$ 3 500–3 100, 2 100, and 1 659 cm$^{-1}$; $\delta_H$ 3.17 (1 H, br d, 4α-H), 4.08 (1 H, dd, *J* 4.5 and 12 Hz, 2β-H), and 9.65 (1 H, br s, =N–OH); $\delta_C$ 26.92 (C-4), 58.47 (C-2), and 156.55 (C-3) (Found: C, 73.35; H, 10.7; N, 12.55. $C_{27}H_{46}N_4O$ requires C, 73.25; H, 10.47; N, 12.65%).

3β-*Acetoxy*-7β-*azido*-5α-*cholestan*-6-*one oxime* (**2**). Elution with EtOAc–benzene (1:40) gave (**2a**) which recrystallized from methanol as needles (69% yield); m.p. 161—162 °C (decomp); $\nu_{max.}$ 3 350, 2 100, 1 720, and 1 280 cm$^{-1}$; $\delta_H$ 2.60 (3 H, s, MeCO), 3.40 (1 H, d, *J* 10 Hz, 7α-H), 4.52 (1 H, m, $w_{\frac{1}{2}}$ 18 Hz, 3α-H), and 8.05 (1 H, br s, =N–OH); $\delta_C$ 31.10 (C-5), 55.64 (C-7), 73.49 (C-3), and 154.17 (C-6) (Found: C, 69.75; H, 10.0; N, 10.95. $C_{29}H_{48}N_4O_3$ requires C, 69.56; H, 9.66; N, 11.18%). Further elution with same solvent afforded (**2b**) (21% yield) after recrystallization from MeOH; m.p. 166—168 °C (decomp.); $\delta_C$ 42.30 (C-5), 50.97 (C-7), 73.49 (C-3), and 152.23 (C-6) (Found: C, 69.41; H, 9.77; N, 11.16%).

3β-*Acetoxy*-21-*azido*-5α-*pregnan*-20-*one oxime* (**3**). Recrystallization of the residue resulting from ether–MeOH afforded (**3**) as needles (80% yield), m.p. 182—184 °C (decomp.); $\nu_{max.}$ 3 370, 2 130, 1 710, and 1 280 cm$^{-1}$; $\delta_H$ 4.05 (2 H, br s, 21-H$_2$), 4.45—4.90 (1 H, br m, 3α-H), and 8.85—9.05 (1 H, br s, =N–OH); $\delta_C$ 46.61 (C-21), 54.02 (C-17), 73.76 (C-3), 156.51 (C-20), and 170.94 (3β-OCOMe) (Found: C, 66.3; H, 8.85; N, 13.4. $C_{23}H_{36}N_4O_3$ requires C, 66.31; H, 8.71; N, 13.44%).

3β-*Acetoxy*-21-*azidopregn*-5-*en*-20-*one oxime* (**5**). Recrystallization of the residue resulting from ether–MeOH afforded (**5**) (76.3% yield) as needles, m.p. 177—178 °C (decomp.); $\nu_{max.}$ 3 370, 3 040, 2 120, 1 710, and 1 280 cm$^{-1}$; $\delta_H$ 2.05 (3 H, s, MeCO), 4.07 (2 H, q, *J* 14 Hz, 21-H$_2$), 4.60 (1 H, m, $w_{\frac{1}{2}}$ 18 Hz, 3α-H), 5.40 (1 H, m, $w_{\frac{1}{2}}$ 5 Hz, 6-H), and 9.05 (1 H, s, =N–OH); $\delta_C$ 46.65 (C-21), 53.89 (C-17), 74.03 (C-3), 122.43 (C-6), 139.83 (C-5), and 156.28 (C-20) (Found: C, 66.8; H, 8.5; N, 13.85. $C_{23}H_{34}N_4O_3$ requires C, 66.64; H, 8.27; N, 13.52%).

2α-*Azido*-3-*hydroxyimino*-5αH,4,6,11βH-*eudesman*-6,13-*olide* (**14**).—Elution with AcOEt–benzene (1:10) gave (**14**), which recrystallized from benzene–hexane as plates (74.3% yield), m.p. 179—181 °C (decomp.); $\nu_{max.}$ 3 370, 2 110, 1 780, and 1 640 cm$^{-1}$; $\delta_H$ 3.10 (1 H, dq, *J* 10 and 7 Hz, 6β-H), 4.34 (1 H, dd, *J* 4 and 9 Hz, 2β-H), and 8.92 (1 H, s, =N–OH); $\delta_C$ 31.73 (C-4), 58.74 (C-2), 84.68 (C-6), 160.19 (C-3), and 179.57 (C-13) (Found: C, 58.85; H, 7.2; N, 18.45. $C_{15}H_{22}N_4O_3$ requires C, 58.80; H, 7.23; N, 18.28%).

