Synthesis of Derivatives of Aza[14]annulene, Aza[16]annulene, Aza[18]annulene, Aza[20]annulene, and Aza[22]annulene, Diatropic and Paratropic Vinylogues of Pyridine

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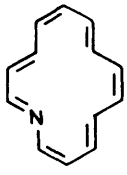
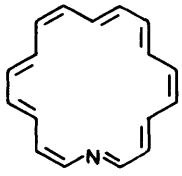
Syntheses of the tetradehydroaza[14]annulene (**5**), the tetradehydroazabenz[14]annulene (**6**), the tetradehydroazadibenz[14]annulene (**7**), the tetradehydroaza[16]annulene (**8**), the tetradehydroaza[18]annulene (**9**), the tetradehydroaza[20]annulene (**10**), and the tetradehydroaza[22]annulene (**11**) are described. The aza[16]annulene (**8**) and the aza[20]annulene (**10**) are the first examples of monocyclic aza-annulenes to show a paramagnetic ring current. The lactams, the precursors of these aza-annulenes, proved to exist in zwitterionic forms and to exhibit tropic behaviour. Comparison with the carbocyclic annulene series is made on the basis of ^{1}H n.m.r. and electronic spectra of these compounds.

Macrocyclic conjugated polyenes (annulenes) and polyenynes (dehydroannulenes) have been thoroughly investigated[1] and heteroannulenes in which one or more carbons in the conjugated system are replaced by hetero atoms such as nitrogen, oxygen, and sulphur, have also received considerable attention.[2] Among them, the aza[14]annulene (**1**) and the aza[18]annulene (**2**), prepared by Schröder,[3] were the only examples of the vinylogues of pyridine to show a diamagnetic

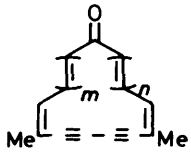


(**1**)



(**2**)

(**3**)

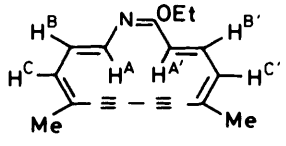


(**4**)

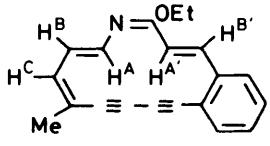
$\begin{bmatrix} m = 1\text{-}5 \\ n = 1\text{-}5 \end{bmatrix}$

ring current, but a systematic examination of monocyclic aza-annulenes containing [4*n*]-members has only recently been made. The first example of a monocyclic [4*n*]-membered, tetradehydroaza[16]annulene (**8**), which proved to be paratropic, as well as the diatropic tetradehydroaza[14]- (**5**) and tetradehydroaza[18]annulene (**9**), were only reported very recently.[4]

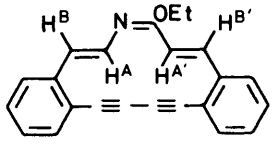
In order to compare the tropic nature of the [4*n* + 2]π- and [4*n*]π-electron systems of the monocyclic aza-annulenes more systematically, we have now extended our work to the synthesis of the tetrahydroaza[20]annulene (**10**) and the tetradehydroaza[22]annulene (**11**). Details of the synthesis of the tetradehydroaza[14]annulene (**5**) and its benzannelated derivatives (**6**) and (**7**), tetradehydroaza[16]annulene (**8**), and the tetradehydroaza[18]annulene (**9**), are also given.



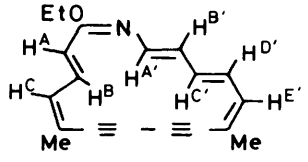
(**5**)



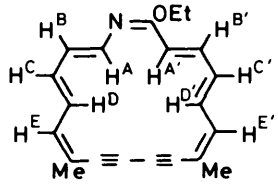
(**6**)



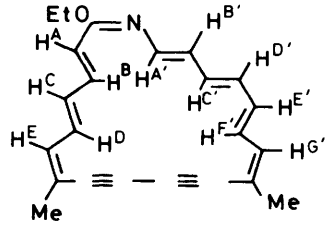
(**7**)



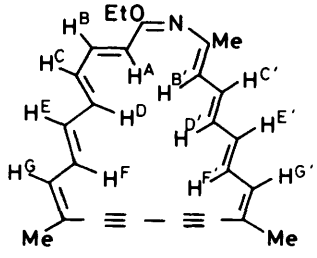
(**8**)



(**9**)



(**10**)



(**11**)

Synthesis of the benzannelated compounds (**6**) and (**7**) has enabled us to study the effect on the ring current produced by fusion of one or two benzene rings onto a diatropic, conformationally fixed, monocyclic aza[4*n* + 2]π-electron system,

i.e. the tetradehydroaza[14]annulene (**5**), while keeping possible changes in stereochemistry to a minimum. Compounds (**5**) and (**8**)—(**11**) are members of a series of monocyclic aza-annulenes in which the number of double bonds is increased systematically, and hence a study of their spectral properties is particularly informative. The tetrahydroaza-[20]annulene (**10**) and -[22]annulene (**11**) are the largest monocyclic heteroannulenes so far obtained.[5]

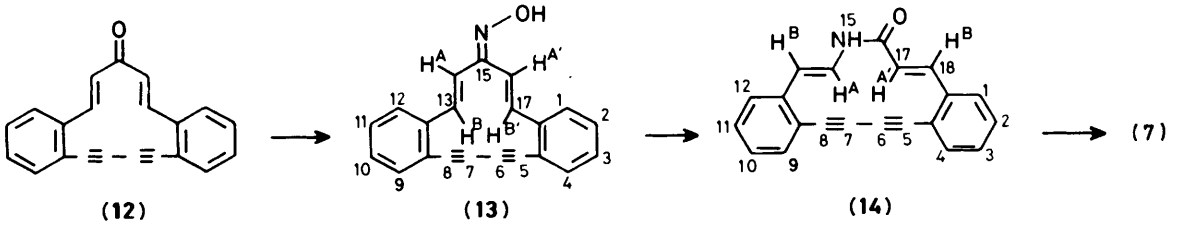
Results and Discussion

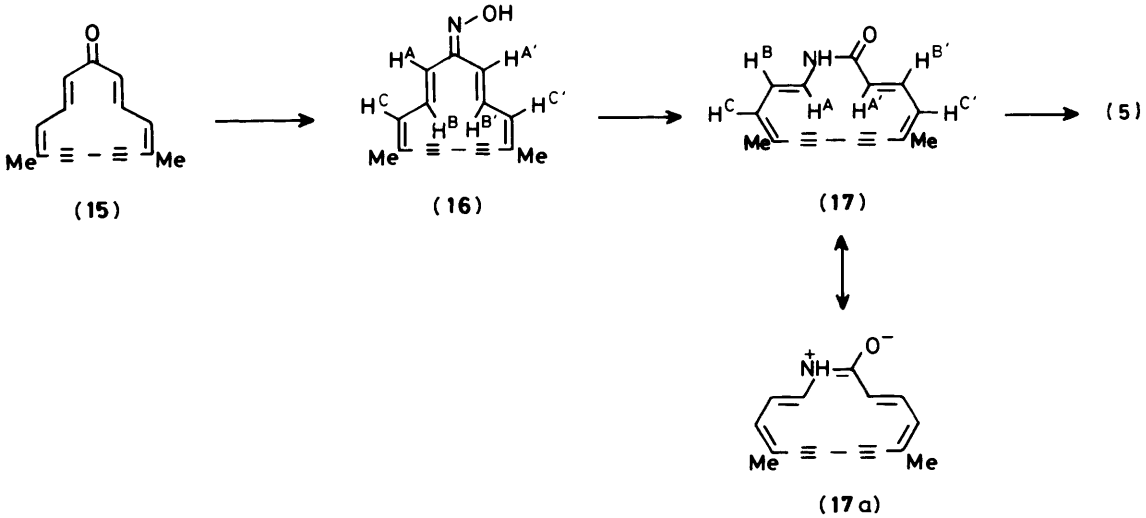
Synthesis.—Some bridged aza[10]annulene derivatives, vinylogues of quinoline or isoquinoline, *e.g.* (**3**), were prepared starting from the appropriate ketones.[6] The method involves essentially (i) preparing an oxime (or its tosyl ester), (ii) Beckmann rearrangement to a lactam, and finally (iii) *O*-alkylation with Meerwein's reagent. This simple, general sequence of reactions from a ketone to an aza-annulene skeleton intrigued us, since we had previously accomplished the synthesis of a series of both diatropic and paratropic tetradehydroannulenones of type (**4**).[7] In view of their convenient and relatively easy preparation, these annulenones appeared to be desirable starting materials for the synthesis of monocyclic azaannulenes. Since we considered that a stable annulenone would be more useful in investigating the reaction conditions, and since benzannelated annulenones are more stable than nonannelated ones, we initiated our study using the tetradehydrodibenz[13]annulenone (**12**).[8]

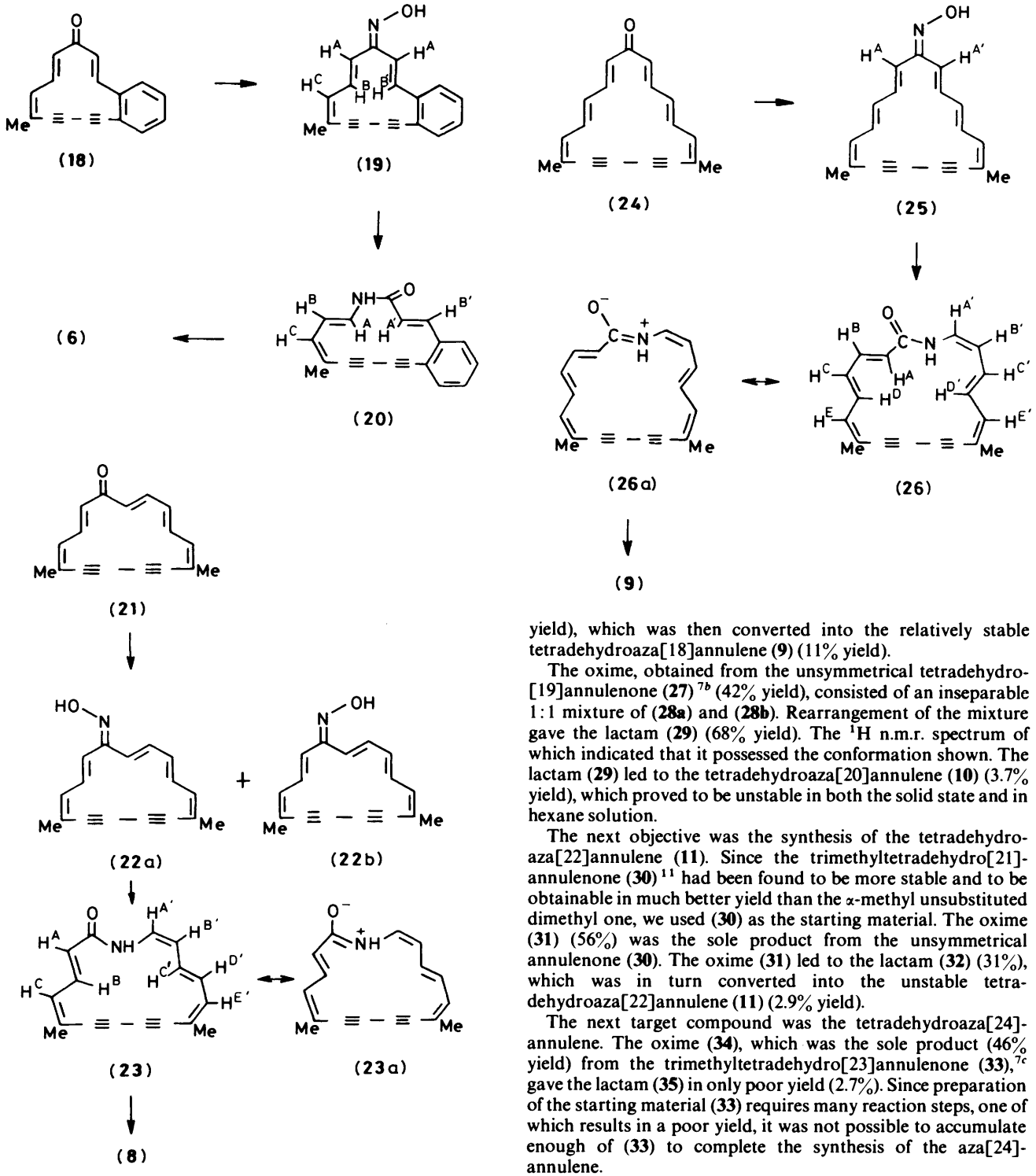
Attempts to obtain the oxime (**13**) under ordinary conditions using 1 equiv., or a little excess, of hydroxylamine hydrochloride with aqueous alkali in ethanol,[9] were fruitless. After several unsuccessful experiments, it was found that treatment of (**12**) with a large excess of hydroxylamine hydrochloride readily gave the oxime (**13**) (66%). Treatment of (**13**) with phosphorus pentachloride caused Beckmann rearrangemment to give the lactam (**14**) (37% yield). Inspection of molecular models revealed that (**14**) should have the conformation indicated. Compound (**14**) reacted with a large excess of triethyloxonium tetrafluoroborate to give the desired dibenz[14]annulene imino ether (**7**) (59% yield). As expected, compound (**7**), as well as the intermediates (**13**) and (**14**), proved to be stable.

