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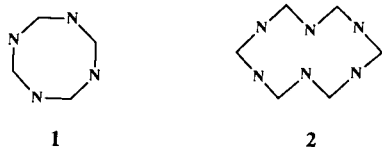
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The dimerization of the hydroxypyrrolidinones **5** and **9** yield the tetrazocines **8** and **11**. In addition, in the case of compound **9**, the ring-fused hexaazacyclododecane **12** was isolated. X-ray diffraction analysis of compound **11** verified the dimeric structure of these products.

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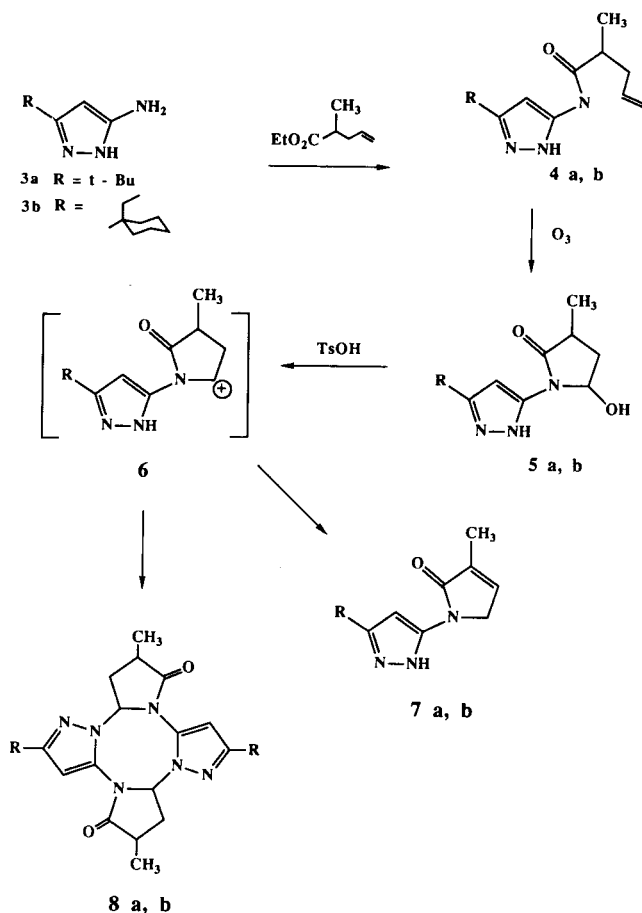
In a recent study of *N*-pyrazolyl-5-hydroxypyrrolidinones, **5**, we discovered an interesting product formed when these compounds were treated with acid. The compounds formed were highly substituted tetrazocines, **1** and hexaazacyclododecanes, **2**. In this paper we will describe the formation and identification of these compounds formed via their iminium ion intermediates.



Previous work by Speckamp and others [1] has shown that iminium ions are very useful in the synthesis of substituted pyrrolidinones by the addition of nucleophiles to the iminium ion. In addition, they have shown their utility in the preparation of medium and large ring compounds *via* trapping of internal nucleophiles such as olefins, acetylenes or aromatic rings. In our case, we were interested in the dehydration of the *N*-pyrazolyl-5-hydroxypyrrolidinones, **5**, to the corresponding unsaturated compounds, the Δ -3,4-pyrrolidinones, **7**. What we discovered was that accompanying the desired dehydration to **7**, there occurred the dimerization of the intermediate iminium ion, **6**, to the tetrazocine. Although previous work by Speckamp [2] has shown that dimerizations can occur at the 4-position of the pyrrolidinone ring, no dimerizations of the type we report here have been published to our knowledge.

