A MASS SPECTRAL STUDY OF 2-PYRIMIDONES AND 2-PYRIMIDTHIONES

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ABSTRACT

EVA MARIA KAZDAN

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The fragmentation patterns obtained from electron impact upon 2-pyrimidone, N- methyl-, ethyl-, isopropyl-, benzyl- and phenyl-2-pyrimidone, and those of the corresponding N- unsubstituted, methyl-, ethyl-, and phenyl-2-pyrimidthiones were examined. There was a considerable resemblance in the patterns between the thio- and oxo-analogues in that the primary fragmentations for both series involved loss of CX (X= O or S) and loss of HCN. The main difference between the two series was that whereas loss of SH from the 2-thiones was significant, the loss of OH from the oxygen analogues was negligible. With different N-substituents the fragmentation pattern changed and new high abundant ions appeared, resulting in suppression of the major fragmentation routes. Larger N-alkyl substituents gave rise to more fragments, due partly to McLafferty rearrangements. Deuterium labelling showed that loss of hydrogen from the molecular ion of the N-unsubstituted, N-methyl and N-ethyl-2-pyrimidone involves rupture of a ring C-H bond. The N-phenyl-oxo and thio-pyrimidine molecular ions lose hydrogen from the ortho--position of the benzene ring. In some cases high resolution mass measurements as well as a special technique to resolve the metastable ions were performed.

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PART I - INTRODUCTION

A. GENERAL

The widespread application of ultraviolet, infrared and nuclear magnetic resonance spectroscopy in the last thirty years has led to a considerable decrease in the time required to solve structural problems successfully.

Mass spectrometry, in comparison, has been neglected for a long time as a tool to be used in experimental organic chemistry, in part perhaps because the instrumentation involved is complex, tricky to handle, and expensive.

In most laboratories, however, these difficulties have been overcome, and mass spectrometry is now a well-developed technique with which excellent spectra of rather complex organic molecules can be easily obtained.

The general principles of mass spectrometry will be discussed here very briefly, because many excellent books[1-4] dealing in detail with this subject are available.

All forms of spectroscopy involve excitation of the molecules under investigation. In most spectroscopic methods, excluding mass spectrometry, the absorbed excitation energy is evaluated in order to gain qualitative and/or quantitative information about the sample compound. After this physical measurement, the substance may be recovered unchanged.

In mass spectrometry sample molecules are excited by the impact of electrons usually having an energy of about 70 eV. This energy is sufficient to ionize them, that is to produce the parent or molecular ions, and break them into fragments so that the molecules undergo a real chemical degradation which does not permit recovery of the sample.

e.g. $ABC + e^- \longrightarrow 2e^- + ABC^+ \longrightarrow A^+ + BC^\bullet$

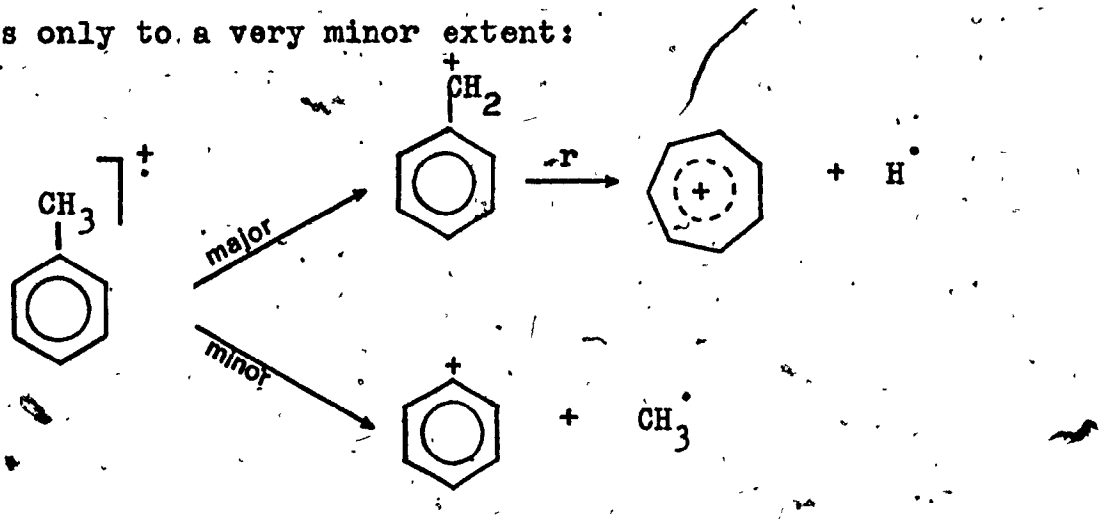
$ABC^+ \longrightarrow A^\bullet + BC^+$

$BC^+ \longrightarrow B + C^+$

The charged degradation products, usually only the positive ones, are separated with the aid of electrical and magnetic fields and are recorded according to their mass to charge (m/e) ratio. A mass spectrum therefore does not show absorption energies, but the amount of singly or multiply charged ions as a function of m/e. Quite frequently peaks corresponding to doubly or even triply charged ions are found in the mass spectrum, particularly if there exists a very intense peak from a singly charged ion. The ions will be recorded at half or a third of the m/e value of the singly charged species.

The main fragmentation pathways of the initially produced molecular ion are those which require the lowest amount of energy. That is, the weakest bonds are cleaved and the most stable fragmentation products are preferentially formed by the most favorable reaction pathways. For example in the fragmentation pattern of toluene[1-3] the

main fragmentation pathway is due to the formation of the resonance stabilized tropylium ion by loss of hydrogen, while the formation of phenyl cation and methyl radical occurs only to a very minor extent:



If a molecule contains only bonds of nearly equal strength, no special fission is preferred so that the mass spectrum shows many peaks, resulting from the nearly equal probability of cleaving any of a number of bonds.

e.g. $CH_3CH_2CH_2CH_3]^{+\cdot} \longrightarrow CH_3^{\cdot} + CH_3CH_2CH_2^+$

$\longrightarrow CH_3CH_2^{\cdot} + CH_3CH_2^+$

$\longrightarrow CH_3CH_2CH_2^{\cdot} + CH_3^+$

On the other hand, molecules, which possess heteroatoms and aromatic rings have bonds of varying strength, and may give rise to fragments stabilized by delocalization. The mass spectra of such compounds show a smaller number of very intense peaks, corresponding to the ions produced by specific favored fissions. These features are shown by heteroaromatic compounds, whose mass spectra will be reviewed later.[5]

B. ION FRAGMENTATION MECHANISMS

Mass spectral reactions are unimolecular since the sample pressure in the ion source is kept sufficiently low that bimolecular reactions are usually negligible. Molecular ions are formed with a wide range of internal energies. Those that are sufficiently "cool" will not decompose further and will appear as $M^{+\cdot}$ in the spectrum. If less energy is required to ionize the molecule, that is, if it has a lower ionization potential, more molecular ions of lower internal energy (cool ions) will be formed and $M^{+\cdot}$ will tend to be higher.

Reactions involving the cleavage of a single bond in an odd-electron ($OE^{+\cdot}$) molecular ion must produce an even-electron (EE^{+}) fragment ion and a neutral radical species. The two fragments compete for the charge and the unpaired electron.

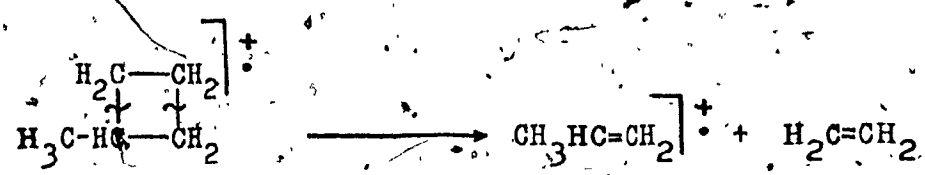
e.g. $CH_3CH_2CH_3]^{+\cdot} \longrightarrow CH_3CH_2^{+} + {}^{\cdot}CH_3$

or $\longrightarrow CH_3CH_2^{\cdot} + CH_3^{+}$

These reactions are called "simple cleavage reactions" to distinguish them from rearrangement and other more complex reactions.

In contrast an $OE^{+\cdot}$ ion is formed from $M^{+\cdot}$ through reactions involving the cleavage of two bonds. Rearrangements and reactions involving fragmentation of a ring are two ways in which abundant $OE^{+\cdot}$ ions can be produced.

e.g. $H_2C(H)-CH_2(OH)]^{+\cdot} \longrightarrow H_2C{=}CH_2]^{+\cdot} + HOH$



Detailed studies of favoured fragmentation reactions have been carried out[1,2,6,7] for a wide variety of compounds. Such studies have led to generalizations[8,9,10] concerning the common types of fragmentation which occur.

There appear to be three general driving forces for unimolecular ion decomposition:

(i) Stability of the fragments. Product ion abundance increases with an increase in the stability of either the ionic or the neutral reaction products; although the ion's stability is the more important influence. Ion stabilization through electron sharing of nonbonding electrons is a primary force in many reactions. For example, the stability of the even-electron acylium ion $R-\overset{+}{C}=\ddot{O} \leftrightarrow R-C\equiv\overset{+}{O}$ is largely due to the latter canonical structure which has greater bonding chracter. Resonance stabilization of the π-electrons, such as the aromaticity of the tropylium cation $C_7H_7^+$, is also important.

(ii) Lability of the bond(s) cleaved and the stability of the bonds formed. Bond labilities within the decomposing ion often parallel reactivities known from chemical processes in solution. For example, the decreasing strength of the C-X bond for the halogens (X=F, Cl, Br and I) is reflected in an increasing abundance of the cleavage product $(M-X)^+$ in haloalkane spectra.

(iii) Steric factors. These are of special importance in

rearrangement reactions. For example, hydrogen atom rearrangements are much more prevalent than rearrangement of larger groups.

Almost all the fragmentation processes leading to intense peaks in the mass spectra of organic molecules can be summarized as follows:

(i) SIGMA ELECTRON IONIZATION

$$R\text{-}CR_3 \longrightarrow R^{\cdot} + \overset{+}{C}R_3$$

or $$R\text{-}YR \longrightarrow R^{\cdot} + \overset{+}{Y}R \qquad (Y = \text{heteroatom})$$

The more abundant ionized fragment will be the one better able to stabilize the positive charge.

(ii) RADICAL SITE INITIATION(alpha cleavage)

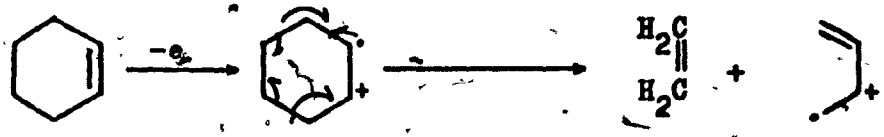
For saturated groups: $R\text{-}\overset{\curvearrowright}{CR_2}\text{-}\overset{+}{Y}R \longrightarrow R^{\cdot} + CR_2{=}\overset{+}{Y}R$

$$\overset{+}{Y}R\text{-}\overset{\curvearrowright}{CH_2}\text{-}\overset{\cdot}{C}H_2 \longrightarrow YR^{+\cdot} + CH_2{=}CH_2$$

For unsaturated heteroatom: $R\text{-}\overset{\curvearrowright}{CR}{=}\overset{+}{Y} \longrightarrow R^{\cdot} + CR{=}\overset{+}{Y}$

For alkenes(allylic cleavage): $R\text{-}\overset{\curvearrowright}{CH_2}\text{-}\overset{\curvearrowright}{CH}{=}\overset{+}{C}H_2 \longrightarrow R^{\cdot} + CH_2{=}CH\text{-}\overset{+}{C}H_2$

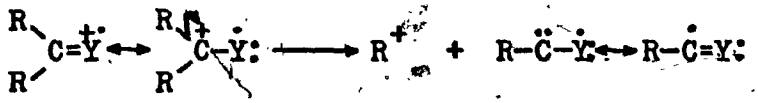
Retro-Diels-Alder(double alpha cleavage):

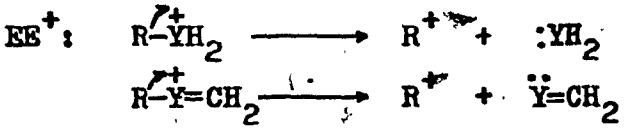


Reaction initiation at the radical site arises from its strong tendency for electron pairing. The odd electron is donated to form a new bond to an adjacent atom. The tendency for radical site to initiate a reaction is in the order: N>S,O,π,R>Cl>Br>I, where π signifies an unsaturated site and R$^{\cdot}$ an alkyl radical.

(iii) CHARGE SITE INITIATION(inductive effect)

OE$^{+\cdot}$: $$R\text{-}\overset{\curvearrowright}{\overset{+}{Y}}\text{-}R \longrightarrow R^{+} + :YR$$

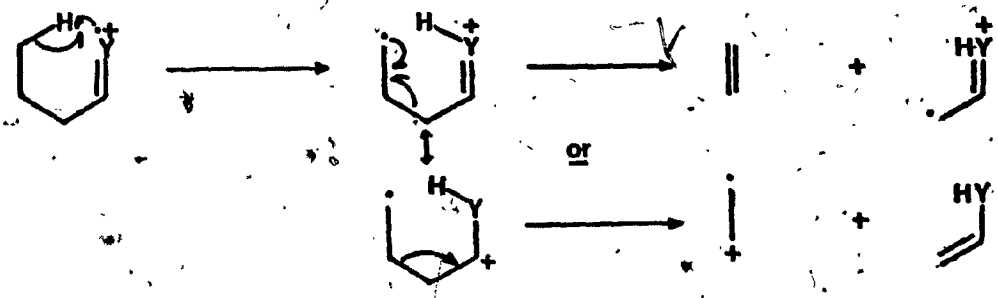




Initiation of a cleavage reaction by the positive charge involves attraction of an electron pair. The tendency for the formation of R^+ from RY is: Y = halogens>O,S≫N,C.

Mass spectral reactions can also produce ions in which the atoms do not have the same sequence as in the original molecule. Such rearrangement ions are often formed through specific mechanisms which are now well understood. Hydrogen-transfer rearrangements are common, though migration of an alkyl group can also occur.

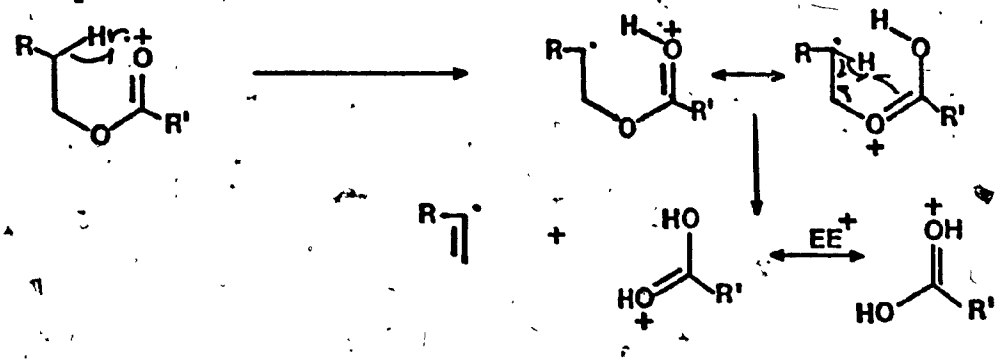
A very general hydrogen rearrangement is known as "McLafferty rearrangement". It involves the transfer of a hydrogen atom through a sterically favorable six-membered ring transition state, followed by β-cleavage to a polar functional group:



The second step involves radical and/or charge site initiation as shown above.

Rearrangement of two hydrogen atoms, sometimes called the "McLafferty + 1" rearrangement involves a transfer of the second hydrogen by three bond cleavage process.

An added driving force is the resonance stabilization of the EE^+ product ion:



C. IMPORTANCE OF PEAKS IN SPECTRAL INTERPRETATION

Abundance is not the only criterion of the significance of a spectral peak. A measurable molecular ion, no matter how weak, is still the most important peak.

Another criterion of the significance of an ion is its relative mass position in the spectrum. The smaller, more stable ions of low mass are mainly formed by further fragmentations of larger mass fragment ions. Thus, although the ions at low m/e of the spectrum are often more abundant, the ions at higher masses give us the essential information about the main fragmentation pathways.

Of substantial importance, despite their very weak abundances, are the broad peaks observed sometimes in the spectrum due to the metastable ion transitions. These transitions provide evidence of the origins of ions produced in many fragmentation processes. They involve the decomposition of an ion of mass m_1 to form another ion of mass m_2

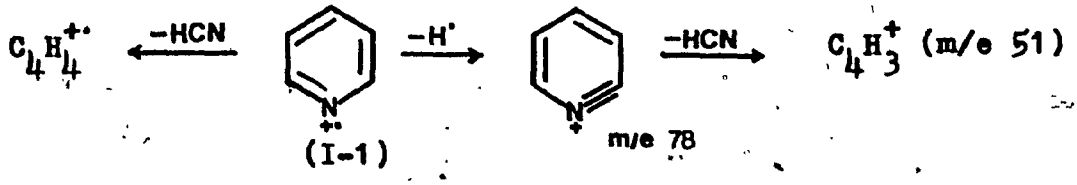
plus a neutral fragment in a field free region of the spectrometer and are recorded as broad peaks of low intensity at m/e values m^* given by relation $m^* = m_2^2/m_1$.[1]

The observation of a metastable peak can provide confirmation of a proposed fragmentation process. However, the absence of a metastable does not indicate that such a process does not occur.

D. PYRIDINE DERIVATIVES

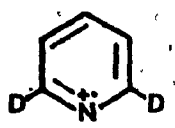
Simple six-membered heterocycles with two nitrogens have not been subjected to much in the way of mass spectroscopic investigation. Before reviewing previous work on pyrimidines it will be useful to review the fragmentation patterns of some other simple heterocyclic compounds, principally pyridine derivatives.

The mass spectrum of pyridine[11] (I-1) is dominated by loss of HCN from the molecular ion. A minor process is loss of HCN from the M-1 ion, to give the peak at m/e 51.

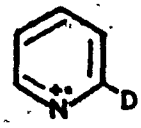


(I-1)

Williams et al.[12] studied the fragmentation of 2,6-d_2-pyridine(I-2) and 2-d_1-pyridine(I-3).



(I-2)

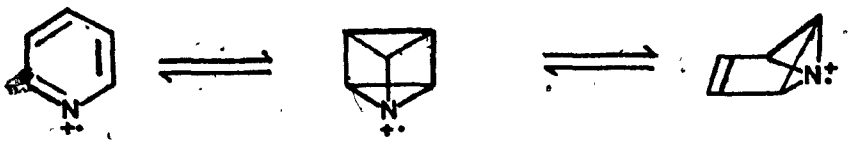


(I-3)

From the intensities of the metastable ions of HCN and DCN from I-2 and I-3 the authors concluded that the hydrogens

of pyridine are randomized prior to the expulsion of HCN from the molecular ion and probably also prior to the reaction m/e 78→m/e 51.

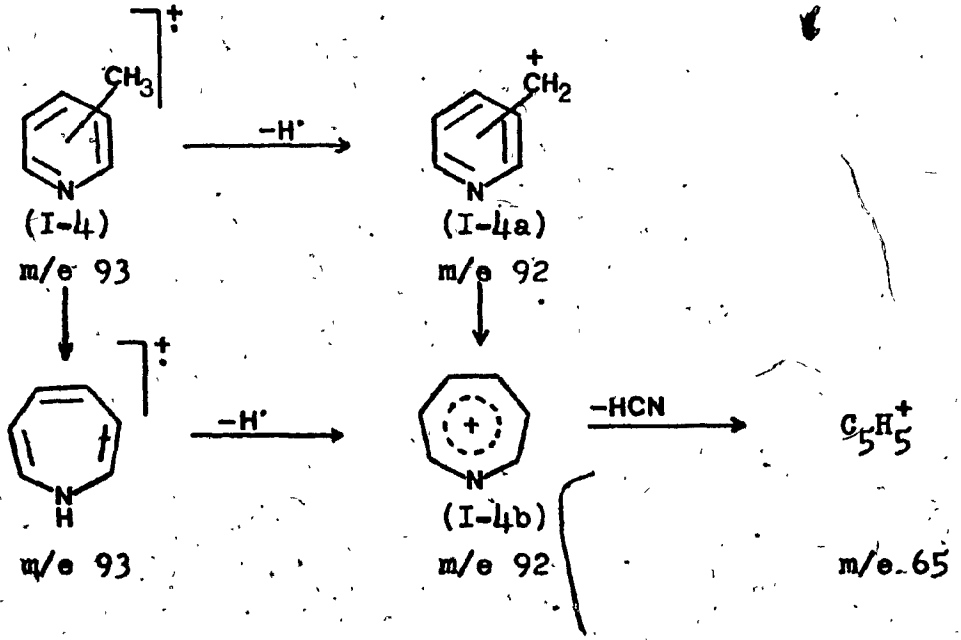
There are two explanations for this phenomenom. One possibility is valence tautomerism of pyridine, which involves the synchronous movement of carbon atoms with their attached hydrogen atoms[12].



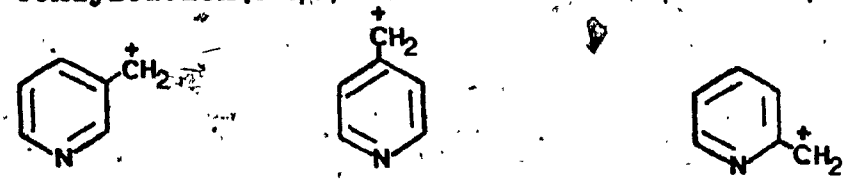
The alternative would be a rapid equilibration of hydrogen atoms only, via a series of 1,2 - shifts. No experimental work has been done so far to differentiate between these mechanisms.

Biemann et al.[13] studied the spectra of three monomethylpyridines(picolines)(I-4). Here again loss of HCN from the molecular ion is an important process, but a significant M-1 ion is formed. Labelling experiments to determine the origin of the hydrogen atoms lost in the formation of the M-1 species have not been carried out. It seems likely, however, that to a large extent the loss of hydrogen is from the methyl groups, leading to either an aza-benzyl cation(I-4a) or, if ring expansion occurs to an azatropylium ion(I-4b). The ring expansion can take place either before or after loss of hydrogen from the molecular ion(scheme I-1).
For 3-methylpyridine the M-1 peak is the most intense. This is probably a reflection of the greater stability of the

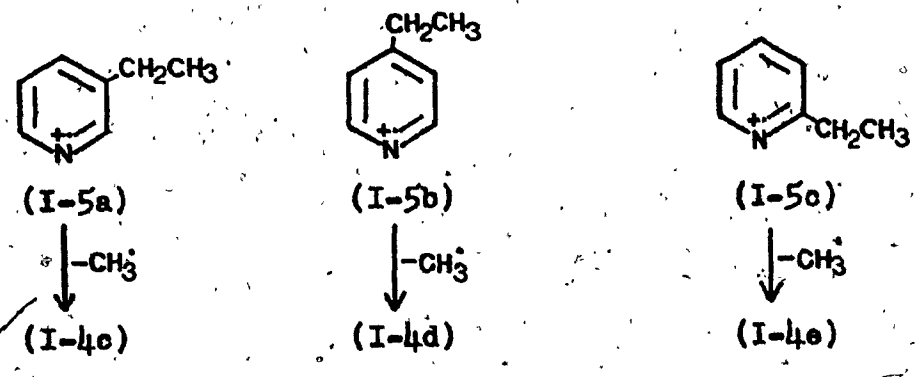
Scheme I-1



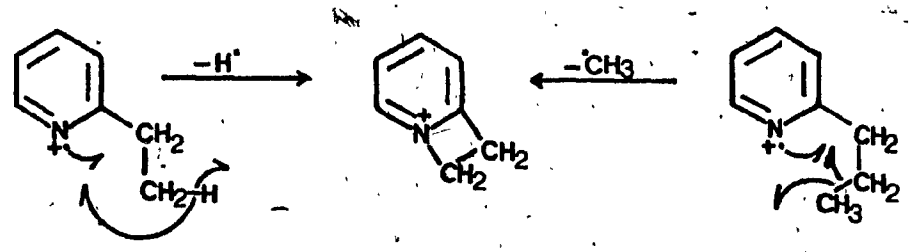
3-aza-benzylcation(I-4c) versus either I-4d or I-4e:



Biemann[13] noticed similar effects in the cleavage of ethylpyridines. The M-CH_3 ion is the base peak of the spectrum of 3-ethylpyridine(I-5a), but is considerably weaker in those of the 2- and 4-ethylcompounds(I-5c and I-5b):

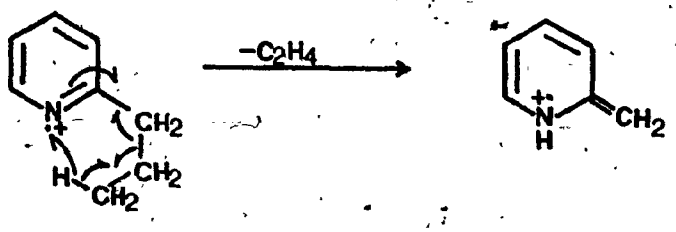


Of some interest is the intense M-1 ion in the mass spectrum of 2-ethylpyridine(I-5c). It seems that γ-fission is involved with stabilization of the resultant fragment(I-6a) by ring formation[14]. This interpretation is supported by the observation that 2-n-propylpyridine(I-6) shows a very intense M-CH_3 ion, whereas in 3- or 4-n-propylpyridines methyl loss is a minor process only[15,21].



(I-5c) (I-6a) (I-6)

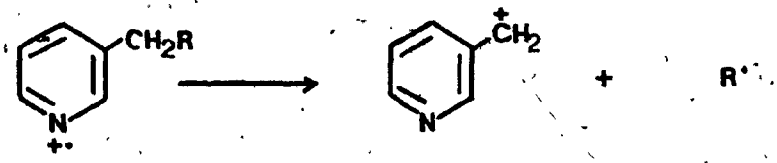
The base peak of the spectrum of 2-n-propylpyridine is the ion I-6b, resulting from a McLafferty rearrangement with hydrogen transfer to the nitrogen atom.



(I-6) (I-6b)

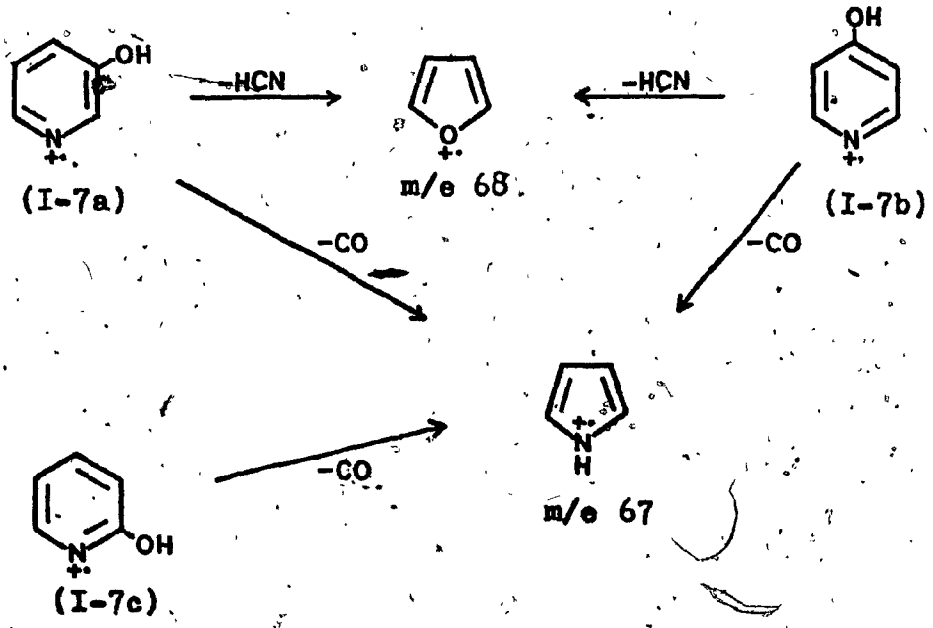
Generally pyridines with a C-2 propyl or higher alkyl group undergo a McLafferty rearrangement with the elimination of the appropriate olefin. This type of rearrangement does not occur to any appreciable extent with the 3-isomer where again

the following process prevails:



The mass spectra of 2,3,- and 4- hydroxypyridines were first studied by Spiteller[16]. The molecular ion forms the base peak in all three cases. The fragmentation is at a minimum with the 3-hydroxycompound(I-7a), Scheme I-2, where losses of CO and HCN lead to the ion at m/e 67 and 68, respectively. They are best represented as the pyrrole and furan radical cations. Similar behaviour occurs with 4-hydroxypyridine(I-7b) but 2-hydroxypyridine(I-7c) only loses CO.

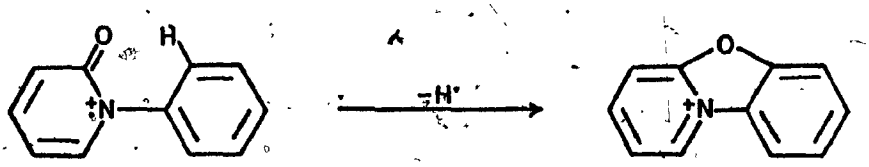
Scheme I-2



Recently Katritzky[17] et al. performed a mass spectroscopic study on the three hydroxypyridines, mentioned above, in order to confirm the prevailing existence of their enol forms in the source of a mass spectrometer. By measuring the primary isotope effects on the basis of direct and metastable fragments for the loss of CO from equimolar mixtures of HO and DO - pyridines, the authors concluded that 2,3,- and 4-hydroxypyridines exist predominantly as enol tautomers in the gas phase. This is supported by gas-phase spectral studies by Beak et al.[18].

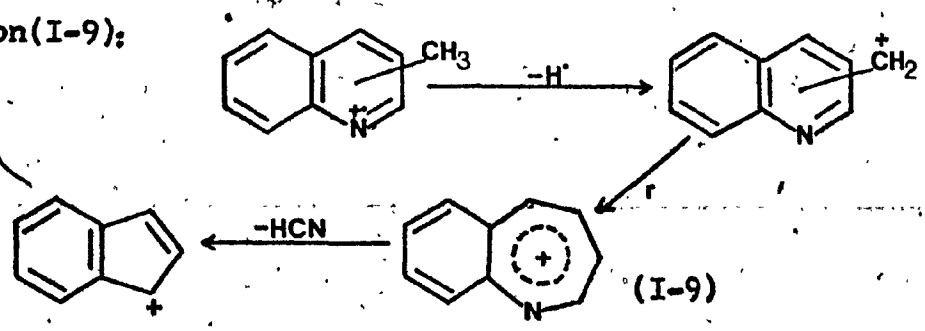
The mass spectra of several 2-pyridine-thiones and some related 2-pyridones have been also reported[19,20]. In comparison to 2-oxo-derivatives, where loss of HO, loss of H· and loss of HCN from the molecular ion are scarcely detectable, the fragmentation modes of 2-pyridinthione molecular ions associated with loss of H, HS· and HCN form significant processes. However the loss of CX(where X=S,O) occurs in both series as the major fragmentation pathway. Also loss of a hydrogen atom from the molecular ion of 1-phenyl-2-pyridone(I-8) produces highly abundant fragment, much stronger than in the 4- or 6-phenyl-2-pyridones. Deuterium labelling showed that the hydrogen lost probably comes from the ortho position of the benzene ring and it is postulated that this fragmentation involves attack by oxygen on the benzene ring with formation of an oxazolium ion(vide infra). 1-Phenyl-2-pyridinthione has not been investigated.