The three-step sequence of reactions from tetradehydroannulenones thus established was then applied to the synthesis of the aza-annulenes (**5**) and (**6**). Treatment of the dimethyltetradehydro[13]annulenone (**15**)[7a] with an excess of hydroxylamine hydrochloride in methanol, tetrahydrofuran (THF), and water gave the oxime (**16**) (90% yield) and this with phosphorus pentachloride in THF afforded the lactam (**17**) (56% yield). Compound (**17**) reacted with a large excess of triethyloxonium tetrafluoroborate in dichloromethane for 7 h at room temperature to give the desired tetradehydroaza[14]annulene (**5**) (24% yield) which was relatively stable, both in the solid state and in hexane solution. The reaction of tetradehydrobenz[13]annulenone (**18**)[8] gave the isomer (**19**) (44%), one of two possible stereoisomeric products, which was then converted into the lactam (**20**) (40% yield). Since Beckmann rearrangement is recognized to proceed usually in an *anti* fashion with respect to the hydroxy group,[10] the precursor of the lactam (**20**), the oxime (**19**), should have the structure indicated. The tetradehydroazabenz[14]annulene (**6**) was obtained from the lactam (**20**) (38% yield).

We now turn our attention to the synthesis of the tetradehydroaza[16]annulene (**8**). Treatment of the tetrahydro-[15]annulenone (**21**)[7b] with hydroxylamine gave a 5:2 (^{1}H n.m.r.) mixture of the oximes (**22a**) and (**22b**) (93% yield); this was separated by crystallization, only the isomer (**22a**) being







isolated. The rearrangement of the mixture with phosphorus pentachloride gave the lactam (**23**) (41% yield), whose structure was determined by ^{1}H n.m.r. spectroscopy. In view of the *anti*-migration in the rearrangement, as mentioned above, the main isomer of the oxime must have structure (**22a**). The lactam (**23**) reacted with the oxonium salt to give the relatively stable tetradehydroaza[16]annulene (**8**) (38% yield).

The oxime (**25**), obtained from the tetradehydro[17]-annulenone (**24**)[7b] (88% yield), led to the lactam (**26**) (43% yield), which was then converted into the relatively stable tetradehydroaza[18]annulene (**9**) (11% yield).

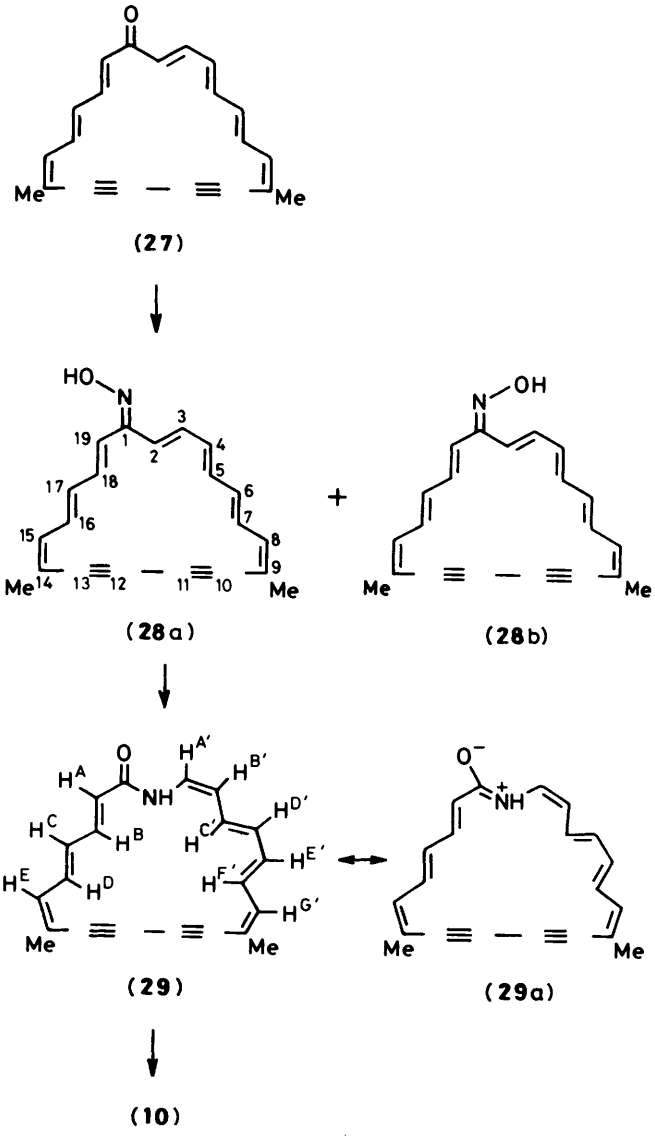
The oxime, obtained from the unsymmetrical tetradehydro-[19]annulenone (**27**)[7b] (42% yield), consisted of an inseparable 1:1 mixture of (**28a**) and (**28b**). Rearrangement of the mixture gave the lactam (**29**) (68% yield). The ^{1}H n.m.r. spectrum of which indicated that it possessed the conformation shown. The lactam (**29**) led to the tetradehydroaza[20]annulene (**10**) (3.7% yield), which proved to be unstable in both the solid state and in hexane solution.

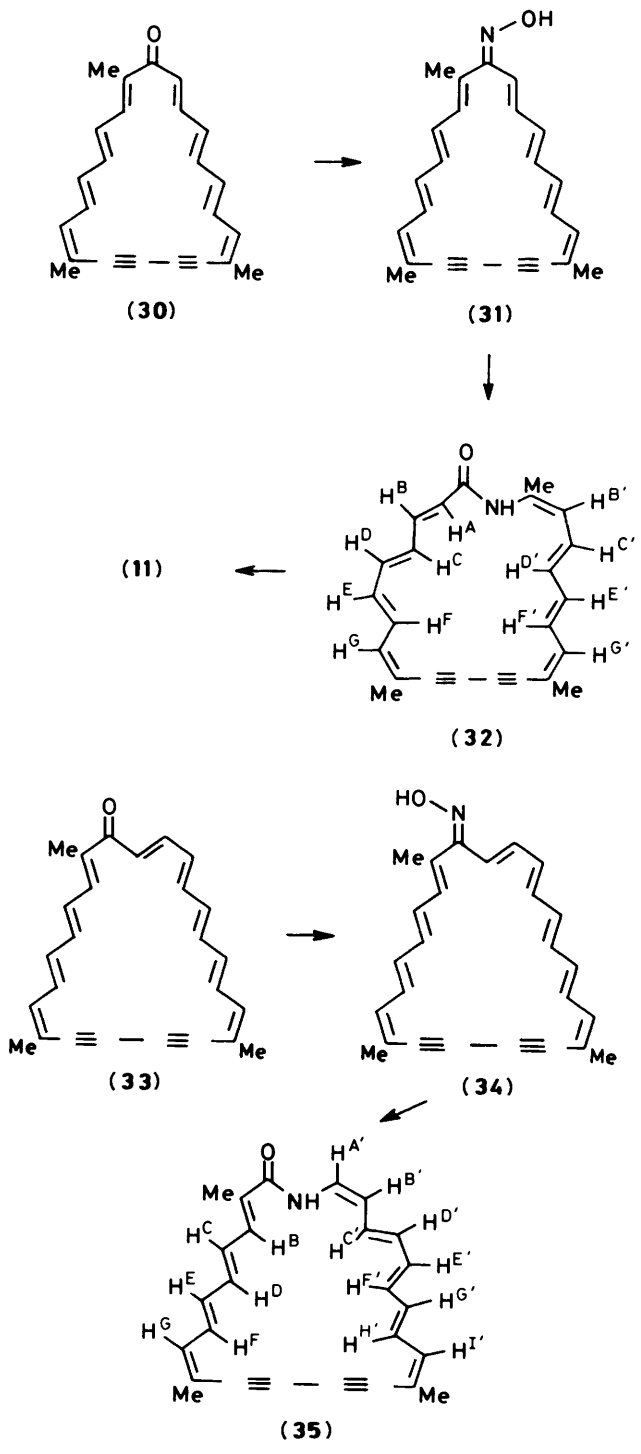
The next objective was the synthesis of the tetradehydroaza[22]annulene (**11**). Since the trimethyltetradehydro[21]-annulenone (**30**)[11] had been found to be more stable and to be obtainable in much better yield than the α-methyl unsubstituted dimethyl one, we used (**30**) as the starting material. The oxime (**31**) (56%) was the sole product from the unsymmetrical annulenone (**30**). The oxime (**31**) led to the lactam (**32**) (31%), which was in turn converted into the unstable tetradehydroaza[22]annulene (**11**) (2.9% yield).

The next target compound was the tetradehydroaza[24]-annulene. The oxime (**34**), which was the sole product (46% yield) from the trimethyltetradehydro[23]annulenone (**33**),[7c] gave the lactam (**35**) in only poor yield (2.7%). Since preparation of the starting material (**33**) requires many reaction steps, one of which results in a poor yield, it was not possible to accumulate enough of (**33**) to complete the synthesis of the aza[24]-annulene.

^{1}H *N.m.r. Spectra.*—The ^{1}H n.m.r. spectra of the tetradehydroaza-annulenes (**5**)—(**11**) are given in Figures 1—3, and the chemical shifts of the non-benzannelated aza-annulenes (**5**) and (**8**)—(**11**) are listed in Table 1. The spectra were taken using Fourier transform techniques, and this is responsible for the water and solvent impurity peaks in the spectra.

The assignments of the resonances to the individual protons of the tetradehydroaza[14]annulene (**5**) follow explicitly from the multiplicities and coupling constants. In contrast, the spectra of the higher-membered aza-annulenes, illustrated in





Figures 2 and 3, were complex. The assignments of the resonances in the aza-annulenes (**8**)—(**11**) are also based on the multiplicities and coupling constants, and the assumption that protons in a similar environment resonate at similar field. The analyses of the spectra of these aza-annulenes are fully in accord with the consideration of ring current.

Variable-temperature ^{1}H n.m.r. spectra of the tetradehydroaza[14]annulene (**5**) and its benzannelated derivatives (**6**) and (**7**) as well as those of the tetradehydroaza[16]annulene (**8**) were run over the range −60—60 °C, and the results show all the spectra to be essentially temperature-independent, ruling out changes in the conformations of (**5**)—(**8**) between these temperatures.

The spectra of the tetradehydroaza[14]annulene (**5**) and its benzannelated derivatives (**6**) and (**7**) are shown in Figure 1. The dimethylaza[14]annulene (**5**) is clearly diatropic, as expected of a 14π-electron system, the outer protons of the ring being deshielded and the inner protons shielded. In contrast, the chemical shifts of the protons of the benzannelated aza-annulenes suggest the monobenzannelated (**6**) to be at most weakly diatropic and the dibenzannelated aza-annulene (**7**) to be atropic, indicating that the skeletons of the benzannelated aza-annulenes are less delocalized π-electron systems than that of the non-annelated one, as shown by the electronic spectra of these compounds (see below), and as has already been demonstrated for carbocyclic annulene,[1] dehydroannulene,[1] and dehydroannulenone [12] systems.

The spectra of the [4*n*]-membered, aza[16]- (**8**) and aza[20]-annulene (**10**), are illustrated in Figure 2 and those of the [4*n* + 2]-membered, aza[18]- (**9**) and aza[22]-annulene (**11**), in Figure 3. Figure 2 shows both the aza[16]- (**8**) and the aza[20]-annulene (**10**) to be paratropic, the outer protons, including ethoxy and methyl protons (see also Table 1), absorbing at high field, the inner protons at low field.

Table 1. The ^{1}H n.m.r. parameters of tetradehydroaza-annulenes (**5**) and (**8**)—(**11**) in $CDCl_3$ at 200 MHz or 400 MHz (τ values)

Compd.	H^A	$H^{A'}$	H^B	$H^{B'}$	H^C	$H^{C'}$	H^D	$H^{D'}$	H^E	$H^{E'}$	H^F	$H^{F'}$	H^G	$H^{G'}$	OCH_2CH_3	OCH_2CH_3	CH_3
[14]- (**5**)	6.25	7.06	2.99	2.19	2.62	2.70									5.40	8.51	7.49, 7.54
(**5**)[a]	6.35	6.52	2.76	1.69	2.54	2.66									5.15	8.32	7.32, 7.52
[16]- (**8**)	4.61	0.60	−0.14	4.27	4.11	0.63		4.25		4.12					6.00	8.78	8.33, 8.38
(**8**)[a]	4.01	1.02	−0.53	3.87	3.96	1.14		3.66		4.02					5.61	8.59	8.19, 8.35
[18]- (**9**)	5.85	6.74	2.96	2.14	2.72	2.76	6.65	6.44	2.44	2.44					5.40	8.50	7.52, 7.56
(**9**)[a]	6.52	6.84	2.58	1.48	2.63	2.79	6.64	6.16	2.28	2.35					5.11	8.30	7.42, 7.51
[20]- (**10**)	5.50	0.86	1.01	(3.86—4.36)		1.65	0.90	3.86—	4.02	3.86—		0.90		4.02	6.01	8.79	8.32, 8.36
						2.99—		4.36		4.36							
[22]- (**11**)	4.52		2.67	5.52	3.76		4.21	4.85	(2.99—3.28)		4.45	4.52	(2.99—3.28)		5.74	8.63	7.85, 7.90
						3.28											8.05[b]

[a] A few drops of CF_3CO_2D was added; [b] This methyl protons are adjacent to nitrogen atom.

