SOME STUDIES ON CARBENE REACTIONS

THESIS SUBMITTED FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY (SCIENCE)
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By

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ABSTRACT

In this work a study has been made to compare the addition reactions of various α-diazoacetophenones with various cinnamic esters. No rigorous degassing or sophisticated photolytic equipment was used. The principal object was to provide easy synthetic routes to a class of similar compounds. The relative reactivity and the various physical and other data has been noted for the compounds prepared. These provide an interesting feature of the work embodied here. The work also includes similar types of reactions with some other diazoketones diazomethane. The catalytic effect of the carbene additions with some metal ions, rearrangements of the cyclopropane compound, intramolecular reactions have also been attempted. Although it has not been possible as yet to make a comparative study of the shift data from cmr and the benzylic proton in pmr with various substituent constants the comparison of the UV absorption gives a linear relationship analogous to that obtained by simple Hammett equation.

SUMMARY

The work embodied in the present thesis has been divided into two parts.

PART-I

SOME STUDIES ON KETOCARBENES ADDITION TO DOUBLE BONDS AND RELATED REACTIONS.

Chapter-I:

In this chapter a short introduction to the Chemistry of carbenes is given.

Section-A:

This section gives a review of the historical background of the methylene (rather carbene) reactive intermediate.

Section-B:

This section gives a short review of the singlet and triplet state of the carbene.

Section-C:

This section deals with some of the general procedures of carbene generation.

Section-D:

This section attempts to record some of the factors affecting these reactions. These effects which come into play in the carbene reaction often play an important role. The effects are mainly due to electronic factors, steric factors and the effects due to the mesomeric and induction are discussed curiously.

Section-E:

This section deals with the nature of the transition state for C-H insertion and addition of Carbene to double bonds.

Chapter-II:

This chapter records some additional aspects of keto carbene reaction.

Section-A:

This section gives a short review on keto carbenes and their reactions.

Section-B:

This section gives some idea about the mechanistic pattern of keto carbene addition to double bonds.

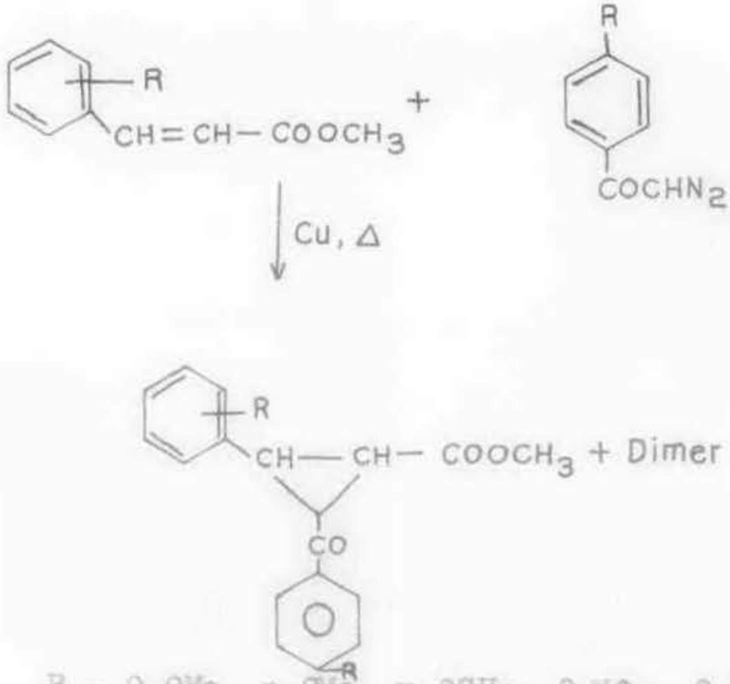
Chapter-III:

This chapter deals with the present studies on the reactions of diazoketones with some selected cinnamic esters.