The requisite 5-hydroxypyrrolidinones, **5**, were synthesized in a straightforward manner. Condensation of 3-*t*-butyl-5-aminopyrazole [3] **3a** with ethyl 2-methyl-4-pentenoate [4] in the presence of a base (sodium methoxide, tetrahydrofuran, reflux, 50-75%) gave the desired *N*-(3-*t*-butyl-1*H*-pyrazol-5-yl)-2-methyl-4-pentenamamide, **4a**. Subsequent ozonolysis of amide **4a** (ozone, dimethyl sulfide, -15 to -25°, 30-55%) yielded the 1-(3-*t*-butyl-1*H*-pyrazol-5-yl)-5-hydroxy-3-methyl-2-pyrrolidinone, **5a**. No open chain aldehyde was seen in these cases. Treatment of compound **5a** with a catalytic amount of *p*-toluenesulfonic acid (toluene, reflux, 1 hour) gave, in addition to unreacted **5a**, two products. After chromatography and

Scheme I



crystallization, the first product isolated was a white solid (mp 190-193°) obtained in 39% yield and was identified by 250 MHz proton nmr, electron impact mass spectrometry and field desorption mass spectrometry (*m/e* 438) to be the 8-membered ring compound 2,10-di-*t*-butyl-6,14-dimethyl-6,7,14,15-tetrahydro-7*aH*,15*aH*-dipyrzolo[1,5-*a*:1',5'-*e*]dipyrrolo-[1'',5''-*c*:1''',5'''-*g*][1,3,5,7]tetrazocine-5,13-dione, **8a**. Initially, a structure was difficult to assign to this product. The first substantial evidence for a dimeric structure was the field desorption mass spectrum showing a molecular ion at 438. The 250 MHz proton nmr and carbon-13 nmr confirmed these results. Attempts to obtain suitable crystals for an X-ray crystallographic analysis, however,

were unsuccessful. In addition to the 8-membered ring compound, **8a**, 1-(3-*t*-butyl-1*H*-pyrazol-5-yl)-3-methyl- Δ^3 -pyrrolin-2-one, **7a**, was isolated in 30% yield.

This sequence of reactions was repeated with the 3-amino-5-(1-ethylcyclohexyl)-1*H*-pyrazole. As depicted in Scheme I, these reactions led to 1-[3-(1-ethylcyclohexyl)-1*H*-pyrazol-5-yl]-5-hydroxy-3-methyl-2-pyrrolidinone, **5b**. In a similar manner, compound **5b** was treated with a catalytic amount of *p*-toluenesulfonic acid (toluene, reflux, 1 hour) to give two major products. After chromatography and crystallization, 1-[3-(1-ethylcyclohexyl)-1*H*-pyrazol-5-yl]-3-methyl- Δ^3 -pyrrolin-2-one, **7b** (mp 187-189°) was obtained in 28% yield and 2,10-di(1-ethylcyclohexyl)-1*H*-6,14-dimethyl-6,7,14,15-tetrahydro-7*aH*,15*aH*-dipyrazolo-[1,5-*a*:1',5'-*e*]dipyrrolo[1'',5''-*c*:1''',5'''-*g*] [1,3,5,7]tetrazocine-5,13-dione, **8b**, was obtained in 25% yield (mp 152-154°). Both compounds were identified by 250 MHz proton nmr and mass spectrometry (FD *m/e* 546 for **8b**) as was the case above. Again, no suitable crystals of **8b** could be obtained for X-ray analysis.