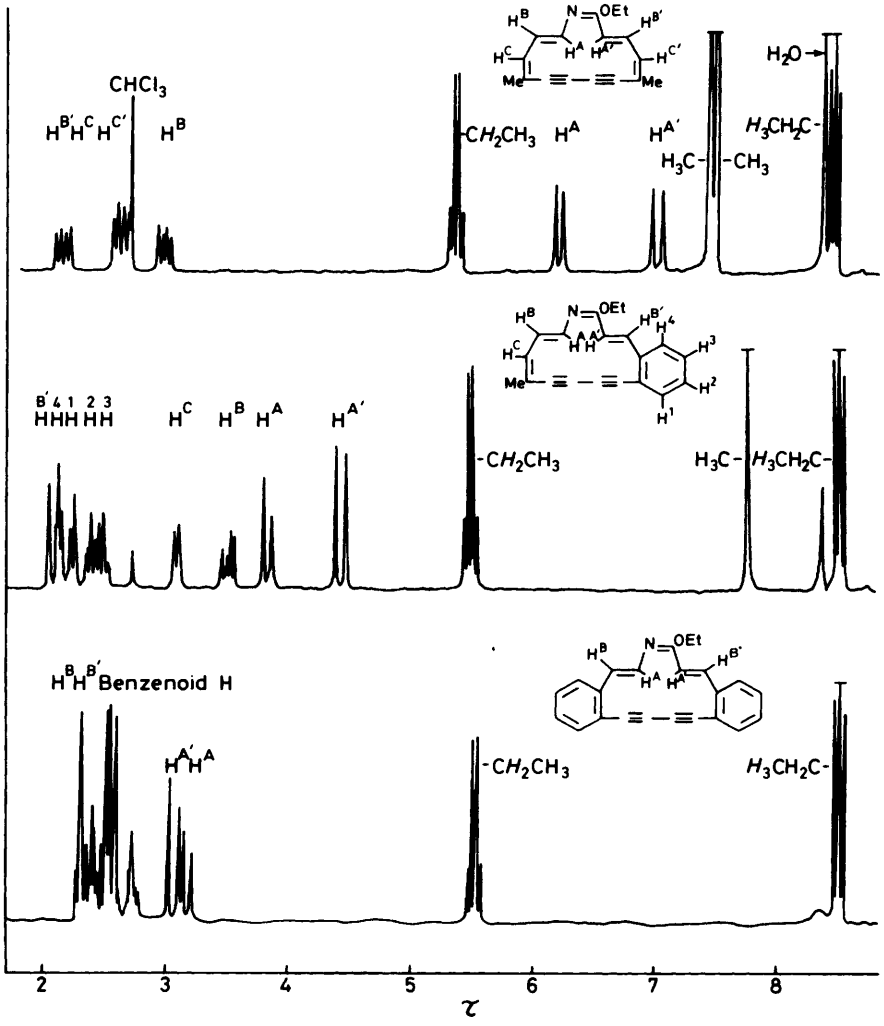


Figure 1. ^{1}H n.m.r. spectra of tetradehydroaza[14]annulenes (**5**)—(**7**) in $CDCl_3$ at 200 MHz, determined at 21 °C (τ values)

In contrast, Figure 3 shows the aza[18]- (**9**) and the aza[22]-annulene (**11**) to be diatropic, as observed for the aza-[14]annulene (**5**) (Figure 1), the inner protons absorbing at high field and the outer protons, including ethoxy and methyl protons (Table 1), at lowfield. This is a reversal of the behaviour of the paratropic aza[16]- (**8**) and the aza[20]-annulene (**10**). The alternation of the tropic nature between the aza[4*n* + 2]annulenes (**5**), (**9**), and (**11**), and the aza[4*n*]annulenes (**8**) and (**10**) is thereby clearly established, as has been previously demonstrated for carbocyclic annulene series.[1]

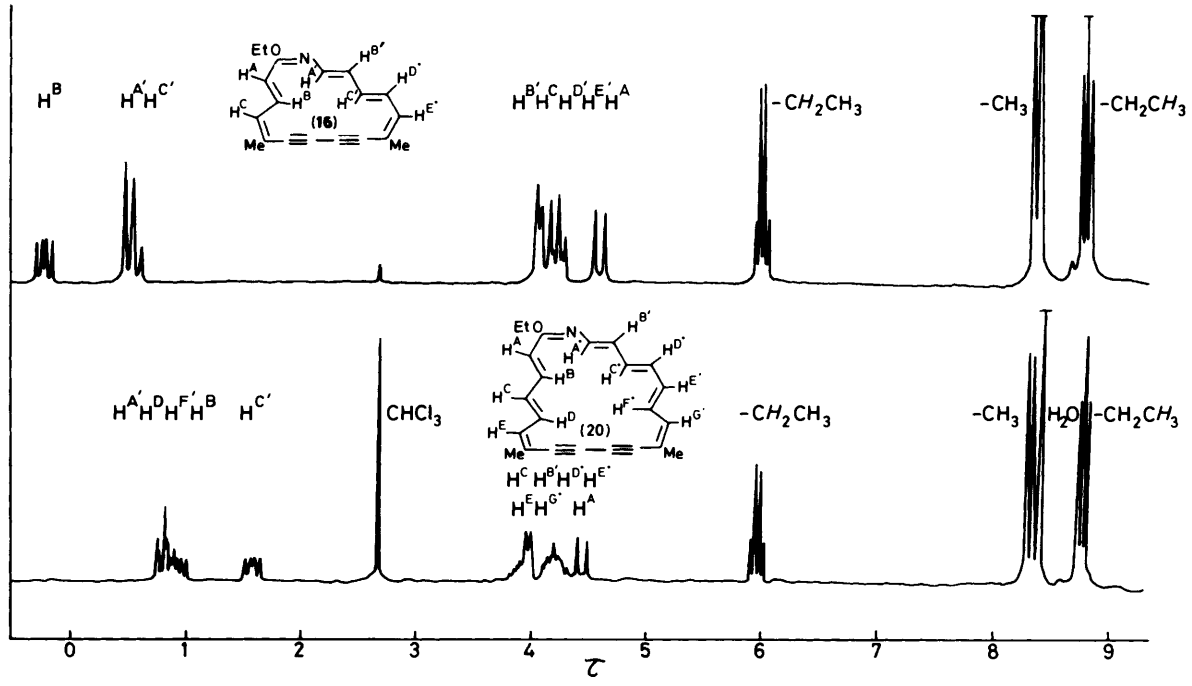


Figure 2. ^1H n.m.r. spectra of tetradehydroaza[16]- (**8**) and -[20]annulene (**10**) in $CDCl_3$ at 200 MHz, determined at 21 °C (τ values)

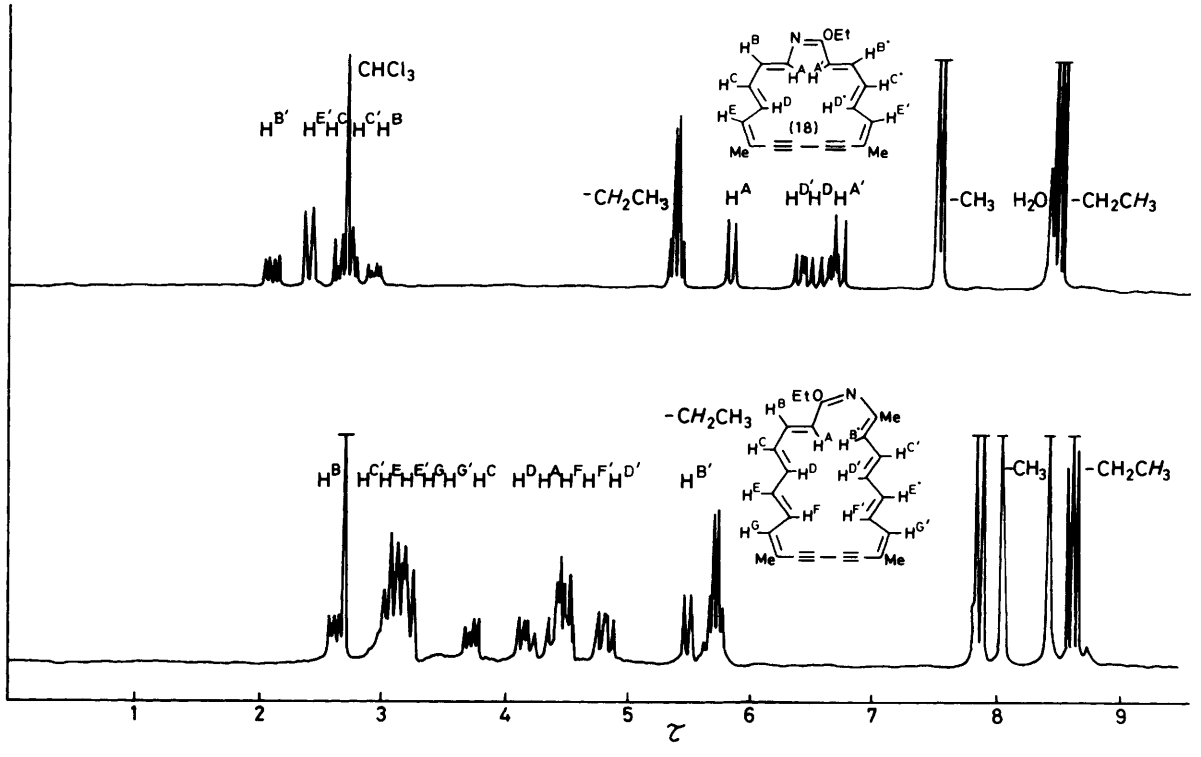


Figure 3. ^1H n.m.r. spectra of tetradehydroaza[18]- (**9**) and -[22]annulene (**11**) in $CDCl_3$ at 200 MHz, determined at 21 °C (τ values)

It is also noted from Figure 2 and Table 1 that the difference in chemical shifts between the outer protons and the inner protons, which can be regarded as an approximate measure of tropicity, falls off in the sequence (**8**) > (**10**) as the ring size is increased. Similarly, the difference falls off in the sequence (**9**) > (**11**) (Figure 3 and Table 1). Thus, the observation that both the diamagnetic ring current effect in $[4n + 2]\pi$-electron systems, and the paramagnetic ring current effect in the $[4n]\pi$-electron systems, become less as the ring size of the macrocycles is increased suggests increasing flexibility of the tetradehydroaza-annulene perimeter associated with an increase in ring size, as has been found for the carbocyclic annulenes.[1]

Table 2. The ^{1}H n.m.r. parameters of the lactams (**17**), (**23**), (**26**), (**29**), (**32**), and (**35**) in $CDCl_3$ at 200 MHz, determined at 21 °C (τ values)

Compd.	NH	H^A	$H^{A'}$	H^B	$H^{B'}$	H^C	$H^{C'}$	H^D	$H^{D'}$	H^E
[14]- (**17**)	1.19	3.82	4.36	3.98	2.44	3.27	3.17			
[16]- (**23**)	−0.69	3.96	3.66	0.26	5.24	3.94	1.74		2.82	
[18]- (**26**)	4.56	5.84	2.44	2.19	4.32	3.18	3.25	4.82	5.65	2.79
[20]- (**29**)	−0.05	4.15	3.52	1.44	5.15	4.15	3.04	0.90	2.83	3.88
[22]- (**32**)	4.02	5.20		2.33	4.63	3.95	3.62	3.62	4.25	3.28
[24]- (**35**)	0.71		3.42	2.08	4.99	3.76—4.10	3.03	2.21	3.40	3.76—4.10

Compd.	$H^{E'}$	H^F	$H^{F'}$	H^G	$H^{G'}$	$H^{H'}$	$H^{I'}$	CH_3
[14]- (**17**)								7.76, 7.85
[16]- (**23**)	4.19							8.30, 8.32
[18]- (**26**)	2.96							7.68, 7.74
[20]- (**29**)	4.23		1.21		3.97			8.28, 8.29
[22]- (**32**)	3.18	4.82	4.70	3.15	3.06			7.41,[a] 7.81 7.84
[24]- (**35**)	3.76—4.10	1.76	2.40	3.76—4.10		1.97	3.76—4.10	8.13[a], 8.22

[a] This methyl protons are adjacent to electronegative groups.