Section-A:

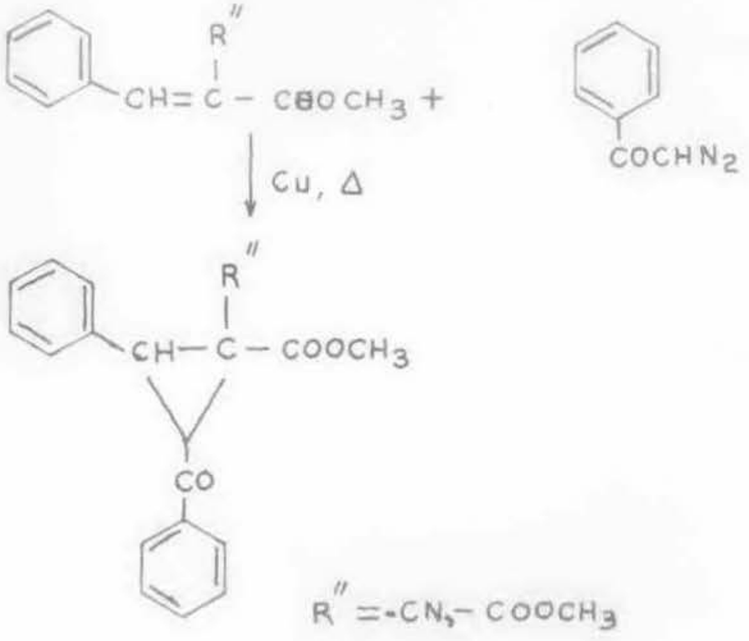
This section deals with the aims and objects of this study i.e. keto carbene addition to cinnamic esters. In this study various cinnamic esters, substituted in the ring at ortho, meta and para positions as also α-substituted cinnamic esters were taken. Whereas the diazo ketones used were α-diazoacetophenone, p-chloro-α-diazoacetophenone, p-methoxy-α-diazo acetophenone, p-nitro α-diazoacetophenone and α-diazoacetonaphthone. Reactions of these diazoketones and cinnamic esters are recorded.

The reactions may be written in the following way.



R = O-OMe, p-OMe, m-OCH_3, O-NO_2, O-Cl, P-Cl,
P-NO_2, O-$COOCH_3$ and H.
R' = P-Cl, P-OMe, P-NO_2 and H.

and also



R'' =-CN,- COOCH$_3$

A comparative study of the reaction of the diazoketones with these cinnamic esters has been made.

Section-B:

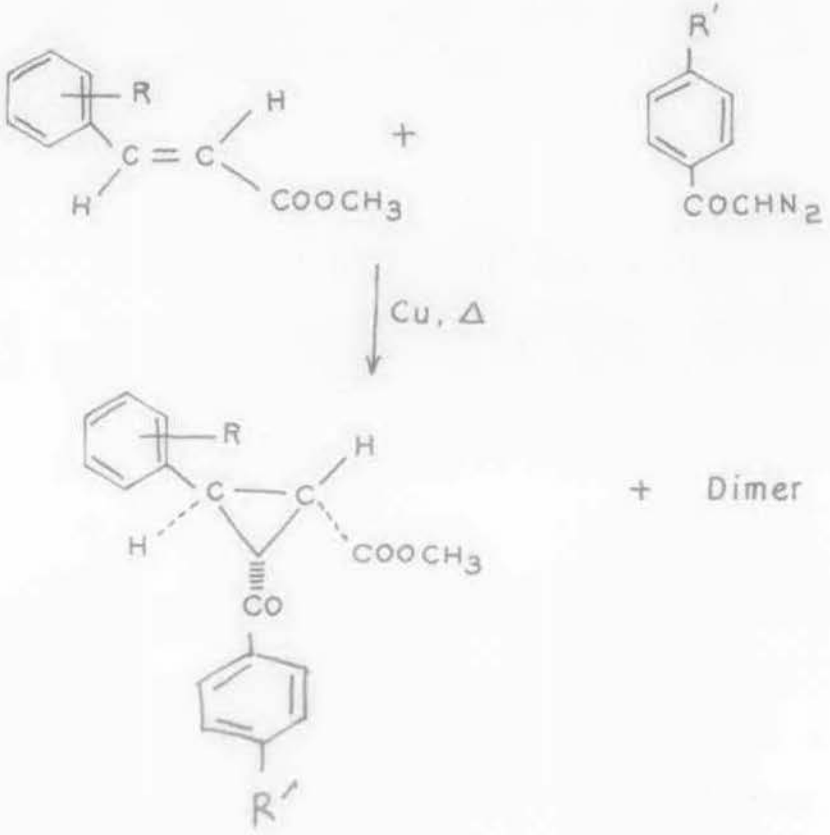
This section deals with the results and discussions of the reactions of diazoketones with cinnamic esters.