In an attempt to obtain suitable crystals, we undertook the synthesis of the less substituted pyrrolidinone, 1-(3-*t*-butyl-1*H*-pyrazol-5-yl)-5-hydroxy-2-pyrrolidinone, **9**. The above sequence was again repeated using ethyl 4-pentenoate instead of ethyl 2-methyl-4-pentenoate (Scheme II). Subsequent ozonolysis provided hydroxypyrrolidinone **9**. Treatment of compound **9** with a catalytic amount of *p*-toluenesulfonic acid (toluene, reflux, 1 hour) gave three products. The major product was the unsaturated pyrrolidinone 1-(3-*t*-butyl-1*H*-pyrazol-5-yl)- Δ^3 -pyrrolin-2-one, **10** (57%). The second product was the 8-membered ring compound 2,10-di-*t*-butyl-7,7*a*,15,15*a*-tetrahydrodipyrazolo-[1,5-*a*:1',5'-*e*]dipyrrolo[1'',2''-*c*:1''',2'''-*g*] [1,3,5,7]tetrazocine-5,13-(6*H*,14*H*)dione, **11** (mp 272-274°, 28% yield). This was identified by 250 MHz proton nmr and mass spectrometry (FD *m/e* 410). In this case a suitable crystal was obtained and ORTEP plot of the X-ray analysis is shown in Figure 1. The third product isolated in 10% yield (mp 325°) was a white crystalline material which by 250 MHz proton nmr and mass spectrometry (FD-technique, *m/e* 618) was assigned the 12-membered ring 2,10,18-tri-*t*-butyl-6,7,14,15,22,23-hexahydrotripyrzolo-[1,5-*a*:1',5'-*e*:1'',5''-*i*]tripyrrolo[1''',5'''-*c*:1''''',5''''-*g*:1''''',5''''-*k*] [1,3,5,7,9,11]hexaazacyclododecane-5,13,21-trione, **12**.

Compound **11** was crystallized from methylene chloride-diethyl ether in the monoclinic space group $P2_1/c$, with four molecules in the unit cell having the dimensions $a = 11.466 \text{ \AA}$, $b = 8.420 \text{ \AA}$, $c = 24.532 \text{ \AA}$, and $\beta = 96.922^\circ$. The calculated density was 1.159 g/cm^3 . Intensities of 2115 unique reflections with 20 less than 102° were measured on a 4-angle diffractometer using a monochromatic copper radiation. Positions of the atoms were obtained by inter-

Table 1

Atom Coordinates ($\times 10^4$) and Temperature Factors ($\text{A} \times 10^3$)

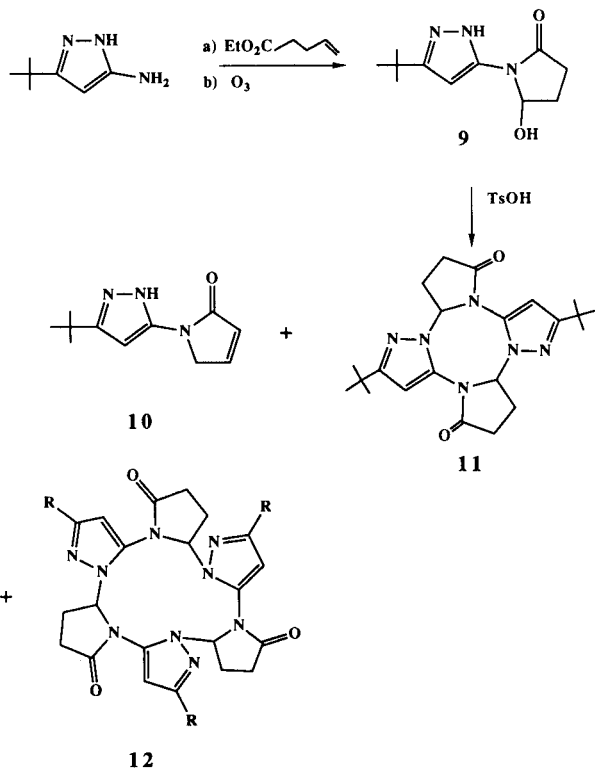
Atom	* x	y	z	U
N(1)	3815(3)	6837(4)	3895(1)	38(1)*
C(2)	3638(4)	8184(5)	4174(2)	37(1)*
N(3)	3934(3)	9702(4)	3986(2)	39(1)*
C(4)	5102(4)	10371(5)	4094(1)	46(2)*
N(5)	5953(3)	9493(4)	3806(2)	42(1)*
C(6)	5827(4)	8446(5)	3385(2)	39(1)*
N(7)	4719(3)	7911(4)	3140(1)	36(1)*
C(8)	4129(4)	6547(5)	3340(2)	38(1)*
C(9)	4205(4)	8472(6)	2644(2)	47(2)*
C(10)	3141(4)	7474(7)	2467(2)	63(2)*
C(11)	3038(4)	6313(6)	2919(2)	54(2)*
N(12)	3437(3)	5547(4)	4153(2)	43(1)*
C(13)	3028(4)	6106(6)	4603(2)	43(2)*
C(14)	3143(4)	7770(6)	4633(2)	43(2)*
N(15)	7102(3)	9852(5)	3959(2)	52(1)*
C(16)	7685(4)	9008(6)	3620(2)	53(2)*
C(17)	6928(4)	8094(6)	3256(2)	49(2)*
C(18)	4924(5)	12083(6)	3881(2)	62(2)*
C(19)	3843(5)	12016(6)	3459(3)	66(2)*
C(20)	3201(4)	10513(5)	3587(2)	51(2)*
O(21)	4578(3)	9582(5)	2405(2)	67(1)*
O(22)	2264(3)	10048(4)	3388(2)	70(1)*
C(23)	2520(4)	4964(6)	4986(2)	51(2)*
C(24)	1615(7)	3921(10)	4654(3)	126(4)*
C(25)	1877(7)	5900(9)	5392(3)	119(4)*
C(26)	3461(6)	4016(10)	5294(3)	130(4)*
C(27)	9024(4)	9157(7)	3646(3)	69(2)*
C(28)	9309(6)	10335(18)	3280(6)	335(10)*
C(29)	9549(6)	9551(19)	4214(4)	234(9)*
C(30)	9538(6)	7646(13)	3534(7)	262(10)*