*Fragmentation of* (E)-2α-*azido*-5α-*cholestan*-3-*one Oxime*.—(*a*) *With toluene*-p-*sulphonyl chloride*. A solution of oxime (**1**) (200 mg) and toluene-*p*-sulphonyl chloride (400 mg) in dry pyridine (5 ml) was refluxed for 30 min in a stream of $N_2$. Quenching of the reaction mixture in MeOH–$H_2O$ (3:7) followed by extraction with $CHCl_3$ afforded a crude residue, which was chromatographed on a silica-gel column [AcOEt–benzene (1:40) as eluant] to give the dicyano derivative (**10**), which crystallized from hexane as needles (152 mg, 85%), m.p. 118—119 °C (lit.,[13] 118—119 °C); $\nu_{max.}$ 2 240 cm$^{-1}$; $\delta_H$ 2.35 (4 H, m, 1- and 4-H$_2$); $\delta_C$ 116.86 (CN) and 118.89 (CN); *m/z* 396 ($M^+$), 356 ($M^+ - CH_2CN$), and 316 ($M^+ - 2CH_2CN$).

(*b*) *With phosphorus trichloride oxide*. The oxime (**1**) (200 mg) was dissolved in dry pyridine (5 ml). Phosphorus trichloride oxide (0.25 ml) was added to this solution and the mixture was refluxed in a stream of $N_2$ for 20 min. Work-up and crystallization of the resulting oil gave compound (**10**) (169 mg, 94%).

(*c*) *With thionyl chloride*. Thionyl chloride (1 ml) was added to a solution of (**1**) (200 mg) in dry pyridine (10 ml), and the mixture was stirred at room temperature for 1 h. Work-up and crystallization of the resulting oil gave compound (**10**) (132 mg, 73%).

(*d*) *With methanesulphonyl chloride*. Methanesulphonyl chloride (0.20 ml) was added to a solution of (**1**) (200 mg) in dry pyridine (5 ml), and the mixture was refluxed for 30 min in a stream of $N_2$. Work-up and crystallization of the resulting oil gave compound (**10**) (126 mg, 65%).

(*e*) *With phosphorus pentachloride*. Phosphorus pentachloride

(500 mg) was added to a solution of (**1**) (200 mg) in dry pyridine (5 ml), and the mixture was refluxed for 20 min in a stream of $N_2$. Work-up and crystallization of the resulting oil gave compound (**10**) (126 mg, 70%).

(*f*) *With phosphorus pentaoxide.* Phosphorus pentaoxide (350 mg) was added to a solution of (**1**) (200 mg) in dry benzene (12 ml), and the mixture was refluxed for 20 min in a stream of $N_2$. After work-up, the resulting residue was chromatographed on silica-gel. Elution with benzene gave 2α-azido-5α-cholest-1-en-3-one (**11**), which recrystallized from ether–MeOH as needles (44 mg, 23%), m.p. 114—115 °C (decomp.); $\nu_{max.}$ 2 120, 1 680, and 1 600 $cm^{-1}$; $\delta_H$ 6.62 (1 H, s, 1-H); $\delta_C$ 133.94 (C-2), 141.27 (C-1), and 194.31 (C-3) (Found: C, 75.95; H, 9.95; N, 9.8. $C_{27}H_{43}N_3O$ requires C, 76.18; H, 10.18; N, 9.87%).

Further elution with benzene–AcOEt (20:1) afforded (**10**) (69 mg, 39% yield) after recrystallization from EtOH.

*Fragmentation of* (E)-3β-*Acetoxy*-7β-*azido*-5α-*cholestan*-6-*one Oxime* (**2a**).—Oxime (**2a**) (200 mg) was dissolved in dry pyridine (5 ml). Phosphorus trichloride oxide (0.22 ml) was added to this solution and the mixture was heated at 80 °C for 15 min. After work-up, the resulting residue was chromatographed on silica-gel. Elution with benzene–EtOAc (30:1) gave (**12**), which recrystallized from MeOH as plates (160 mg, 83%), m.p. 129—131 °C; $\nu_{max.}$ 2 250, 2 240, 1 740, 1 250, and 1 010 $cm^{-1}$; $\delta_H$ 2.10 (3 H, s, MeCO), 3.02 (1 H, dd, *J* 4 and 11 Hz, 1 H, 5α-H), and 4.68 (1 H, m, $w_{\frac{1}{2}}$ 16 Hz, 3α-H); $\delta_C$ 69.58 (C-3), 119.65 (CN), and 122.30 (CN); *m/z* 454 ($M^+$), 274, and 180 (Found: $M^+$, 454.3572. $C_{29}H_{46}N_2O_2$ requires *M*, 454.3562).