Djerassi[21] et al. examined the mass spectra of



(I-8)

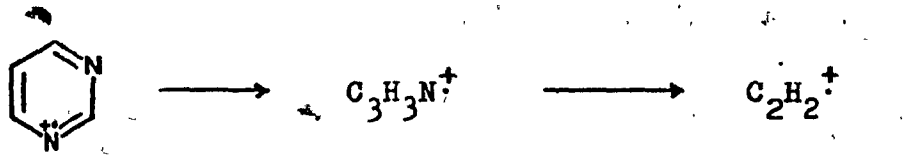
alkylquinolines and alkylisoquinolines. While the only important fragment in the mass spectra of quinoline and isoquinoline arises by expulsion of HCN from the molecular ion, introduction of a methyl substituent decreases the importance of this process. Two new modes of cleavage are then favored. The first is loss of a hydrogen radical from the molecular ion. Hydrogen cyanide is then expelled from the M-H species to give an M-(H+HCN) fragment. If the methyl substituent is in the heterocyclic ring(2,3, or 4 position) of quinoline the ratio of peak intensities M-(H+HCN)/M-H is nearly constant. This suggests that before further decomposition, each of the M-H fragments rearranges to an intermediate in which the carbon of the original methyl group is equivalent to the ring carbon atoms. Since hydrogen cyanide is then expelled from a common M-H intermediate ion, the extent of formation of the M-(H+HCN) fragment should not depend upon the position of the original methyl substituent. The intermediate in question may be written as a benzo-azatropylium ion(I-9):



(I-9)

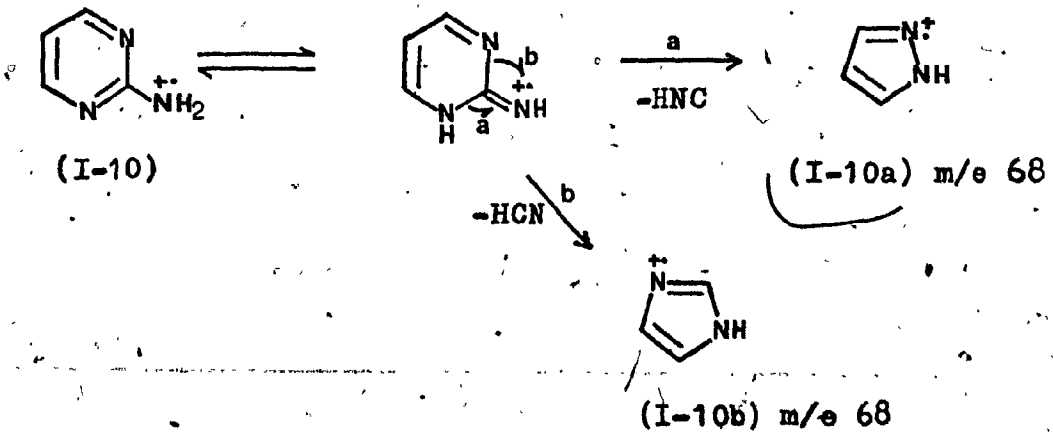
E. PYRIMIDINE DERIVATIVES

Besides pyrimidine itself, it has been mostly aminopyrimidines that have been subjected to mass spectroscopic investigation. Rice[22] et al. described the fragmentation pattern of pyrimidine, where two successive expulsions of HCN from the molecular ion belong to the dominant fragmentation mode. The second extrusion leads to the base peak of the spectrum, which is due to ionized acetylene at m/e 26:



m/e 80 m/e 53 m/e 26

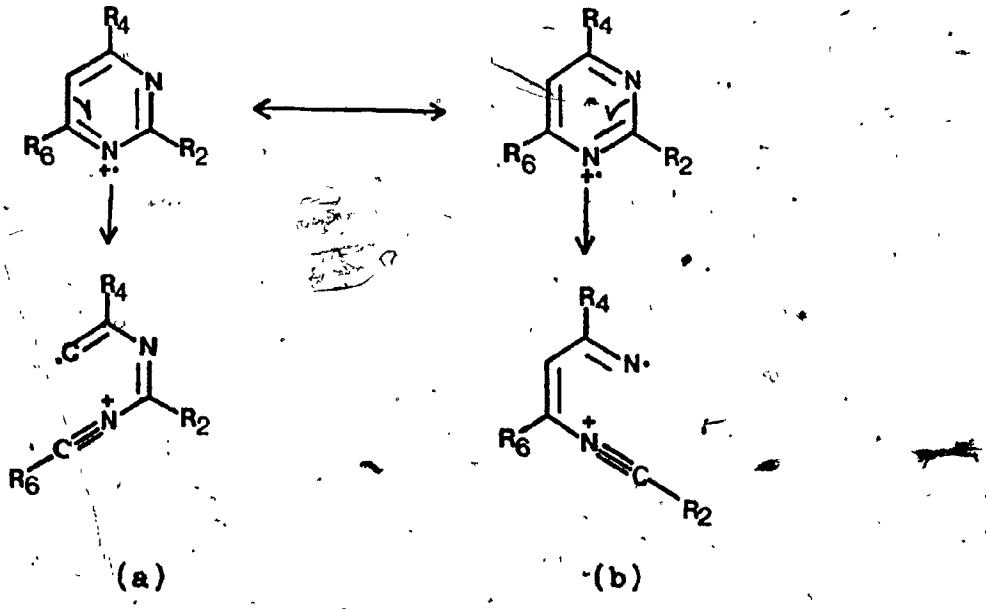
2-Amino pyrimidine(I-10) also decomposes by sequential losses of two molecules of HCN. The product of the first decomposition may well be the pyrazole(I-10a) or imidazole radical cation(I-10b) as further decomposition of the m/e 68 species agrees qualitatively with that previously described for pyrazole and imidazole:



(I-10) (I-10a) m/e 68

(I-10b) m/e 68

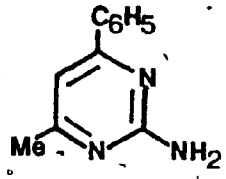
Kato[23] et al. studied the mass spectra of alkyl, phenyl, and chloropyrimidines and showed that prior to further fragmentation there are two intermediate ions(a and b), formed by α-cleavage principal:



(a) (b)

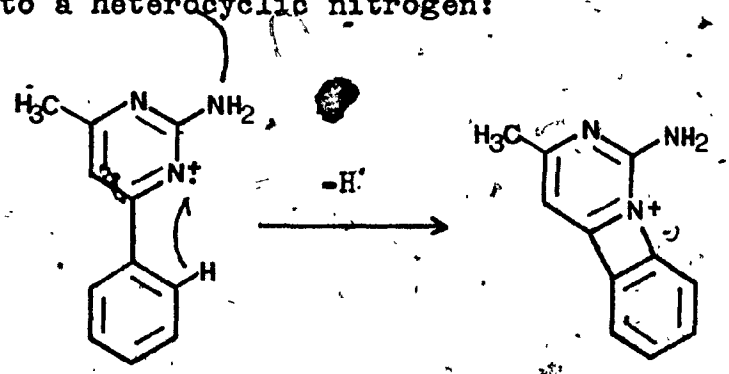
The authors investigated mass spectra of eleven related compounds, having the chloro, alkyl, and phenyl groups substituted for R_2, R_4 and R_6 in various combinations. It was observed that further fragmentation of the intermediates depends on their structures and on the character and position of the substituents.

Nishiwaki[24] et al. studied the mass spectrum of 2-amino-4-phenyl-6-methylpyrimidine(I-11). The molecular ion at m/e 185, which is the base peak and amounts to 32% of the total ion current, loses hydrogen, giving rise to a very in-



(I-11)

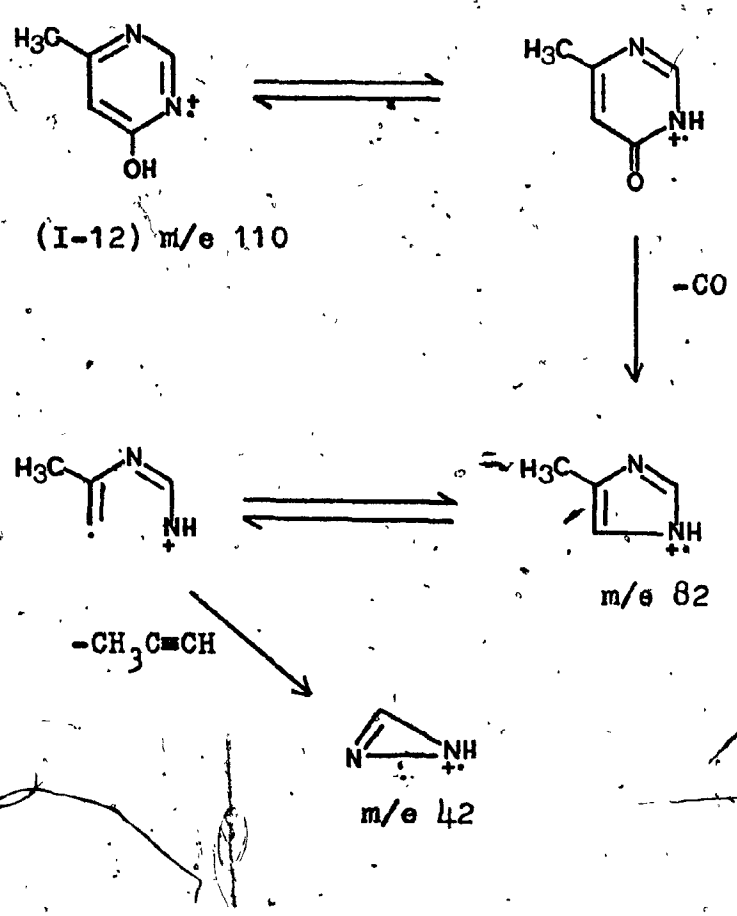
tense ion(25%) at m/e 184. This is an unexpected feature, since for 2-amino-4,6-dimethylpyrimidine, the two main fragments are due to loss of HCN and probably CH_3CN from the molecular ion[24]. The fact that the spectrum of N,N,5d_3-2--amino-4-phenyl-6-methylpyrimidine also displays a very prominent M-1 ion signifies that the phenyl ring is involved in loss of the hydrogen. A hydrogen in the methyl group will not be involved in view of the behaviour of 2-ethylpyridine[25]. The particular M-1 ion may well be the following cyclic ion(I-11a), the formation of which would present γ-cleavage to a heterocyclic nitrogen:



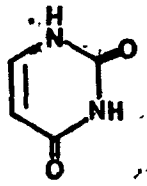
(I-11) m/e 185 (I-11a) m/e 184

The only previous study of hydroxypyrimidines seems to be that of 4-hydroxy-6-methylpyrimidine(I-12).

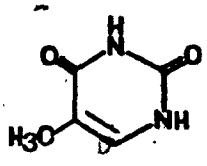
The mass spectrum of this compound showed little loss of HCN from the molecular ion but marked loss of CO[26]. This is most conveniently formalized as arising from the keto form of the molecular ion, and the resultant species(m/e 82) can be written as the open-chain ion or the imidazole ion. Loss of 40 mass units from m/e 82 produces the intense ion at m/e 42, and it has been suggested that the neutral fragment is methylacetylene:



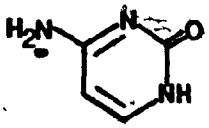
The mass spectra of the important pyrimidine derivatives uracil(I-13a), thymine(I-13b) and cytosine(I-13c) have been determined by Rice[22]. The main fragmentation path-



(I-13a)

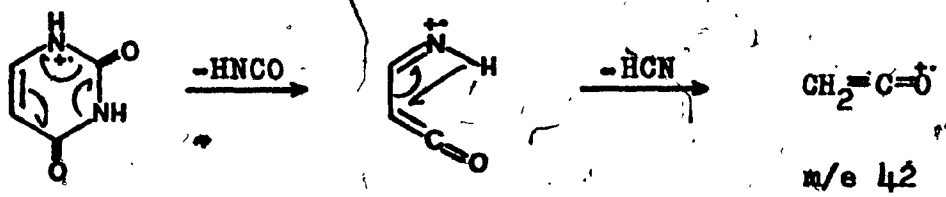


(I-13b)



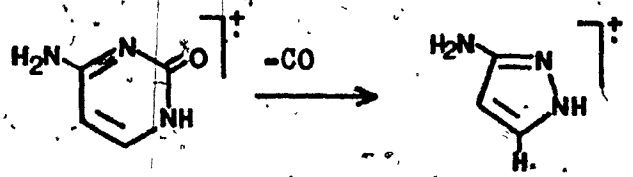
(I-13c)

way of uracil(I-13a) and thymine(I-13b) is loss of HNCO by "retro-Diels-Alder" cleavage, followed by expulsion of HCN to form a ketene odd electron ion at m/e 42:



(I-13a)

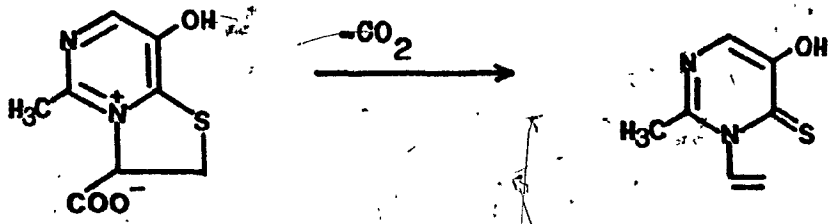
The mass spectrum of cytosine(I-13c) is much more complex and is characterized by three distinct fragmentation pathways, namely loss of NH_2 radical, loss of CO and loss of HNCO from the parent ion. Of interest is the expulsion of carbon monoxide from the molecular ion, which does not occur significantly with the two dioxygenated compounds:



(I-13c)

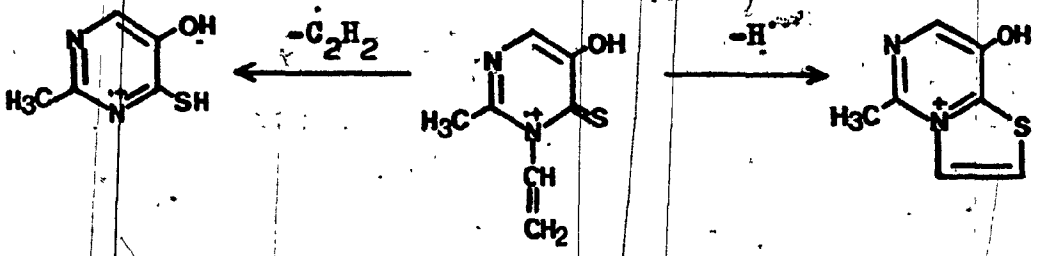
Undheim[27] et al. studied mass spectra of some dihydrothiazolopyrimidinium salts and zwitterions. The investi-

gated compounds undergo structural or electronic rearrangement prior to evaporation in the mass spectrometer to become covalent. Of some interest to our study is the spectrum of I-14, where first decarboxylation occurs with ring opening to form the N-vinylthione(I-14a), which forms the mo-



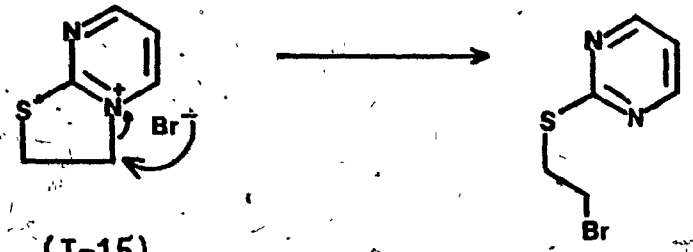
(I-14) (I-14a) m/e 168

lecular ion at m/e 168. The ion expels hydrogen to yield a thiazolopyrimidinium cation at m/e 167, which is the base peak. The second fragmentation pathway is loss of acetylene from the molecular ion to form a peak at m/e 142, which probably proceeds via McLafferty rearrangement.



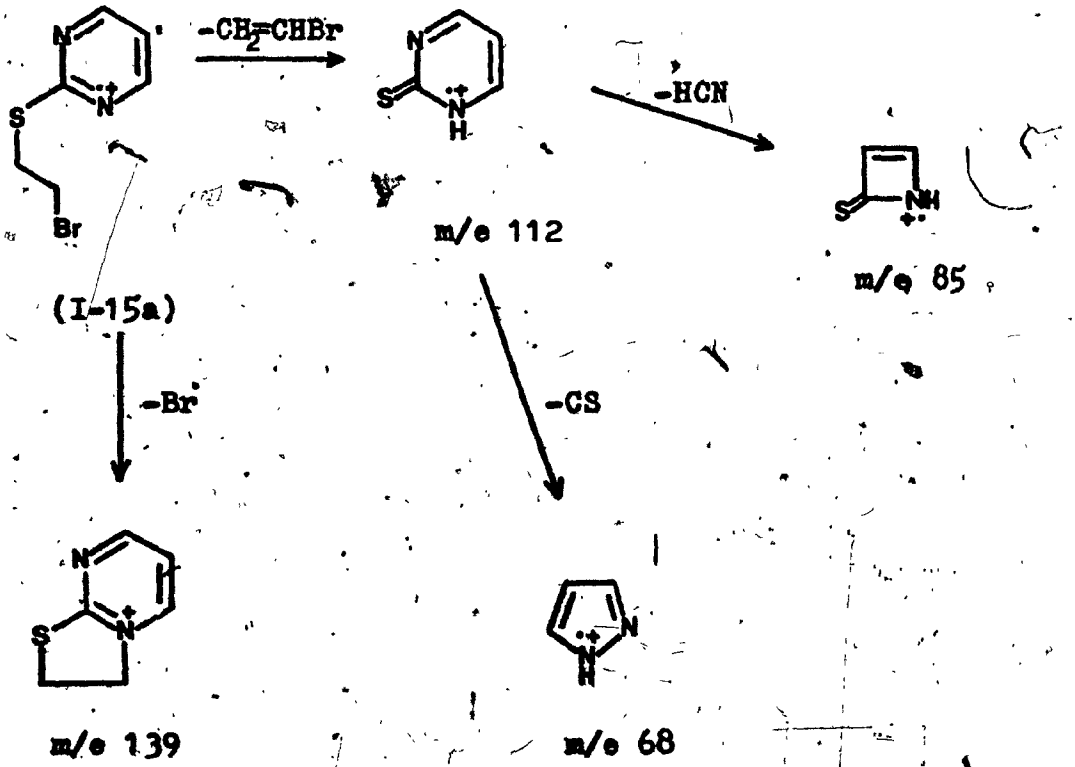
m/e 142 (I-14a) m/e 168 m/e 167

Another interesting spectrum is that of I-15, where first nucleophilic substitution by the anion takes place with opening of the thiazoline ring to form I-15a:



(I-15) (I-15a)

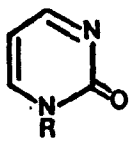
The molecule I-15a, upon electron impact, fragments as shown in the the scheme below.



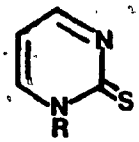
F. OBJECT

The object of the present work was to synthesise and to study the electron impact induced fragmentation of two series of compounds, namely the N-substituted 2-pyrimidones(I-16) and their 2-thio-homologues(I-17).

(I-16)



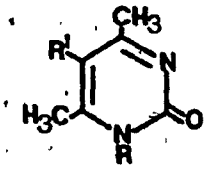
(I-17)



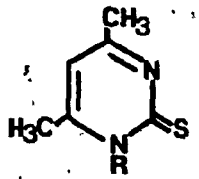
R=	(I-16)	(I-17)
	H(and D)	H
	CH_3(and CD_3)	CH_3
	CH_2CH_3(and CD_2CD_3)	CH_2CH_3
	$CH(CH_3)_2$	-
	CH_2Ph	-
	Ph	Ph

Also studied, but in lesser detail, were

(I-18)



(I-19)



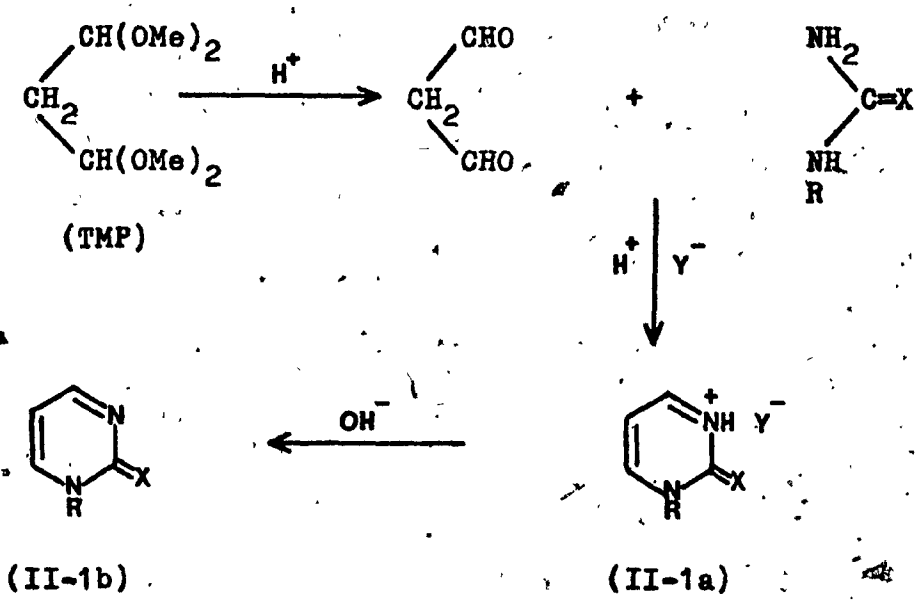
	(I-18)	(I-19)
R=	H or Me	H or Me
R'=	H or Me	-

These compounds were chosen firstly in order to investigate what influence the N-substituents have on the fragmentation of the oxo- or thio-pyrimidine ring and secondly to search for correlation between the behaviour of the oxygen and sulfur analogues.

PART II - EXPERIMENTAL SECTION

A. SYNTHESIS

Most of the desired compounds were synthesized using 1,3-tetramethoxypropane(TMP) as a precursor for malondialdehyde, which reacts with the appropriate urea in the presence of acid to give first the salt of the pyrimidine (II-1a). Subsequent neutralization yields the free base (II-1b)[28].

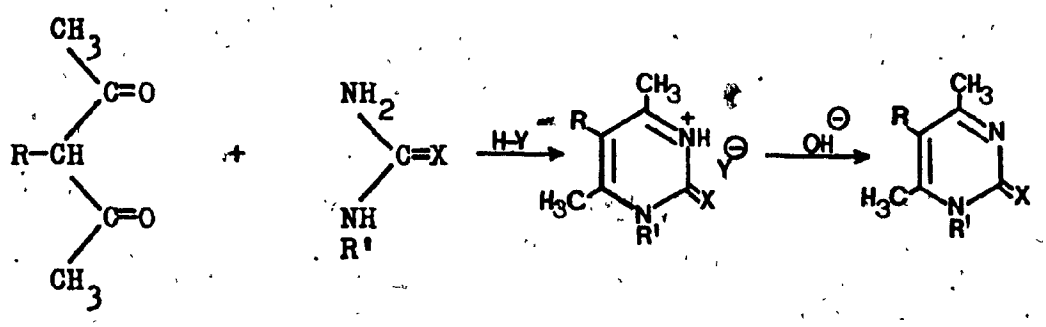


(II-1b) (II-1a)

X = O or S

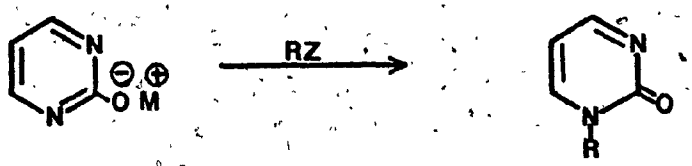
R = H, Me, Et, iPr, Ph, $PhCH_2$

In the case of 4,6- and 4,5,6-methyl-substituted pyrimidones, acetylacetone and 3-methyl-pentane-2,4-dione were used in analogous reactions.



R = H or Me, R' = H or Me, X = O or S

An alternative method for the synthesis of N-substituted pyrimidones is a direct N-alkylation applied to the silver or sodium salt of 2-pyrimidone[28].



M = Na or Ag

R = alkyl

Z = Cl,Br,I

This method was used in few cases, especially to make the deuterated compounds.

Unless indicated otherwise, the starting materials used below were purchased. All the known compounds that were synthesised gave melting points that agreed with the literature values and gave satisfactory NMR spectra. Some compounds, especially those not found in the literature, were submitted to micro analysis by Galbraith Labs. Inc. Knoxville, Tennessee.

The following compounds were prepared by literature

methods:

2-Pyrimidone[29]

The final product was recrystallized from ethyl-acetate. Yield = 47%, m.p. 165° (Lit.[30]:179-181°; 160°; N.B., this compound exists in two polymorphous forms[30]).

1-Isoprepyl-2-pyrimidone[31]

The final product was recrystallized from boiling cyclohexane. Yield = 30%, m.p. 88° (Lit[31]: 90°).

3-Methylpentane-2,4-dione[32]

Yield = 40%, b.p. 170°/760 mm (Lit[32]: 170-172°/760)

1-Benzyl-2-pyrimidone[33]

Yield = 58%, m.p. 138° (Lit[33]: 137-8°).

2-Pyrimidthione[34,35]

Yield = 61%, m.p. 231° (Lit[35]: 230°).

1-Methyl-2-pyrimidthione[36]

Yield = 37%, m.p. 189° (Lit[36]: 189-191.5°).

4,6-Dimethyl-2-pyrimidthione[37]

Yield = 40%, m.p. 208° (Lit[37]: 210°).

1,4,6-Trimethyl-2-pyrimidthione[37]

Yield = 68%, m.p. 156 (Lit[37]: 156°)

1-d_1-2-Pyrimidone

2-Pyrimidone (100 mg) was dissolved in 5 ml of D_2O. The solution was immediately vacuum evaporated to yield off-white crystals. The NMR spectrum in DMSO did not show any

trace of the broad peak at ~δ12, present in the spectrum of the unlabelled 2-pyrimidone, due to the NH hydrogen.
Yield = 100%, m.p. 178°.

1-Methyl-2-pyrimidone - cf. ref. (31)

The sodium salt of 2-pyrimidone (0.01 mole, see p.31) was suspended in 50 ml of methanol. After cooling the mixture in liquid nitrogen or dry ice-acetone, methyl iodide (0.01 mole) was added and the resultant stirred at room temperature over night. The solvent was removed under reduced pressure to give an oily residue, from which the product was extracted with eight times 50 ml of $CHCl_3$. The collected chloroform extracts were passed through a short column of activated alumina and then vacuum evaporated. The residue was crystallised from acetone-light petroleum. Yield = 68%, m.p. 131° (Lit[31]: 131-132°).

The same procedure, using appropriate alkyl iodides, was used to prepare:

1-(Methyl-d_3)-2-pyrimidone

Yield = 69%, m.p. 131°.

1-Ethyl-2-pyrimidone

Yield = 25%, m.p. 63° (Lit[31]: 64-65°).

1-(Ethyl-d_5)-2-pyrimidone

Yield = 25%, m.p. 63°.

(N.B. In the case of both ethyl-pyrimidones, the silver salt instead of the sodium salt of 2-pyrimidone was used and the reaction mixture was refluxed for 5 hrs).

1-Phenyl-2-pyrimidone[38]

The literature method[38] was used for this synthesis. The final product was, however, recrystallised from acetone--light petroleum and not from aqueous ethanol. Yield = 35%, m.p. 154° (Lit[38]: 155°).

Analysis: $C_{10}H_8N_2O$ Calc. C 69.75; H 4.68; N 16.27%

Found C 69.64; H 4.56; N 16.12%

4,5,6-Trimethyl-2-pyrimidone- cf. reference (39)

Urea (1.5 g) was refluxed for 5 hrs with an excess of 3-methylpentane-2,4-dione (10 ml). The mixture was then three times co-evaporated with 5 ml of ethanol, the last time almost to dryness. The white precipitate was then filtered, washed with cold ethanol and recrystallised from abs. ethanol. Yield = 23%, m.p. 230° (Lit[40]: 230°).

NMR spectra (D_2O, DSS): δ2.1(S,3), δ2.4(S,6).

4,6-Dimethyl-2-pyrimidone - was supplied by Dr Tee.

The reference (41) was followed for the synthesis. M.p. 197° (Lit[28]: 194-196°).

1,4,6-Trimethyl-2-pyrimidone

1,4,6-Methyl-2-pyrimidone hydrochloride, prepared as described in the reference (42), was neutralized with saturated aqueous Na_2CO_3 solution and evaporated almost to dryness. The remaining small amount of water was removed by azeotropic distillation with benzene. To remove the Na_2CO_3 crystals that remained, the benzene solution was filtered hot, and upon cooling the filtrate white crystals of 1,4,6-

-trimethyl-2-pyrimidone appeared, which were filtered off and dried. Yield = 80%, m.p. 62° (Lit[28]: 63°).

1-Ethyl-2-pyrimidthione - cf. ref. (38)

Ethylthiourea (0.01 m) and tetramethoxypropane (0.01 m) were refluxed for 2 hrs with 7.5 ml of ethanol and 2.5 ml of conc. HCl. The mixture was then vacuum evaporated and upon adding acetone to the oily residue, yellowish crystals of the hydrochloride salt came out of the solution. These were suction filtered, washed with acetone and dried at room temperature. This salt was dissolved in 5 ml H_2O and 5 drops of 10% aq. NaOH was added. The mixture was then extracted with 50 ml of chloroform and the extract was evaporated to dryness. The residue was recrystallised from acetone-light petroleum. Yield = 50%, m.p. 102°.

Analysis: $C_6H_8N_2S$ Calc. C 51.39; H 5.75; N 19.97; S 22.86%

Found C 51.32; H 6.20; N 20.09; S 22.71%

1-Phenyl-2-pyrimidthione

This compound was prepared by cyclization of phenylthiourea and tetramethoxypropane (cf. ref. 38). The final product was recrystallised from acetone-light petroleum. Yield = 46%, m.p. 155°.