* Equivalent isotropic U defined as one-third of the trace of the orthogonalized U_{ij} tensor.

pretation of an E map phased by the direct methods routine SOLV of the SHELXTL program. The structure was refined by the least-squares method with anisotropic

temperature factors for all atoms and with hydrogen atoms at calculated positions. The final R factor was 0.0819. Table 1 shows unit cell atomic coordinates.

Scheme II



In that the pyrrolidinones 7 and 10 were also obtained in these reactions, the stability of the 8-membered rings was studied. We found that treatment of the 8-membered ring compounds, 8a or 8b, with a catalytic amount of concentrated sulfuric acid in refluxing xylene for 30 minutes gave exclusively the pyrrolidinones 7a and 7b (100%), respectively.

The pyrrolidinones 7a and 7b can be obtained directly

from the hydroxypyrrolidinones, 5a and 5b, by direct dehydration with a catalytic amount of concentrated sulfuric acid in refluxing xylene (57% and 56%, respectively). In these cases, neither of the 8-membered ring compounds were identified.

In summary, the chemistry described above represents an interesting extension to the chemistry of iminium ions. Also, the dimerization of these compounds results in a unique class of heterocyclic compounds.

EXPERIMENTAL

Melting points were determined on a Thomas Hoover capillary melting point apparatus and are uncorrected. Infrared spectra were recorded on a Bechmann spectrometer neat or as nujol mulls. Proton magnetic resonance spectra were determined with a Bruker 250 MHz or IBM 80 MHz instrument using tetramethylsilane as an internal standard. Low pressure liquid chromatography with silica gel was used for all chromatographic separations. Mass spectra were obtained on a Hewlett Packard mass spectrometer.

N-(3-*t*-Butyl-1*H*-pyrazol-5-yl)-2-methyl-4-pentenamide, 4a.