*Fragmentation of* (Z)-3β-*Acetoxy*-21-*azido*-5α-*pregnan*-20-*one Oxime* (**3**).—The cleavage of (**3**) (155 mg) was carried out using the technique for the cleavage of (**2a**). After work-up, the resulting oil was chromatographed on silica-gel. From the first elution with benzene–AcOEt (30:1), 3β-acetoxy-5α-androstane-17β-carbonitrile (**6**) (25 mg, 20%) was obtained from methanol as needles, m.p. 196—198 °C (lit.,[14] 194—195 °C); $\nu_{max.}$ 2 240 $cm^{-1}$; $\delta_C$ 121.45 (CN). The next fraction, eluted with benzene–AcOEt (5:1), on crystallization from methanol gave needles of 3β-acetoxy-17β-azidoacetamido-5α-androstane (**8**) (69 mg, 45% yield), m.p. 177—178 °C (decomp.); $\nu_{max.}$ 3 380, 2 100, 1 715, 1 680, 1 535, and 1 280 $cm^{-1}$; $\delta_H$ 2.02 (3 H, s, MeCO), 3.80 (1 H, m, $w_{\frac{1}{2}}$ 10 Hz, 17α-H), 3.96 (2 H, s, $COCH_2N_3$), 4.65 (1 H, m, $w_{\frac{1}{2}}$ 18 Hz, 3α-H), and 6.17 (1 H, br d, NH); $\delta_C$ 52.90 ($CH_2N_3$), 58.88 (C-17), 73.67 (C-3), 166.31 (NHCO), and 170.76 (Found: C, 66.35; H, 8.65; N, 13.3. $C_{23}H_{36}N_4O_3$ requires C, 66.31; H, 8.71; N, 13.44%).

*Fragmentation of* (Z)-3β-*Acetoxy*-21-*azidopregn*-5-*en*-20-*one Oxime* (**5**).—(*a*) *With phosphorus trichloride oxide.* The cleavage reaction of (**5**) (150 mg) was carried out using the technique for the cleavage of (**2a**). After work-up, the resulting oil was chromatographed on silica-gel. From the first elution with benzene–AcOEt (20:1), 3β-acetoxyandrost-5-ene-17β-carbonitrile (**7**) (40 mg, 32%) was obtained from methanol as needles, m.p. 226—228 °C (lit.,[15] 226—227 °C); $\nu_{max.}$ 2 240 $cm^{-1}$; $\delta_C$ 121.27 (CN). The next fraction, eluted with benzene–AcOEt (5:1), on crystallization from methanol gave plates of 3β-acetoxy-17β-azidoacetamidoandrost-5-ene (**9**) (71 mg, 47.3%), m.p. 214—216 °C (decomp.); $\nu_{max.}$ 3 380, 3 025, 2 120, 1 720, 1 680, 1 520, and 1 250 $cm^{-1}$; $\delta_H$ 2.02 (3 H, s, MeCO), 3.80 (1 H, m, 6-H), and 6.15 (1 H, br d, *J* 8 Hz, NH); $\delta_C$ 52.90 ($CH_2N_3$), 58.83 (C-17), 73.94 (C-3), 122.35 (C-6), 139.96 (C-5), 166.49 (NHCO), and 170.62 (Found: C, 66.75; H, 8.4; N, 13.85. $C_{23}H_{34}N_4O_3$ requires C, 66.63; H, 8.26; N, 13.51%).

(*b*) *With thionyl chloride.* To solid (**5**) (65 mg) was slowly added neat thionyl chloride (0.2 ml) at 0 °C, and the mixture was stirred for 30 min in a stream of $N_2$. Quenching of the reaction mixture in methanol–$H_2O$ (3:7) followed by extraction with $CHCl_3$ afforded a crude residue which was chromatographed on silica-gel. Elution with benzene–AcOEt (20:1) gave (**7**), which recrystallized from MeOH–ether as needles (31 mg, 57.9% yield).

*Fragmentation of* 2α-*Azido*-3-*hydroxyimino*-5αH,4,6,11βH-*eudesman*-6,13-*olide* (**14**).—The cleavage reaction of (**14**) (200 mg) was carried out using the technique described above. Elution with benzene–AcOEt (5:1) gave (**15**), which recrystallized from benzene–hexane as plates (114 mg, 67.1% yield), m.p. 159—161 °C; $\nu_{max.}$ 2 250 and 1 770 $cm^{-1}$; $\delta_H$ 2.68 (2 H, q, *J* 7.3 Hz, 1-$H_2$), 3.07 (1 H, q, *J* 4 Hz and 7 Hz, 4-H), and 4.00 (1 H, t, *J* 11 Hz, 6β-H); $\delta_C$ 80.23 (C-6), 117.13 (C-2), 122.21 (C-3), and 177.99 (C-13) (Found: C, 69.15; H, 7.7; N, 10.5. $C_{15}H_{20}N_2O_2$ requires C, 69.2; H, 7.44; N, 10.76%).

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