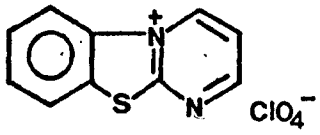
Analysis: $C_{10}H_8N_2S$ Calc. C 63.80; H 4.28; N 14.88%

Found C 63.90; H 4.26; N 14.83%

Pyrimido(2,1-b)benzothiazol-5-ium perchlorate (II-2)

2-Aminobenzothiazole (1.5 g) and TMP (1.6 g) was suspended in the mixture of 70% $HClO_4$ (2 ml) in 10 ml of

methanol and refluxed for 5 hrs. The final product, a green



(II-2)

precipitate, was filtered, washed with cold H_2O and dried at room temperature. Yield = 67%, m.p. 255°.

Analysis: $C_{10}H_7O_4N_2ClS$ Calc. C 41.89; H 2.46; N 9.77%

Found C 41.83; H 2.41; N 9.64%

Phenylthiourea

Phenylisothiocyanate 6 ml (0.05 m) was heated at 70-80° under reflux with 10 ml of conc. ammonia solution (14 N) for 8 hrs. Then ~100 ml of water was added, boiled to dissolve the precipitate and filtered hot. The white crystals that appeared upon cooling the filtrate were suction filtered, washed with cold water and dried at room temperature. Yield = 59%, m.p. 154° (Lit[43]: 154°).

Ethylthiourea

Ethylisothiocyanate and 10 ml of conc. ammonia solution was refluxed at 50° for 24 hrs. Then 10 ml of H_2O was added and the crystals thus obtained were filtered, washed with small amount of cold water, and dried at room temperature. Yield = 44%, m.p. 107° (Lit[44]: 108-110°).

Sodium salt of 2-pyrimidone - cf. reference (31)

Freshly cut sodium (2.4 g, 0.1 g-atom) in 100 ml of dry methanol was added to a suspension of 2-pyrimidone hydrochloride (6.65 g, 0.05 m) in 100 ml of dry methanol.

After stirring at room temperature, the methanol was vacuum evaporated and the residual yellow powder dried at room temperature. The appropriate amount of the final product, that contained 1:1 mixture of sodium salt of 2-pyrimidone and sodium chloride, was used for synthesis of the N-alkyl-2-pyrimidones.

Silver salt of 2-pyrimidone - cf. reference (31)

2-Pyrimidone hydrochloride (1.33 g, 0.01 m) was mixed with silver nitrate (1.69 g, 0.01 m) in 10 ml of H_2O and the precipitate was filtered. One more equivalent of silver nitrate in 10 ml H_2O was added to the filtrate and the solution was immediately neutralized with 0.7 ml of NH_4OH. The precipitate was filtered off, washed with water and dried at room temperature.

B. PROCEDURE FOR MASS SPECTROMETRY

The solid compounds were introduced directly into ion source of a Hitachi RMU-6EI double-focusing mass spectrometer. Approximately 100 µg of sample was used. Spectra were recorded at ionization voltages of 70 eV . The elemental composition of some ions was determined by high resolution mass measurement relative to CF_3^+, using the MS-902 S mass spectrometer at the University of Ottawa, and some of the metastable transitions were confirmed by defocusing operation using the sector voltage scan method[45]. Some spectra were also obtained from the MS-902 instrument at McGill university.

A small computer program that calculated masses lost due to all possible fragmentation pathways with m/e of the relevant metastable ions, written by Dr O.S.Tee, was very helpful for interpretation of the spectra. Another computer program, written by Dr R.T.Rye, was used for the calculation of percentages of the relative intensities and total ionization of the ions, and also for plotting of the spectral graphs.

In the next section the following abbreviations are used:

R.I. %	per cent of relative intensity with respect to the base peak
r	rearrangement
m^*	metastable ion for the unlabelled species
$m^\bullet$	metastable ion for the labelled species.

PART III - RESULTS AND DISCUSSION

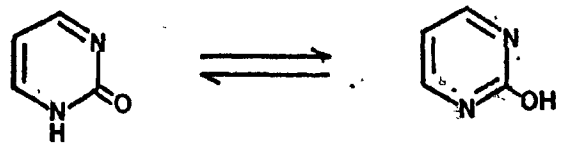
2-Pyrimidone (III-1) (Fig. III-1)

m/e	96	95	69	68	67	54	53	52
R.I.%	100.0	31.8	27.3	93.2	18.2	5.1	23.9	43.2
m/e	51	44	43	42	41	40	39	
R.I.%	20.5	23.9	10.5	75.0	72.7	70.5	31.8	

N-d$_1$-2-Pyrimidone (III-2) (Fig. III-2)

m/e	97	96	95	70	69	67	54	53	68
R.I.%	99.1	76.1	12.4	25.2	100.0	13.8	12.4	37.6	79.4
m/e	52	51	45	44	43	42	41	40	
R.I.%	56.0	39.4	25.7	19.3	56.9	78.0	71.6	71.6	

This molecule, of course, is potentially tautomeric. In aqueous or ethanolic solution it exists largely (>94%) in the keto-form (III-1a)[18], whereas, at equilibrium, in the vapour phase the enol-form (III-1b) predominates (>91%).[18]

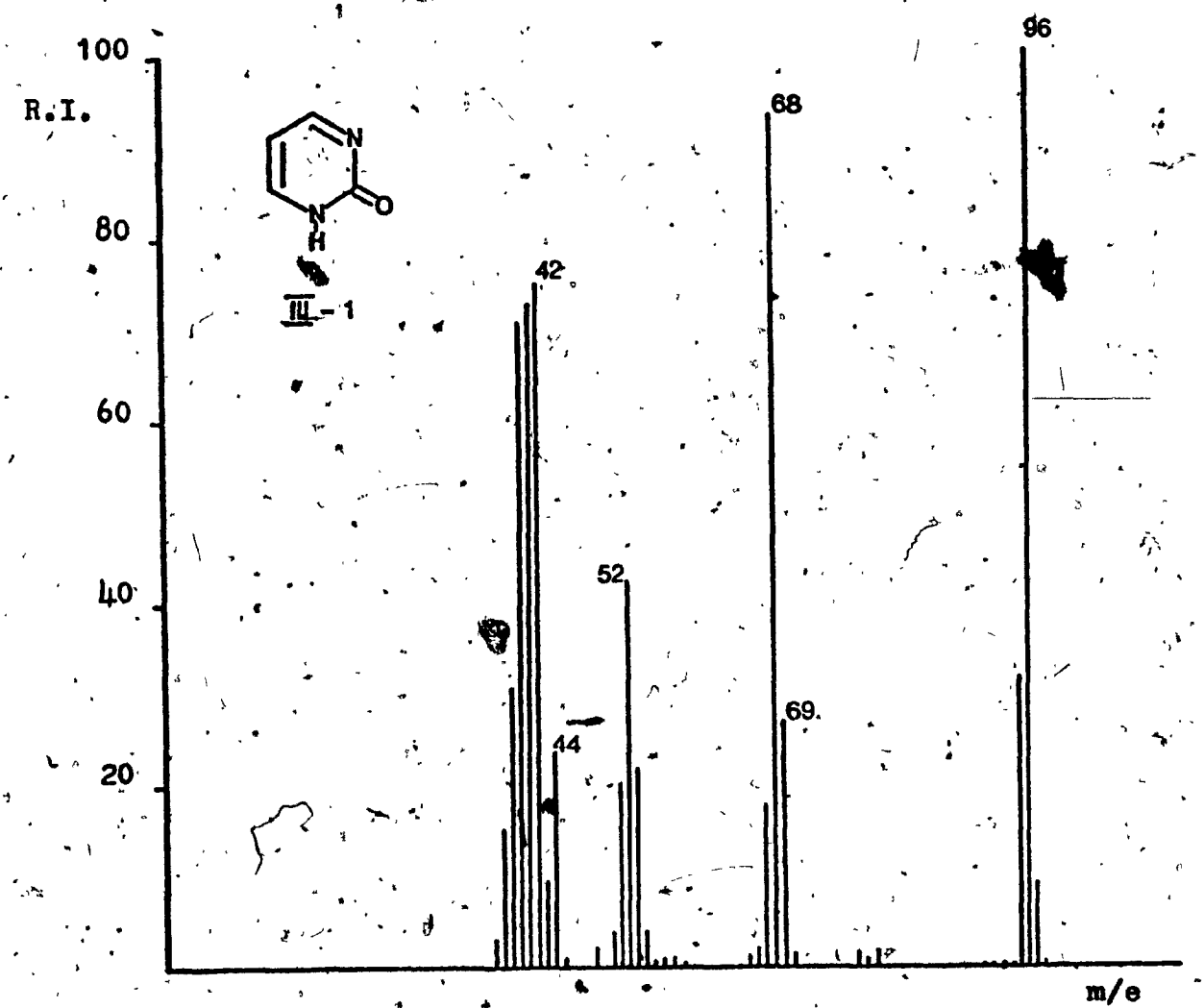


(III-1a) (III-1b)

In the solid state the material most probably contains molecules in the keto-form (III-1a)[46]. Thus, in the source of the mass spectrometer, following vaporization but prior to

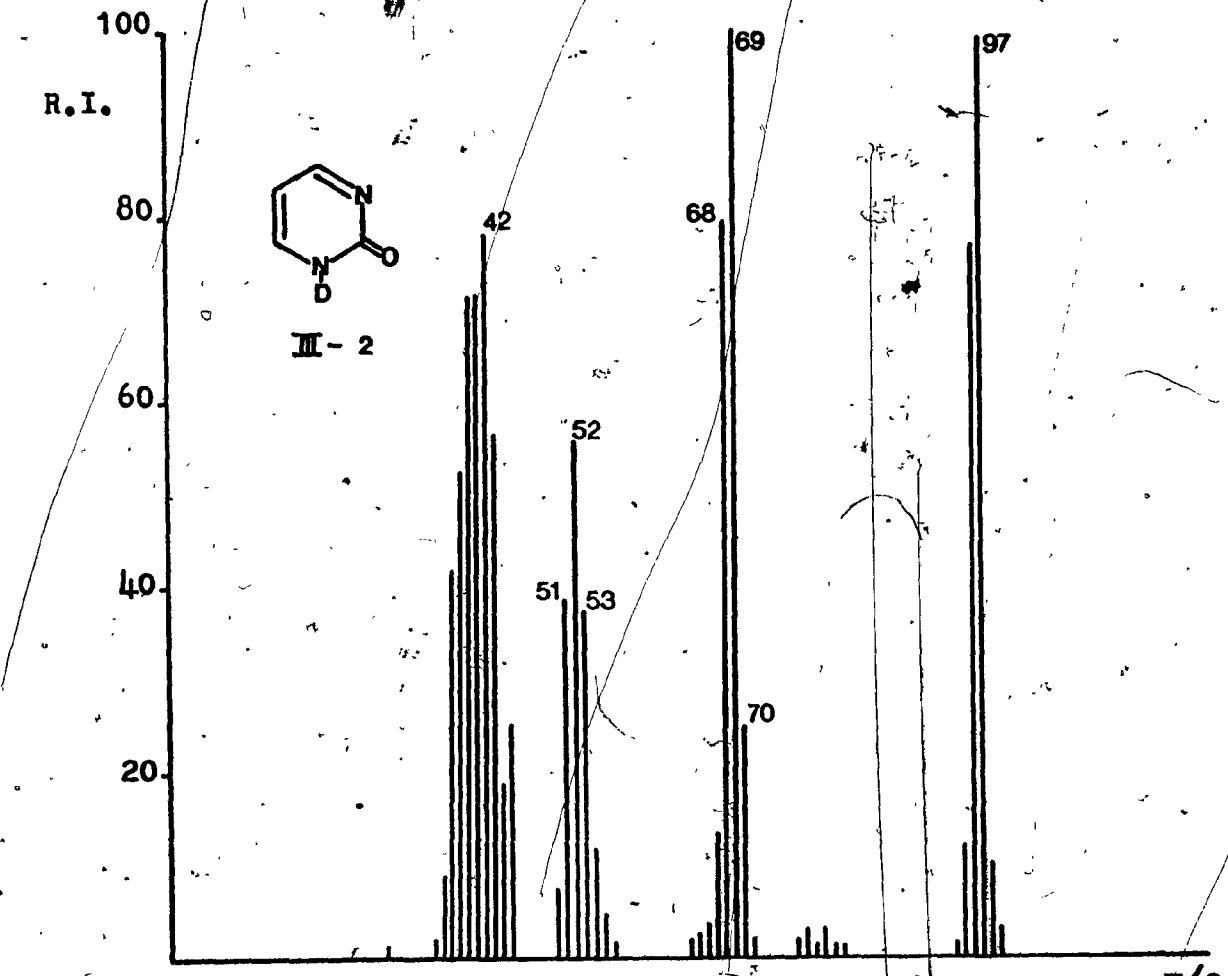
ionization, 2-pyrimidone may well be present in both tautomeric forms.

The mass spectrum of this compound shows a large (100.0%) molecular ion peak (M^+, m/e 96). In view of the preceding discussion the structure of this ion is quite problematical. It may be derived from the keto-form as III-1c,



III-1

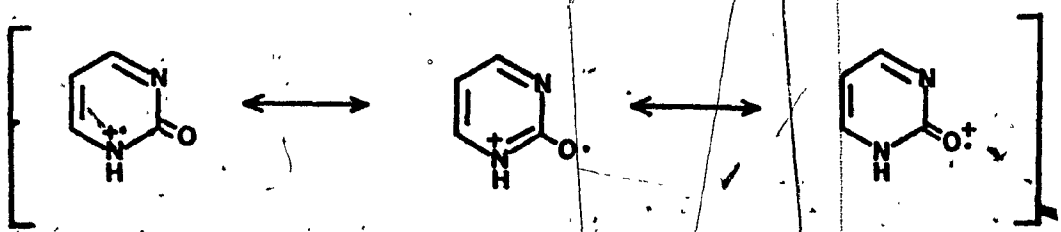
Fig. III-1 Mass spectrum of 2-pyrimidone



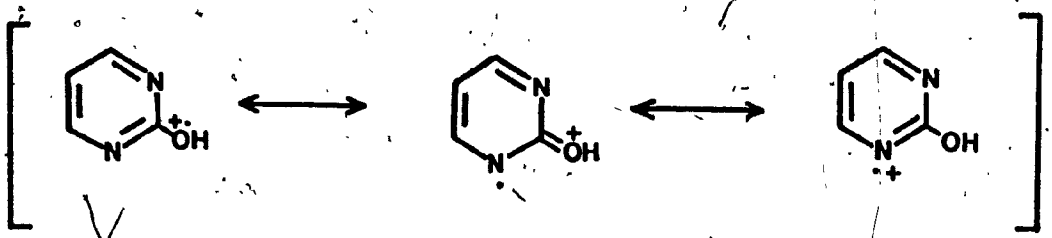
III-2

Fig. III-2 Mass spectrum of N-d_1-2-pyrimidone

or from the enol-form as III-1d.

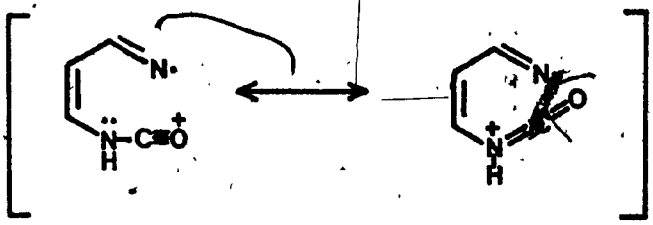


(III-1c)

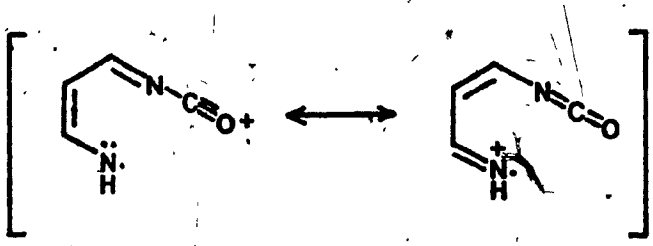


(III-1d)

Of these two, the former looks more favorable on electronic grounds. However, one cannot rule out open forms such as III-1e and III-1f,

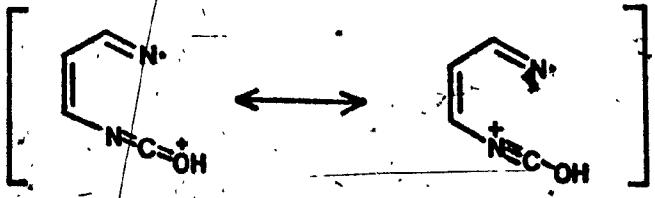


(III-1e)



(III-1f)

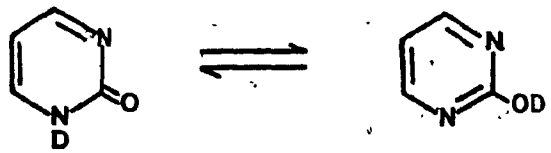
which are formally derived from the keto-cation-radical (III-1c) by C-N cleavage. Likewise, opening of the enol--cation-radical (III-1d) might lead to the open form III-1g.



(III-1g)

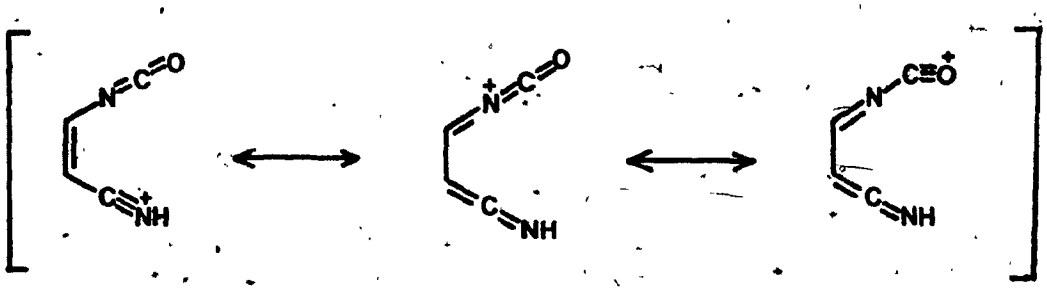
There is also the possibility of ring-expanded structures, although these are unlikely for an odd-electron cation.

Judging by the sizeable (R.I. 31.8%) peak at m/e 95, and the metastable at ~94.0, the molecular ion loses hydrogen. Moreover, for the deuterated substrate (III-2a,b) loss of H· (not D·) is also significant. Thus the loss of hydrogen



(III-2a) (III-2b)

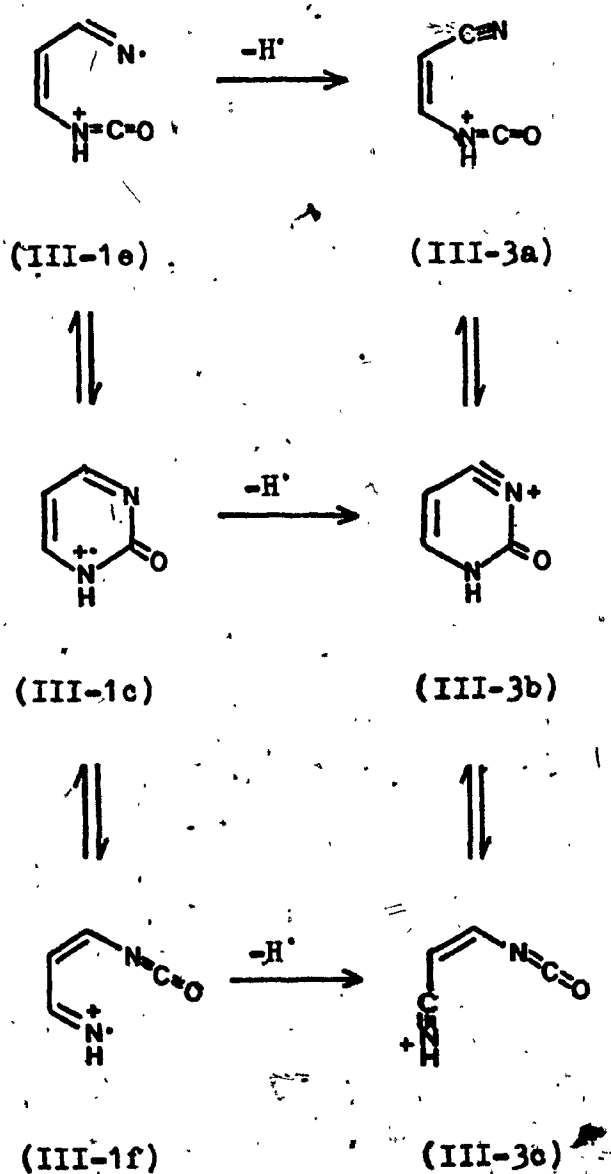
from the molecular ion results from C-H bond rupture. In some way this cleavage must be facilitated by the second nitrogen of the pyrimidine ring since 2-pyridone does not show a significant (M-1) peak[16]. The major possibilities related to the parent keto-structure are shown below (Scheme III-1). Of the structures (III-3a,b,c) the last may be the most stable due to delocalisation.



(III-3c)

Also both nitrogens are involved in its stabilization.

Scheme III-1



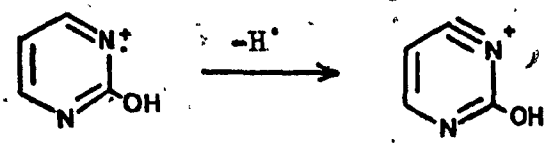
(III-1e) (III-3a)

(III-1c) (III-3b)

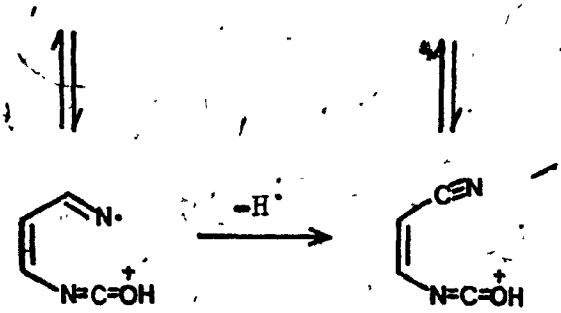
(III-1f) (III-3c)

The loss of hydrogen might also be associated with the enol-form of the molecular ion (III-1d) as shown

below:

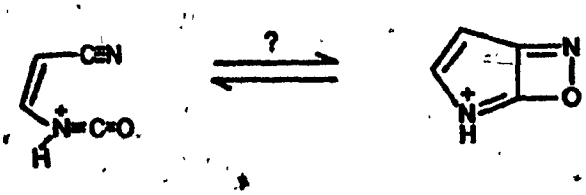


(III-1d) (III-3d)



(III-1g) (III-3e)

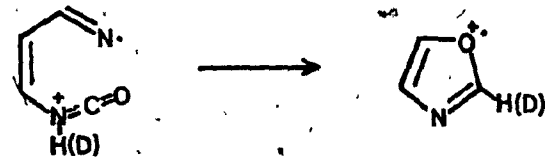
The possibility that the (M-1) ion exists as a 7-membered ring appears remote since a structure which is strictly isoelectronic with the tropylium ion cannot be written for $C_4H_3N_2O^+$. More likely would be a bicyclic structure such as III-3f, which is closely related to the open structure III-3a.



(III-3a) (III-3f)

After the $M^{+\cdot}$ and $(M-1)^+$ ions the next significant peaks occur at m/e 69(27.3%), 68(93.2%), and 67(18.2%). For the deuterated substrate (III-2) these are replaced by peaks at m/e 70(25.2%), 69(100.0%) and 68(79.4%). Thus these ions appear to still contain the tautomeric H or D of the original substrates (III-1 or III-2).

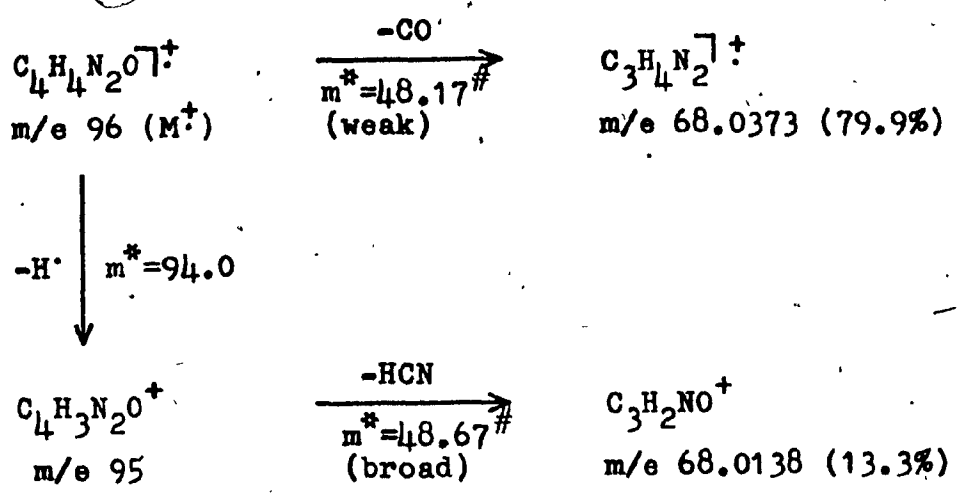
For the unlabelled substrate high-resolution mass spectroscopy showed that the m/e 69 ion has the composition C_3H_3NO (calc. 69.0215; obs. 69.0212). This corresponds to loss of HCN from the molecular ion and may involve the formation of the oxazole cation (III-4) from III-1e.



m/e 96(97) (III-1e) → m/e 69.0212 (70) (III-4)

The large m/e 68 peak (93.2%) was shown to be due to two ions: $C_3H_4N_2^+$ (calc. 68.0374; obs. 68.0373) and $C_3H_2NO^+$ (calc. 68.0136; obs. 68.0138) in the ratio 6:1. In view of the observed metastables these arise as shown in the Scheme III-2 (vide infra).

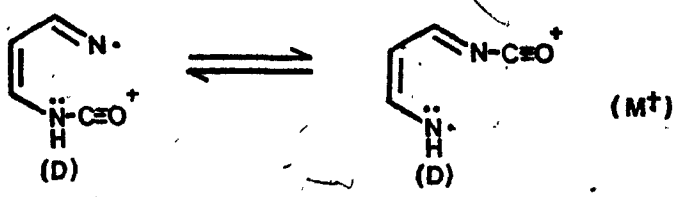
The loss of CO from the molecular ion (as III-1e or III-1f) may result in the formation of the pyrazole



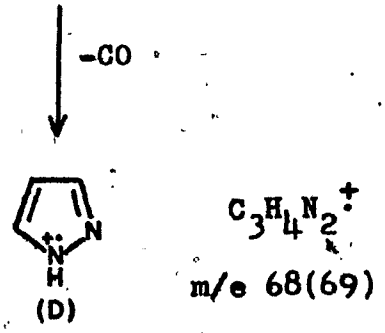
Scheme III-2

N.B. These metastables were resolved.

cation (III-5):

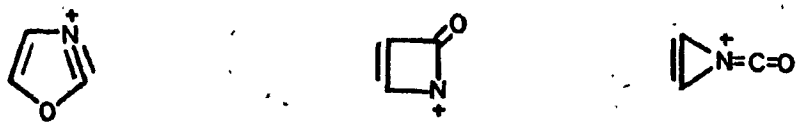


(III-1e) (III-1f)



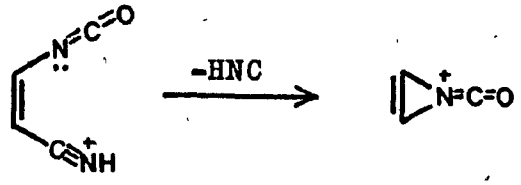
(III-5)

The minor ion $C_3H_2NO^+$ may have various structures such as:



(III-6)

Of these III-6 is the most attractive, and might arise from the open ion III-3c by the loss of HNC. Note that this



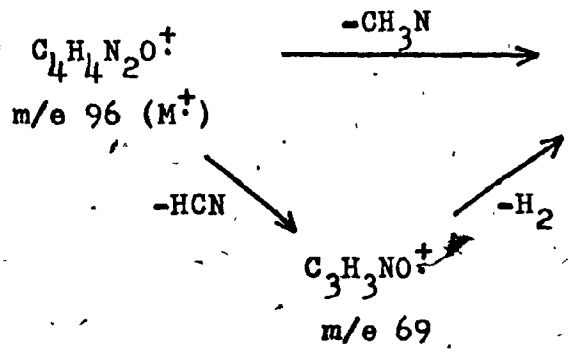
(III-3c) m/e 95 (III-6) m/e 68.0138

mechanism requires that the (M-1) ion from the deuterated substrate lose DNC. Whether this is the case or not has not yet been ascertained.

Resolution of the smaller m/e 67 peak showed that it also is due to two ions: $C_3H_3N_2^+$ (calc. 67.0296; meas. 67.0298) and C_3HNO^+ (67.0058; meas. 67.0057) in the ratio 4:1. The former may well represent loss of hydrogen from the pyrazole cation or loss of CO from the (M-1) ion:

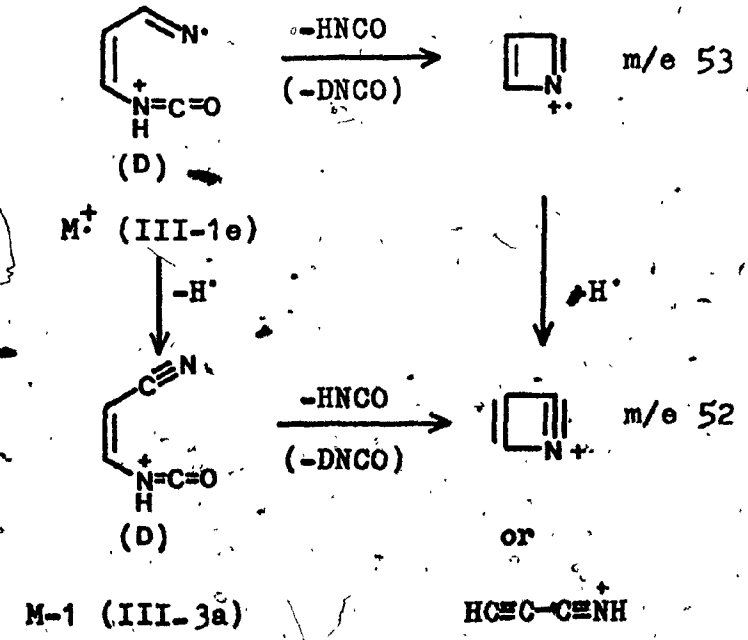
(III-5) m/e 68 (III-7) m/e 67 $(M-1)^+$ m/e 95

The origin and structure of $C_3HNO^{+\cdot}$ is not so easily rationalized. However, since it is an odd-electron ion, it most likely arises from either the molecular ion or the m/e 69 ion.



A possible structure for $C_3HNO^{+\cdot}$ is $H-C\equiv C-N=C=O^{+\cdot}$.