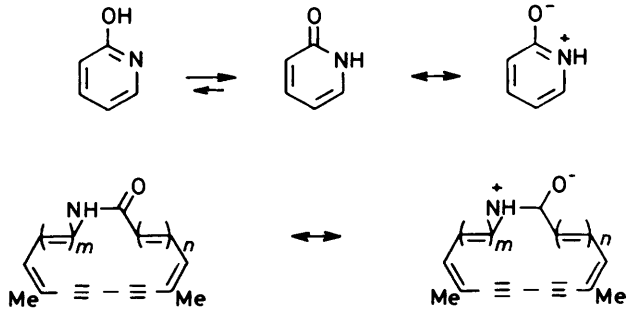
The observation that despite the presence of two acetylenic linkages, the dimethyltetradehydroaza-[14]- (**5**) and -[18]-annulene (**9**) are much less diatropic than the aza[14]- (**1**)[3] (inner protons: τ 10.61—12.57; outer protons: τ −0.11—2.33) and the aza[18]-annulenes (**2**)[3] (inner protons: τ 11.84; outer protons: τ −0.11—1.14), respectively, is presumably due to decreased planarity of the former system, caused by steric strain of the molecular skeletons.

The ^{1}H n.m.r. spectral data of the aza[14]- (**5**), aza[16]- (**8**), and aza[18]-annulene (**9**), taken in deuteriochloroform solution admixed with a few drops of deuteriotrifluoroacetic acid, are also listed in Table 1. The resonances of almost all the protons, including ethoxy and methyl protons but excluding protons near the nitrogenation, in these aza-annulenes as well as the benzannelated ones (**6**) and (**7**) (see Experimental section) shift toward lower field. This is attributable to diminished π-electron perimeters in aza-annulenes (**5**)—(**9**), arising from withdrawal of electrons by deuteriation.

^{1}H N.m.r. data for the lactams (**17**), (**23**), (**26**), (**29**), and (**32**), which are the precursors of the aza-annulenes, (**5**), (**8**), (**9**), (**10**), and (**11**), respectively, are listed in Table 2, along with those of the lactam (**35**). The 14-membered lactam (**17**) shows its inner proton resonances at highfield and the outer proton resonances at lowfield, although the outer H^B proton resonance appears at rather highfield. Almost the same observation is made in the spectra of the 18-membered (**26**) and the 22-membered lactam (**32**). On the other hand, the 16-membered (**23**), the 20-membered (**29**), and the 24-membered lactam (**35**) show their inner proton resonances at lowfield and the outer proton resonances at highfield.

It is not possible to compare the ^{1}H n.m.r. chemical shifts of the aza-annulenes and the lactams directly, since the conformations are slightly different, but it is noted that the spectra of the aza-annulenes resemble those of the corresponding lactams with respect to the highfield and lowfield shifts of the olefinic protons.

The simplest test for the nature of the ring current of the compounds listed in Tables 1 and 2 is provided by the chemical shifts of the methyl groups, these always being external in this series of aza-annulenes and the lactams, and readily recognizable.[13] Therefore, the alternation of the methyl resonances between the (4*n* + 2)lactams (**17**), (**26**), and (**32**) (relatively lowfield) and the (4*n*)lactams (**23**), (**29**), and (**35**) (relatively highfield) confirms the diatropicity of the former and the paratropicity of the latter (Table 2), although the degree of the alternation is no greater than that between the aza[4*n* + 2]annulenes (**5**), (**9**), and (**11**), and the aza[4*n*]annulenes (**8**) and (**10**) (Table 1). These results suggest that the lactams can be considered to exist in zwitterionic forms such as (**17a**), (**23a**), (**26a**), and (**29a**), and thus constitute fully conjugated macrocycles. Such a phenomenon has been demonstrated in the simplest lactam 2-pyridone, recognized as the greatly preferred tautomeric form of 2-hydroxypyridine. In addition, a rather large dipole moment and an aromatic character show that 2-pyridone can be written as a charged structure.[14] Thus, it seems reasonable to assume that macrocyclic lactams can also be written as charged structures to show diatropicity and paratropicity, and that the zwitterionic forms can occur as resonance hybrids, as shown in the diagram.



Scheme 1.

Electronic Spectra.—The electronic absorption spectra, measured in THF, of the tetradehydroaza-annulenes (**5**) and (**8**)—(**11**) are illustrated in Figure 4, and the maxima and shoulders are given in Table 3, together with those of the benzannelated aza[14]annulenes (**6**) and (**7**).

As is seen from Figure 4, it is noteworthy that the spectra of the aza[4*n*]annulenes such as aza[16]- (**8**) and aza[20]-annulene (**10**), exhibit broadening of the absorption curves, as compared with the aza[4*n* + 2]annulenes such as aza[14]- (**5**), -[18]- (**9**), and -[22]- (**11**) annulene, although some broadening of the absorption curve is notable in the spectrum of the aza[22]annulene (**11**); some of this is however attributable to the regular bathochromic shift which accompanies an increase in ring size. The broadening of the absorption curve seems to be due to an increase in the twisting vibration of the molecular perimeter of the aza[22]annulene (**11**). This observation has been also made in the carbocyclic annulene series.[1]

Table 3 shows that in the spectra of the aza[14]annulene series, the main maxima shift to shorter wavelengths in the order non-benzannelated- (**5**) > monobenzannelated- (**6**) > dibenzannelated-aza-annulene (**7**). In the corresponding carbocyclic benzannelated annulene series it is recognized that fusion of benzene rings results in an appreciable bathochromic shift (4—16 nm), but in this series of tetradehydro-aza[14]annulenes, fusion of benzene rings results in an appreciable hypsochromic shift. In contrasts, the bands of the longest wavelength exhibit a considerable hypsochromic shift in the order (**7**) < (**6**) < (**5**) as the degree of annelation of benzene ring increases, suggesting that skeletons of the benzannelated aza-annulenes contain less delocalized π-electron systems than that of the non-annelated one, as continued by ^{1}H n.m.r. spectra.

Table 3 shows that the main maxima of the aza[4*n* + 2]-annulenes (**5**), (**9**), and (**11**) are of rather longer wavelength than those of the aza[4*n*]annulenes (**8**) and (**10**) ([14]:317, [16]:287, [18]:346 nm, *etc.*). Thus, it is evident that in these tetra-dehydroaza-annulenes the same alternation in the wavelengths of the main electronic absorption maxima between [4*n* + 2] and [4*n*] systems occurs, as has already been demonstrated for monocyclic annulenes and dehydroannulenes.[16]

The electronic absorption spectral data of the lactams are listed in Table 4. In the 14-membered lactam series (**17**), (**20**), and (**14**), fusion of benzene rings again results in an appreciable hypsochromic shift in both the main absorption maxima and the longest wavelength bands, as for the aza[14]annulene series (**5**)—(**7**). Also, it is found that in the non-benzannelated lactams the same alternation in the wavelengths of the main absorption maxima between [4*n* + 2] and [4*n*]systems occurs. This supports the interpretation that the (4*n* + 2)-membered lactams (**17**), (**26**), and (**32**) are diatropic, while the (4*n*)-membered ones (**23**), (**29**), and (**35**) are paratropic.

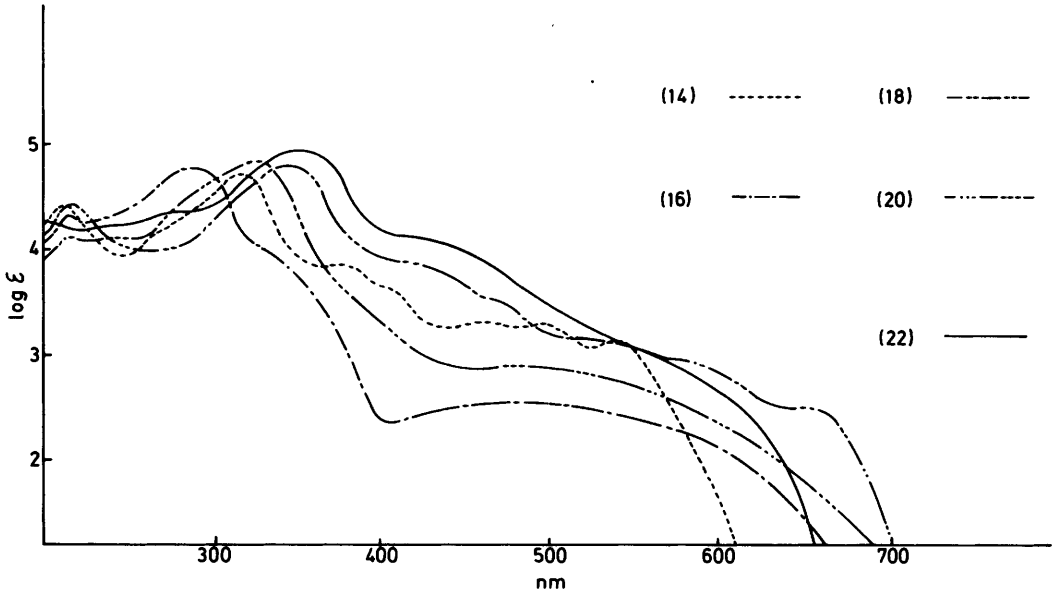


Figure 4. Electronic absorption spectra of tetradehydroaza[14]- (**5**), -[16]annulene (**8**), -[18]annulene (**9**), -[20]annulene (**10**), and -[22]annulene (**11**) in tetrahydrofuran

Table 3. Electronic absorption maxima of the aza-annulenes (**5**)—(**11**) in tetrahydrofuran $\lambda_{max.}$ (nm) ($\varepsilon_{max.}$)

[14]-,	(**5**):	285sh (21 900), 308sh (37 600), **317 (40 000)**, 374 (6 970), 403sh (4 530), 459 (2 050), 494 (1 990), 540 (1 390)
benz[14]-,	(**6**):	229 (33 000), 290sh (34 500), **300 (37 800)**, 321sh (25 100), 398 (7 000), 424sh (5 700), 458sh (2 500), 491sh (1 000)
dibenz[14]-,	(**7**):	222 (27 200), 264sh (15 400), 280sh (23 600), **292 (28 000)**, 313sh (20 500), 330 (18 800), 355sh (7 050), 394sh (3 840)
[16]-,	(**8**):	250sh (23 400), **287 (47 000)**, 345sh (6 850), 479 (353)
[18]-,	(**9**):	**346 (59 000)**, 385sh (10 500), 412sh (7 320), 535sh (1 190), 587sh (773), 654sh (238)
[20]-,	(**10**):	244 (12 500), 298sh (41 700), **326 (63 600)**, 480 (800)
[22]-,	(**11**):	243 (32 200), 273sh (39 000), 292sh (41 300), **353 (73 600)**, 453sh (8 390)

Table 4. Electronic absorption maxima of the lactams (**14**), (**17**), (**20**), (**23**), (**26**), (**29**), (**32**), and (**35**) in tetrahydrofuran; $\lambda_{max.}$ (nm) ($\varepsilon_{max.}$)

[14]-,	(**17**):	253sh (15 700), **305 (34 700)**, 312sh (33 700), 365sh (5 250), 435 (3 060)
benz[14]-,	(**20**):	226 (36 500), 258sh (26 700), 273sh (38 500), **284 (43 000)**, 300sh (24 800), 388 (7 900)
dibenz[14]-,	(**14**):	228 (27 500), **282 (36 000)**, 326sh (14 200), 340sh (11 500), 372sh (4 030)
[16]-,	(**23**):	253sh (13 800), 266sh (18 700), **292 (30 100)**, 310sh (20 700), 342sh (5 640), 463 (776)
[18]-,	(**26**):	267sh (12 400), 296sh (22 000), **333 (42 400)**, 403sh (6 260)
[20]-,	(**29**):	244 (15 800), 298sh (43 700), **328 (65 600)**, 346sh (47 900), 446 (2 320)
[22]-,	(**32**):	238 (15 500), 273 (17 000), 350sh (78 800), **358 (80 300)**, 433sh (40 100)
[24]-,	(**35**):	238 (25 500), 265sh (24 500), 327sh (56 400), **355 (85 300)**, 492sh (20 400)

Experimental

M.p.s were determined with a hot-stage apparatus and are uncorrected. I.r. spectra were taken with a Hitachi 260-50 spectrophotometer as KBr discs; only significant maxima are described. U.v. spectra were measured in tetrahydrofuran (THF) solution and run with a Hitachi 220A spectrophotometer. Mass spectra were recorded with a JEOL JMS-300 spectrometer operating at 75 eV using a direct-inlet system. ^{1}H N.m.r. spectra were recorded as $CDCl_3$ solutions (unless otherwise stated) with a FX-90Q (90 MHz), a Varian XL-200 (200 MHz) or a JEOL JX-400 (400 MHz) spectrometer, tetramethylsilane being used as an internal standard. Assignments were clarified by the use of decoupling experiments where necessary. Merck alumina (activity II—III) was used for column chromatography and preparative t.l.c. was carried out on 20 × 20 cm alumina plates (Merck, 0.5 or 2 mm thick). Progress of most reactions was followed by t.l.c. using Merck precoated alumina. Dichloromethane was distilled over calcium hydride before use. THF was refluxed over patassium hydroxide pellets and distilled before use. Organic extracts with dichloromethane or chloroform were washed with saturated aqueous sodium chloride and dried over anhydrous calcium chloride prior to solvent removal. Solvents were evaporated under water-pump pressure.