To 17.0 g (0.12 mole) of 3-*t*-butyl-5-aminopyrazole in 100 ml of dry tetrahydrofuran at room temperature under a nitrogen atmosphere was added 14.0 g (0.26 mole) of sodium methoxide. A slight exotherm was noted. Then, 19.0 g (0.13 mole) of ethyl 2-methyl-4-pentenoate was added and the mixture heated to reflux for 6 hours. The tetrahydrofuran was then evaporated *in vacuo*. Water (200 ml) was added to the resulting oil and the mixture cooled in an ice bath (5°) causing the oil to solidify. This material was acidified with concentrated hydrochloric acid to pH 2 and an orange solid formed. This solid was filtered and washed with 500 ml of cold water then air dried *in vacuo* at 80° to give 22 g (72%, mp 149-151°) of crude amide. This material was dissolved in acetone, decolorized with carbon, filtered, concentrated to a small volume, and diluted with ether. Upon cooling, white crystals formed. Collection gave 17 g (56%) of a white crystalline material, mp 167-169°; ir (Nujol): 1680 (C=O) cm⁻¹; ¹H nmr (deuteriochloroform): δ 1.3 (m, 12H), 2.2 (m, 1H), 2.6 (m, 2H), 5.2 (m, 2H), 5.8 (m, 1H), 6.6 (s, 1H), and 8.6 (s, 1H).

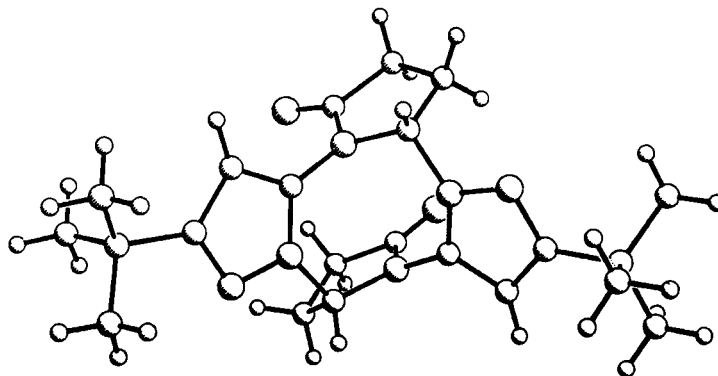


Figure 1. ORTEP plot of compound 11.

Anal. Calcd. for $C_{13}H_{21}N_3O$: C, 66.35; H, 8.99; N, 17.86. Found: C, 66.29; H, 9.15; N, 17.58.

N-[3-(1-Ethylcyclohexyl)-1*H*-pyrazol-5-yl]-2-methyl-4-pentenamide, **4b**.

Following the procedure for **4a**, compound **4b** was obtained in 74% yield as a white crystalline material, mp 144-146°; ir (Nujol): 1680 (C=O) cm^{-1} ; 1H nmr (deuteriochloroform): 0.7 (t, 3H), 1.5 (m, 15H), 2.3 (m, 4H), 5.0 (m, 2H), 5.7 (m, 1H), 6.6 (s, 1H), 9.4 (s, 1H), 10.5 (broad s, 1H).

Anal. Calcd. for $C_{17}H_{27}N_3O$: C, 70.55; H, 9.40; N, 14.52. Found: C, 70.50; H, 9.21; N, 14.74.

N-[3-(*t*-Butyl)-1*H*-pyrazol-5-yl]-4-pentenamide.

Following the procedure for **4a**, compound was obtained in 84% yield as a white crystalline solid, mp 161-163°; ir (Nujol): 1680 (C=O) cm^{-1} ; 1H nmr (deuteriochloroform): δ 1.3 (s, 9H), 2.18 (t, 3H), 2.6 (m, 2H), 5.2 (m, 2H), 5.79 (m, 1H), 6.6 (s, 1H), 8.9 (s, 1H).

Anal. Calcd. for $C_{12}H_{19}N_3O$: C, 65.13; H, 8.65; N, 18.99. Found: C, 65.01; H, 8.59; N, 19.05.

1-[3-(*t*-Butyl)-1*H*-pyrazol-5-yl]-5-hydroxy-3-methyl-2-pyrrolidinone, **5a**.