The next group of peaks in the spectrum is at m/e 53(23.9%), 52(43.2%), 51(20.5%), and is little different for the deuterated substrate. The first two probably represent ions resulting from the loss of HNCO (or DNCO) from the $M^{+\cdot}$ and $(M-1)^{+}$ ions. The m/e 51 ion is probably structu-



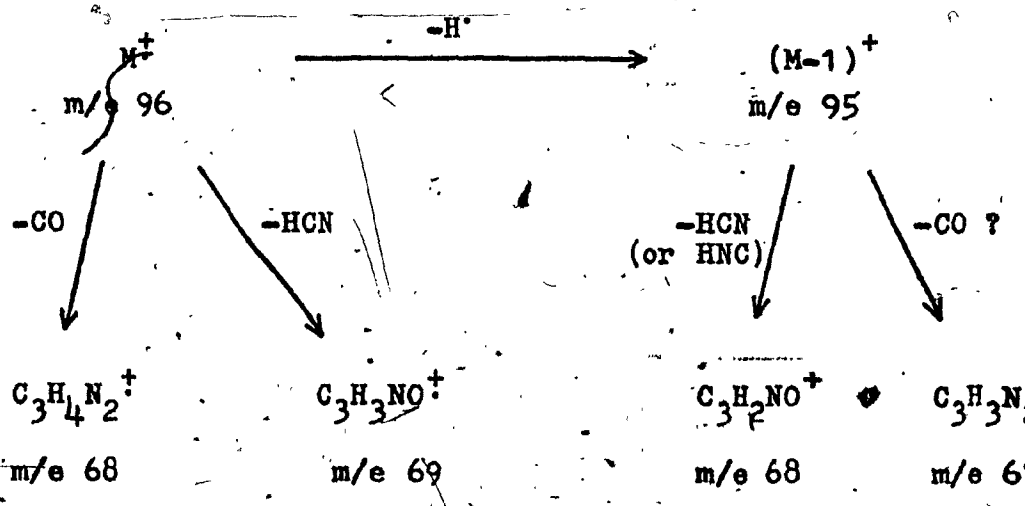
rally related to these and may be $HC{\equiv}C{-}C{\equiv}N^+$.

The last group of peaks to be considered are those centred around m/e 42. These contain 3 heavy atoms and the major possibilities are:

m/e 39	$C_3H_3^+$,	$C_2HN^{\cdot+}$			
40		$C_2H_2N^+$			
41		$C_2H_3N^{\cdot+}$			
42		$C_2H_4N^+$,	$CH_2N_2^{\cdot+}$,	CNO^+,	$C_2H_2O^{\cdot+}$
43			$CH_3N_2^+$,	$CHNO^{\cdot+}$	
44				CH_2NO^+	

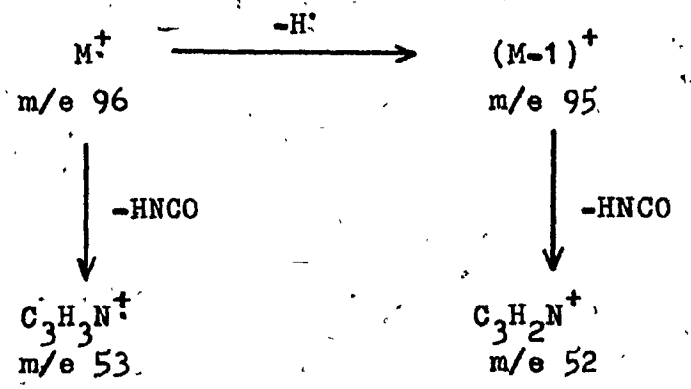
These probably result, to a large extent, from fragmentations of the pyrazole cation (III-5) and the oxazole cation (III-4), both of which are known to give such fragments[47].

In summary the primary fragmentations involve loss of CO and HCN from the molecular ion, and loss of HNC (or HCN) and possibly CO from the (M-1) ion as outlined below:



These fragments, in turn, are probably responsible for

peaks in the range m/e 39-44. Finally, a minor fragmentation pathway seems to result from the loss of HNCO from the M^+ and $(M-1)^+$ ions:



1-Methyl-2-pyrimidone (III-8) (Fig. III-3)

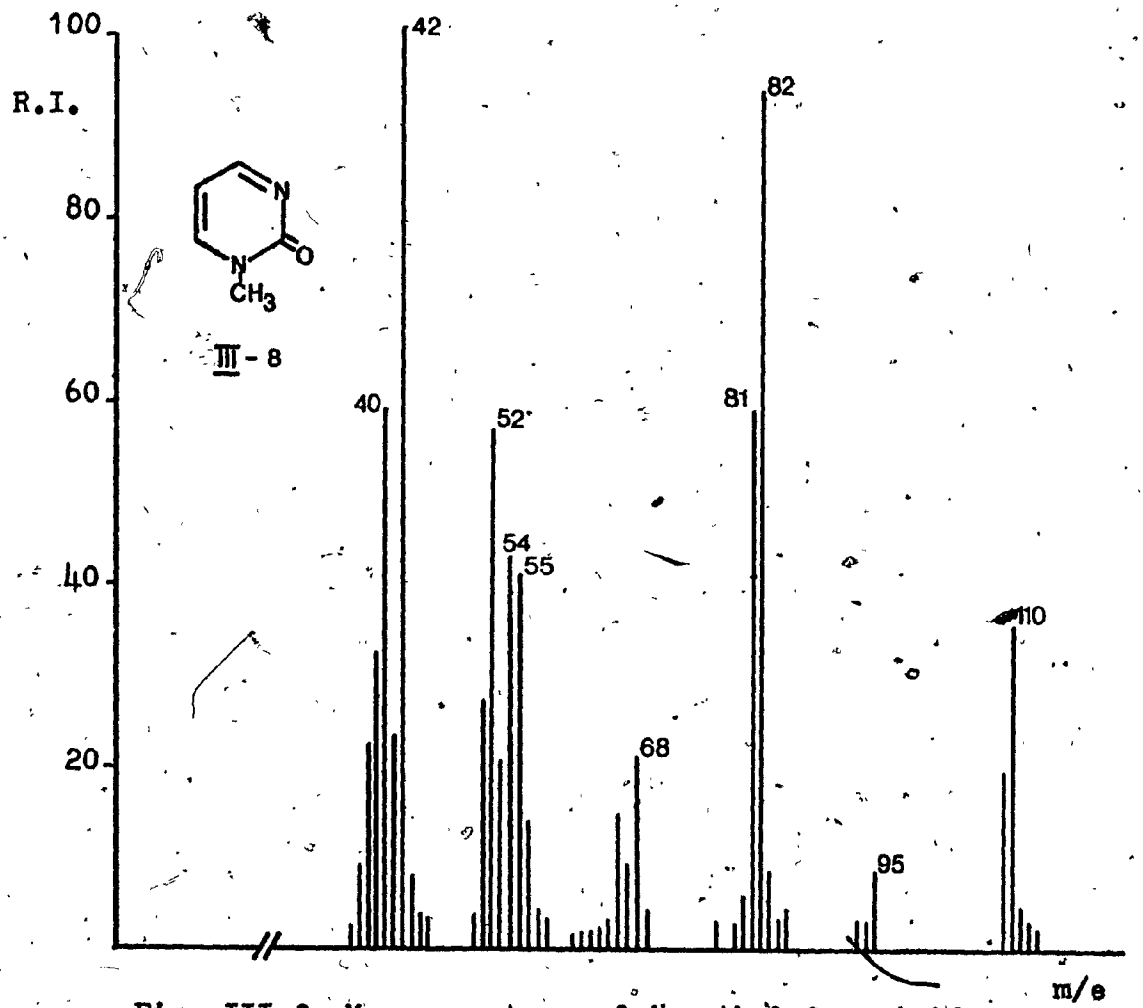
m/e	110	109	95	83	82	81	68	55
R.I.%	34.6	19.7	9.3	9.4	92.8	59.0	21.5	41.0
m/e	54	52	42					
R.I.%	43.2	56.3	100.0					

1-d_3-Methyl-2-pyrimidone (III-9) (Fig. III-4)

m/e	113	112	95	86	85	84	83	71
R.I.%	44.7	20.1	11.1	7.2	82.7	27.1	32.7	12.0
m/e	69	68	58	52	45			
R.I.%	18.9	14.4	39.7	34.8	100.0			

The molecular ion (III-8a) at m/e 110 loses hydrogen to form an ion at m/e 109. Also the 1-d_3-methyl-2-pyrimidone (III-9) forms relatively high abundant M-1 ion, which shows that the hydrogen loss does not affect the

methyl-group, but most probably involves 4 or 6 position of the pyrimidine ring. By analogy to 2-pyrimidone the M-1 ion of III-8 can adopt the following structures, derived from the keto-form of the parent molecular ion (cf. Scheme



III - 8

Fig. III-3 Mass spectrum of 1-methyl-2-pyrimidone

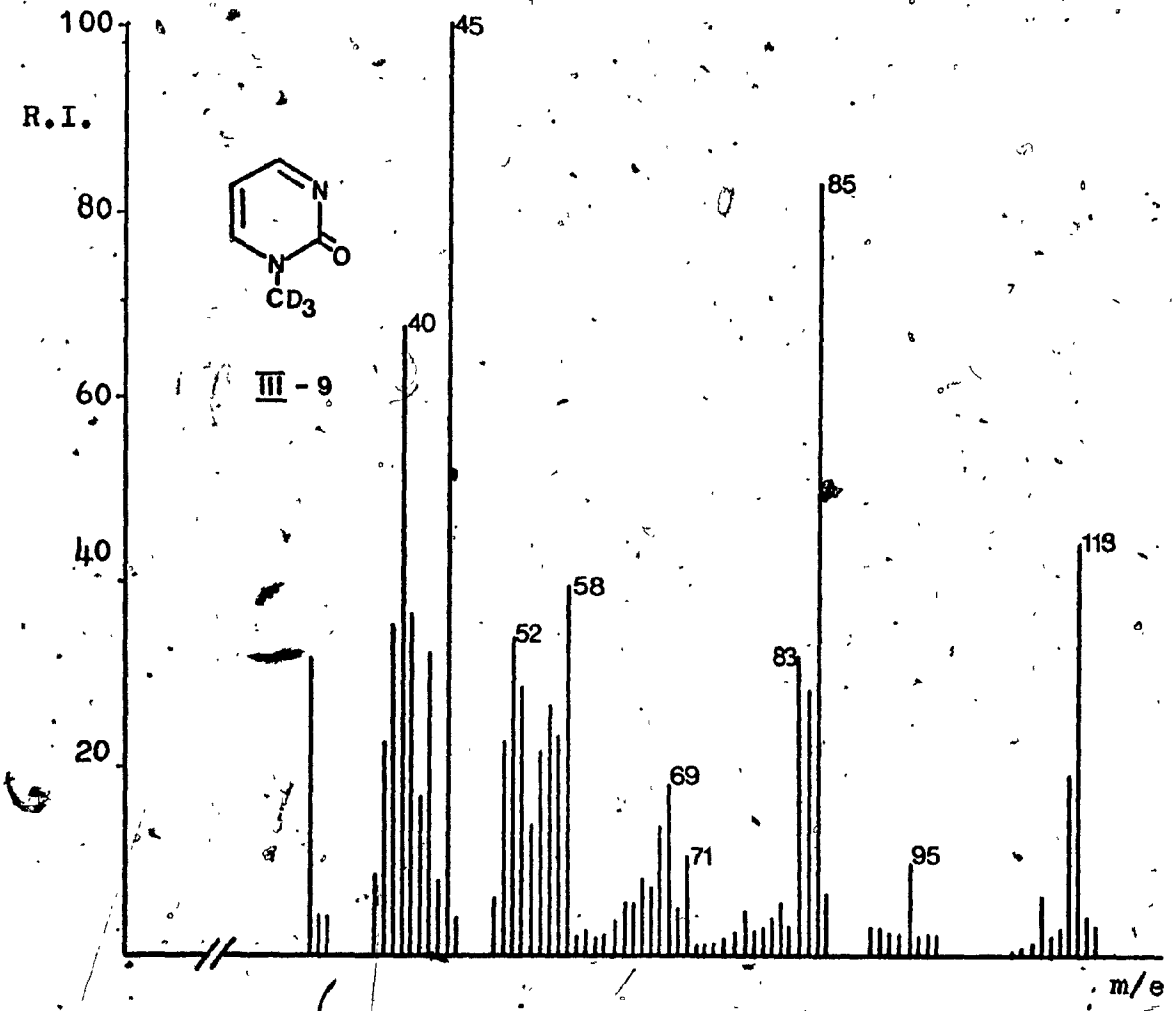
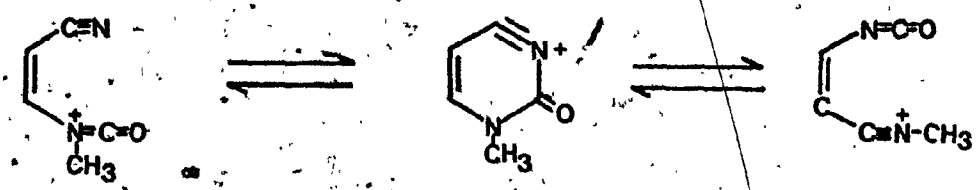


Fig. III-4 Mass spectrum of 1-d_3-methyl-2-pyrimidone

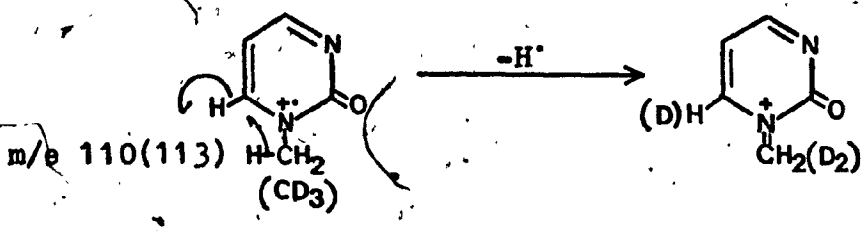
III-1 p. 38):



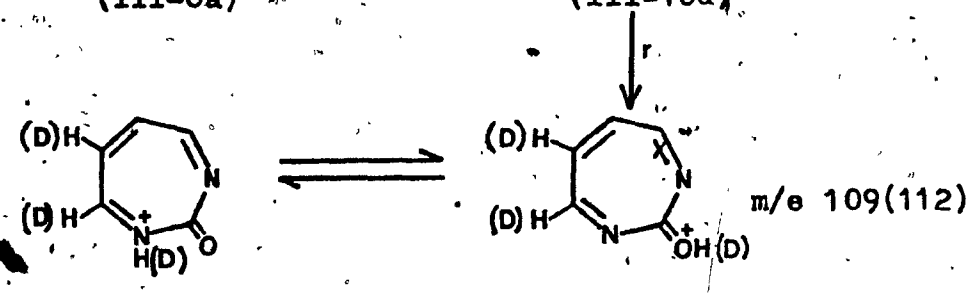
(III-10a) (III-10b) (III-10c)

m/e 109(112)

However, since the loss of HCN from M-1 ion possibly occurs, the following possibilities for the loss of hydrogen from the molecular ion (III-8a) are also considered (cf. refs. 48,49,50)



(III-8a) (III-10d)

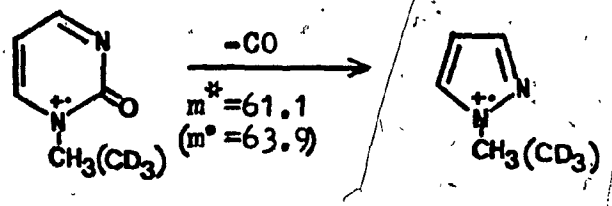


(III-10e)

On the other hand, judging from the most abundant fragments in the spectrum of the undeuterated and deuterated compound (III-8 and III-9 resp.), it seems that the scrambling of the methyl hydrogens with the ring hydrogens occurs only to a minor extent.

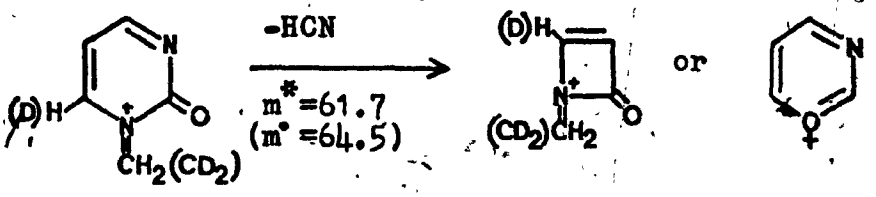
The next significant peak is at m/e 82 and contains possibly two fragments by analogy to the fragmentation pattern of the unsubstituted 2-pyrimidone (III-1). The first fragment, which arises from the molecular ion by expulsion of CO to form an ion $C_4H_6N_2^+$, is most probably the N-methyl--pyrazolium ion. The corresponding peak for the deuterated

compound appears at m/e 85 ($C_4H_3D_3N_2^+$).



(III-8a) m/e 110(113) (III-11) m/e 82(85)

The second fragment can be derived from the M-1 ion (III-10d) by loss of HCN to yield the $C_4H_4NO^+$ ($C_4HD_3NO^+$) ion (III-10d):

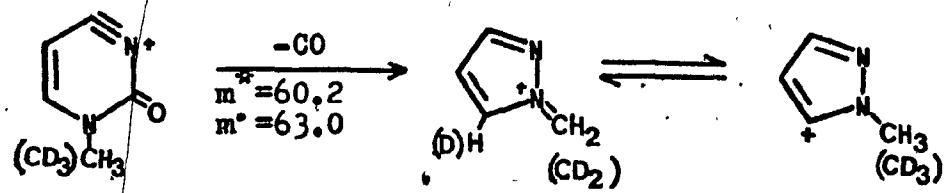


(III-10d) m/e 109(112) (III-12) m/e 82(85)

The corresponding metastable ions for the two processes occurring in the unlabelled compound are difficult to distinguish without using special techniques, since they should appear at m/e 61.1 and 61.7 respectively. For the deuterated compound, however, the two metastable transitions are more easy to observe, as indicated in the last two schemes.

Another important fragment is at m/e 81, in the labelled compound at m/e 84. In view of the observed metastable ions this transition involves loss of CO from

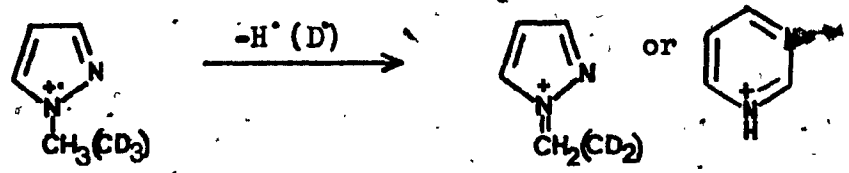
the M-1 ion (cf. ref. 48):



(III-10b)
m/e 109(112)

(III-13)
m/e 81(84)

Of interest is that the relative intensity of m/e 81 in the unlabelled compound is almost double the peak at m/e 84 that occurs in the spectrum of the labelled species. It looks like there is another pathway that contributes to the abundance of the m/e 81 ion. It may well be that the methyl-pyrazolium ion (III-11) at m/e 82(85) loses hydrogen, which, according to the literature[49], is expelled to a large extent (93%) from the methyl-group. Thus in the deuterated compound loss of deuterium would be involved, giving rise to the relatively high abundant peak at m/e 83:

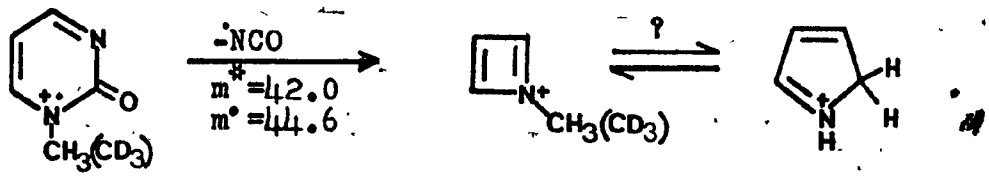


(III-11)
m/e 82(85)

(III-14)
m/e 81(83)

More problematical is the ion at m/e 68. It partly comes from the molecular ion by loss of NCO and is

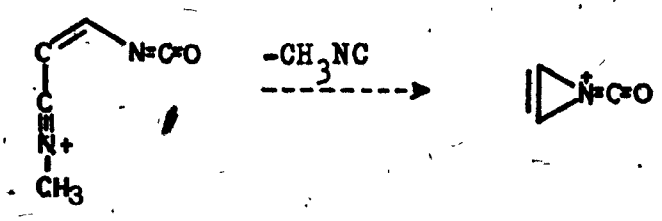
confirmed by the appropriate metastable ions. In the deuterated compound the resultant ion appears at m/e 71:



(III-8a)
m/e 110(113)

(III-15)
m/e 68(71)

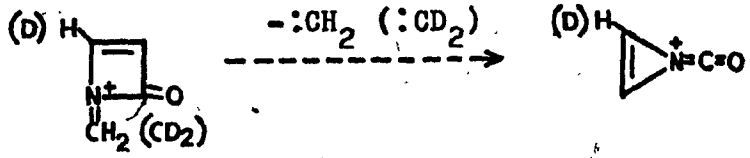
Another fragmentation pathway, which would give rise to m/e 68 in the spectra of both, the unlabelled and the labelled substrates, would involve loss of CH_3NC (CD_3NC) from the M-1 ion (III-10c), by analogy with the loss of HNC from the M-1 ion (III-3c) of 2-pyrimidone (see p. 42):



(III-10c)

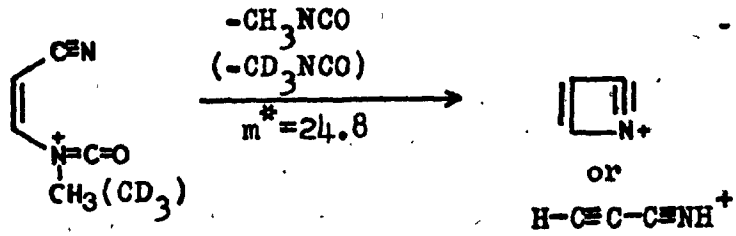
(III-6)
m/e 68

There is still one more alternative that could yield the m/e 68, or m/e 69 ion in the spectrum of the labelled compound, and that is the expulsion of $:CH_2$ ($:CD_2$) from the ion III-12:



(III-12) (cf. p. 60) (III-6a)
m/e 82(85) m/e 68(69)

The loss of CH_3NCO (CD_3NCO) from M-1 ion that is responsible for the peak at m/e 52 in both spectra is confirmed by the appropriate metastable ion for the unlabelled compound:



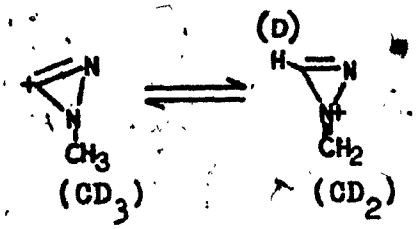
(III-10a)
m/e 109(112)

m/e 52(52)

Also expulsion of acetylene from III-13 is confirmed by the appropriate metastable ions and gives rise to the peak at m/e 55(58):

(III-13)
m/e 81(84)

(see p.50)

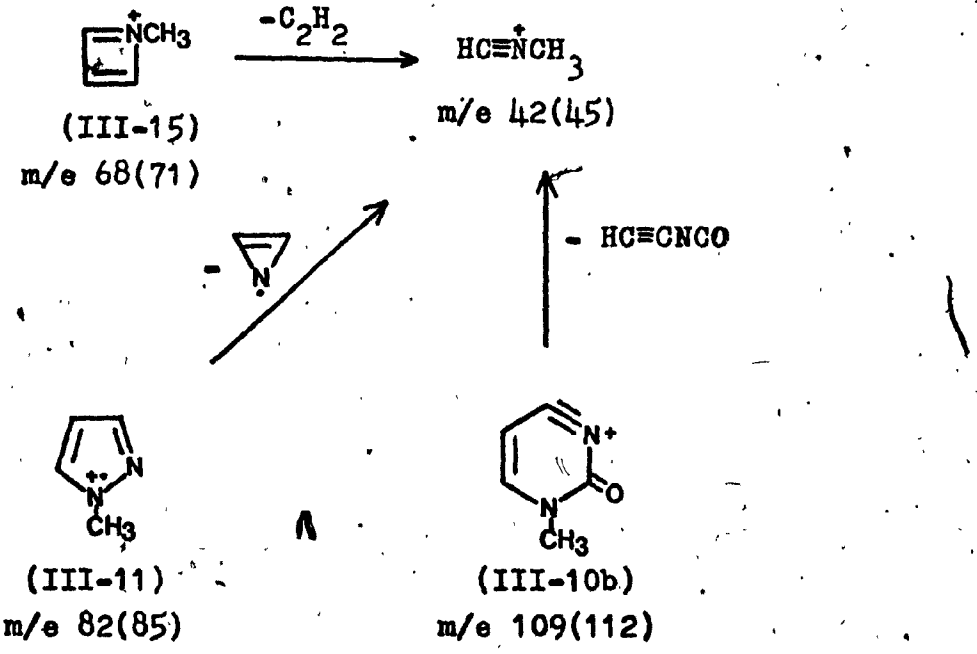


(III-16)
m/e 55(58)

A minor fragment appears in both spectra at m/e 95 and involves loss of $^{\cdot}CH_3$ ($^{\cdot}CD_3$) from the molecular ion.

The small peak at m/e 83(86) most probably involves loss of HCN from the molecular ion, although no metastable ions are observed for this process.

Finally, there is a high abundant fragment at m/e 42(45) which forms the base peak and most probably is the $CH_3\overset{+}{N}{\equiv}CH$ ion. There are numerous possibilities that can give rise to this fragment. For example it may arise from fragmentations of the 4-, 5-, and 6-membered cyclic ions III-15, III-11 and III-10b:



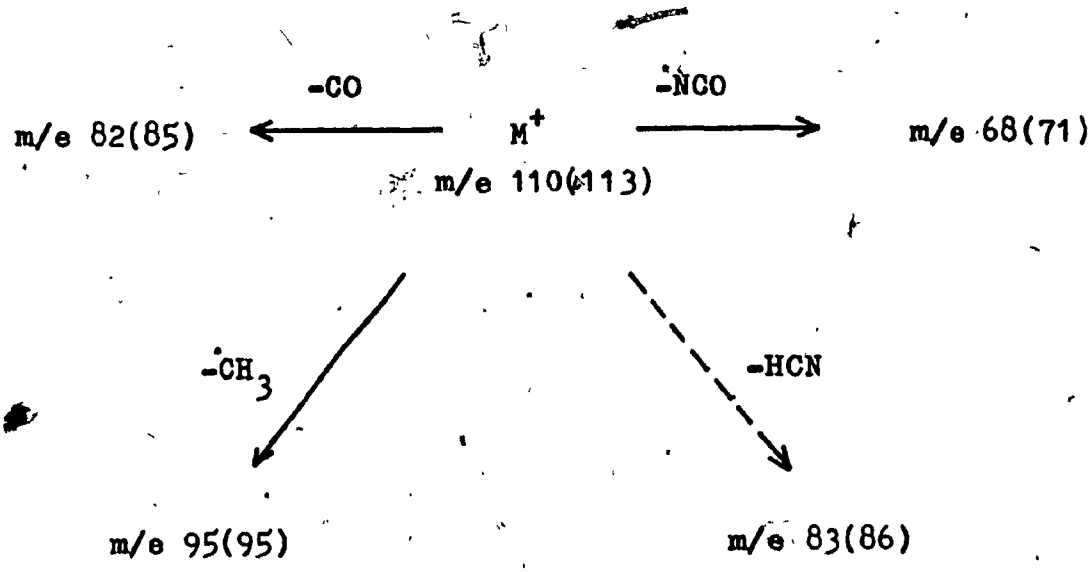
(III-11)
m/e 82(85)

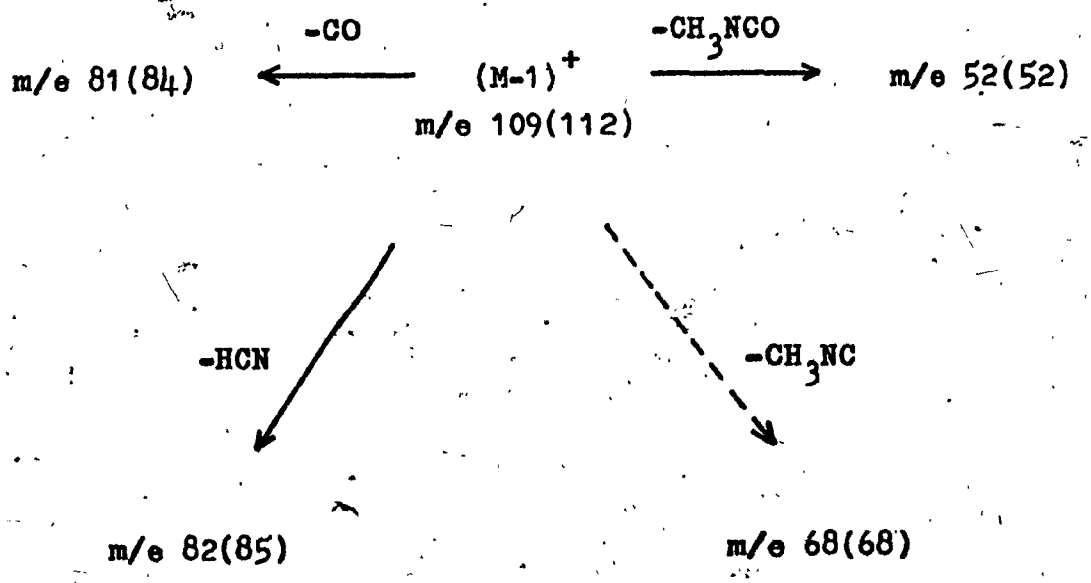
(III-10b)
m/e 109(112)

The last possibility is particularly attractive since there are signs of the appropriate metastables for the labelled and unlabelled substrates.