5,6,7,8-*Tetradehydro*-15H-*dibenzo*[a,g]*cyclotridecen*-15-*one Oxime* (**13**).—A suspension of the ketone (**12**)[8] (830 mg, 2.96 mmol) in methanol (90 ml) and THF (40 ml) was stirred and warmed to 35—40 °C and a solution of hydroxylamine hydrochloride (1.90 g, 27.3 mmol) in water (10 ml) was then added in one portion. The mixture was stirred for 3 h at the same temperature after which it was poured into water and the precipitate filtered off to afford the oxime (**13**) (446 mg, 66%). It formed pale yellow *needles*, m.p. 149—150 °C (decomp.), from chloroform; *m/z* 295 (M^+, 48%) and 277 (100); *M*, 295.3; $\lambda_{max.}$ 220sh (ε 33 600), 229 (35 700), 282 (40 300), 295sh (34 800), and 340 nm (7 900); $\nu_{max.}$ 3 170 (OH), 2 200 (C≡C), and 975 cm^{-1} (*trans* C=C); τ [90 MHz, $(CD_3)_2SO$] −1.89 (1 H, s, OH exchangeable with D_2O), 2.20 (1 H, d, *J* 9 Hz, 1-H), 2.32 (2 H, d, *J* 17 Hz, H^B and $H^{B'}$), 2.34 (1 H, d, *J* 9 Hz, 12-H), 2.44 (2 H, d, *J* 8 Hz, 4-H and 9-H), 2.56 (2 H, d, *J* 8 Hz, 3-H and 10-H), 2.59 (2 H, d, *J* 8 Hz, 2-H and 11-H), 2.83 (1 H, d, *J* 17 Hz, $H^{A'}$), and 3.11 (d, *J* 17 Hz, H^A) (Found: C, 85.6; H, 4.4; N, 4.8. $C_{21}H_{13}NO$ requires C, 85.4; H, 4.4; N, 4.7%).

5,6,7,8-*Tetradehydro*-15-*azadibenzo*[a,g]*cyclotetradecen*-16(15H)-*one* (**14**).—Phosphorus pentachloride (322 mg, 1.55 mmol) was added in one portion to an ice-cooled, stirred solution of the oxime (**13**) (91.3 mg, 0.301 mmol) in dry THF (40 ml) and the solution was allowed to rise to room temperature; it was then stirred overnight. After being stirred for a further 4 h at 40—45 °C, the solution was poured into water and the mixture warmed to 40 °C on a steam-bath. The brown precipitate so formed was filtered off to afford a yellow gum, which was passed through a short column of alumina (3.7 × 4.5 cm). The fractions eluted with chloroform were combined and evaporated to afford the lactam (**14**) (34.0 mg, 37%). It formed yellow *needles*, m.p. 296—298 °C (decomp.), from hexane–THF; *m/z* 295 (M^+, 90%) and 266 (100); *M*, 295.3; for u.v. data seee Table 4; $\nu_{max.}$ 3 160, 3 050 (NH), 2 200 (C≡C), 1 665, 1 640, 1 620 (C=O, C=C, NH), and 950 cm^{-1} (*trans* C=C); τ [200 MHz, $(CD_3)_2SO$] −0.51 (1 H, br d, *J* 11 Hz, NH), 2.01 (1 H, dd, *J* 15 and 11 Hz, H^A), 2.20—2.78 (8 H, m, ArH), 2.24 (1 H, d, *J* 16 Hz, $H^{A'}$), 2.61 (1 H, d, *J* 16 Hz, $H^{B'}$), and 3.67 (1 H, d, *J* 15 Hz, H^B) (Found: C, 85.3; H, 4.5; N, 4.7. $C_{21}H_{13}NO$ requires C, 85.4; H, 4.4; N, 4.7%).

16-*Ethoxy*-5,6,7,8-*tetradehydro*-15-*azadibenzo*[a,g]*cyclotetradecene* (**7**).—To a stirred suspension of the lactam (**14**) (214 mg, 0.723 mmol) in dichloromethane (100 ml) was added dropwise a solution of triethyloxonium tetrafluoroborate (5.50 g, 29.0 mmol) in dichloromethane (40 ml) over 30 min at room temperature under argon. The mixture was stirred for 8 h at the same temperature after which 50% aqueous potassium carbonate (50 ml) was added. The mixture was poured into water and extracted with dichloromethane and the combined extracts were washed with brine and dried. The residue after solvent removal was chromatographed on alumina (3.7 × 7.0 cm). The fractions eluted with 5% ether in hexane afforded the title compound (**7**) (139 mg, 59.4%). It formed yellow *needles*, m.p. 164—165 °C, from hexane–benzene; *m/z* 323 (M^+, 50%) and 278 (100); *M*, 323.3; for u.v. data see Table 3; $\nu_{max.}$ 2 200 (C≡C), 1 310, 1 060 (–O–), 960 and 940 cm^{-1} (*trans* C=C); τ (200 MHz) 2.25—2.59 (10 H, m, H^B, $H^{B'}$, and ArH), 3.06 (1 H, d, *J* 16 Hz, $H^{A'}$), 3.18 (1 H, d, *J* 14 Hz, H^A), 5.52 (2 H, q, *J* 8 Hz, $-CH_2CH_3$), 8.53 (3 H, t, *J* 8 Hz, CH_2CH_3), and see also Figure 1, τ (200 MHz, CF_3COOD in $CDCl_3$) 1.75 (1 H, d, *J* 16 Hz, $H^{B'}$), 2.12—2.55 (8 H, m, ArH), 2.78 (1 H, d, *J* 14 Hz, H^B), 2.86 (1 H, d, *J* 16 Hz, $H^{A'}$), 2.93 (1 H, d, *J* 14 Hz, H^A), 5.16 (2 H, q, *J* 7 Hz, CH_2CH_3), and 8.30 (3 H, t, *J* 7 Hz, CH_2CH_3) (Found: C, 85.6; H, 5.1; N, 4.3. $C_{23}H_{17}ON$ requires C, 85.4; H, 5.3; N, 4.3%).

The later fractions eluted with chloroform gave the recovered lactam (**14**) (71.3 mg).

5,10-*Dimethylcyclotrideca*-2,4,9,11-*tetraene*-6,8-*diynone Oxime* (**16**).—To a stirred solution of the ketone (**15**)[7a] (204 mg, 0.979 mmol) in methanol (40 ml) and THF (10 ml) was added a solution of hydroxylamine hydrochloride (1.02 g, 14.7 mmol) in water (5 ml) at 40 °C in one portion. The solution was stirred for 5 h at the same temperature and then poured into water. The precipitate so formed was filtered off to give the oxime (**16**) (197 mg, 89.9%). It formed orange *cubes*, m.p. 144—146 °C (decomp.), from hexane–chloroform; *m/z* 223 (M^+, 95%) and 190 (100); *M*, 223.2; $\lambda_{max.}$ 215 (ε 27 000), 273 (37 100), and 349sh nm (9 730); $\nu_{max.}$ 3 200 (OH), 2 170 (C≡C), 1 015 and 970 cm^{-1} (*trans* C=C); τ (90 MHz) 1.92 (1 H, dd, *J* 17 and 10 Hz, H^B), 1.96 (1 H, dd, *J* 17 and 10 Hz, $H^{B'}$), 3.39 (1 H, d, *J* 17 Hz, $H^{A'}$), 3.52 (2 H, d, *J* 10 Hz, H^C and $H^{C'}$), 3.98 (1 H, d, *J* 17 Hz, H^A), and 8.23 (6 H, s, CH_3); the peak due to hydroxy proton could not be detected (Found: C, 80.5; H, 5.8; N, 6.1. $C_{15}H_{13}NO$ requires C, 80.7; H, 5.9; N, 6.3%).

6,11-*Dimethyl*-1-*azacyclotetradeca*-3,5,11,13-*tetraene*-7,9-*diyn*-2-*one* (**17**).—Phosphorus pentachloride (4.60 g, 22.1 mmol) was added portionwise to an ice-cooled, stirred solution of the oxime (**16**) (714 mg, 3.20 mmol) in THF (100 ml). The temperature of the solution was allowed to rise to room temperature and stirring was continued for 1.5 h. The solution was then poured into water and aqueous sodium hydrogen carbonate was added (pH 8). The mixture was then extracted with chloroform. The extract was evaporated and the residue was chromatographed on alumina (3.7 × 5.5 cm). The fractions eluted with benzene–chloroform afforded the lactam (**17**) (399 mg, 55.8%). It formed orange *needles*, m.p. 196—198 °C (decomp.) (from hexane–tetrahydrofuran); *m/z* 223 (M^+, 90%) and 195 (100); *M*, 223.2; for u.v. data see Table 4; $\nu_{max.}$ 3 160, 3 030 (NH), 2 140 (C≡C), 1 650, 1 620, 1 605 (C=O, C=C, NH), and 950 cm^{-1} (*trans* C=C); τ (200 MHz) 1.19 (1 H, br d, *J* 11 Hz, NH), 2.44 (1 H, dd, *J* 16 and 7 Hz, $H^{B'}$), 3.17 (1 H, d, *J* 7 Hz, $H^{C'}$), 3.27 (1 H, d, *J* 7 Hz, H^C), 3.82 (1 H, dd, *J* 14 and 11 Hz, H^A), 3.98 (1 H, dd, *J* 14 and 7 Hz, H^B), 4.36 (1 H, d, *J* 16 Hz, $H^{A'}$), 7.76 (3 H, s, CH_3), and 7.85 (3 H, s, CH_3), τ [200 MHz, $(CD_3)_2SO$] − 0.92 (1 H, br s, NH), 2.61 (1 H, dd, *J* 16 and 7 Hz, $H^{B'}$), 3.01 (1 H, d, *J* 7 Hz, $H^{C'}$), 3.11 (1 H, br s, H^C), 3.90—3.94 (2 H, m, H^A and H^B), 4.48 (1 H, d, *J* 15.5 Hz, $H^{A'}$), 7.79 (3 H, s, CH_3), and 7.91 (3 H, s, CH_3) (Found: C, 80.4; H, 6.1; N, 5.9. $C_{15}H_{13}NO$ requires C, 80.7; H, 5.9; N, 6.3%).

2-*Ethoxy*-6,11-*dimethyl*-1-*azacyclotetra*-1,3,5,11,13-*pentaene*-7,9-*diyne* (**5**).—To a stirred solution of the lactam (**17**) (382 mg, 1.71 mmol) in dichloromethane (130 ml) was added dropwise a solution of triethyloxonium tetrafluoroborate (4.87 g, 25.6 mmol) in dichloromethane (20 ml) during 20 min at room temperature under argon. After the mixture had been stirred for 7 h, a further quantity of the oxonium salt (1.60 g) in dichloromethane (10 ml) was added, and stirring was continued overnight at room temperature. The solution was then cooled in an ice-bath, 50% aqueous potassium carbonate (40 ml) was cautiously added and the mixture then poured into water and extracted with dichloromethane. The extract was evaporated and the residue chromatographed on alumina (3.7 × 6.0 cm). The initial fractions eluted with 5% ether in hexane gave the title compound (**5**) (104 mg, 24.1%). It formed red *needles*, m.p. 103—104 °C, from hexane; *m/z* 251 (M^+, 66%) and 194 (100); *M*, 251.3; for u.v. data see Table 3 and Figure 4; $\nu_{max.}$ 2 120 (C≡C), 1 315, 1 050 (–O–), and 965 cm^{-1} (*trans* C=C); τ (200 MHz) 2.19 (1 H, dd, *J* 15.5 and 8 Hz, $H^{B'}$), 2.62 (1 H, d, *J* 8 Hz, H^{C}), 2.70 (1 H, d, *J* 8 Hz, $H^{C'}$, 2.99 (1 H, dd, *J* 13.5 and 8 Hz, H^{B}), 5.40 (2 H, q, *J* 7 Hz, $-CH_2CH_3$), 6.25 (1 H, d, *J* 13.5 Hz, H^{A}), 7.06 (1 H, d, *J* 15.5 Hz, $H^{A'}$), 7.49 (3 H, s, CH_3), 7.54 (3 H, s, CH_3) and 8.51 (3 H, t, *J* 7 Hz, $-CH_2CH_3$), and see also Figure 1; τ (200 MHz, CF_3COOD in $CDCl_3$) 1.69 (1 H, dd, *J* 15.5 and 8 Hz, $H^{B'}$), 2.54 (1 H, d, *J* 8 Hz, H^{C}), 2.66 (1 H, d, *J* 8 Hz, $H^{C'}$), 2.76 (1 H, dd, *J* 13.5 and 8 Hz, H^{B}), 5.15 (2 H, q, *J* 7 Hz, $-CH_2CH_3$), 6.35 (1 H, d, *J* 13.5 Hz, H^{A}), 6.52 (1 H, d, *J* 15.5 Hz, $H^{A'}$), 7.32 (3 H, s, CH_3), 7.52 (3 H, s, CH_3), and 8.32 (3 H, t, *J* 7 Hz, $-CH_2CH_3$) (Found: C, 81.0; H, 6.8; N, 5.5. $C_{17}H_{17}NO$ requires C, 81.2; H, 6.8; N, 5.6%).