To 8.0 g of compound **4a** was added 200 ml of acetone and 20 ml of water. This mixture was cooled to -20°. An ozone/air stream was passed through the solution until the calculated amount of ozone had been added (ca. 20 minutes). An excess of dimethyl sulfide was added and the mixture warmed to room temperature. The solution was evaporated *in vacuo* and methylene chloride was added. The methylene chloride solution was washed with brine, dried (magnesium sulfate), then evaporated to a white solid. Crystallization with diethyl ether gave 4.4 g (55%) of white, crystalline material, mp 155-157°; ir (Nujol): 3500 (OH), 1670 (C=O) cm^{-1} ; 1H nmr (deuteriochloroform): 1.4 (m, 12H), 1.9 (m, 1H), 2.7 (m, 2H), 5.1 (broad s, 1H), 5.9 (m, 1H), 6.7 (m, 1H), 7.3 (s, 1H).

Anal. Calcd. for $C_{12}H_{19}N_3O_2$: C, 60.74; H, 8.07; N, 17.71. Found: C, 60.53; H, 7.85; N, 17.76.

1-[3-(1-Ethylcyclohexyl)-1*H*-pyrazol-5-yl]-5-hydroxy-3-methyl-2-pyrrolidinone, **5b**.

Following the procedure for **5a**, compound **5b** was obtained in 38% yield as a white solid, mp 173-175°; ir (Nujol): 3520 (OH), 1685 (C=O) cm^{-1} ; 1H nmr (deuteriochloroform): 0.8 (t, 3H), 1.45 (m, 15H), 1.95 (m, 1H), 2.6 (m, 2H), 5.0 (broad s, 1H), 5.8 (m, 1H), 6.7 (m, 1H), 7.3 (s, 1H).

Anal. Calcd. for $C_{16}H_{23}N_3O_2$: C, 65.95; H, 8.65; N, 14.42. Found: C, 66.20; H, 8.48; N, 14.31.

1-[3-(*t*-Butyl)-1*H*-pyrazol-5-yl]-5-hydroxy-2-pyrrolidinone, **9**.

Following the procedure of **5a**, compound **9** was obtained in 89% yield as a viscous, colorless oil; ir (neat): 3520 (OH), 1685 (C=O) cm^{-1} ; 1H nmr (deuteriochloroform): 1.4 (s, 9H), 2.3 (m, 2H), 2.8 (m, 2H), 5.1 (s, 1H), 5.9 (m, 1H), 6.6 (s, 1H), 7.25 (s, 1H).

Anal. Calcd. for $C_{11}H_{17}N_3O_2$: C, 59.17; H, 7.67; N, 18.82. Found: C, 58.89; H, 7.41; N, 18.71.

2,10-Di-*t*-butyl-6,14-dimethyl-6,7,14,15-tetrahydro-7*aH*,15*aH*-dipyrzolo[1,5-*a*:1',5'-*e*]dipyrrolo[1'',5''-*c*:1''',5'''-*g*][1,3,5,7]tetrazocine-5,13-dione, **8a** and 1-(3-*t*-Butyl-1*H*-pyrazol-5-yl)-3-methyl- Δ^3 -pyrrolin-2-one, **7a**.

To 3.6 g (0.015 mole) of compound **5a** in 50 ml of toluene was added 0.1 g of *p*-toluenesulfonic acid. The mixture was refluxed under a Dean-Stark trap for 1 hour. The solution was cooled to room temperature and evaporated. The residue was dissolved in methylene chloride, washed with brine, dried (magnesium sulfate), then evaporated to a viscous oil. Chromatography gave two fractions. The first fraction yielded 1.7 g (39%) of a white solid, **8a**, mp 190-193°; ir (Nujol): 1685 (C=O) cm^{-1} ; 1H nmr (deuteriochloroform): 1.35 (m, 24H), 1.9 (m, 2H), 2.7 (m, 4H), 5.95 (m, 2H), 6.1 (s, 2H); ^{13}C nmr (deuteriochloroform): 15.0, 15.2, 15.5, 15.7, 30.3, 32.5, 33.3, 33.8, 35.8, 35.9, 36.1, 36.5, 37.0, 76.3, 76.5, 76.7, 76.8, 76.9, 77.0, 77.6, 101.8, 102.2, 103.0, 103.3, 134.0, 162.3, 162.6, 176.3, 177.4, 178.5, and 178.8 ppm; ms: FD *m/e* 438; ei *m/e*, 438, 355, 259, 220.