In summary the primary fragmentations are loss of

CO, HCN, $\dot{C}H_3$ and $\dot{N}CO$ from the molecular ion and loss of CO, CH_3NCO and possibly HCN and CH_3NC from the M-1 ion:





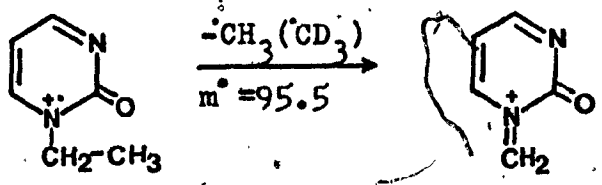
1-Ethyl-2-pyrimidone (III-17) (Fig. III-5)

m/e	124	123	109	97	96	95	83	82
R.I.%	100.0	12.0	55.0	11.1	60.3	42.7	5.1	48.4
m/e	81	80	79	69	68	67	66	56
R.I.%	36.5	11.0	5.1	24.0	75.2	12.0	10.9	27.3
m/e	55	54	53	52	41			
R.I.%	10.3	41.3	17.0	27.3	36.6			

1-d_5-Ethyl-2-pyrimidone (III-18) (Fig. III-6)

m/e	129	128	111	101	97	96	87	84
R.I.%	100.0	8.0	80.0	4.0	60.0	46.7	8.0	40.0
m/e	83	69	68	67	58	57	56	55
R.I.%	53.3	86.7	12.7	9.3	10.7	14.0	23.3	22.0
m/e	54	53	52	40				
R.I.%	12.0	17.3	22.0	46.7				

Loss of hydrogen from the molecular ion (III-17a) is of minor importance and also the fragmentation pattern of III-17 indicates, that no significant fragment ions originate from the M-1 ion. The loss of $\cdot CH_3$ from the molecular ion



(III-17a) m/e 124(129)

(III-19) m/e 109(111)

takes priority instead and is responsible for the peak at m/e 109, which for the labelled 1-d$_5$-ethyl-2-pyrimidone (III-18) appears at m/e 111, and is confirmed by a metastable peak at m/e 95.5. The resulting fragment is most likely the

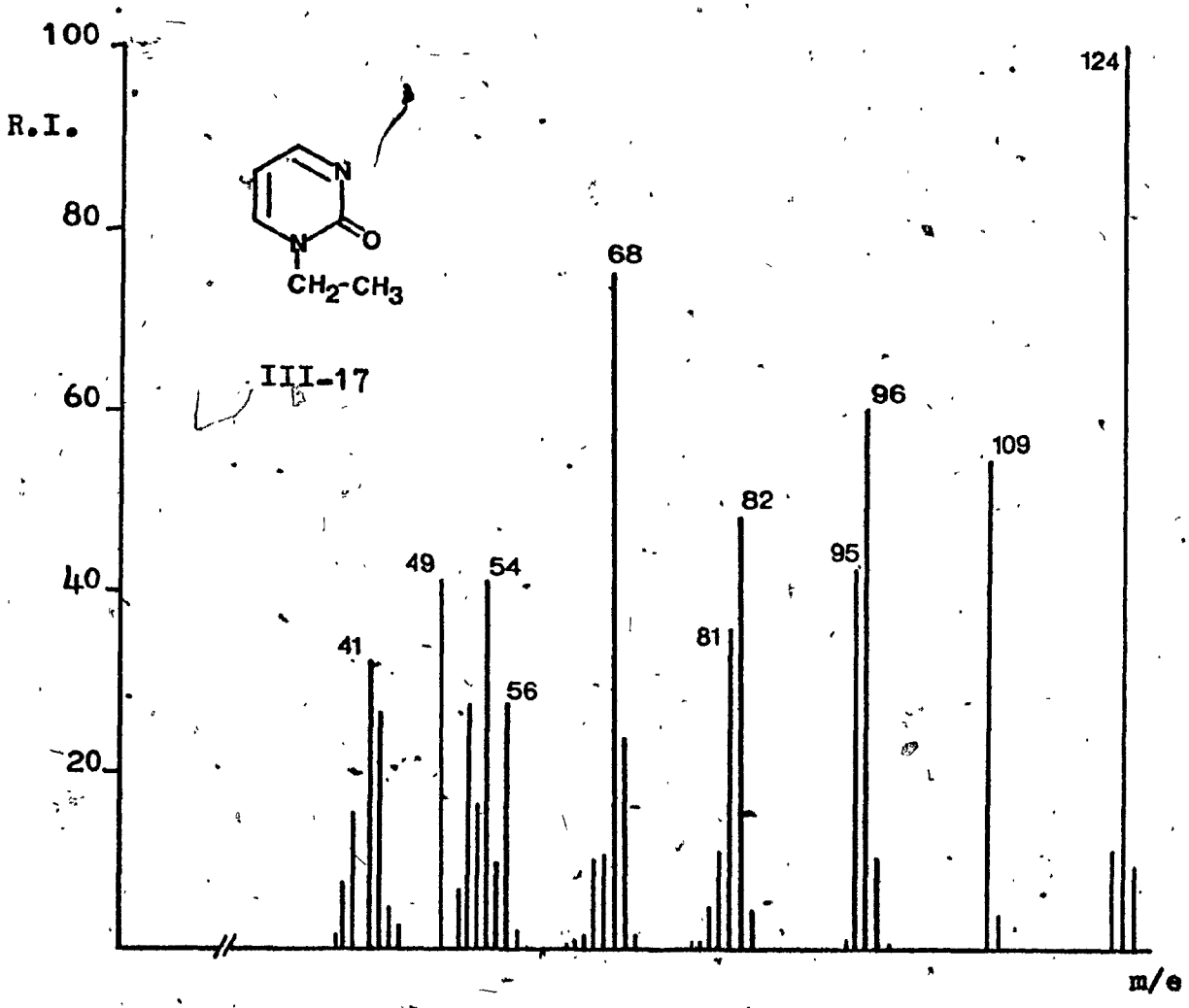


Fig. III-5 Mass spectrum of 1-ethyl-2-pyrimidone

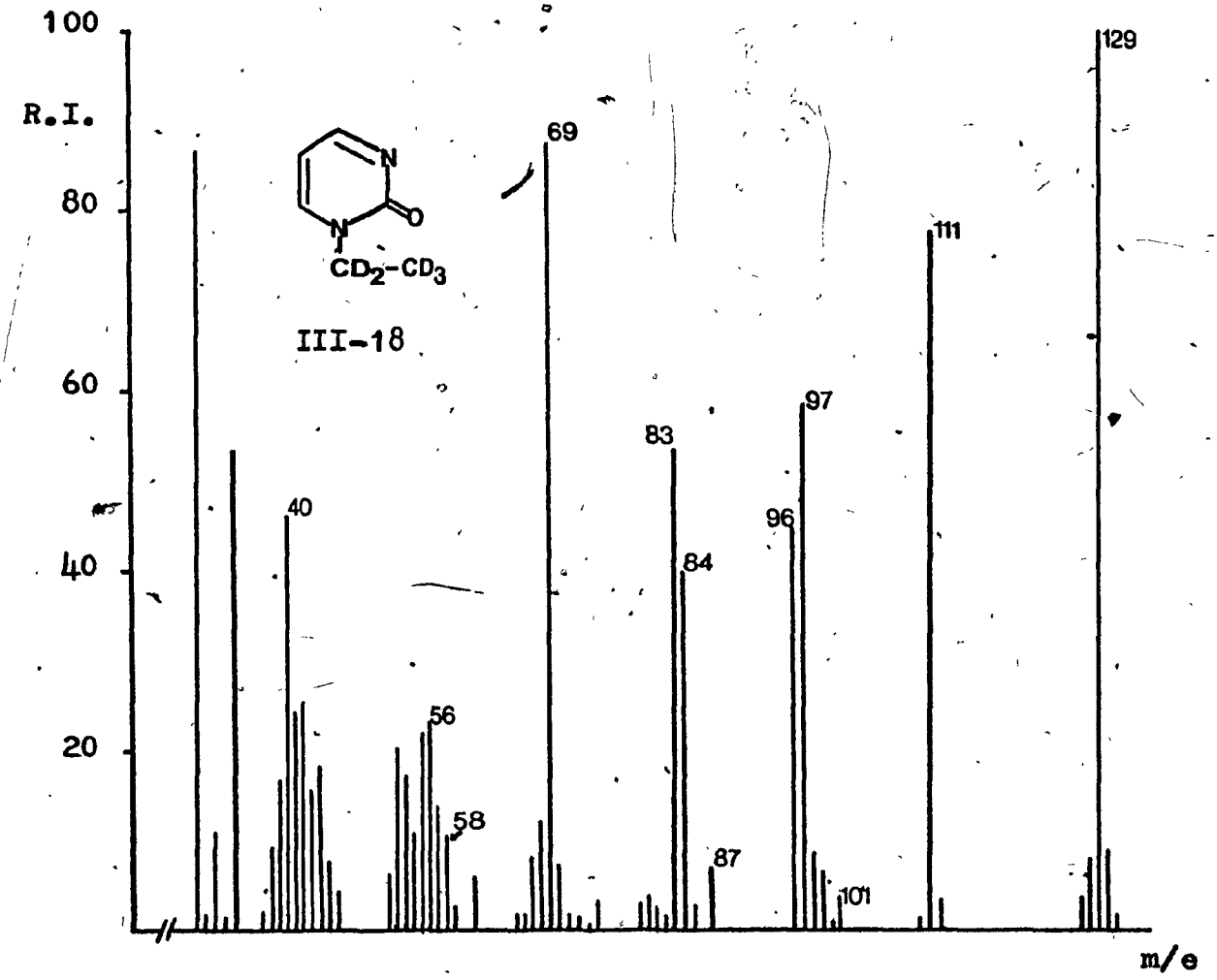
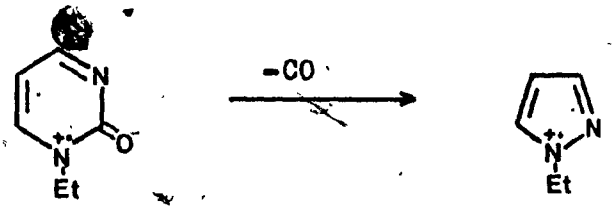


Fig. III-6 Mass spectrum of 1-d_5-ethyl-2-pyrimidone

stable iminium ion III-19 (cf. III-10d, p.48), from which further significant peaks arise (vide infra).

The intense peak at m/e 96 can originate from two different fragmentation pathways. The molecular ion (III-17a) can lose either carbon monoxide(28) or ethylene(28) arising from McLafferty rearrangement. A metastable peak at m/e 74.3 (124→ 96), which can belong to both described pathways, is

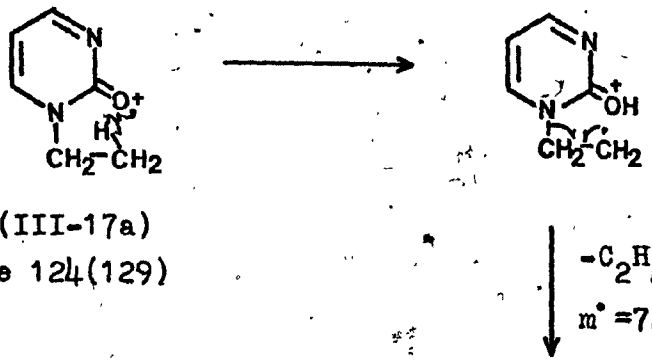
observed in the spectrum of III-17.



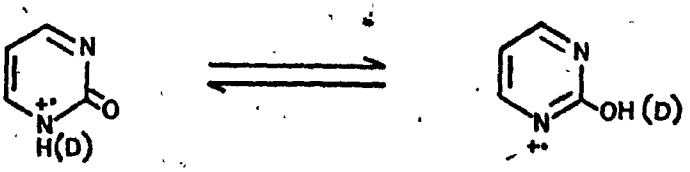
(III-17a)
m/e 124(129)

(III-20)
m/e 96(101)

or:



(III-17a)
m/e 124(129)

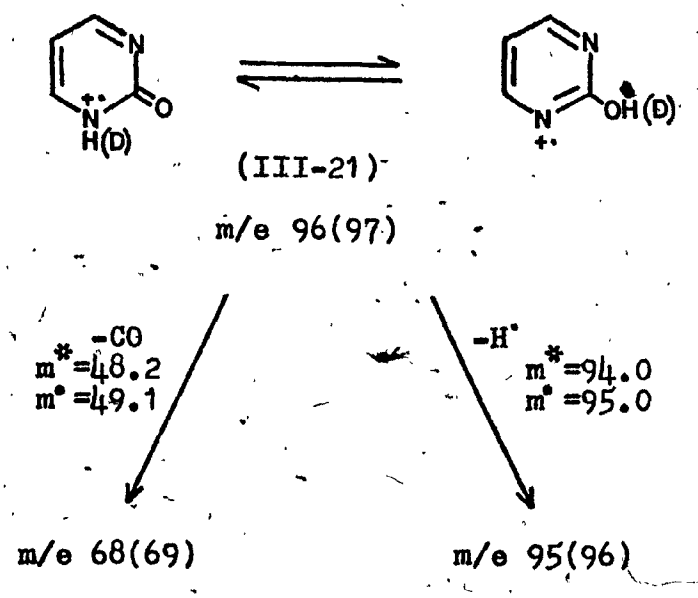


(III-21)
m/e 96(97)

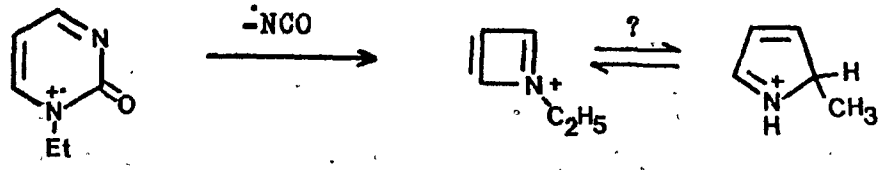
The spectrum of the deuterated compound helps to resolve the two peaks, since there the ion due to the loss of CO appears at m/e 101 in relatively low abundance, while the expulsion of C_2D_4(32), to which a metastable ion at m/e 72.9(129 → 97) refers, gives an intense peak at m/e 97. It seems, therefore,

that the loss of carbon monoxide here belongs to a minor fragmentation pathway, in contrast to the 1-methyl and the unsubstituted 2-pyrimidone. Evidently the major contribution to the m/e 96 ion is the fragment III-21, which originates from the molecular ion by expulsion of ethylene.

According to the observed metastable transitions, the fragment III-21, which is most probably the 2-pyrimidone radical cation, decomposes further by loss of $^{\cdot}H$ and CO to yield ions at m/e 95(96) and m/e 68(69) respectively (cf. III-1, p.44):



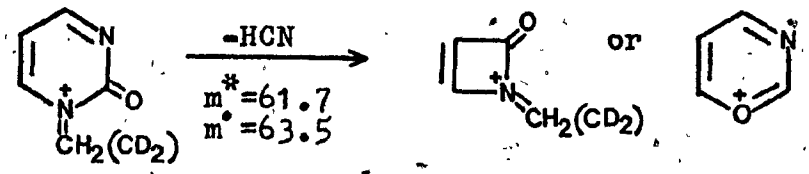
Comparison of the peak intensities at m/e 82 and m/e 87 in the deuterated spectrum, which probably results from loss of $^{\cdot}NCO(42)$ from the molecular ion (III-17a), indicates that this fragmentation is a minor process:



(III-17a)
m/e 124(129)

(III-22)
m/e 82(87)

The major contribution to the intense peak at m/e 82 arises from the expulsion of HCN from M-CH_3 ion(III-19). The corresponding peak in the spectrum of the deuterated compound appears at m/e 84. Both metastable ions are observed for this transition:

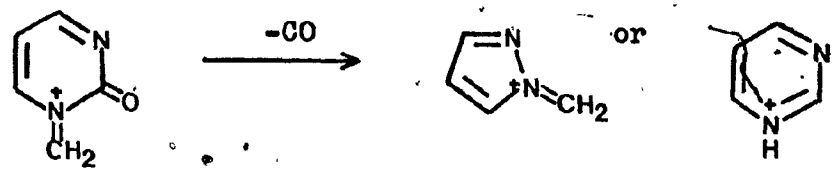


(III-19)
m/e 109(111)

(III-23)
m/e 82(84)

The ion III-23 probably decomposes further by loss of :CH_2 (:CD_2) (cf. III-12, p.52).

The ion at m/e 81(83) is most probably due to loss of CO from III-19 (cf.p.49,50), but no metastable transition was observed for this process:

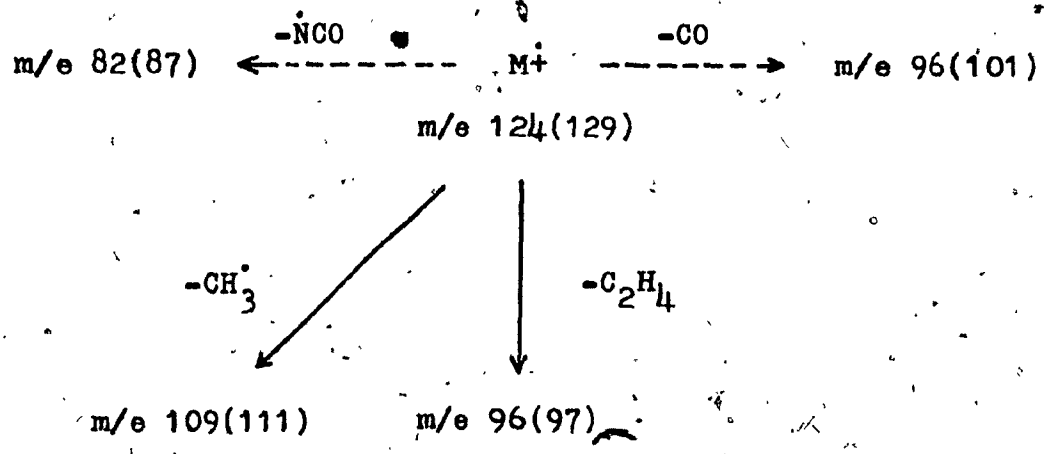


(III-19) (III-24)

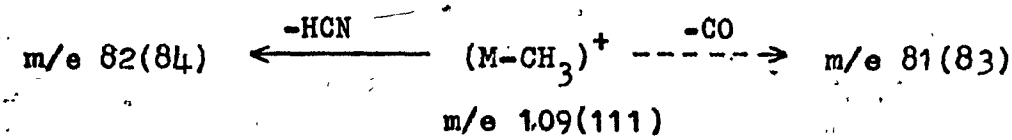
m/e 109(111) m/e 81(83)

Judging from the cracking pattern of the deuterated species, no loss of HCN from the molecular ion occurs, since a m/e 102 ion is not observed.

In summary the primary fragmentations are loss of $CH_3^{\cdot}$, $C_2H_4^{\cdot}$ and most probably loss of NCO and CO from the molecular ion:

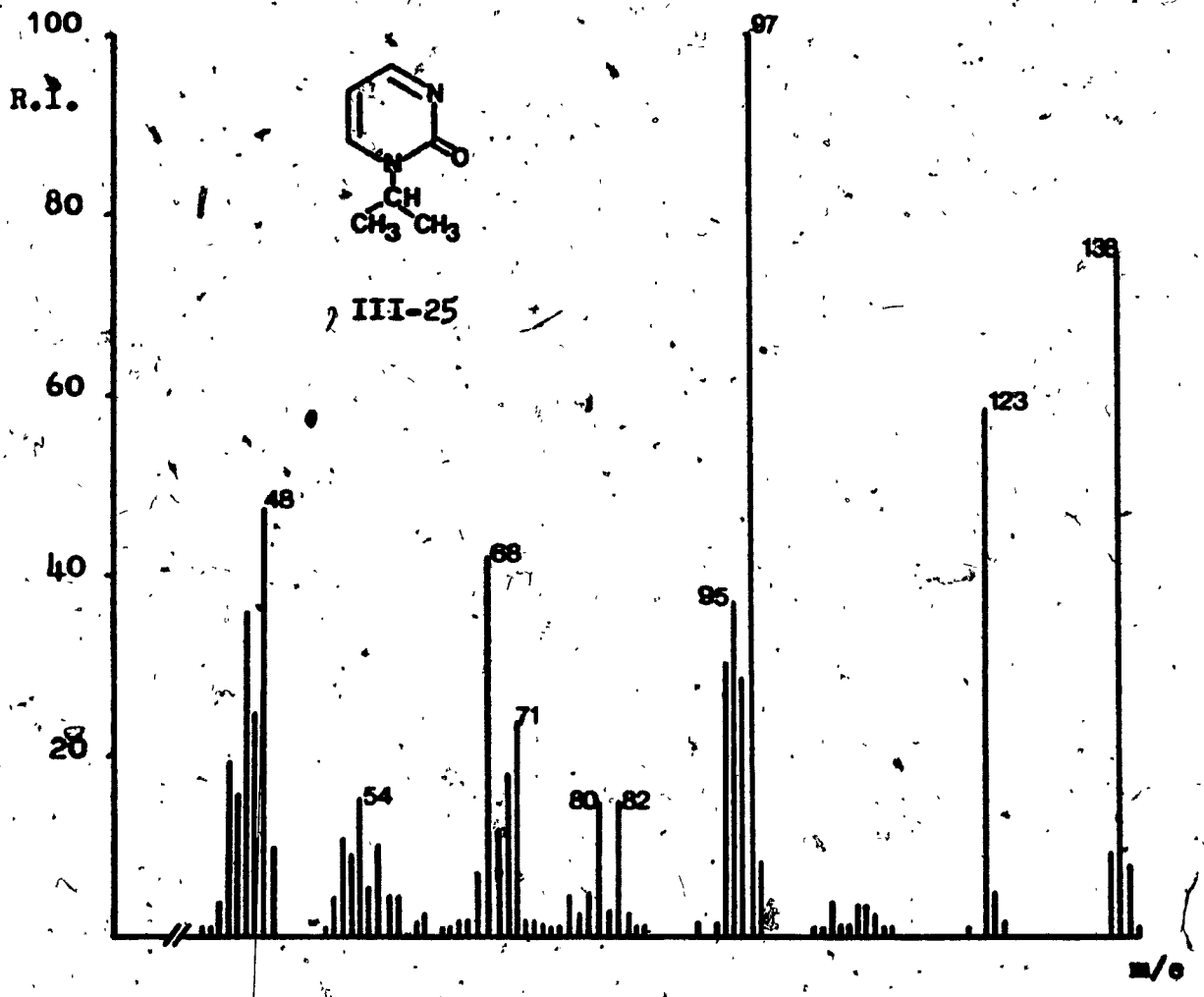


Further loss of HCN and most likely of CO from the $M-CH_3$ ion:



1-Isopropyl-2-pyrimidone (III-25) (Fig. III-7)

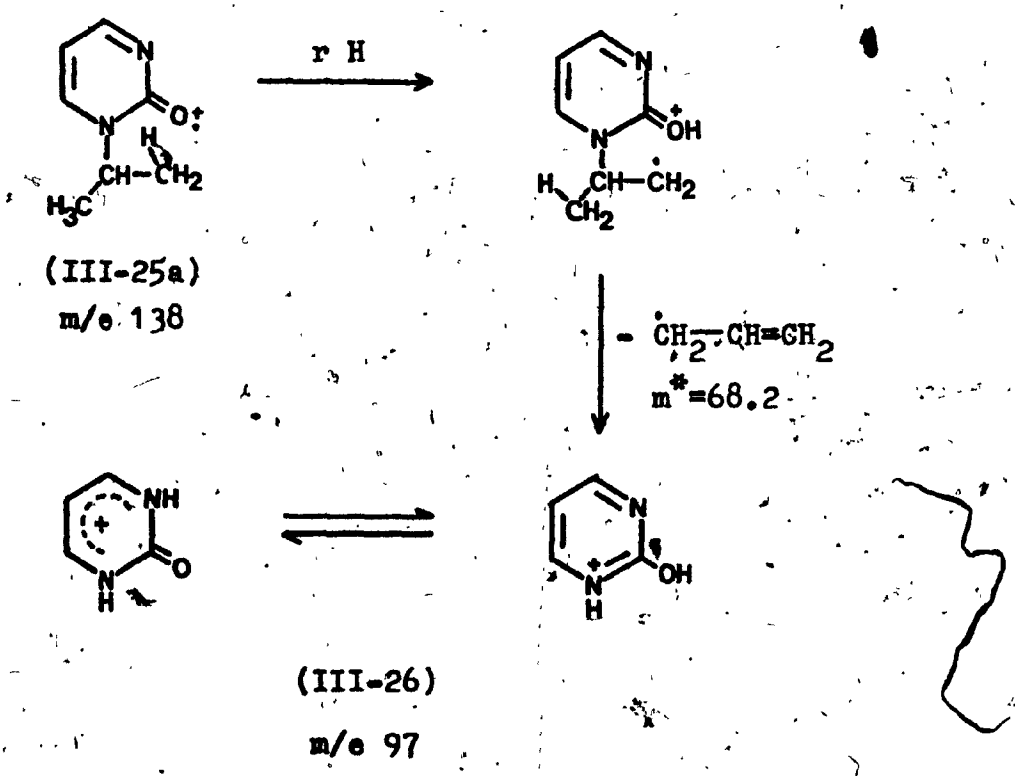
m/e	138	137	123	97	96	95	94	82
R.I.%	82.5	9.6	59.3	100.0	29.0	37.2	30.1	15.3
m/e	80	71	70	69	68	54	43	
R.I.%	15.3	25.7	19.7	12.0	42.1	15.8	48.1	



III-25

Fig. III-7 Mass spectrum of 1-isopropyl-2-pyrimidone

The base peak in the spectrum of III-25 is at m/e 97, which most probably originates largely from the molecular ion(III-25a) by a double hydrogen rearrangement. This process occurs frequently with compounds where an iso-propyl group is present[51]. The driving force for this reaction would be formation of the allyl radical and the stable cation III-26:

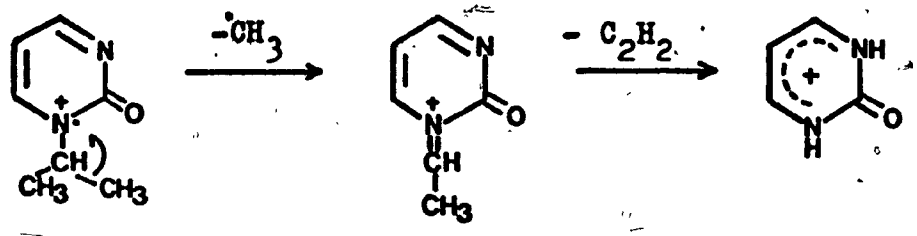


(III-25a)
m/e 138

(III-26)
m/e 97

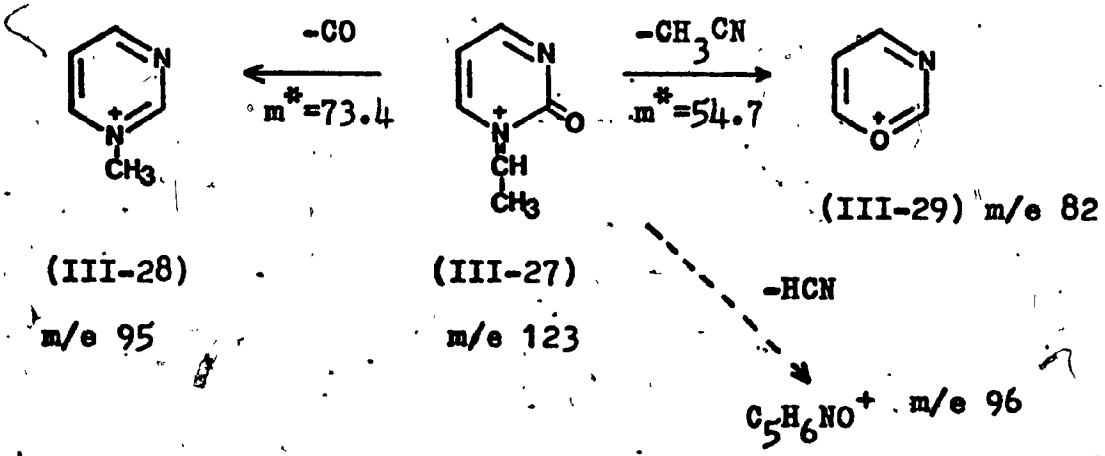
A metastable peak observed at m/e 68.2 confirms this process.