The later fractions eluted with benzene–chloroform (1:1) gave the unchanged lactam (**17**) (33 mg).

11-*Methyl*-12,13,14,15-*tetradehydro*-7H-*benzocyclotridecen*-7-*one Oxime* (**19**).—To a stirred solution of the ketone (**18**)[8] (600 mg, 2.46 mmol) in methanol (150 ml) and THF (45 ml) was added in one portion a solution of hydroxylamine hydrochloride (2.60 g, 37.4 mmol) in water (10 ml) at 38 °C, and the mixture was stirred for 7 h at the same temperature before being poured into water. The resulting precipitate was filtered off to afford the oxime (**19**) (278 mg, 44%). It formed yellow *needles*, m.p. 146—147 °C (decomp.), from hexane–chloroform; *m/z* 259 (M^+, 31%) and 240 (100); *M*, 259.2; $\lambda_{max.}$ 227 (ε 26 100), 265sh (32 500), 276 (35 000), 346 (6 700), and 371sh nm (5 300); $\nu_{max.}$ 3 200 (OH), 2 175 (C≡C), and 970 cm^{-1} (*trans* C=C); τ [90 MHz, $(CD_3)_2SO$] −2.00 (1 H, s, OH exchangeable with D_2O), 2.28—2.65 (6 H, m, H^{B}, $H^{B'}$, and Ar-H), 3.00 (1 H, d, *J* 17 Hz, $H^{A'}$), 3.10 (1 H, d, *J* 11.5 Hz, H^{C}), 3.53 (1 H, d, *J* 16.5 Hz, H^{A}), and 8.13 (3 H, s, CH_3) (Found: C, 83.4; H, 5.1; N, 5.4. $C_{18}H_{13}NO$ requires C, 83.4; H, 5.05; N, 5.4%).

12-*Methyl*-13,14,15,16-*Tetradehydro*-8-*azabenzotetradecen*-7(8H)-*one* (**20**).—Phosphorus pentachloride (830 mg, 4.0 mmol) was added in one portion to a stirred solution of the oxime (**19**) (199 mg, 0.77 mmol) in THF (50 ml), and the solution was stirred for 7 h at room temperature. The solution was then poured into water and the stirred mixture warmed on a steam-bath. Aqueous sodium hydrogen carbonate was then added (pH 8), and the mixture extracted with chloroform. The extract was evaporated and the residue chromatographed on alumina (3.7 × 6.0 cm). The fractions eluted with benzene–chloroform (2:3) gave the lactam (**20**) (79.0 mg, 39.8%). It formed yellow *needles*, m.p. 217—218 °C (decomp.); from hexane–THF; *m/z* 259 (M^+, 71%) and 230 (100); *M*, 259.2; for u.v. data see Table 4; $\nu_{max.}$ 3 165, 3 040, 3 005 (NH), 2 170 (C≡C), 1 660, 1 625 (C=O, NH), and 950 cm^{-1} (*trans* C=C); τ [200 MHz, $(CD_3)_2SO$] −0.70 (1 H, br d, *J* 11 Hz, NH), 2.17 (1 H, d, *J* 16 Hz, $H^{B'}$), 2.17 (1 H, d, *J* 8 Hz, 4-H), 2.21 (1 H, d, *J* 7 Hz, 1-H), 2.29—2.47 (2 H, m, 2-H and 3-H), 2.73 (1 H, dd, *J* 14 and 11 Hz, H^{A}), 3.27 (1 H, d, *J* 16 Hz, $H^{A'}$), 3.31 (1 H, d, *J* 7 Hz, H^{C}), 4.12 (1 H, dd, *J* 14 and 7.5 Hz, H^{B}), and 7.98 (3 H, s, CH_3) (Found: C, 83.3; H, 4.9; N, 5.6. $C_{18}H_{13}NO$ requires C, 83.4; H, 5.05; N, 5.4%).

7-*Ethoxy*-12-*methyl*-13,14,15,16-*tetradehydro*-8-*azabenzocyclotetradecene* (**6**).—To a stirred suspension of the lactam (**20**) (98.5 mg, 0.38 mmol) in dichloromethane (80 ml) under argon was added dropwise a solution of triethyloxonium tetrafluoroborate (2.20 g, 11.6 mmol) in dichloromethane (28 ml) during 1 h at 16—18 °C. The solution was stirred for 22 h at the same temperature after which 50% aqueous potassium carbonate (40 ml) was added. The mixture was poured into water and extracted with dichloromethane. The extract was evaporated and the residue was chromatographed on alumina (3.7 × 6.5 cm). The initial fractions eluted with 10% ether in hexane gave the title compound (**6**) (41.0 mg, 37.5%). It formed yellow *needles*, m.p. 163—164 °C, from hexane–benzene; *m/z* 287 (M^+, 67%) and 230 (100); *M*, 287.3; for u.v. data see Table 3; $\nu_{max.}$ 2 160 (C≡C), 1 320, 1 308, 1 060 (–O–), and 970 cm^{-1} (*trans* C=C); τ (200 MHz) 2.11 (1 H, d, *J* 16 Hz, $H^{B'}$), 2.16 (1 H, d, *J* 7 Hz, 4-H), 2.26 (1 H, d, *J* 7.5 Hz, 1-H), 2.37—2.55 (2 H, m, 2-H and 3-H), 3.10 (1 H, d, *J* 6.5 Hz, H^{C}), 3.52 (1 H, dd, *J* 13.5 and 6.5 Hz, H^{B}), 3.84 (1 H, d, *J* 13.5 Hz, H^{A}), 4.46 (1 H, d, *J* 16 Hz, $H^{A'}$), 5.50 (2 H, q, *J* 7 Hz, $-CH_2CH_3$), 7.78 (3 H, s, CH_3), and 8.52 (3 H, t, *J* 7 Hz, $-CH_2CH_3$), and see Figure 1; τ (200 MHz, CF_3COOD in $CDCl_3$) 1.53 (1 H, d, *J* 16 Hz, $H^{B'}$), 1.98—2.24 (4 H, m, ArH), 3.12—3.20 (2 H, m, H^{A} and H^{B}), 4.14 (1 H, d, *J* 16 Hz, $H^{A'}$), 4.16 (1 H, d, *J* 12 Hz, H^{C}), 5.17 (2 H, q, *J* Hz, $-CH_2CH_3$), 7.73 (3 H, s, CH_3), and 8.30 (3 H, t, *J* 7 Hz, $-CH_2CH_3$) (Found: C, 83.3; H, 6.0, N, 5.1. $C_{20}H_{17}NO$ requires C, 83.6; H, 6.0; N, 4.9%).

The later fractions eluted with benzene–chloroform afforded the recovered lactam (**20**) (36.7 mg).

5,10-*Dimethylcyclopentadeca*-2,4,10,12,14-*pentaene*-6,8-*diyn*-*one Oxime* (**22**).—To a stirred solution of the ketone (**21**)[7b] (300 mg, 1.28 mmol) in methanol (66 ml) and THF (17 ml) was added a solution of hydroxylamine hydrochloride (2.25 g, 32.4 mmol) in water (12 ml) in one portion. The solution was stirred for 5.5 h at 38—40 °C after which it was poured into water. The precipitate so formed was filtered off to afford a mixture of the oximes (**22a**) and (**22b**) (5:2) (296 mg, 92.6%). Repeated recrystallization effected separation, and only the isomer (**22a**) was isolated. It formed orange *needles*, m.p. 201—202 °C (decomp.), from hexane–chloroform; *m/z* 249 (M^+, 100%); *M*, 249.3; $\lambda_{max.}$ 262sh (ε 26 700), 276 (35 200), 302 (42 400), and 394sh nm (3 550); $\nu_{max.}$ 3 230 (OH), 2 170 (C≡C), 985, 975, and 925 cm^{-1} (*trans* C=C); τ [90 MHz, $(CD_3)_2SO$] −1.66 (1 H, s, OH exchangeable with D_2O), 2.68—3.82 (8 H, m, olefinic H), and 8.08 (3 H, s, CH_3) (Found: C, 81.7; H, 5.9; N, 5.5. $C_{17}H_{15}NO$ requires C, 81.9; H, 6.1; N, 5.6%).

6,11-*Dimethyl*-1-*azacyclohexadeca*-3,5,11,13,15-*pentaene*-7,9-*diyn*-2-*one* (**23**).—A solution of phosphorus pentachloride (1.79 g, 8.60 mmol) in THF (100 ml) was added dropwise to a stirred solution of the mixture of the oximes (**22a**) and (**22b**) (307 mg, 1.23 mmol) in THF (100 ml) during 30 min at −10 °C and stirring was continued for 5 h at room temperature. The solution was then poured into water and mixed with aqueous sodium hydrogen carbonate (pH 8). The reaction mixture was extracted with chloroform and the extract evaporated to provide a residue which was chromatographed on alumina (3.7 × 8.0 cm). The fractions eluted with 5% chloroform in benzene afforded the lactam (**23**) (127 mg, 41.3%). It formed brown *needles*, m.p. 138—140 °C (decomp.), from hexane–benzene; *m/z* 249 (M^+, 100%); *M*, 249.3; for u.v. data see Table 4; $\nu_{max.}$ 3 270 (NH), 2 180 (C≡C), 1 650, 1 625, 1 615 (C=O, C=C, NH), and 975 cm^{-1} (*trans* C=C); τ (200 MHz) −0.69 (1 H, d, *J* 11

Hz, NH), 0.26 (1 H, dd, *J* 16.5 and 10 Hz, H^B), 1.74 (1 H, dd, *J* 16 and 9.5 Hz, $H^{C'}$), 2.82 (1 H, dd, *J* 16 and 9 Hz, $H^{D'}$), 3.66 (1 H, dd, *J* 11 and 9.5 Hz, $H^{A'}$), 3.94 (1 H, d, *J* 11 Hz, H^C), 3.96 (1 H, d, *J* 16.5 Hz, H^A), 4.19 (1 H, d, *J* 9 Hz, $H^{E'}$), 5.24 (1 H, t, *J* 9.5 Hz, $H^{B'}$), 8.30 (3 H, s, CH_3), and 8.32 (3 H, s, CH_3) (Found: C, 81.9; H, 6.1; N, 5.6. $C_{17}H_{15}NO$ requires C, 81.9; H, 6.1; N, 5.6%).

2-*Ethoxy*-1-*azacyclohexadec*-1,3,5,11,13,15-*hexaene*-7,9-*diyne* (**8**).—To a stirred solution of triethyloxonium tetrafluoroborate (6.27 g, 33.0 mmol) in dichloromethane (50 ml) under argon was added a solution of the lactam (**23**) (328 mg, 1.32 mmol) in dichloromethane (40 ml) during 1 h at room temperature. The mixture was stirred for 6 h, after which a further quantity of the oxonium salt (2.51 g) in dichloromethane (10 ml) was added; the solution was then stirred at the same temperature overnight. The solution was cooled in an ice-bath and 50% aqueous potassium carbonate (40 ml) was cautiously added. The mixture was then poured into water and extracted with dichloromethane. The extract was evaporated and the residue chromatographed on alumina (3.7 × 6.5 cm). The initial fractions eluted with 5% ether in hexane afforded the title compound (**8**) (141 mg, 38.4%). It formed purple *needles*, m.p. 115—116 °C, from hexane; *m/z* 277 (M^+, 85%) and 248 (100); *M*, 277.3; for u.v. data see Table 3 and Figure 4; $\nu_{max.}$ 2 190, 2 120 (C≡C), 1 310, 1 295, 1 030 (–O–), and 975 cm^{-1} (*trans* C=C); τ (400 MHz) −0.14 (1 H, dd, *J* 16 and 11 Hz, H^B), 0.60 (1 H, d, *J* 13 Hz, $H^{A'}$), 0.63 (1 H, dd, *J* 15.5 and 11 Hz, $H^{C'}$), 4.11 (1 H, d, *J* 11 Hz, H^C), 4.12 (1 H, d, *J* 6Hz, $H^{E'}$), 4.25 (1 H, dd, *J* 16 and 6 Hz, $H^{D'}$), 4.27 (1 H, dd, *J* 13 and 11 Hz, $H^{B'}$), 4.61 (1 H, d, *J* 16 Hz, H^A), 6.00 (2 H, q, *J* 8 Hz, $-CH_2CH_3$), 8.33 (3 H, s, CH_3), 8.38 (3 H, s, CH_3), and 8.78 (3 H, t, *J* 7 Hz, $-CH_2CH_3$), and see also Figure 2, τ (200 MHz, CF_3CO_2D in $CDCl_3$) −0.53 (1 H, dd, *J* 16 and 11 Hz, H^B), 1.02 (1 H, d, *J* 13.5 Hz, $H^{A'}$), 1.14 (1 H, dd, *J* 15.5 and 11 Hz, $H^{C'}$), 3.66 (1 H, dd, *J* 16 and 6 Hz, $H^{D'}$), 3.87 (1 H, dd, *J* 13.5 and 11 Hz, $H^{B'}$), 3.96 (1 H, d, *J* 11 Hz, H^C), 4.01 (1 H, d, *J* 16 Hz, H^A), 4.02 (1 H, d, *J* 16 Hz, $H^{E'}$), 5.61 (2 H, q, *J* 7 Hz, CH_2CH_3), 8.19 (3 H, s, CH_3), 8.35 (3 H, s, CH_3), and 8.59 (3 H, t, *J* 7 Hz, CH_2CH_3) (Found: C, 82.5; H, 7.0; N, 4.9. $C_{19}H_{19}NO$ requires C, 82.3; H, 6.9; N, 5.05%).