Anal. Calcd. for $C_{24}H_{34}N_6O_2$: C, 65.72; H, 7.82; N, 19.17. Found: C, 65.62; H, 7.74; N, 18.78.

The second major fraction provided 1.0 g (30%) of a white solid, mp 199-201°, which was the pyrrolinone **7a**; ir (Nujol): 1685 (C=O) cm^{-1} ; 1H nmr (deuteriochloroform): 1.2 (s, 9H), 1.8 (s, 3H), 4.3 (s, 2H), 6.4 (s, 1H), 7.0 (s, 1H).

Anal. Calcd. for $C_{12}H_{17}N_3O$: C, 65.73; H, 7.81; N, 19.16. Found: C, 65.58; H, 7.66; N, 19.03.

2,10-Di(1-ethylcyclohexyl)-6,14-dimethyl-6,7,14,15-tetrahydro-7*aH*,15*aH*-dipyrzolo[1,5-*a*:1',5'-*e*]dipyrrolo[1'',5''-*c*:1''',5'''-*g*][1,3,5,7]tetrazocine-5,13-dione, **8b** and 1-[3-(1-Ethylcyclohexyl)-1*H*-pyrazol-5-yl]-3-methyl- Δ^3 -pyrrolin-2-one, **7b**.

Following the procedure for **5a**, compound **8b** was isolated in 25% yield after chromatography as a white solid, mp 152-154°; ir (Nujol): 1680 (C=O) cm^{-1} ; 1H nmr (deuteriochloroform): 0.5 (m, 6H), 1.3 (m, 26H), 2.0 (m, 4H), 2.2 (m, 2H), 2.8 (m, 4H), 6.1 (m, 4H); ^{13}C nmr (deuteriochloroform): 8.0, 8.2, 15.0, 15.9, 16.0, 22.4, 26.4, 33.5, 34.5, 35.0, 35.2, 35.3, 35.7, 36.0, 36.1, 36.8, 39.5, 76.1, 76.5, 76.6, 76.9, 77.0, 77.5, 103.4, 103.6, 104.1, 158.6, 158.9, 159.2, 175.8, 176.9 and 178.0 ppm; ms: ei *m/e* 546, 518, 491, 334, 298, 274, 244; FD *m/e* 546.

Anal. Calcd. for $C_{32}H_{46}N_6O_2$: C, 70.30; H, 8.48; N, 15.37. Found: C, 70.56; H, 8.19; N, 15.12.

The second fraction, compound **7b**, was isolated in 28% yield as a white solid, mp 187-189°; ir (Nujol): 1685 (C=O) cm^{-1} ; 1H nmr (deuteriochloroform): 0.7 (t, 3H), 1.5 (m, 11H), (m, 5H), 4.3 (s, 2H), 6.7 (broad s, 1H), 6.8 (s, 1H), 7.2 (s, 1H).

Anal. Calcd. for $C_{16}H_{22}N_3O$: C, 70.30; H, 8.48; N, 15.37. Found: C, 70.12; H, 8.39; N, 15.12.