Reactions between diazoketones and cinnamic esters give rise to cyclopropyl ketones and dimer of the keto carbenes. But cyclopropyl ketones were not isolated in all the cases studied here.

O-methoxy and p-methoxy methyl cinnamate give rise to larger amount of cyclopropyl ketones. But p-nitro, p-chloro, o-carbomethoxy cinnamic esters do not give cyclopropyl ketones at all. Similarly when α-position of the cinnamic ester contains a carbomethoxy group does not give cyclopropyl ketone at all.

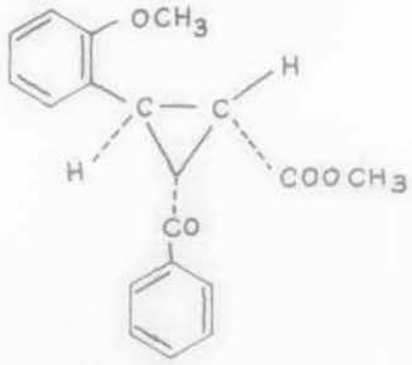
I.R. spectrum of these cyclopropyl ketones showed bands at 1010-1025 cm^{-1} indicating that these compounds contain a cyclopropane ring. I.R. spectra of these compounds also showed bands near 1700 cm^{-1} to 1720 cm^{-1} indicating that these compound contains an ester function also. Bands at 1655 cm^{-1} to 1680 cm^{-1} indicated the presence of carbonyl function in these compounds.

UV spectra showed peaks from 238 to 248 nm for these compounds which indicated that these compounds contained a phenyl group β to the aroyl function. This fact furnished easy evidence for the formation of a cyclopropane ring in these compounds. The studies indicate that the addition was a trans one in the case of trans esters and diazo ketones and we have isolated only one product.



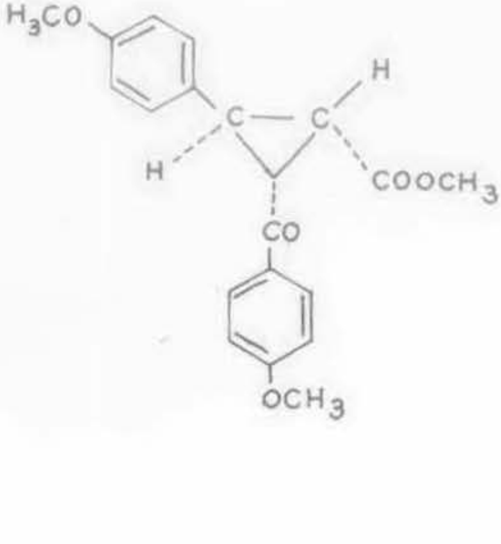
Mass spectrum of 1-benzoyl-2-carbomethoxy-2'-(o-methoxy) phenyl cyclopropane showed peaks at 295 ($M^{+}-OCH_3$), 238, 223, 205, 120, 118, 108, 105, 92, 77, 76, 64 and 44.

These peaks were explained as arising due to the following parent compounds:

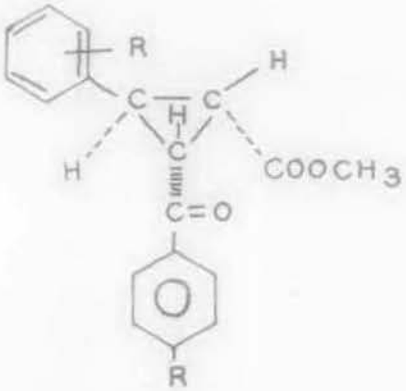


The mass spectrum of 1-(P-OCH_3) benzoyl-2-carbomethoxy-2'-(P-OCH_3) phenyl cyclopropane showed peaks at m/e 325 (M^+-OCH_3), 297, 188, 156, 135, 121, 108, 92, 75, 72 and 44.