The later fractions eluted with 5% ethanol in chloroform gave the recovered lactam (**23**) (25.7 mg).

7,12-*Dimethylcycloheptadeca*-2,4,6,12,14,16-*hexaene*-8,10-*diynone Oxime* (**25**).—To a stirred solution of the ketone (**24**) [7b] (749 mg, 2.88 mmol) in methanol (150 ml) and THF (70 ml) was added in one portion a solution of hydroxylamine hydrochloride (5.80 g, 83.5 mmol) in water (30 ml) at 38 °C. The mixture was stirred for 6.5 h at the same temperature after which it was poured into water. The resulting precipitates was filtered off to afford the oxime (**25**) (492 mg, 88%). It formed orange *cubes*, m.p. 196—198 °C (decomp.), from hexane–chloroform; *m/z* 275 (M^+, 100%); *M*, 275.3; $\lambda_{max.}$ 216 (ε 20 300), 301 (48 100), and 384sh nm (8 600); $\nu_{max.}$ 3 200 (OH), 2 170 (C≡C), and 995 cm^{-1} (*trans* C=C); τ [90 MHz, $(CD_3)_2SO$] 2.86—3.47 (8 H, m, olefinic H), 3.56 (1 H, d, *J* 16 Hz, $H^{A'}$), 3.88 (1 H, d, *J* 16 Hz, H^A), and 8.12 (6 H, s, CH_3); the peak due to hydroxy proton could not be detected (Found: C, 82.6; H, 6.2; N, 4.8. $C_{19}H_{17}NO$ requires C, 82.9; H, 6.2; N, 5.1%).

8,13-*Dimethyl*-1-*azacyclo-octadeca*-3,5,7,13,15,17-*hexaene*-9,11-*diynone* (**26**).—A solution of phosphorus pentachloride (1.50 g, 7.20 mmol) in THF (80 ml) was added dropwise to a stirred solution of the oxime (**25**) (270 mg, 0.981 mmol) in THF (100 ml) during 30 min at −10 °C and stirring was continued for 5.5 h at room temperature. The solution was then poured into water, aqueous sodium hydrogen carbonate added (pH 8), and the mixture extracted with chloroform. The extract was evaporated and the residue chromatographed on alumina (3.7 × 7.5 cm). The initial fractions eluted with benzene afforded the lactam (**26**) (117 mg, 43%). It formed dark brown *needles*, m.p. 189—190 °C (decomp.), from hexane–benzene; *m/z* 275 (M^+, 100%); *M*, 275,3; for u.v. data see Table 4; $\nu_{max.}$ 3 280 (NH), 2 160 (C≡C), 1 655, 1 625, 1 580 (C=O, C=C, NH), and 975 cm^{-1} (*trans* C=C); τ (200 MHz) 2.19 (1 H, dd, *J* 15 and 6 Hz, H^B), 2.44 (1 H, dd, *J* 12 and 9.5 Hz, $H^{A'}$), 2.79 (1 H, d, *J* 12 Hz, H^E), 2.96 (1 H, d, *J* 10.5 Hz, $H^{E'}$), 3.18 (1 H, dd, *J* 15.5 and 5.5 Hz, H^C), 3.25 (1 H, dd, *J* 16 and 8 Hz, $H^{C'}$), 4.32 (1 H, t, *J* 8.5 Hz, $H^{B'}$), 4.56 (1 H, d, *J* 12 Hz, NH), 4.82 (1 H, dd, *J* 15.5 and 11.5 Hz, H^D), 5.65 (1 H, dd, *J* 16.5 and 10.5 Hz, $H^{D'}$), 5.84 (1 H, d, *J* 16 Hz, H^A), 7.68 (3 H, s, CH_3), and 7.74 (3 H, s, CH_3) (Found: C, 82.8; H, 5.9; N, 5.2. $C_{19}H_{17}NO$ requires C, 82.9; H, 6.2; N, 5.1%).

The later fractions eluted with benzene–chloroform afforded a dark brown solid. It showed very similar i.r., u.v., and mass spectra to those of the lactam (**26**), but because of instability its structure could not be determined.

2-*Ethoxy*-8,13-*dimethyl*-1-*azacyclo-octadeca*-1,3,5,7,13,15,17-*heptaene*-9,11-*diyne* (**9**).—A suspension of the lactam (**26**) (208 mg, 0.754 mmol) in dichloromethane (40 ml) was added dropwise to a solution of triethyloxonium tetrafluoroborate (5.34 g, 28.1 mmol) in dichloromethane (50 ml) under argon during 40 min at room temperature, and the solution was stirred overnight. A further quantity of the oxonium salt (1.20 g) in dichloromethane (20 ml) was then added and stirring continued for a further 7 h at room temperature. The solution was then cooled in an ice-bath and 50% aqueous potassium carbonate added cautiously. The mixture was then poured into water and extracted with dichloromethane. The extract was evaporated and the residue chromatographed on alumina (3.7 × 7.0 cm). The initial fractions eluted with 10% ether in hexane afforded the title compound (**9**) (25.9 mg, 11.3%). It formed brown *needles*, m.p. 138—140 °C, from hexane; *m/z* 303 (M^+, 96%) and 244 (100); *M*, 303.3; for u.v. data see Table 3 and Figure 4; $\nu_{max.}$ 2 145 (C≡C), 1 310, 1 055 (–O–), and 960 cm^{-1} (*trans* C=C); τ (200 MHz) 2.14 (1 H, dd, *J* 15.5 and 7 Hz, $H^{B'}$), 2.44 (2 H, d, *J* 11.5 Hz, H^E and $H^{E'}$), 2.72 (1 H, dd, *J* 15 and 6 Hz, H^C), 2.76 (1 H, dd, *J* 15.5 and 7 Hz, $H^{C'}$), 2.96 (1 H, dd, *J* 13 and 6.5 Hz, H^B), 5.40 (2 H, q, *J* 7 Hz, CH_2CH_3), 5.85 (1 H, d, *J* 13 Hz, H^A), 6.44 (1 H, dd, *J* 15.5 and 11.5 Hz, $H^{D'}$), 6.65 (1 H, dd, *J* 15.5 and 11.5 Hz, H^D), 6.74 (1 H, d, *J* 15.5 Hz, $H^{A'}$), 7.52 (3 H, s, CH_3), 7.56 (3 H, s, CH_3), and 8.50 (3 H, t, *J* 7 Hz, $-CH_2CH_3$), and see Figure 3; τ (200 MHz, CF_3CO_2D in $CDCl_3$) 1.48 (1 H, dd, *J* 15 and 7 Hz, $H^{B'}$), 2.28 (1 H, d, *J* 12 Hz, H^E), 2.35 (1 H, d, *J* 12 Hz, $H^{E'}$), 2.58 (1 H, dd, *J* 14 and 6.5 Hz, H^B), 2.63 (1 H, dd, *J* 15.5 and 7 Hz, H^C), 2.79 (1 H, dd, *J* 15.5 and 7 Hz, $H^{C'}$), 5.11 (2 H, q, *J* 7 Hz, CH_2CH_3), 6.16 (1 H, dd, *J* 15.5 and 12 Hz, $H^{D'}$), 6.52 (1 H, d, *J* 14 Hz, H^A), 6.64 (1 H, dd, *J* 16 and 11.5 Hz, H^D), 6.84 (1 H, d, *J* 15 Hz, $H^{A'}$), 7.42 (3 H, s, CH_3), 7.51 (3 H, s, CH_3), and 8.30 (3 H, t, *J* 7 Hz, CH_2CH_3) (Found: C, 83.2; H, 7.0; N, 4.6. $C_{21}H_{21}NO$ requires C, 83.1; H, 7.0; N, 4.6%).

The later fractions eluted with benzene afforded the recovered lactam (**26**) (42.1 mg).

9,14-*Dimethylcyclononadeca*-2,4,6,8,14,16,18-*heptaene*-10,12-*diynone* (**28**).—A solution of hydroxylamine hydrochloride (1.68 g, 24.2 mmol) in water (8 ml) was added in one portion to a solution of the ketone (**27**) [7b] (347 mg, 1.21 mmol) in methanol (80 ml) and THF (20 ml) at room temperature. The mixture was stirred for 24 h, after which a further quantity of hydroxylamine hydrochloride (1.0 g) in water (5 ml) was added and stirring was continued for a further 24 h at room temperature. The solution was then poured into aqueous sodium hydrogen carbonate and the mixture extracted with chloroform. The extract was evaporated and the residue chromatographed on alumina (3.7 × 6.0 cm). The fractions eluted with chloroform afforded a

mixture of the oximes (**28a**) and (**28b**) (1:1) (152 mg, 42%). Repeated recrystallization gave a mixture of (**28a**) and (**28b**), enriched with the former (2:1). It formed orange *microcrystals*, m.p. 164—166 °C (decomp.), from hexane–chloroform; *m/z* 301 (M^+, 20%) and 206 (100); *M*, 301.3; $\lambda_{max.}$ 300sh (ε 32 500), 330 (50 400), and 440sh nm (3 280); $\nu_{max.}$ 3 220 (OH), 2 170 (C≡C), 990, and 965 cm^{-1} (*trans* C=C); τ [90 MHz, $(CD_3)_2SO$] −1.37 and −1.16 (1 H, both s, OH, 2:1, exchangeable with D_2O), 3.03—3.55 (12 H, m, olefinic H), and 8.05 (6 H, s, CH_3) (Found: C, 83.5; H, 6.1; N, 4.7. $C_{21}H_{19}NO$ requires C, 83.7; H, 6.35; N, 4.65%).

8,13-*Dimethyl*-1-*azacycloicosa*-3,5,7,13,15,17,19-*heptaene*-9,11-*diyn*-2-*one* (**29**).—A solution of phosphorus pentachloride (1.18 g, 5.69 mmol) in THF (80 mol) was added dropwise to a stirred solution of the oximes (**28a**) and (**28b**) (204 mg, 0.678 mmol) in THF (80 ml) during 30 min at −9 °C, and stirring was continued for 4 h at room temperature. The mixture was then poured into water and aqueous sodium hydrogen carbonate was added (pH 8). The mixture was extracted with chloroform, the extract evaporated, and the residue chromatographed on alumina (3.7 × 7.0 cm). The initial fractions eluted with 20% chloroform in benzene gave the lactam (**29**) (140 mg, 68.4%). It formed dark brown *cubes*, m.p. 188—190 °C (decomp.), from hexane–benzene; *m/z* 301 (M^+, 100%); *M*, 301.3; for u.v. data see Table 4; $\nu_{max.}$ 3 300 (NH), 2 180 (C≡C), 1 650, 1 630, 1 610, 1 595 (C=O, C=C, NH), and 985 cm^{-1} (*trans* C=C); τ (200 MHz) −0.05 (1 H, d, *J* 11.5 Hz, NH), 0.90 (1 H, dd, *J* 15 and 11.5 Hz, H^D), 1.21 (1 H, dd, *J* 15 and 11.3 Hz, $H^{F'}$), 1.44 (1 H, dd, *J* 16.5 and 10.3 Hz, H^B), 2.83 (1 H, dd, *J* 16.3 and 8.6 Hz, $H^{D'}$), 3.04 (1 H, dd, *J* 16.3 and 8.6 Hz, $H^{C'}$), 3.52 (1 H, dd, *J* 11.3 and 9.5 Hz, $H^{A'}$), 3.88 (1 H, s, *J* 11.2 Hz, H^E), 3.97 (1 H, d, *J* 11.5 Hz, $H^{G'}$), 4.15 (1 H, d, *J* 16.6 Hz, H^A), 4.15 (1 H, dd, *J* 15 and 10 Hz, H^C), 4.23 (1 H, dd, *J* 15 and 8.3 Hz, $H^{E'}$), 5.15 (1 H, t, *J* 9 Hz, $H^{B'}$), 8.28 (3 H, s, CH_3), and 8.29 (3 H, s, CH_3) (Found: C, 83.95; H, 6.8; N, 4.5. $C_{21}H_{19}NO$ requires C, 83.7; H, 6.35; N, 65%).

The later fractions eluted with chloroform gave brown microcrystalline compound (40.9 mg), the i.r., mass, and u.v. spectra of which were very similar to those of the lactam (**29**); its instability however, prevented the determination of the structure.