2,10-Di-*t*-butyl-6,7,14,15-tetrahydro-7*aH*,15*aH*-dipyrzolo[1,5-*a*:1',5'-*e*]dipyrrolo[1'',5''-*c*:1''',5'''-*g*][1,3,5,7]tetrazocine-5,13-dione, **11**, 2,10,18-Tri-*t*-butyl-6,7,14,15,22,23-hexahydrotripyrzolo[1,5-*a*:1',5'-*e*:1'',5''-*i*]tripyrrolo[1''',5'''-*c*:1''''',5''''-*k*][1,3,5,7,9,11]-hexaazacyclododecane-5,13,21-trione, **12** and 1-[3-(*t*-butyl)-1*H*-pyrazol-5-yl]- Δ^3 -pyrrolin-2-one, **10**.

Following the same procedure for **5a**, compound **11** was isolated as a white solid in 28% yield, mp 272-274°; ir (Nujol): 1685 (C=O) cm^{-1} ; 1H nmr (deuteriochloroform): 1.3 (s, 18H), 2.4 (m, 4H), 2.7 (m, 4H), 6.0 (m, 2H), 6.1 (s, 2H); ms: FD *m/e*, 410.

Anal. Calcd. for $C_{22}H_{30}N_6O_2$: C, 64.37; H, 7.37; N, 20.47. Found: C, 64.49; H, 7.47; N, 20.26.

The second product from the chromatography was recrystallized (methylene chloride-diethyl ether) to give a white solid in 10.5% yield, mp = 325° dec; ir (Nujol): 1685 (C=O) cm^{-1} ; 1H nmr (deuteriochloroform): 1.07 (s, 9H), 1.1 (s, 9H), 1.15 (s, 9H), 2.6

(m, 8H), 2.9 (m, 4H), 5.8 (s, 1H), 6.0 (s, 1H), 6.05 (d, J = 1-2, 1H), 6.25 (d, J = 1-2, 1H), 6.5 (d, J = 1-2, 1H); ms: FD m/e, 615/616.

Anal. Calcd. for $C_{23}H_{23}N_5O_3$: C, 64.37; H, 7.37; N, 20.47. Found: C, 64.29; H, 7.22; N, 20.31.

The third product isolated from chromatography was the pyrrolinone **10** in 57% yield as a white solid, mp 199-201°: ir (Nujol): 1680 (C=O); cm^{-1} : 1H nmr (deuteriochloroform): 1.3 (s, 9H), 4.5 (d, 2H), 5.3 (s, 1H), 6.0 (s, 1H).

Anal. Calcd. for $C_{12}H_{17}N_3O$: C, 65.73; H, 7.81; N, 19.16. Found: C, 65.58; H, 7.66; N, 19.03.

Conversion of **5a,b** to **7a,b**.

To 2.7 g (0.011 mole) of **5a** in 75 ml of xylene was added 3 drops of concentrated sulfuric acid. The mixture was heated at reflux under a Dean-Stark trap for 1 hour. The mixture was cooled to room temperature and then evaporated. The resulting solid was dissolved in methylene chloride, washed with brine then dried (magnesium sulfate). Solvent removal followed by subsequent crystallization gave 1.43 g (57%) of a white crystalline solid, mp 199-201°. In a similar manner **5b** was converted to **7b**, (56%).

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[3] 3-Aminopyrazoles are readily synthesized from the reaction of an appropriate β -ketonitrile and hydrazine, see N. Seki, Y. Yamaguchi, Y. Nakamura, H. Kubo and T. Tsuruya, German Patent, 3,305,483 (1983); *Chem. Abstr.*, **99**, 194955c (1983).

[4] The 2-methyl-4-pentenoates are synthesized by an orthoester Claisen rearrangement from allyl alcohol and triethylorthoacrylate (propionic acid catalyst, reflux, 90% yield). See S. J. Rhoads and N. R. Raulins, "Organic Reactions", Vol **22**, W. G. Dauben, ed, John Wiley and Sons, Inc., New York, 1975, Chapter 1. Ethyl pent-4-enoate can be purchased from Lancaster Synthesis, Ltd.