Loss of CH_3 from the molecular ion III-25a gives a fragment at m/e 123 (III-27) which may decompose further by loss of 26, probably acetylene, to contribute to the fragment III-26 at m/e 97:



(III-25a) m/e 138 (III-27) m/e 123 (III-26) m/e 97

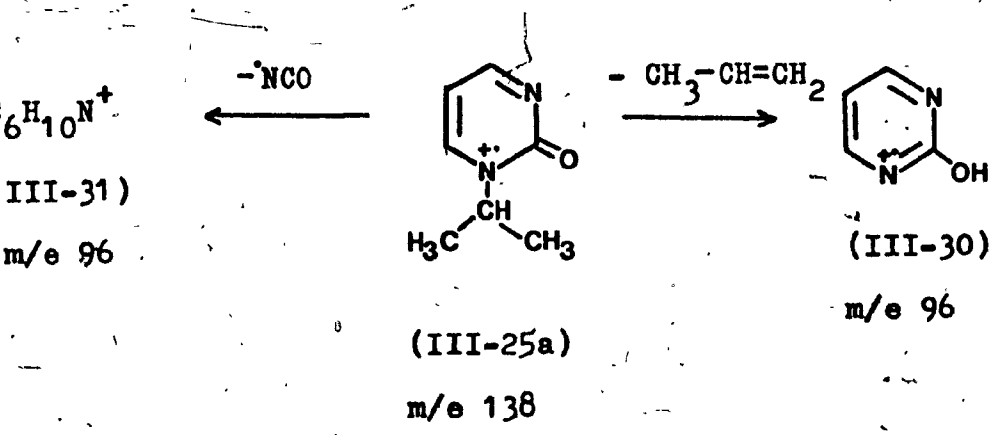
In view of the observed metastable peaks the fragment III-27 also loses CO, and possibly CH_3CN and HCN to form the N-methyl-pyrimidinium ion III-28, the oxazinium ion III-29, and the $C_5H_6NO^+$ at m/e 96:



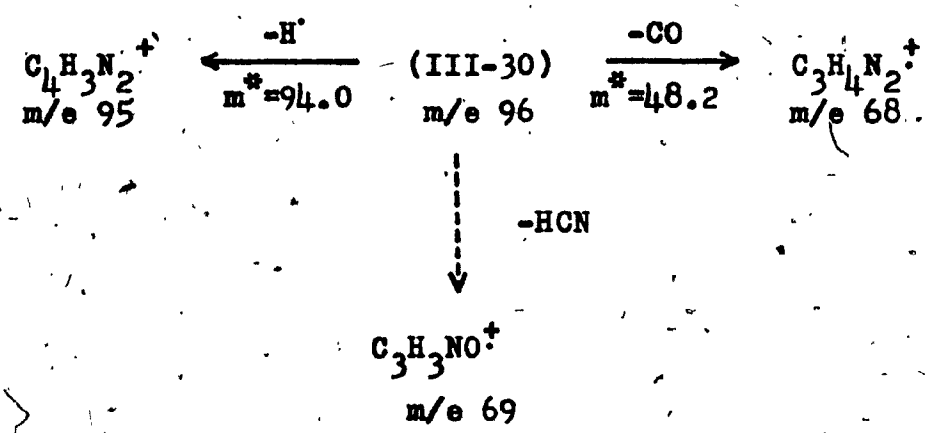
(III-28) m/e 95 (III-27) m/e 123 (III-29) m/e 82

The m/e 96 can arise from the molecular ion by McLafferty rearrangement to yield the 2-pyrimidone radical cation III-30 at m/e 96, and/or from the same molecular ion by loss of NCO to form an even electron ion III-31 at m/e 96. A metastable transition is observed at m/e 66.8 (138→ 96) but without special resolving technique is hard

to decide to which process it refers (cf. 1-ethyl-2-pyrimidone p. 61):

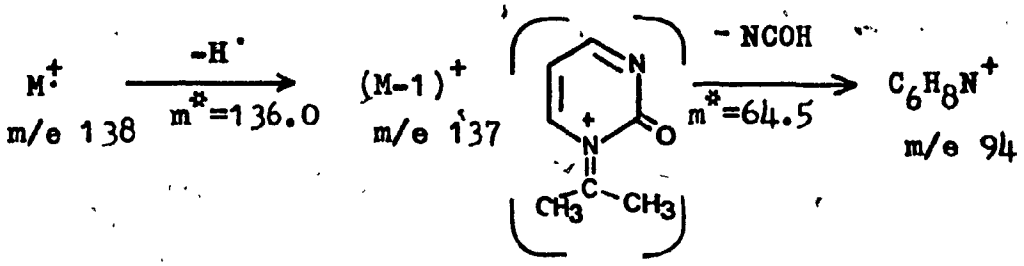


According to the present metastable ions the 2-pyrimidone radical cation III-30 loses H, CO and possibly HCN (cf. III-1, p.44):



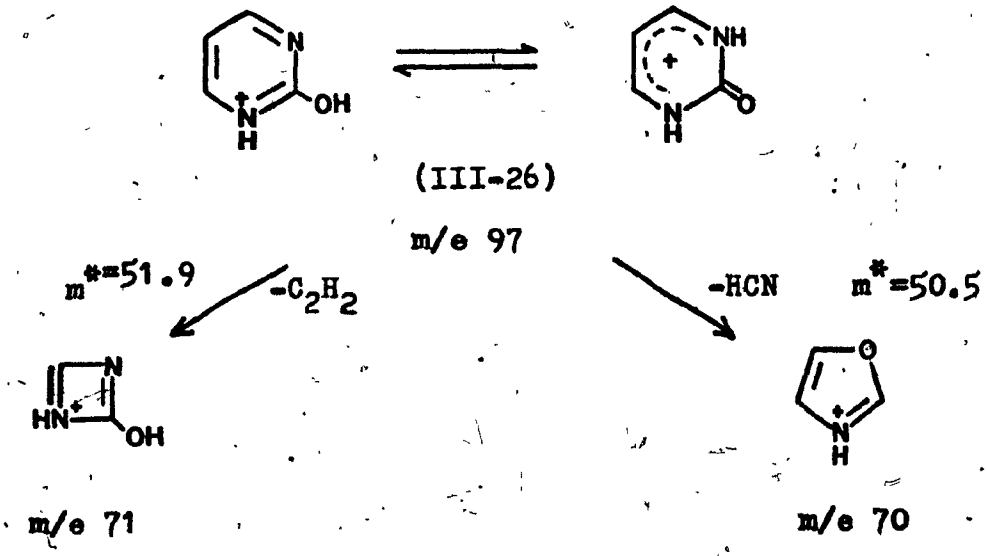
The expulsion of hydrogen from the molecular ion is also confirmed by the appropriate metastable ion, but it is difficult without deuterium labelling studies to assign the structure to the small M-1 ion at m/e 137. It seems, that the only significant fragment, arising from the

M-1 ion by loss of NCOH, is at m/e 94:



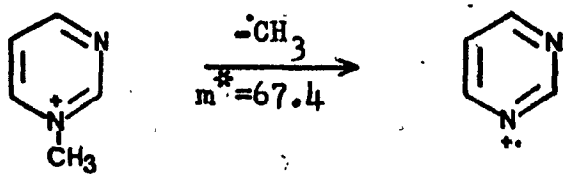
However, the loss of a neutral molecule, possibly $CH_2=C=CH_2$, from M-1 ion via double hydrogen transfer, which may contribute to the III-26 fragment at m/e 97, cannot be excluded.

Finally III-26 fragments further by expulsion of HCN and possibly acetylene, and it could be, that the



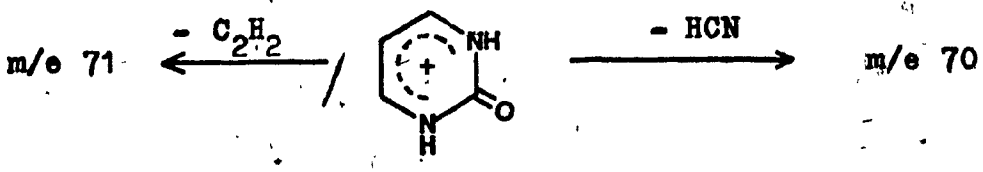
fragment III-28 loses methyl radical to form possibly the pyrimidinium radical cation at m/e 80. This process would involve however a formation of odd electron radical cation

from even electron ion, which rarely happens:

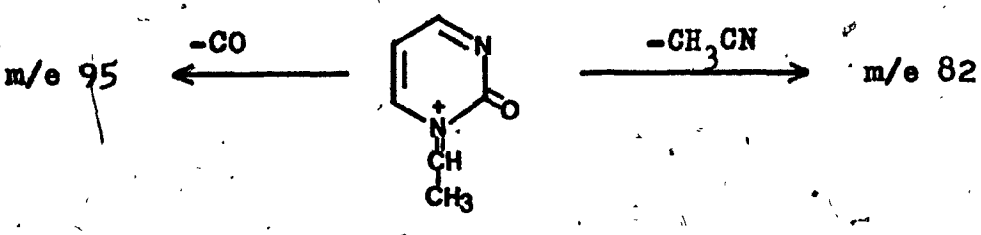


(III-28) m/e 95 m/e 80

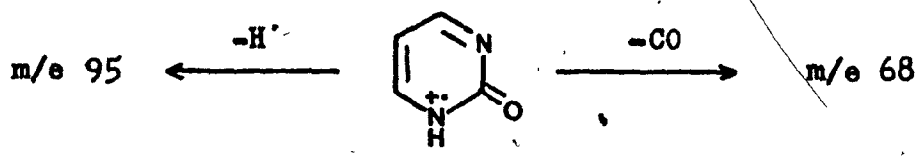
In summary the major fragments come from the molecular ion by loss of the allyl radical, loss of $\cdot CH_3$ and possibly loss of $CH_3-CH=CH_2$ to form ions III-26, III-27 and III-30. These decompose further as outlined below:



(III-26) m/e 97



(III-27) m/e 123



(III-30) m/e 96

-HCN

m/e 69

1-Benzyl-2-pyrimidone (III-32) (Fig. III-8)

m/e	186	185	157	144	130	104	92
R.I.%	100.0	34.1	34.1	25.4	25.8	11.9	43.7
m/e	91	90	89	83	82	81	80	77
R.I.%	87.7	19.0	35.7	13.9	17.9	66.3	55.6	25.4
m/e	65	63	51					
R.I.%	69.0	44.4	51.2					

The most prominent peaks in the spectrum after that of the parent molecular ion III-32a at m/e 186 are those at m/e 91, m/e 65 and m/e 39. These three peaks are almost certainly due to the formation and subsequent fragmentation of the tropylium ion[52]. The latter may be formed more or less directly from the parent ion by N–C bond cleavage to form a stable 2-oxy-pyrimidine radical and the benzyl cation which rearranges[52] to the tropylium ion

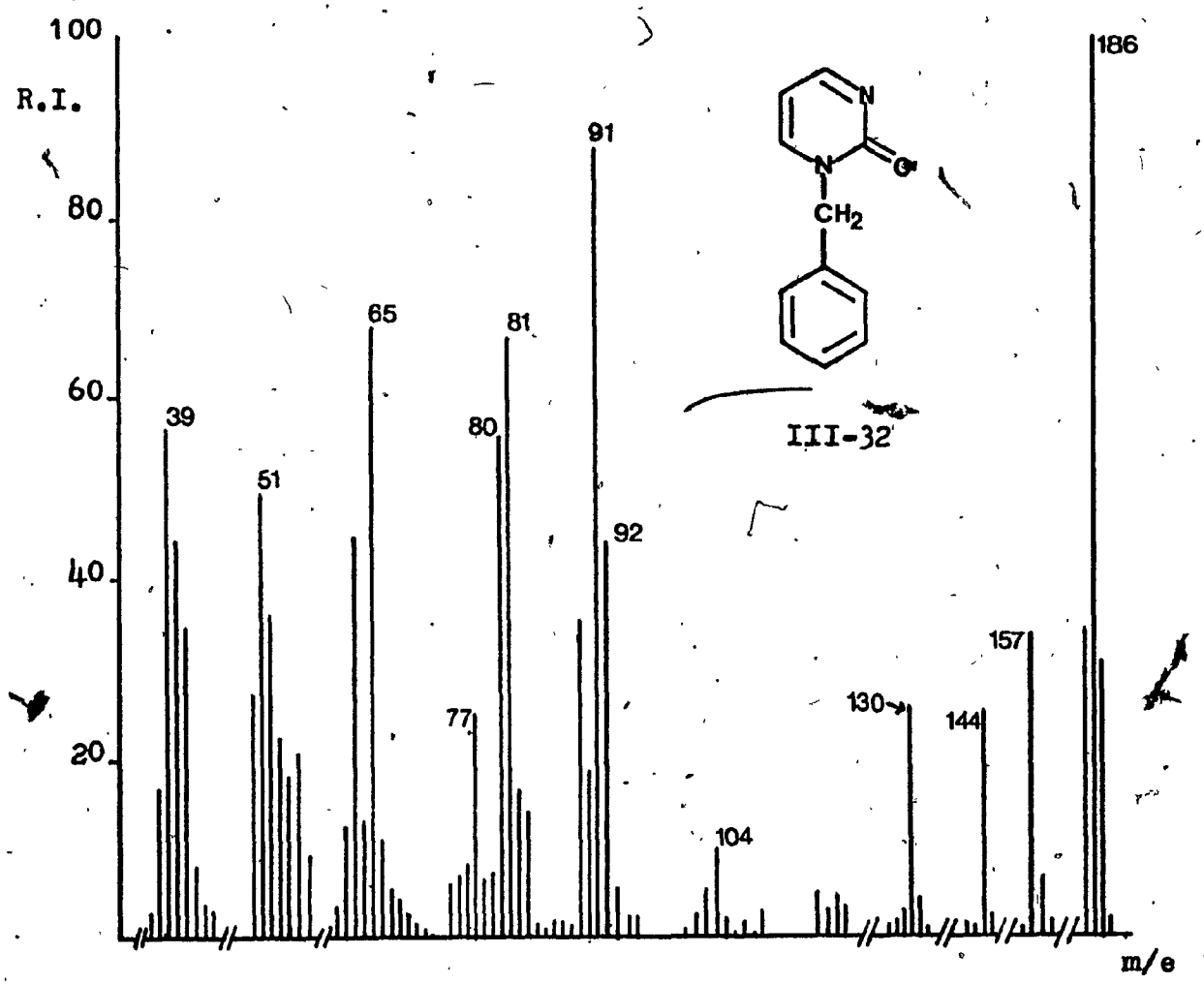
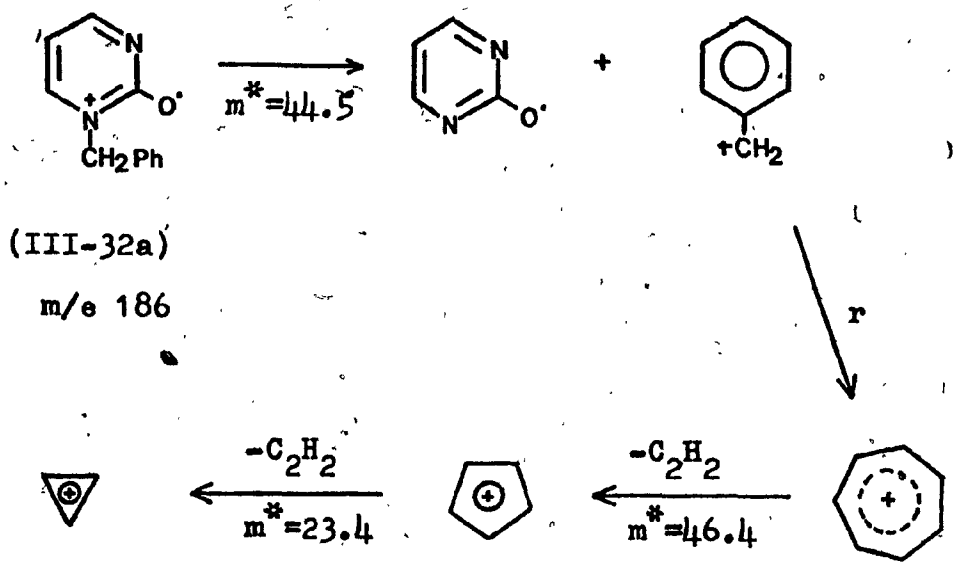


Fig. III-8 Mass spectrum of 1-benzyl-2-pyrimidone

(III-33). As indicated below, metastables were observed for the processes m/e 186 → 91, m/e 91 → 65 and m/e 65 → 39. The metastable for m/e 91 → 65 is particularly intense (sch.III-3).

The tropylium ion may arise in other ways. For example, the peak at m/e 92 may be due to the toluene cation radical, which by loss of H· gives the tropylium ion[1-3].



(III-32a)
m/e 186

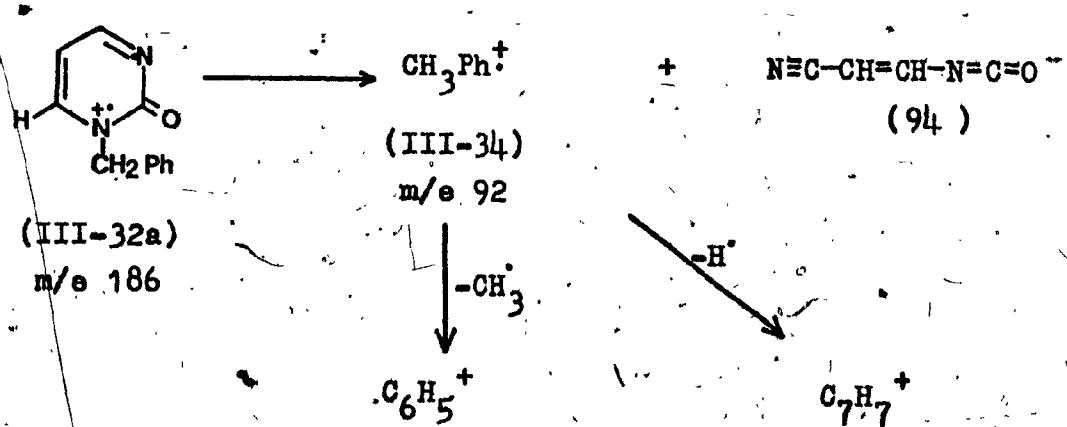
m/e 39

m/e 65

(III-33)
m/e 91

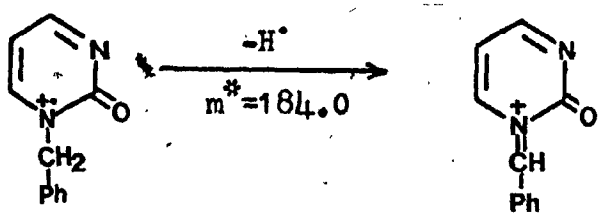
Scheme III-3

The former may arise from the parent ion by loss of $C_4H_2N_2O$ in a process analogous to the fragmentation of some alkylbenzenes[48]:



The cation at m/e 77, which is most probably the phenyl cation (III-35), may arise from methyl loss from the toluene cation (III-34)[48]. Another possibility is that the phenyl cation derives from α-cleavage in the molecular ion. However, no metastable was observed to support this. In turn the phenyl cation may lose acetylene to give the ion $C_4H_3^+$ (m/e 51), which is commonly observed in the spectra of aromatic compounds[55].

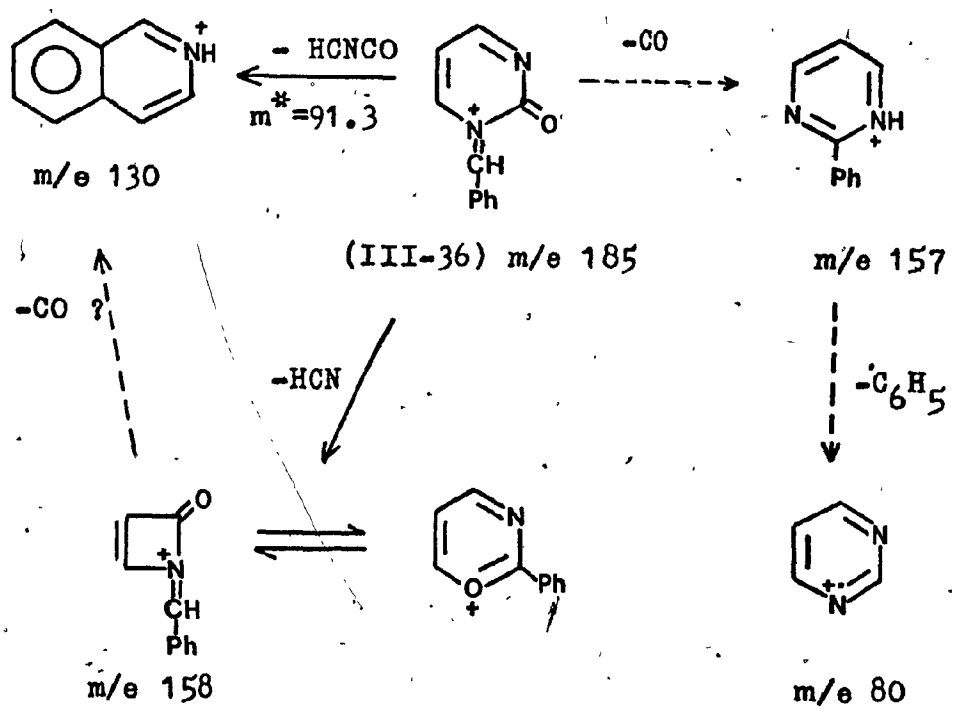
The formation of the M-1 ion (III-36) seems to have a metastable observed at m/e 184.0. No labelling studies were carried out to investigate which hydrogen is expelled from the molecular ion. One of the possibilities is, that one of the benzylic hydrogens is involved in the process:



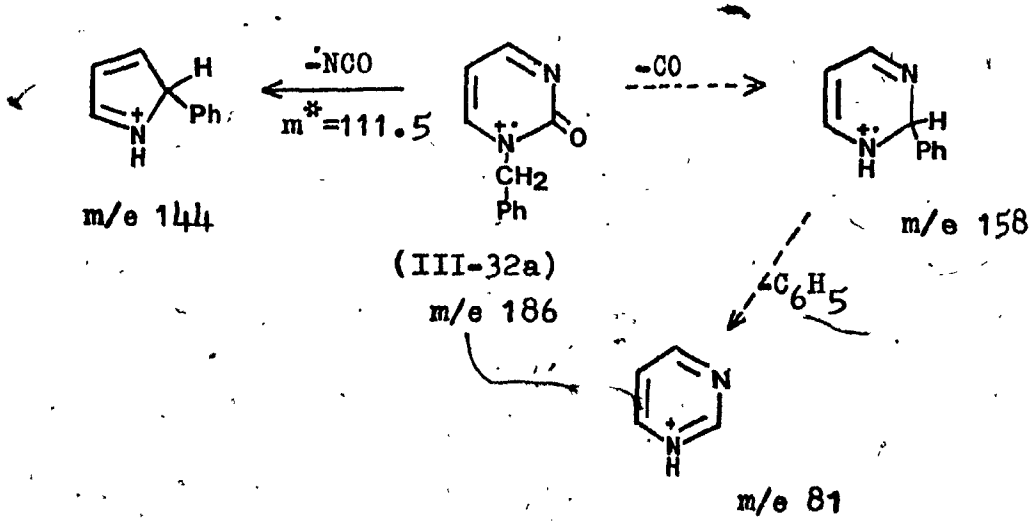
(III-32a) m/e 186 (III-36) m/e 185

The M-1 ion (III-36) fragments further to form an ion at m/e 130 and possibly the ions at m/e 158 and 157. The latter ion may lose phenyl radical to form the cation at m/e 80. The peak at m/e 158 could also arise from the molecular ion by loss of CO and can further expel C_6H_5 to form the

pyrimidinium cation at m/e 81.



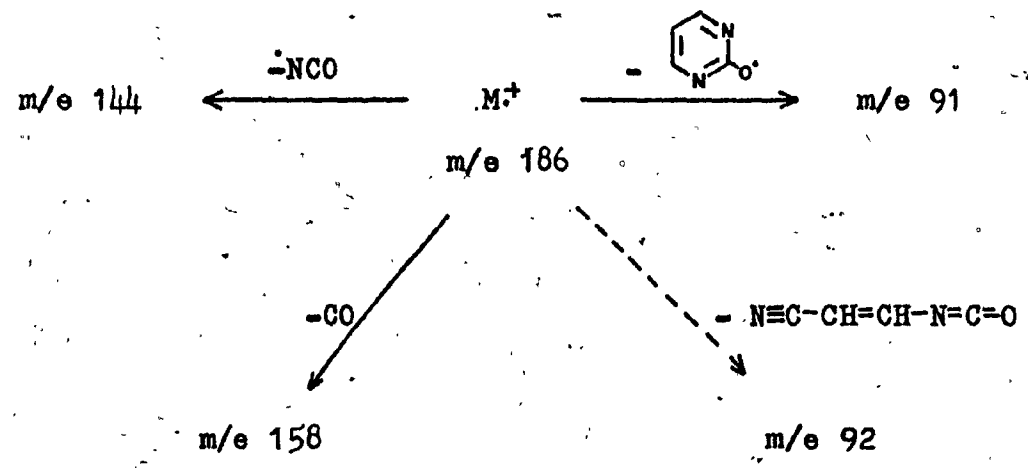
Loss of NCO from the molecular ion to form the ion at m/e 144 is confirmed by the appropriate metastable.



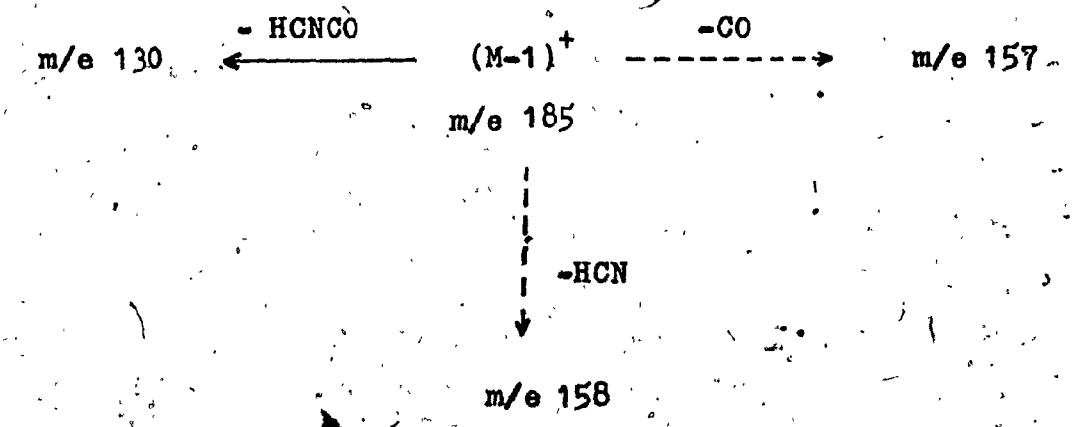
The peak at m/e 104 may be $PhC\equiv\overset{+}{N}H$ (or $Ph\overset{+}{N}\equiv CH$),

but its origin is obscure.

In summary the major fragments come from the molecular ion by loss of 2-oxypyrimidine radical, $^{\bullet}NCO$ and possibly $N{\equiv}C{-}CH{=}CH{-}N{=}C{=}O$. Loss of CO is of minor importance.



The major fragments from the M-1 ion seem to result from loss of HCNCO and loss of CO. Loss of HCN is of relatively minor importance.



1-Phenyl-2-pyrimidone (III-37) (Fig. III-9)

m/e	172	171	145	144	143	130
R.I.%	100.0	41.7	4.3	31.7	7.3	6.0
m/e	117	104	90	77	51	
R.I.%	13.3	13.3	3.8	83.3	38.3	

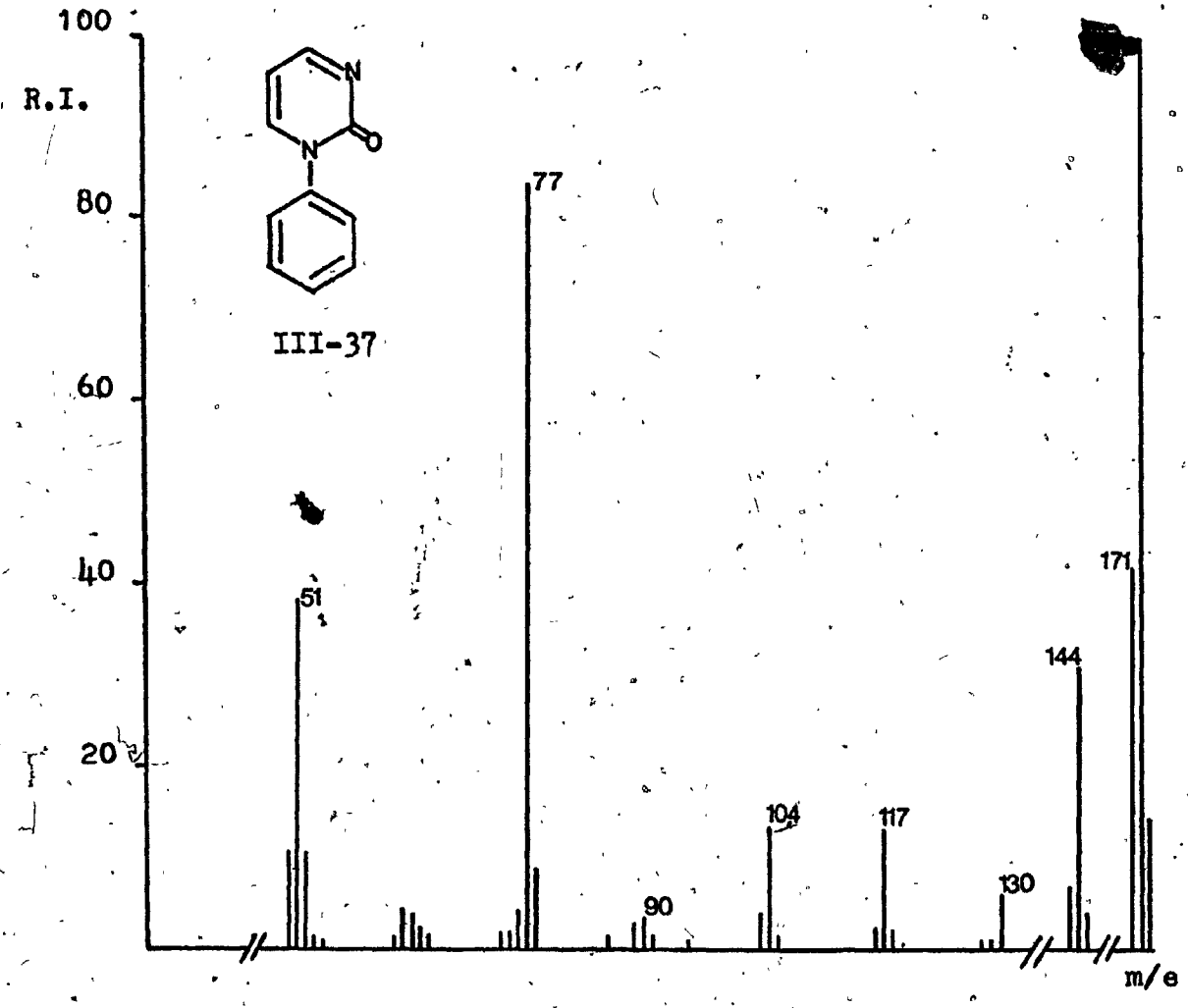
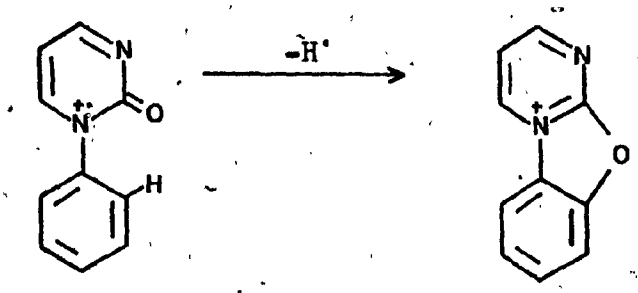


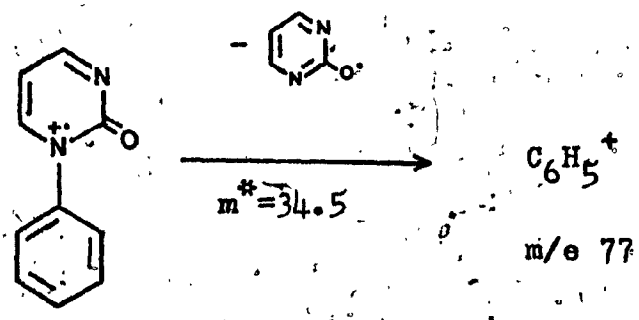
Fig. III-9 Mass spectrum of 1-phenyl-2-pyrimidone

The molecular ion III-37a loses hydrogen to quite an appreciable extent. The hydrogen loss probably involves the benzene ring (cf. p.15) so that the resultant ionic species would be an oxazolium compound III-38.



(III-37a) m/e 172 (III-38) m/e 171

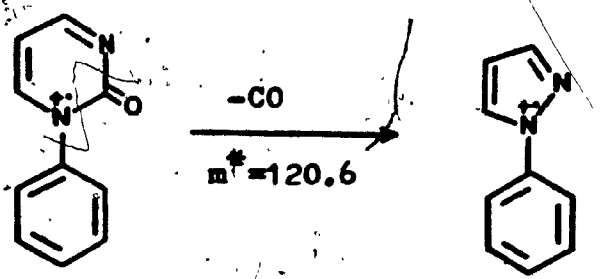
The second most abundant peak at m/e 77 is most probably phenyl cation $C_6H_5^+$, which could originate from more than one ionic species. One of the possibilities is loss of stable oxo-pyrimidinium radical from the molecular ion III-37a.