2-*Ethoxy*-8,13-*dimethyl*-1-*azacycloicosan*-1,3,5,7,13,15,17,19-*octaen*-9,11-*diyne* (**10**).—A solution of the lactam (**29**) (420 mg, 1.39 mmol) in dichloromethane (40 ml) was added to a solution of triethyloxonium tetrafluoroborate (1.32 g, 6.95 mmol) in dichloromethane (30 ml) under argon during 1 h at room temperature and stirring was continued for 30 h at the same temperature. 50% Aqueous potassium carbonate (40 ml) was added to the solution and the mixture was poured into water and extracted with dichloromethane. The extract was evaporated and the residue chromatographed on alumina (3.7 × 8.0 cm). The fractions eluted with 5% ether in hexane gave the title compounds (**10**) (17.0 mg, 3.7%). It formed dark brown *cubes*, m.p. 140—142 °C, from hexane–benzene; *m/z* 329.1782 (M^+ requires 329.1780); for u.v. data see Table 3 and Figure 4; $\nu_{max.}$ 2 180 (C≡C), 1 260, 1 035 (–O–), 980, and 960 cm^{-1} (*trans* C=C); τ (200 MHz) 0.86 (1 H, d, *J* 13.5 Hz, $H^{A'}$), 0.90 (2 H, dd, *J* 15 and 11 Hz, H^D and $H^{F'}$), 1.01 (1 H, dd, *J* 16 and 10 Hz, H^B), 1.65 (1 H, dd, *J* 15 and 11 Hz, $H^{C'}$), 3.86—4.36 (4 H, m, $H^{B'}$, H^C, $H^{D'}$, and $H^{E'}$), 4.02 (2 H, d, *J* 10 Hz, H^E and $H^{G'}$), 5.50 (1 H, d, *J* 16 Hz, H^A), 6.01 (2 H, q, *J* 7 Hz, $-CH_2CH_3$), 8.32 (3 H, s, CH_3), 8.36 (3 H, s, CH_3), and 8.79 (3 H, t, *J* 7 Hz, $-CH_2CH_3$), and see Figure 2.

The later fractions eluted with 5% ethanol in chloroform gave the recovered lactam (**29**) (29.8 mg).

2,9,14-*Trimethylcyclohenicosa*-2,4,6,8,14,16,18,20-*octaene*-10,12-*diynone Oxime* (**31**).—A solution of hydroxylamine hydrochloride (0.928 g, 13.6 mmol) in water (5 ml) was added in one portion to a solution of the ketone (**30**)[11] (218 mg, 0.668 mmol) in methanol (70 ml) and THF (20 ml) at room temperature. The mixture was stirred for 24 h after which further hydroxylamine hydrochloride (0.464 g) in water (4 ml) was added. The mixture was stirred for a further 5 days at room temperature and then poured into aqueous sodium hydrogen carbonate, and extracted with chloroform. The extract was evaporated and the residue chromatographed on alumina (4.5 × 5.0 cm). The fractions eluted with 5% ethanol in chloroform gave the oxime (**31**) (127 mg, 55.6%). It formed orange *microcrystals*, m.p. 180—182 °C (decomp.), from hexane–chloroform; *m/z* 341 (M^+, 100%); *M*, 341.4; $\lambda_{max.}$ 335 (ε 9 040), 357sh (10 500), 310sh (45 600), 333sh (61 200), 341 (62 300), and 432sh nm (7 040); $\nu_{max.}$ 3 250 (OH), 2 180 (C≡C), 990, 975, and 950 cm^{-1} (*trans* C=C); τ [90 MHz, $(CD_3)_2SO$] −1.37 (1 H, s, OH exchangeable with D_2O), *ca.* 2.84—3.72 (13 H, m, olefinic H), 8.03 (3 H, s, CH_3), and 8.09 (3 H, s, CH_3) (Found: C, 84.2; H, 6.7; N, 4.1. $C_{24}H_{23}NO$ requires C, 84.4; H, 6.8; N, 4.1%).

10,15,22-*Trimethyl*-1-*azacyclodocosa*-3,5,7,9,15,17,19,21-*octaene*-11,13-*diyn*-2-*one* (**32**).—A solution of phosphorus pentachloride (1.35 g, 6.49 mmol) in THF (80 ml) was added dropwise to a stirred solution of the oxime (**31**) (277 mg, 0.811 mmol) in THF (80 ml) during 1 h at −9 °C, and stirring was continued for 3.5 h at room temperature. The solution was then poured into water and aqueous sodium hydrogen carbonate was added (pH 8). The mixture was extracted with chloroform and the extract evaporated and the residue chromatographed on alumina (3.7 × 7.5 cm). The fractions eluted with benzene gave the lactam (**32**) (86 mg, 31%). It formed brown *needles*, m.p. 196—198 °C (decomp.), from hexane–benzene; *m/z* 341 (M^+, 87%) and 215 (100); *M*, 341.4; for u.v. data see Table 4; $\nu_{max.}$ 3 280 (NH), 2 170 (C≡C), 1 660, 1 630, 1 605, 1 570 (C=O, C=C, NH), and 990 cm^{-1} (*trans* C=C); τ (200 MHz) 2.33 (1 H, dd, *J* 14.5 and 9.5 Hz, H^B), 3.06 (1 H, d, *J* 11.5 Hz, $H^{G'}$), 3.15 (1 H, d, *J* 11.5 Hz, H^G), 3.18 (1 H, dd, *J* 14.5 and 11.5 Hz, $H^{E'}$), 3.28 (1 H, dd, *J* 16.5 and 7.5 Hz, H^E), 3.62 (2 H, dd, *J* 15.5 and 7.5 Hz, $H^{C'}$ and H^D), 3.95 (1 H, dd, *J* 15 and 9 Hz, H^C), 4.02 (1 H, br s, NH), 4.25 (1 H, dd, *J* 15 and 11 Hz, $H^{D'}$), 4.63 (1 H, d, *J* 7.5 Hz, $H^{B'}$), 4.70 (1 H, dd, *J* 14.5 and 11.5 Hz, $H^{F'}$), 4.82 (1 H, dd, *J* 16.5 and 10 Hz, H^F), 5.20 (1 H, d, *J* 15 Hz, H^A), 7.41 (3 H, s, CH_3), 7.81 (3 H, s, CH_3), and 7.84 (3 H, s, CH_3) (Found: C, 84.7; H, 6.8; N, 3.9. $C_{24}H_{23}NO$ requires C, 84.4; H, 6.8; N, 4.1%).

2-*Ethoxy*-10,15,22-*trimethyl*-1-*azadocosa*-1,3,5,7,9,15,17,19,-21-*nonaen*-11,13-*diyne* (**11**).—A solution of the lactam (**32**) (270 mg, 0.791 mmol) in dichloromethane (35 ml) was added dropwise under argon to a stirred solution of triethyloxonium tetrafluoroborate (4.50 g, 23.7 mmol) in dichloromethane (40 ml) during 1 h at room temperature and stirring was continued overnight. 50% Aqueous potassium carbonate (40 ml) was added to the mixture which was poured into water and extracted with dichloromethane. The extract was evaporated and the residue chromatographed on alumina (3.7 × 7.0 cm). The initial fractions eluted with 8% ether in hexane gave a yellow liquid, which was further purified by preparative thin layer chromatography. The fast-moving coloured band on evaporation afforded the title compound (**11**) (8.6 mg, 2.94%) as a solid. It formed dark brown *cubes*, m.p. 152—154 °C, from hexane; *m/z* 369.2049 (M^+ requires 369.2090); for u.v. data see Table 3 and Figure 4; $\nu_{max.}$ 2 170 (C≡C), 1 270, 1 060 (–O–), and 990 cm^{-1} (*trans* C=C); τ (200 MHz) 2.67 (1 H, dd, *J* 15 and 8 Hz, H^B), 2.99—3.28 (5 H, m, $H^{C'}$, H^E, $H^{E'}$, H^G, and $H^{G'}$), 3.76 (1 H, dd, *J* 15 and 7.5 Hz, H^C), 4.21 (1 H, dd, *J* 15.5 and 9.5 Hz, H^D), 4.45 (1 H, dd, *J* 16 and 12 Hz, H^F or $H^{F'}$), 4.52 (1 H, d, *J* 15.5 Hz, H^A), 4.52 (1 H, dd, *J* 15 and 10.5 Hz, H^F or $H^{F'}$), 4.85 (1 H, dd, *J*

14.5 and 10.5 Hz, $H^{D'}$), 5.52 (1 H, d, *J* 10.5 Hz, $H^{B'}$), 5.74 (2 H, q, *J* 7 Hz, CH_2CH_3), 7.85 (3 H, s, CH_3), 7.90 (3 H, s, CH_3), 8.05 (3 H, s, CH_3), and 8.63 (3 H, t, *J* 7 Hz, CH_2CH_3), and see Figure 3.

2,9,14-*Trimethylcyclotricosa*-2,4,6,8,14,16,18,20,22-*nonaene*-10,12-*diynone Oxime* (**34**).—A solution of hydroxylamine hydrochloride (1.0 g, 14.4 mmol) in water (5 ml) was added in one portion to a stirred solution of the ketone (**33**)[7c] (83.0 mg, 0.235 mmol) in methanol (40 ml) and THF (20 ml) at room temperature. The mixture was stirred for 5 days at 20—40 °C, after which a further quantity of hydroxylamine hydrochloride (1.0 g) in water (5 ml) was added and stirring continued for a further 5 days at the same temperature. The mixture was poured into aqueous sodium hydrogen carbonate extracted with chloroform, and the extract evaporated. The resulting residue was chromatographed on alumina (3.7 × 5.5 cm). The early fractions eluted with benzene gave unchanged starting material (**33**) (7.2 mg). The later fractions eluted with chloroform gave the oxime (**34**) (39.6 mg, 45.9%). It formed red *needles*, m.p. 170—172 °C (decomp.), from hexane–chloroform; *m/z* 367 (M^+, 79%) and 334 (100); *M*, 367.4; $\lambda_{max.}$ 260 (ε 14 400), 276sh (13 000), 320sh (32 800), 362 (82 200), and 456sh nm (4 470); $\nu_{max.}$ 3 250 (OH), 2 170 (C≡C), 985 and 940 cm^{-1} (*trans* C=C); τ [90 MHz, $(CD_3)_2SO$] −1.35 (1 H, s, OH exchangeable with D_2O), *ca.* 3.1—3.8 (15 H, m, olefinic H), and 8.02 (9 H, s, CH_3) (Found: C, 85.1; H, 6.95; N, 3.8. $C_{26}H_{25}NO$ requires C, 85.0; H, 6.9; N, 3.8%).

3,10,15-*Trimethyl*-1-*azacyclotetracosa*-3,5,7,9,15,17,19,21,23-*nonaene*-11,13-*diyn*-2-*one* (**35**).—A solution of phosphorus pentachloride (1.08 g, 5.19 mmol) in THF (80 ml) was added dropwise to a stirred solution of the oxime (**34**) (277 mg, 0.811 mmol) in THF (50 ml) during 30 min at −8 °C and stirring was continued for 5 h at room temperature. The solution was poured into water and then aqueous sodium hydrogen carbonate was added (pH 8). The mixture was extracted with chloroform and the extract evaporated to afford a residue which was chromatographed on alumina (3.7 × 8.5 cm). The fractions eluted with benzene–chloroform (2:3) gave a dark red liquid, which was further purified by preparative t.l.c. The fast-moving, brown band on evaporation afforded the lactam (**35**) (7.50 mg, 2.74%). It formed dark brown *cubes*, m.p. 188—190 °C (decomp.), from hexane–benzene; *m/z* 367.1793; (M^+ requires 367.1934); for u.v. data see Table 4; $\nu_{max.}$ 3 320 (NH), 2 190 (C≡C), 1 670, 1 635, 1 600 (C=O, C=C, NH), and 995 cm^{-1} (*trans* C=C); τ (200 MHz) 0.71 (1 H, d, *J* 11 Hz, NH), 1.76 (1 H, dd, *J* 15.5 and 10.5 Hz, H^F), 1.97 (1 H, dd, *J* 15.5 and 11.5 Hz, $H^{H'}$), 2.08 (1 H, d, *J* 11 Hz, H^B), 2.21 (1 H, dd, *J* 15 and 10 Hz, H^D), 2.40 (1 H, dd, *J* 15 and 10.5 Hz, $H^{F'}$), 3.03 (1 H, dd, *J* 15.5 and 10.5 Hz, $H^{C'}$), 3.40 (1 H, dd, *J* 16 and 7.5 Hz, $H^{D'}$), 3.42 (1 H, dd, *J* 11 and 9 Hz, $H^{A'}$), 3.76—4.10 (6 H, m, H^C, H^E, H^G, $H^{E'}$, $H^{G'}$, and $H^{I'}$), 4.99 (1 H, t, *J* 9.5 Hz, $H^{B'}$), 8.13 (3 H, s CH_3), and 8.22 (3 H, s, CH_3).

The later fractions eluted with 5% ethanol in chloroform gave the unchanged oxime (**34**) (80.5 mg).

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