(III-37a) m/e 172

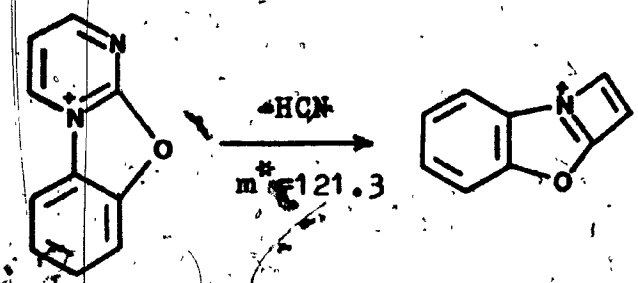
A metastable ion at m/e 34.5, that is associated with this process, is observed in the spectrum.

The molecular ion also expels CO to form a peak of medium intensity at m/e 144 (III-39), with a metastable at m/e 120.6(172 → 144).



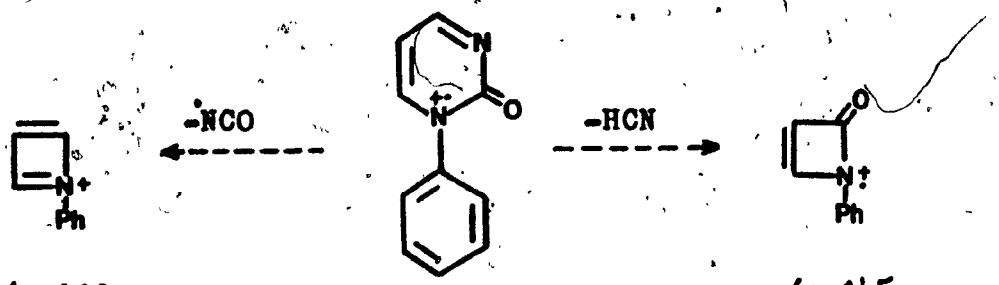
(III-37a) m/e 172 (III-39) m/e 144

By analogy with the spectral behaviour of 2-pyrimidone (cf.p.44), a minor contribution to the peak at m/e 144 would be loss of HCN from the M-1 ion III-38. A metastable for this pathway is observed at m/e 121.3(171 → 144).



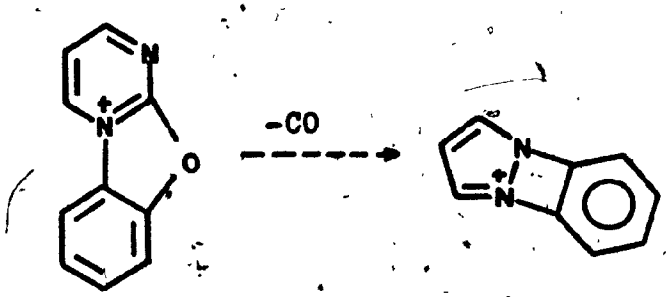
(III-38) m/e 171 (III-40) m/e 144

The molecular ion III-37a possibly expels NCO to form the peak at m/e 130, and to a minor extent HCN to give m/e 145. No metastables were observed for these processes.



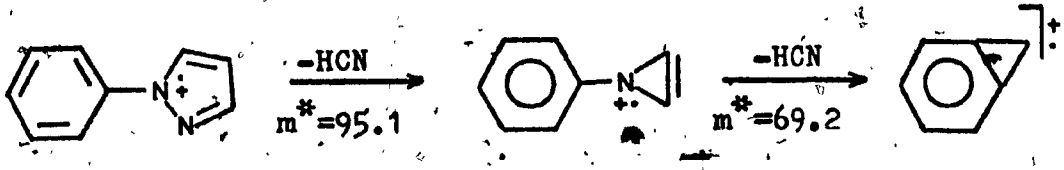
m/e 130 (III-37a) m/e 172 m/e 145

Loss of CO from the M-1 ion could be responsible for the peak at m/e 143:



(III-38) m/e 171 m/e 143

The fragment III-39 decomposes further by two successive expulsions of HCN to give a peak at m/e 117 and m/e 90:



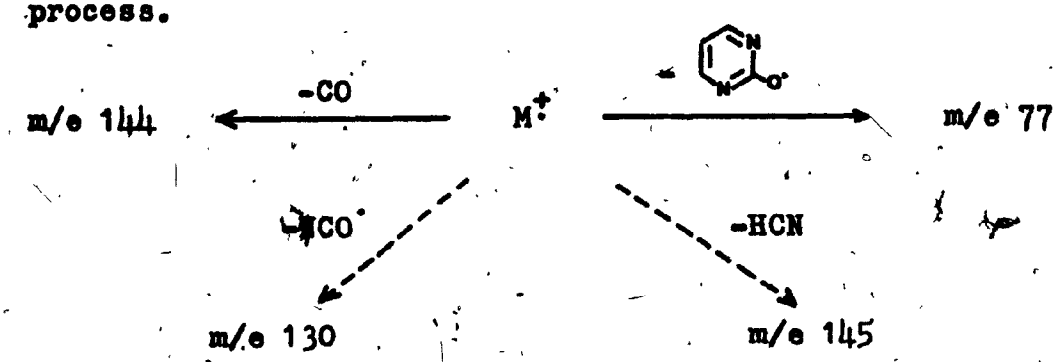
(III-39) m/e 144 m/e 117 m/e 90

The appropriate metastable ions confirm these processes.

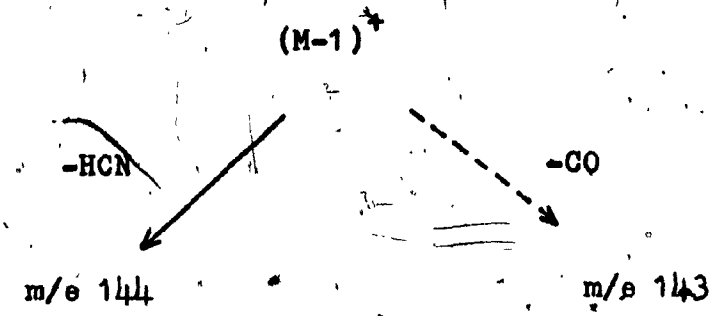
A possible structure for the ion at m/e 104 could be $PhN^{+}=CH$, which can originate from almost any of the above fragments.

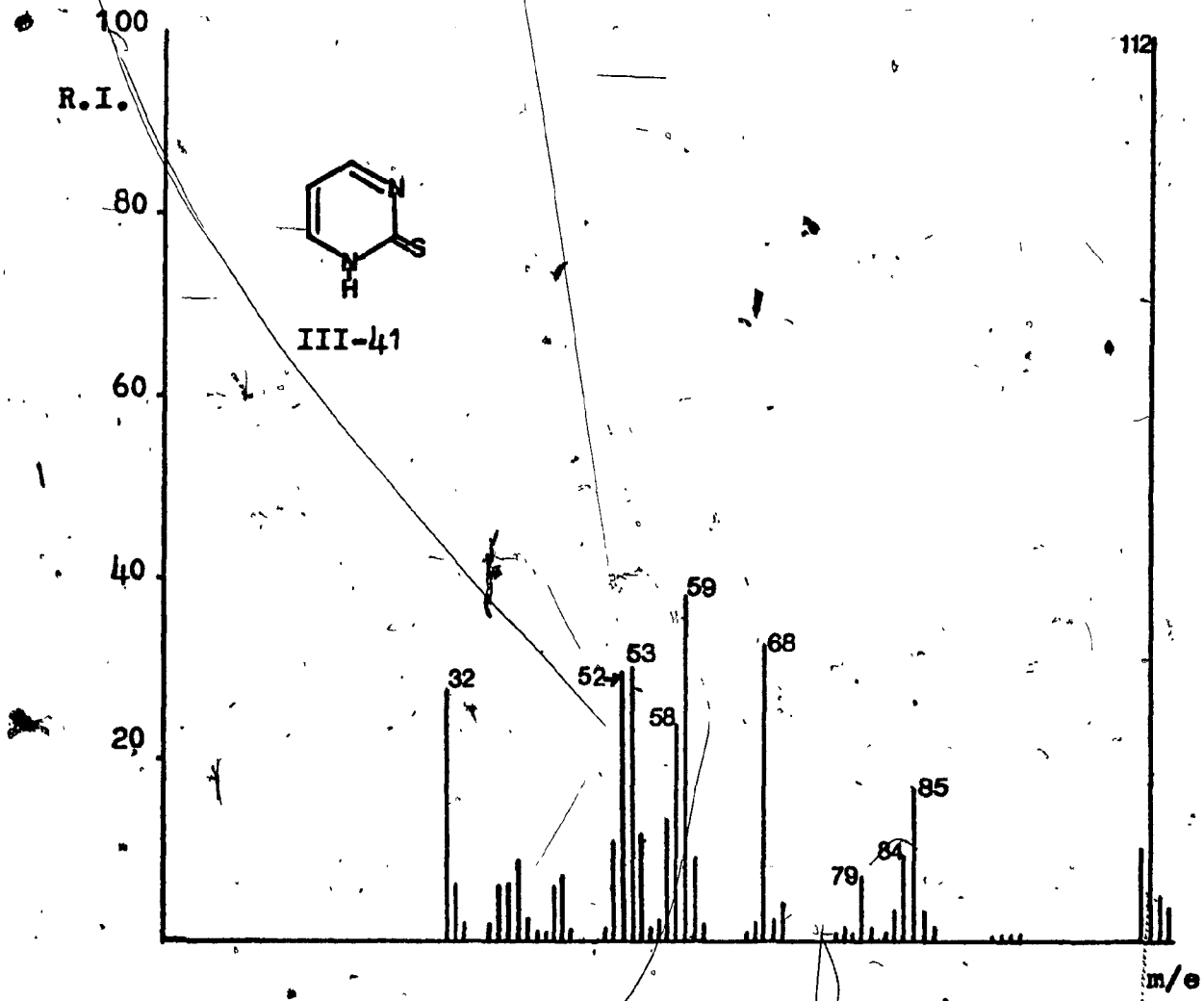
Finally, as already mentioned before (p.71), the peak at m/e 51, most probably $C_4H_3^+$, is associated with loss of acetylene from the phenyl cation.[55]

In summary the major fragments come from the molecular ion by loss of the 2-oxy-pyrimidine radical, CO and possibly NCO. Possible loss of HCN belongs to a minor process.



Another, relatively high abundant, fragment is the M-1 ion, which loses HCN and possibly CO.





III-41

Fig. III-10 Mass spectrum of 2-pyrimidthione

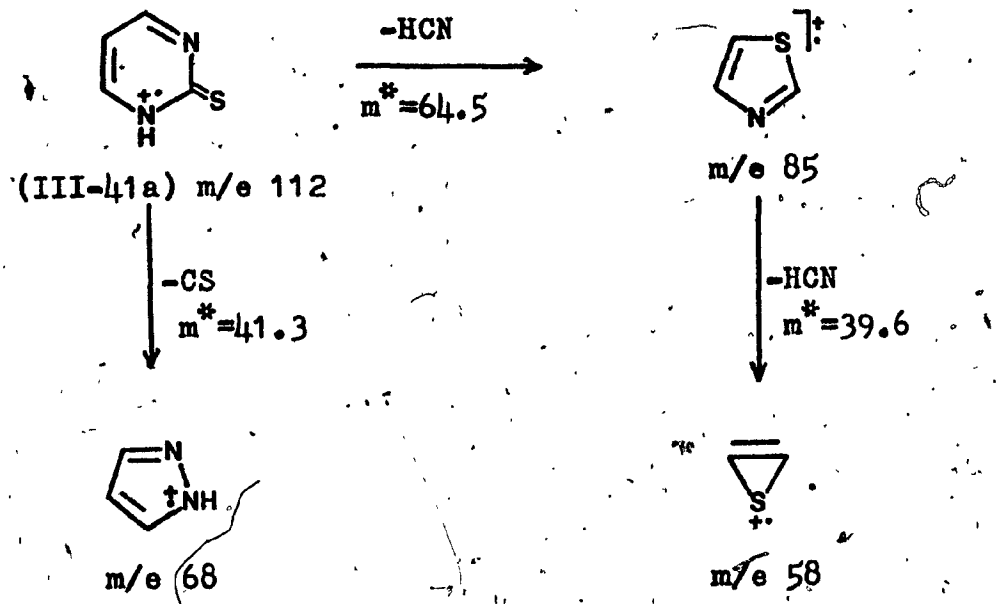
2-Pyrimidthione (III-41) (Fig. III-10)

m/e	112	111	86	85	84	83	79
R.I.%	100.0	12.2	4.4	17.2	10.0	4.2	7.8
m/e	68	59	58	53	52	32	
R.I.%	33.3	38.9	33.3	30.6	30.0	28.3	

The tautomerism of this compound does not appear to have been studied, but for the analogous pyridine derivative the thiol form is preferred in the gas phase (>90%)[18],

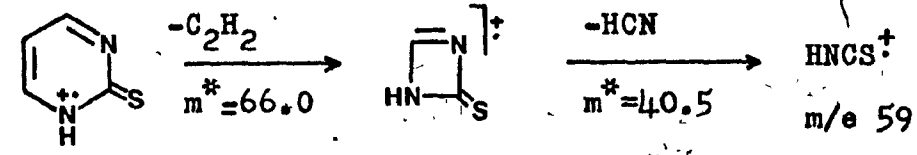
whereas the thione form predominates in solution (99.9986%)[18]. Presumably a similar situation obtains for 2-pyrimidthione(III-41).

By analogy to its oxo-homologue, the molecular ion of 2-pyrimidthione III-41a loses CS and HCN, where with respect to the peak heights, loss of CS forms the main fragmentation pathway. Both processes are characterized by metastable ions at m/e 41.3(112→68) and m/e 64.5(112→85).



As shown above, the peak at m/e 85 can adopt the thiazolium ion structure, which again loses HCN and forms possibly the thiirene odd electron ion at m/e 58.

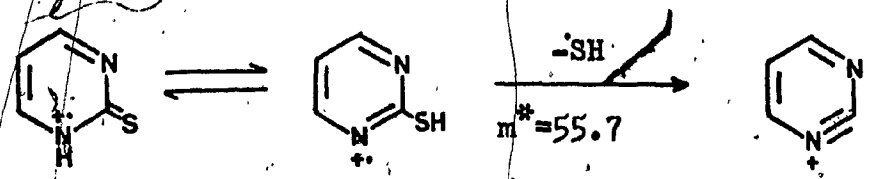
In view of the observed metastable ions the molecular ion III-41a loses 26, probably acetylene, to form an ion at m/e 86, which further expels HCN to yield a peak at m/e 59, possibly $HNCS^{+\cdot}$:



(III-41a)
m/e 112

m/e 86

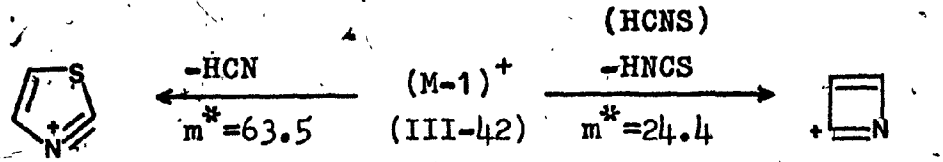
The small peak at m/e 79 is probably due to loss of SH from the molecular ion. A metastable at m/e 55.7 is observed for this process:



(III-41a) m/e 112

m/e 79

Besides the loss of HCN, the M-1 ion III-42 also possibly expels HNCS or HCNS. The appropriate metastable ions are observed for both processes:



m/e 84

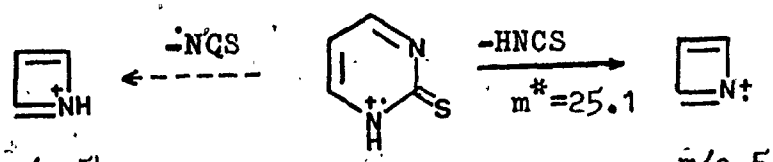
m/e 111

m/e 52

At present there is no evidence as to which hydrogen is expelled from the molecular ion. Therefore, the structure of the M-1 ion is even more problematical than

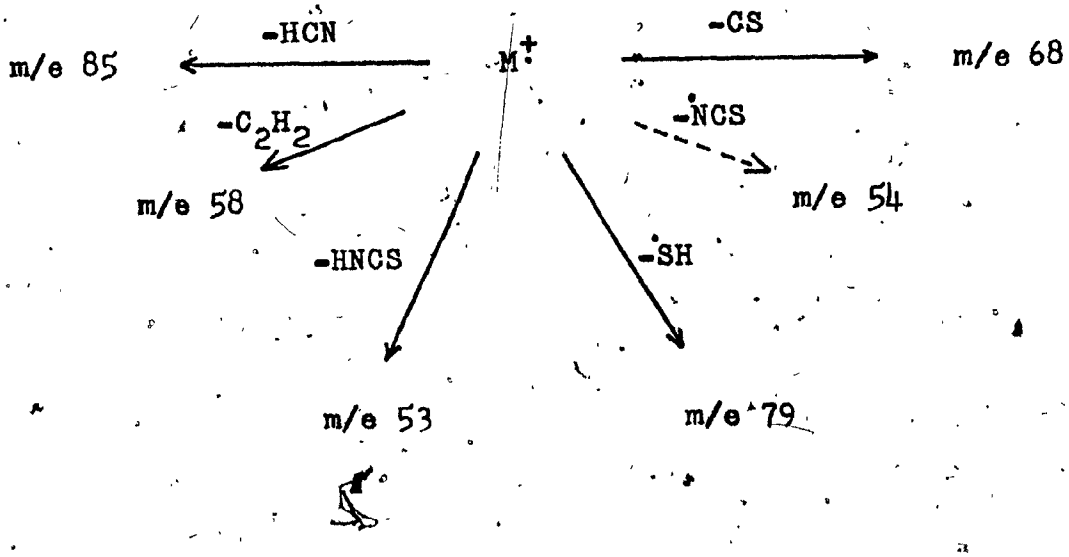
in the case of 2-pyrimidone (vide supra, p.38,39).

The peaks at m/e 54 and m/e 53 are probably due to loss of NCS and HNCS from the molecular ion.

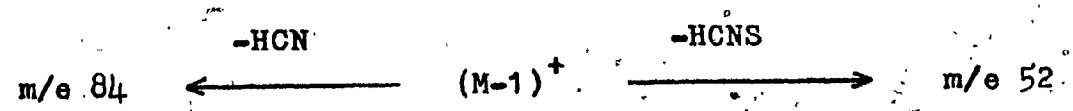


m/e 54 (III-41a) m/e 112 m/e 53

In summary, the primary fragmentations come from the molecular ion by loss of CS, HCN, HNCS, SH, acetylene and possibly NCS.



The M-1 ion possibly expels HNCS or HCNS.



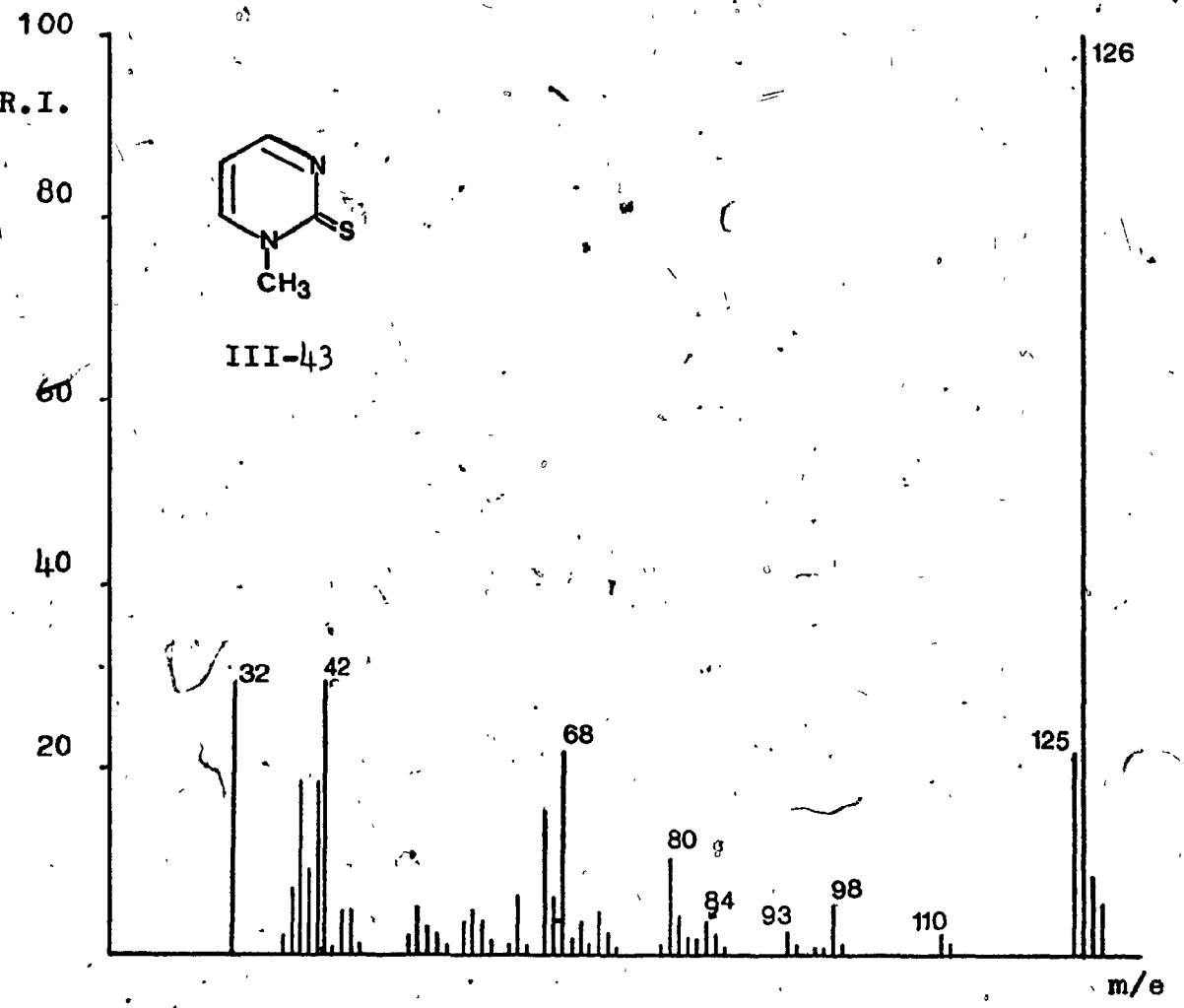


Fig. III-11 Mass spectrum of 1-methyl-2-pyrimidthione

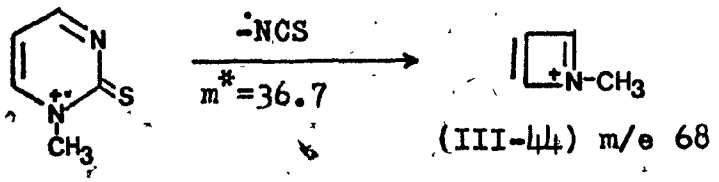
1-Methyl-2-pyrimidthione (III-43) (Fig. III-11)

m/e	126	125	110	98	93	85	84
R.I.%	100.0	22.2	2.2	5.6	2.5	2.5	3.9

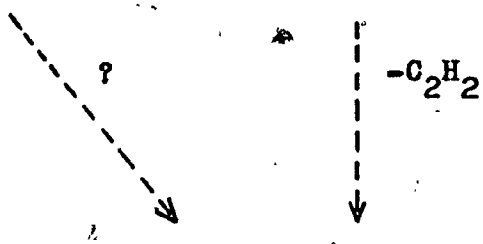
m/e	81	80	68	66	42	32
R.I.%	5.3	10.8	22.2	16.1	30.6	30.6

Loss of NCS from the molecular ion III-43a to form the relatively high abundant peak at m/e 68(III-44), belongs to the major fragmentation route. It is possible,

that the ion III-44 further loses acetylene to give the ion $CH_3\overset{+}{N}CH$ at m/e 42. A broad metastable peak at m/e 36.7 is observed for the first process, while the metastable for the latter pathway is not quite clear. There is also a possibility , that the molecular ion III-43a undergoes a direct fragmentation to yield the m/e 42 ion, but no metastable transition was observed for this.

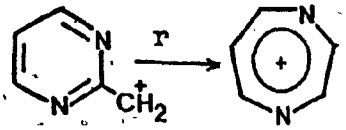


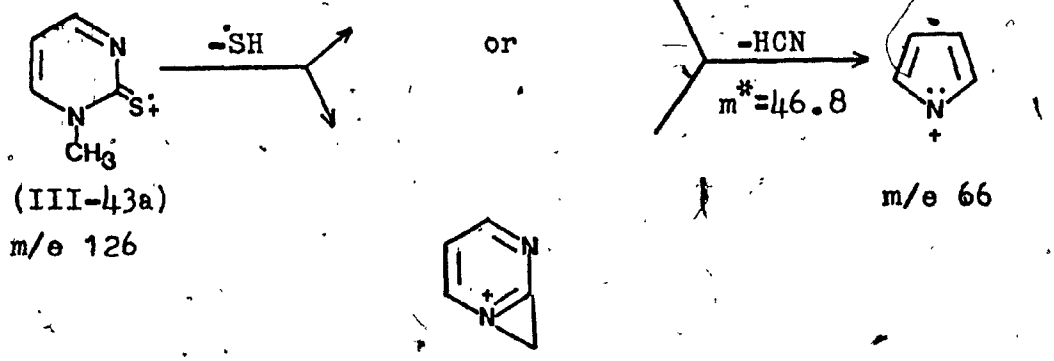
(III-43a) m/e 126 (III-44) m/e 68



$CH_3\overset{+}{N}CH$ m/e 42

The low abundant ion III-45 at m/e 93 could be due to the expulsion of SH from the molecular ion, but there is no evidence for this transition. However, in view of the metastable ion present at m/e 46.8, III-45 most likely expels HCN to yield the ion at m/e 66, possibly the pyrrole cation. Out of the two proposed structures for the III-45 ion (vide infra), the possibility of ring expansion to form the seven-membered ring looks quite attractive[49,50].



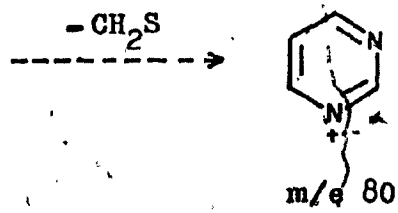


(III-43a)
m/e 126

m/e 66

(III-45) m/e 93

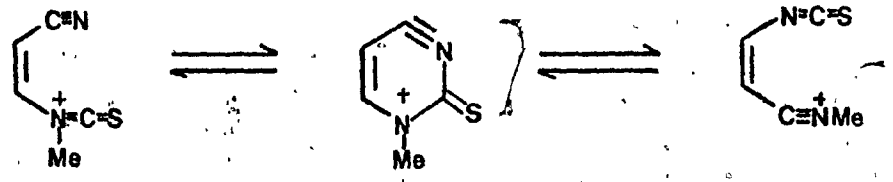
It could be, that the ion at m/e 80, probably the odd electron pyrimidinium cation, is due to the expulsion of CH_2S from the molecular ion, but no metastable transition is observed for this process (cf. ref.19):



(III-43a) m/e 126

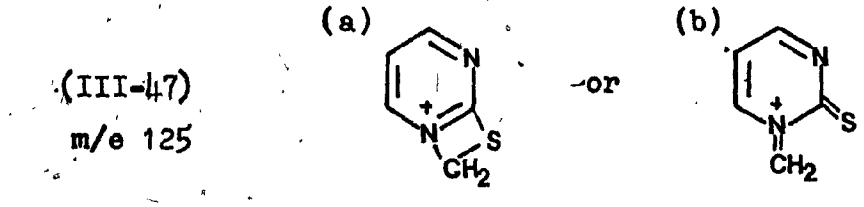
m/e 80

The structure of the M-1 ion is again problematical. It could adopt the tautomeric structures III-46a, III-46b and III-46c (analogous to 2-pyrimidone p.38):

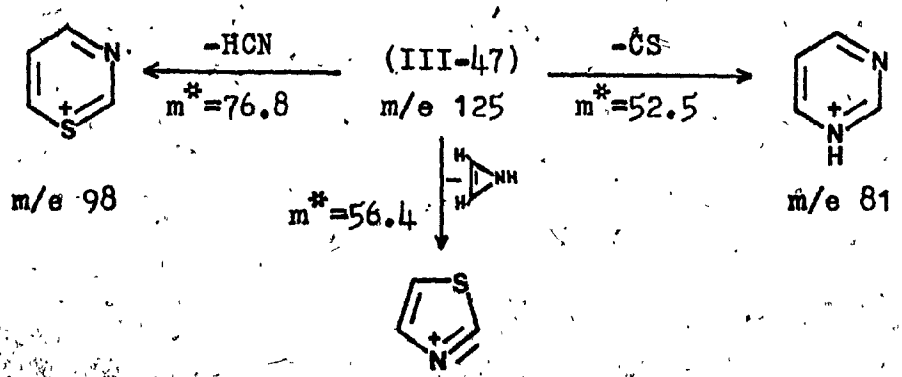


(III-46a) (III-46b) (III-46c)

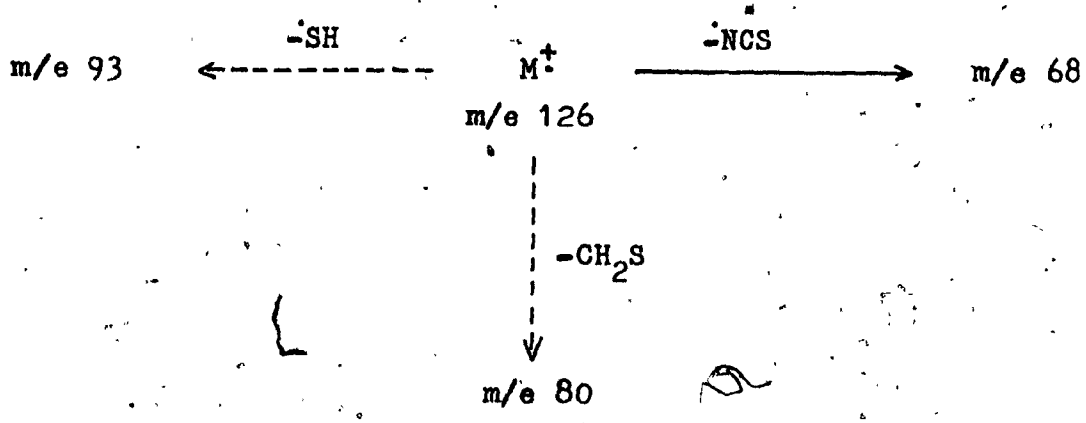
Another possibility is, that one of the methyl hydrogens is expelled and the M-1 ion adopts the following structures (cf. ref.19)



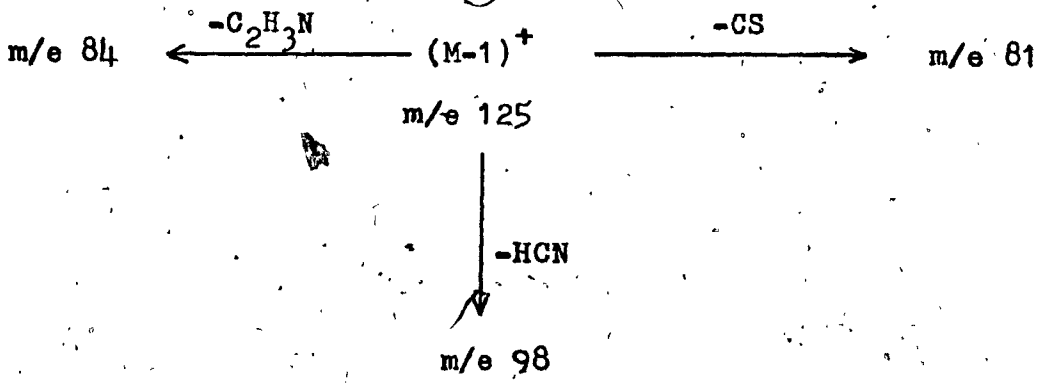
According to the observed metastable ions the M-1 ion loses CS, HCN and C_2H_3N to give the peaks at m/e 81, m/e 98 and m/e 84 respectively. In these cases it is more helpful to visualize the structure of M-1 ion as III-47.

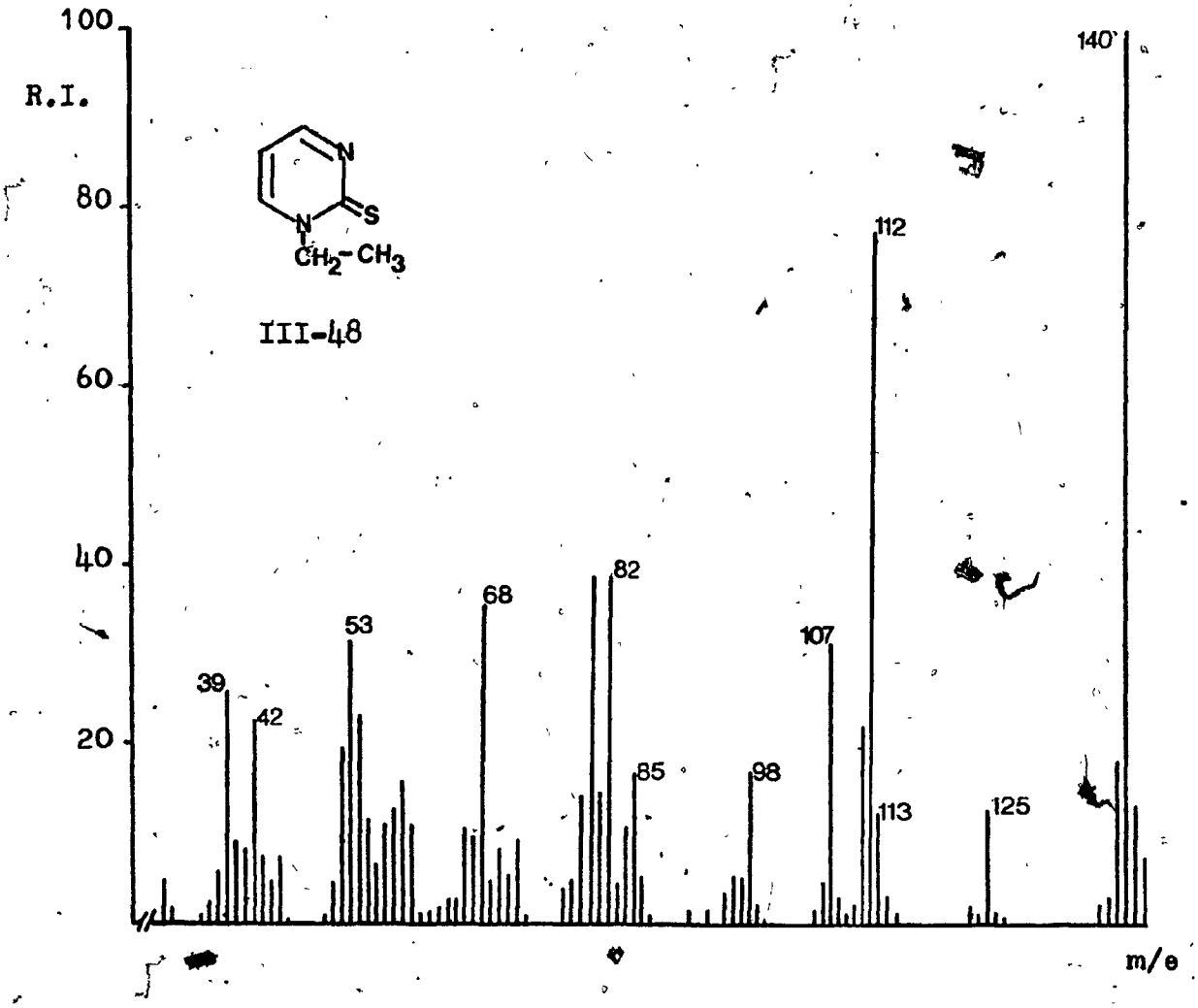


In summary, the primary fragments from the molecular ion arise by loss of ·NCS, possibly ·SH and CH_2S:



The M-1 ion loses CS, HCN and C_2H_3N:





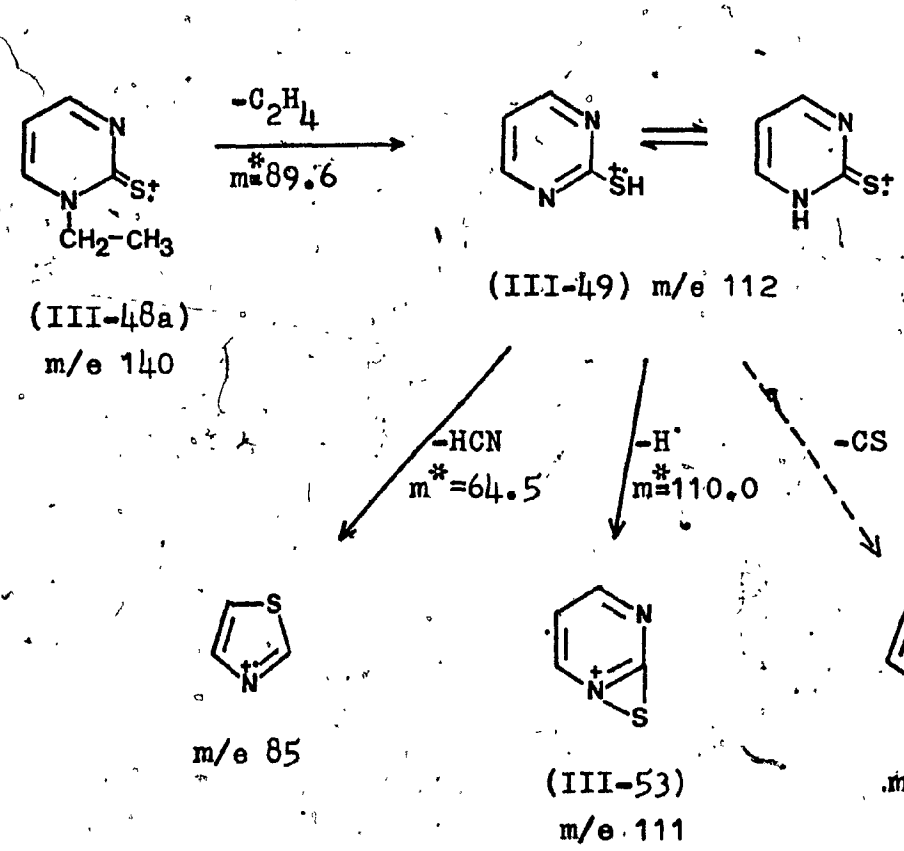
III-48

Fig. III-12 Mass spectrum of 1-ethyl-2-pyrimidthione

1-Ethyl-2-pyrimidthione (III-48) (Fig. III-12)

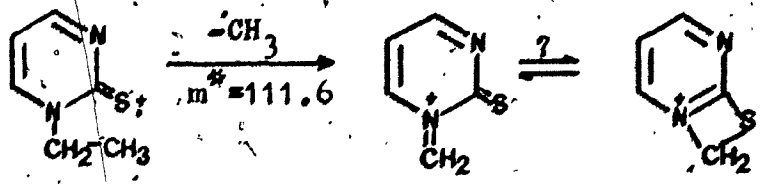
m/e	140	139	125	113	112	111	107
R.I.%	100.0	19.4	13.3	13.3	77.8	24.4	32.2
m/e	98	85	84	82	81	80	79	68
R.I.%	18.3	18.3	12.8	40.0	18.9	40.0	15.6	36.7
m/e	53	42	39					
R.I.%	32.2	23.3	26.7					

The molecular ion (III-48a) of the above compound undergoes a McLafferty rearrangement (cf. 1-ethyl-2-pyrimidone p.58), and loses ethylene to give an abundant ion III-49 at m/e 112. This process is confirmed by a metastable peak at m/e 89.6. The fragment III-49, which is most probably the 2-pyrimidthione odd electron cation, loses HCN, H and probably CS (cf. p.82). The metastables are observed for the first two processes.



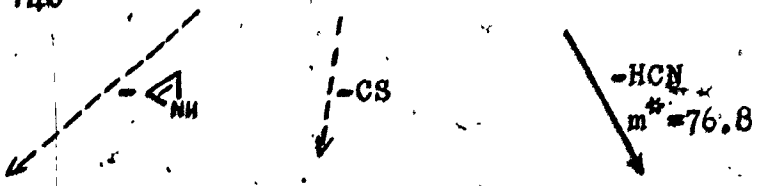
Expulsion of CH_3 from the molecular ion gives the fragment III-50 at m/e 125 (cf. III-47, p.86), which further decomposes by loss of HCN to form an ion at m/e 98. Both fragmentation pathways are confirmed by metastable

transitions at m/e 111.6 and 76.8 (cf. p.86).



(III-48a)
m/e 140

(III-50) m/e 125



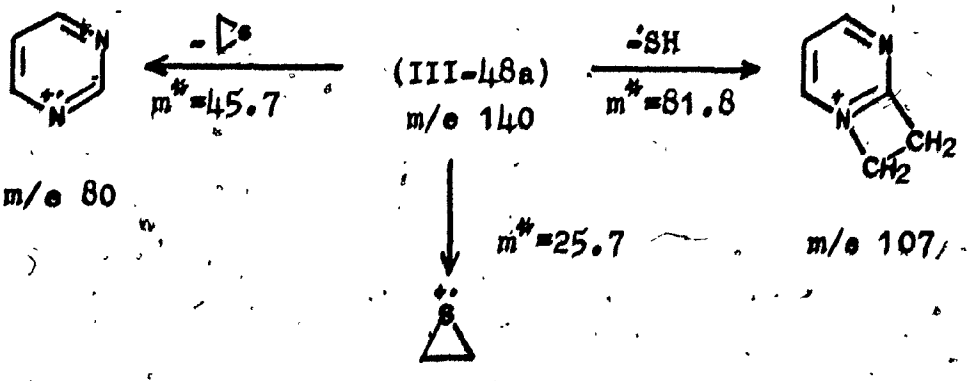
m/e 84

m/e 81

m/e 98

The fragment III-50 possibly loses also CS and C_2H_3N, but there is no evidence from the aspect of metastable transitions for these pathways (vide supra).

In view of the observed metastables, the molecular ion also expels ·SH, $CH_2{-}CH_2$, and pyrimidine.

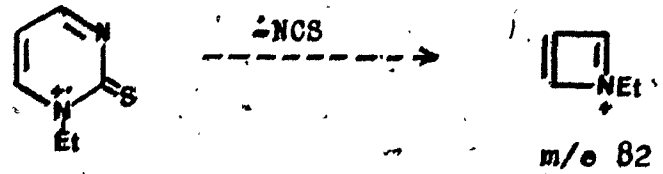


m/e 80

m/e 107

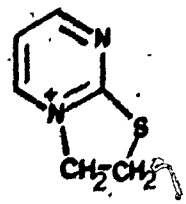
m/e 60

The peak at m/e 82 could be due to the loss of NCS from the molecular ion, but no metastable was observed in the appropriate region.

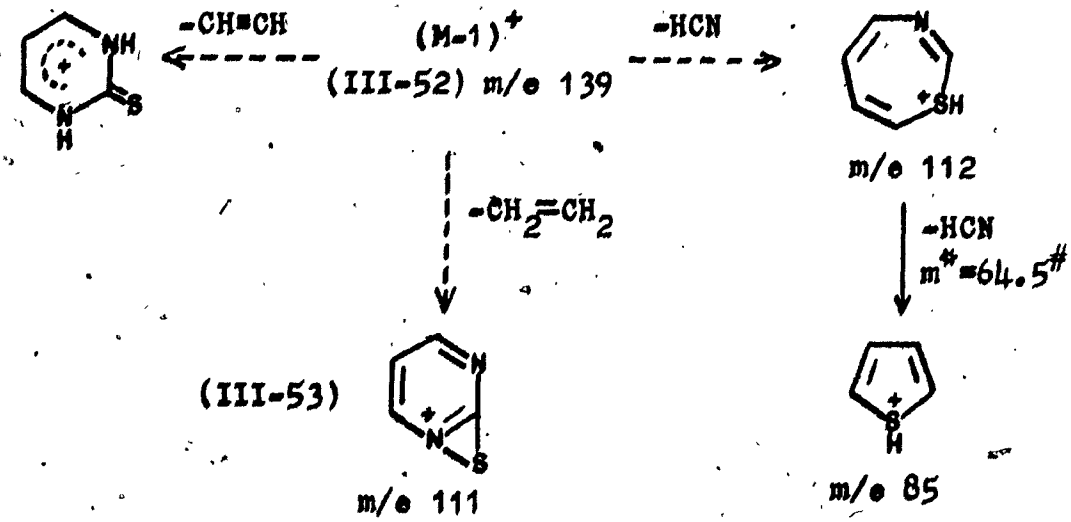


(III-48a) m/e 140

The proposed structure for the M-1 ion is the following: However, there is no evidence, that the expelled hydrogen comes from the ethyl substituent. Also no metastable ions were observed for any possible further fragmentations of the M-1 ion. It could be, that the III-52 ion loses HCN, C_2H_2 and C_2H_4 to contribute to the peaks at m/e 112, m/e 113 and m/e 111.



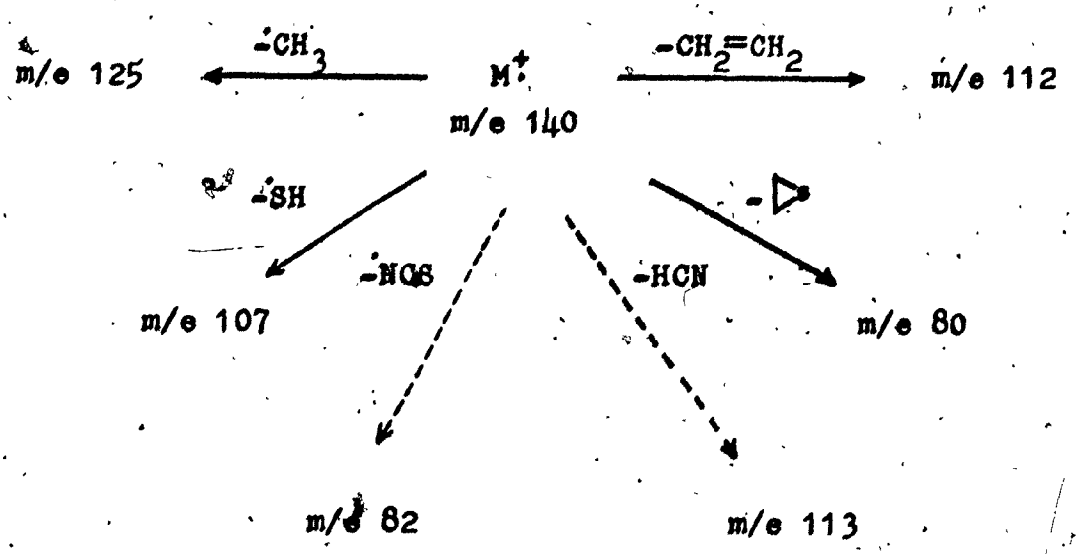
(III-52)



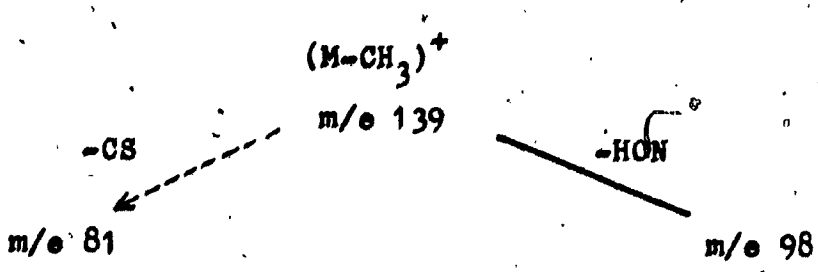
NB This metastable may also refer to the transition (III-49) m/e 112→85, shown on page 89.

The ion III-53 can also arise directly from the molecular ion by loss of ethyl substituent, but no metastable was observed for this process.

In summary, it seems that the major fragments come directly from the molecular ion by loss of $CH_2{=}CH_2$, SH, $CH_2{=}CH_2$, CH_3, possibly NCS and HCN:



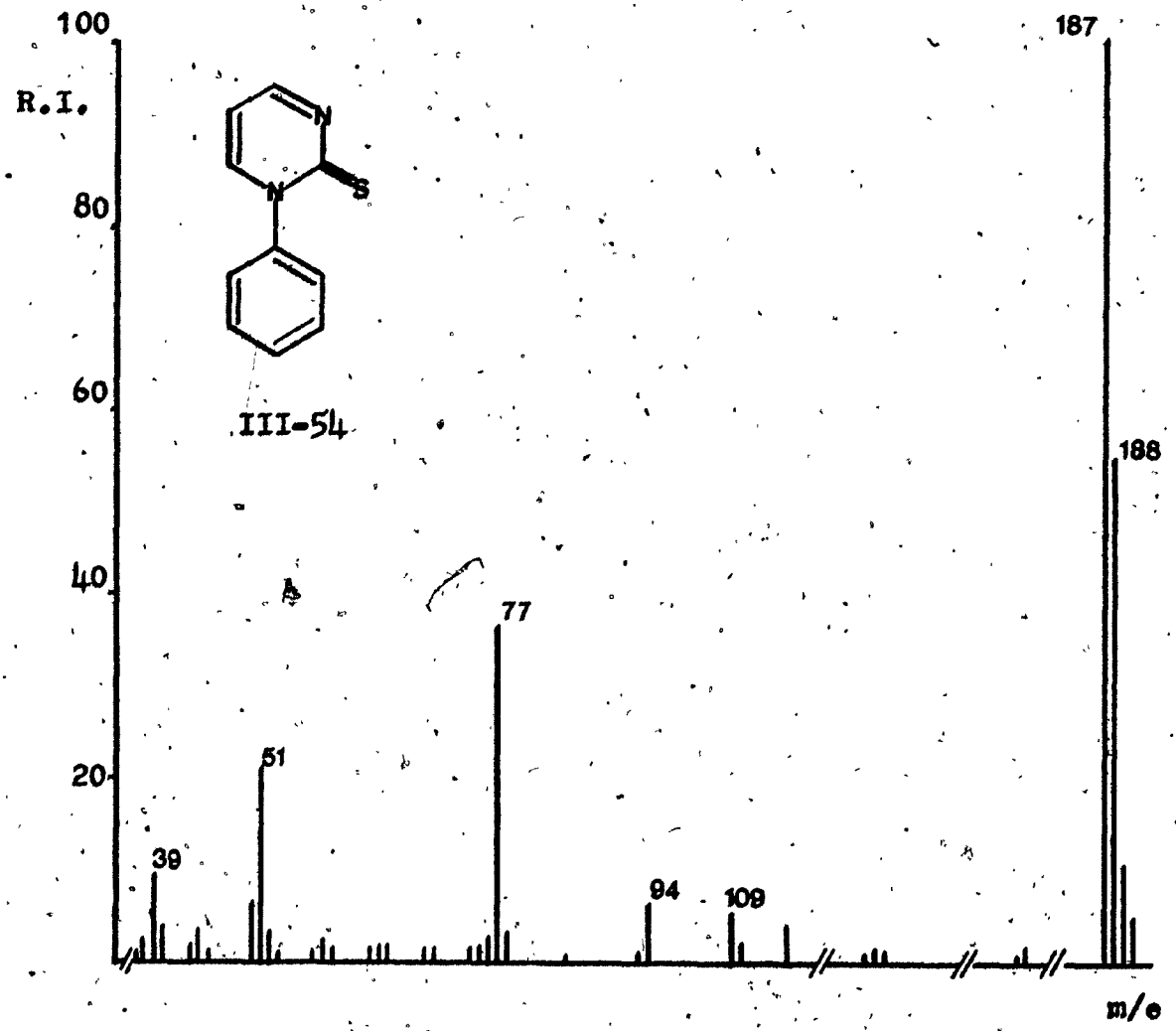
Interesting fragments arise from the $M-CH_3$ ion by loss of HCN and possibly CS (cf. III-17 p.61):



1-Phenyl-2-pyrimidthione (III-54) (Fig. III-13)

m/e	188	187	77	51	39	32
R.I.%	55.3	100.0	36.3	21.6	9.8	58.8

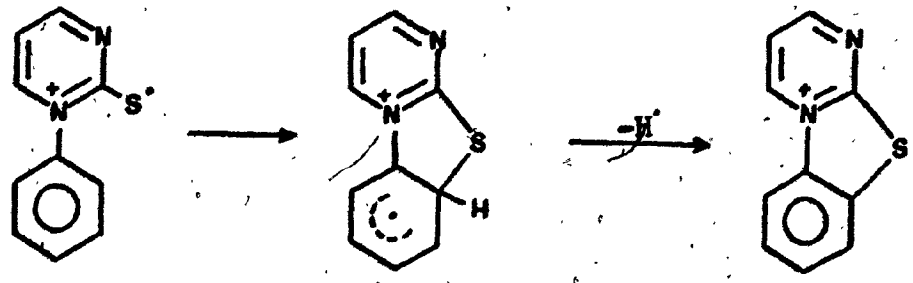
The spectrum of this compound is very simple and by far the most dominant peak is at M-1. Moreover



III-54

Fig. III-13 Mass spectrum of 1-phenyl-2-pyrimidthione

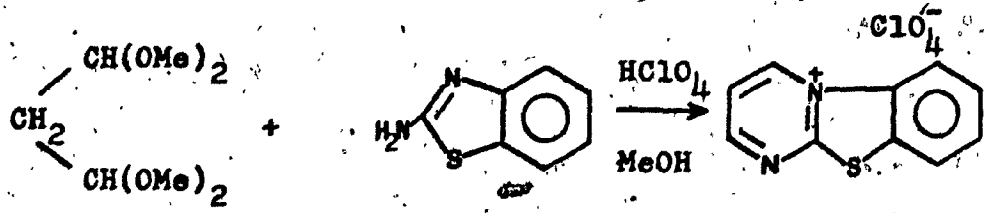
this peak carries 25% of the total ionization current. As with 1-phenyl-2-pyridone[19], and with 1-phenyl-2-pyrimidone (this thesis p.75), the hydrogen lost most probably comes from the benzene ring by a process which is a radical substitution reaction.



$M^{\dagger}$ m/e 188 m/e 187

No metastable was observed for this process which is probably quite fast.

The stability of the m/e 187 ion is in keeping with the assigned structure, a salt of which was easily synthesized by the reaction shown below:

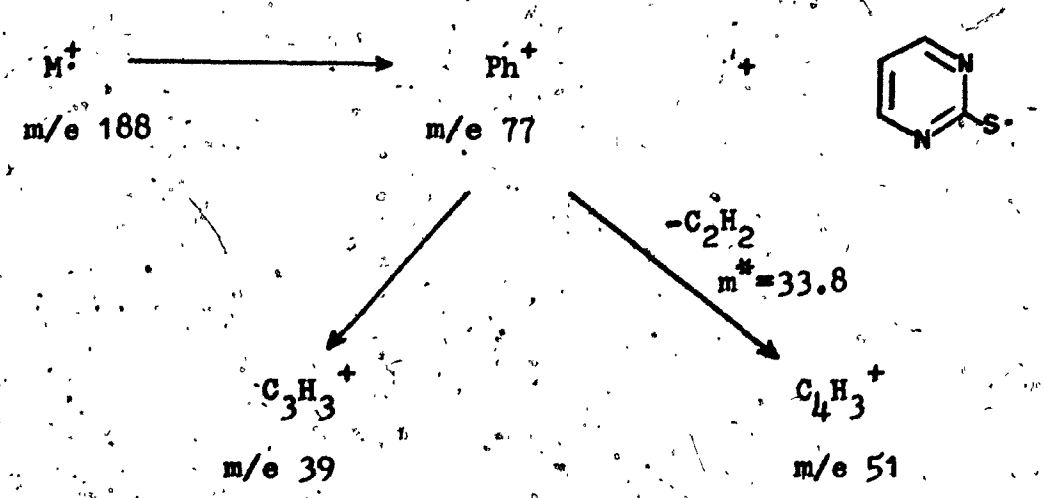


Attempts to obtain mass spectra from this salt were not successful.

The process m/e 188→187 is apparently much more important than the analogous loss of H· from 1-phenyl-2-pyrimidone (p.74). This observation is in accord with the known greater stability of thiazolium versus

oxazolium systems[54].

Besides the molecular ion, the only other large peaks in the mass spectrum of III-54 are at m/e 77, 51, 39 and 32. The m/e 77 ion is presumably the phenyl cation resulting from simple cleavage of the molecular ion.

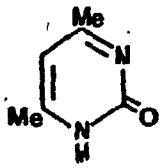
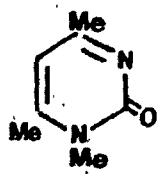
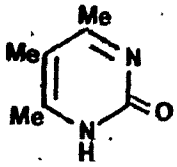
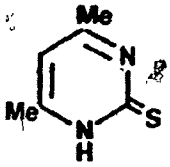
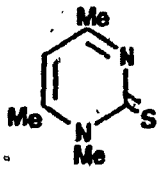


A m/e 51 ion $(C_4H_3)^+$ is a common fragment of aromatic compounds[55] resulting from the loss of acetylene from the $C_6H_5^+$ ion. The metastable (m^*=33.8) for this process is clearly observed. Similarly $C_3H_3^+$ (m/e 39) commonly occurs. The ion at m/e 32 is presumably the sulfur cation S^+.

The absence of significant loss of CS from the molecular ion is presumably due to the preeminence of the m/e 188→187 process.

4,6-Dimethyl derivatives

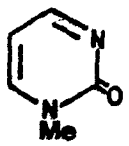
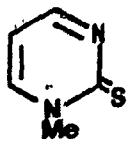
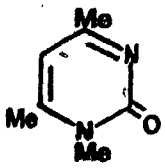
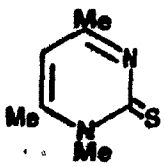
Very little attention was paid to the mass spectra of the last five compounds namely,

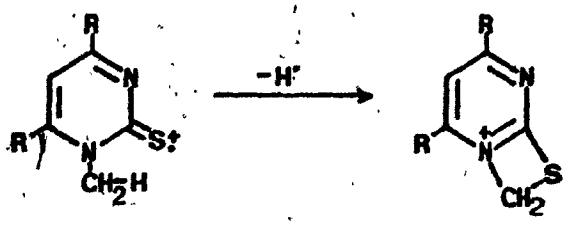
(III-55) (III-56) (III-57) (III-58) (III-59),

since they were not found helpful in the elucidation of the fragmentation patterns described above.

As previously their spectra are characterized by fragments due to loss of CX,HCN,NCX,HNCX and CH_3NCX to various extents plus all of them suffer loss of at least one methyl group from the molecular ion. The only two fragments, that attracted our interest were the M-1 ions of III-56 and III-59. Comparing the intensities of the M-1 ions in the table below,

		$(M-1)^+$ R.I.%
(III-8)		62.5
(III-43)		22.2
(III-56)		<0.9
(III-59)		16.3

we see, that while the intensities of the thio-ions are similar, the difference between the abundances of the two oxo-ions is remarkable. As already indicated before, deuterium labelling showed in the case of III-8, that the hydrogen lost does not come from the methyl group and it was postulated, that most probably the hydrogen from 6 position is expelled by alpha-cleavage, followed by hydrogen transfer from methyl group to form a stable iminium ion (III-10d p.48). This mechanism would explain, why almost no hydrogen is ejected from the molecular ion of III-56. The two thio-compounds however show, that the hydrogen loss to form the M-1 ion might come from the N-methyl group. The following mechanism, via gamma-fission is suggested:



(R = H or Me)

PART IV - SUMMARY

The molecular ions of the compounds investigated may be stabilized by delocalization and so give rise to relatively intense peaks. Their stabilities, however, are not identical and are dependent on the 2-heteroatom (i.e. S or O) and on N-substituents.

For both series of compounds (X = O or S) the major pathways involve loss of CX and loss of HCN, although the intensities of the appropriate fragments vary[53]. The main difference between the two series is that while loss of $^{\bullet}$SH from the 2-thiones is quite evident, loss of $^{\bullet}$OH from the oxygen analogues is not significant.

The different N-substituents, however, alter the fragmentation pattern by giving rise to new ions of high stability, which result in a suppression of the major fragmentation routes (M-CX, and M-HCN). With increasing size of the N-alkyl substituent more fragments appear in the spectra, while the reverse holds for the N-phenyl substituent, where delocalization contributes to the stability of the molecular ion, and the relatively stable M-1 ions preclude certain fragmentations.

Loss of hydrogen radical is encountred in every single spectrum, but the intensities of the M-1 ions vary considerably depending upon the product ion structure. In the case of the unsubstituted-, the N-methyl-, and the

N-ethyl-2-pyrimidone deuterium labelling showed that the lost hydrogen comes from the pyrimidine ring. We believe that 4 or 6 position is involved in the expulsion, but more work has to be done to support this hypothesis. Scrambling of the ring hydrogens, which occurs in numerous examples stated in the literature(e.g. ref. 12), cannot be excluded. It is almost certain that the N-phenyl-oxo- and thio-pyrimidine molecular ions lose hydrogen from the ortho-position of the benzene ring to form the stable oxazolium or thiazolium ions.

Loss of NCX (X = O,S) from $M^{+\cdot}$, although it seldom belongs to a major fragmentation route, appears in all the spectra, to a greater or lesser extent.

The mechanisms proposed earlier are, of course, highly speculative. They may, however, be useful in suggesting future work to identify more closely the origin of the major fragments. Such studies will require the further use of labelled substrates and high resolution techniques.

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