These peaks were explained as arising due to the following structure:



The N.M.R spectra were also obtained and we made a comparative study of the N.M.R. signals of the starting esters and that of the reaction product. In all cases the reaction products did not show any N.M.R. signals at δ 6.22 to δ 6.43 ppm arising as due to simple olefinic proton indicating absence of olefinic double bond. A quasi doublet N.M.R. signals at δ 4.1 to δ 4.9 indicated that the cyclopropyl ketones were 1,2,2', a trisubstituted cyclopropane whose structure should be written in the following way.



In addition other signals due to different protonic absorptions were also noted.

P.M.R. signals at δ 3.9 to δ 3.95 indicating the presence of OCH_3 group attached to phenyl i.e. ether linkage. Signal at δ 3.8 indicating the presence of OCH_3 group of carbomethoxy group, The P.M.R. bands in the region of δ 6.9 to δ 7.5 indicated the presence of phenyl moiety and the N.M.R. bands in the region of δ 7.5 to δ 8.5 indicated the presence of benzoyl group.

These observations have been found in the reaction products of p-methoxy methyl cinnamate with α-diazoacetophenone and p-methoxy α-diazoacetophenone. Detailed P.M.R. records of the products from o-methoxy methyl cinnamate with p-methoxy α-diazoacetophenone and that of methyl cinnamate and α-diazoacetophenone are also recorded.

Section-C:

Experimental details of this chapter have been described in this section.

Chapter-IV:

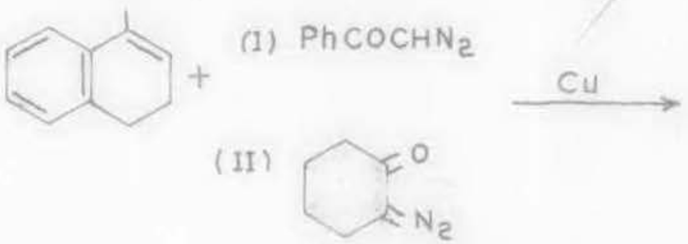
This chapter deals with the reactions of diazoketones with various other olefinic systems.

Section-A:

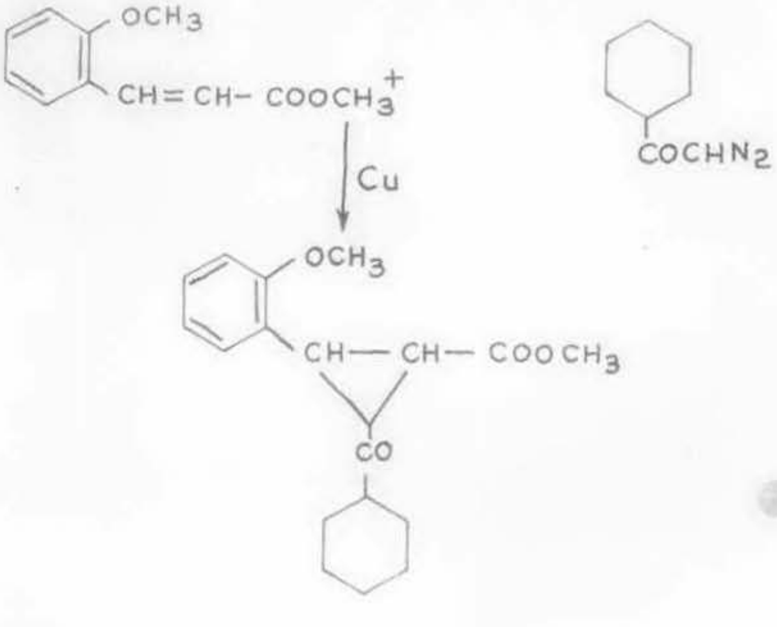
This section deals with the reaction of some diazo ketones other than α-diazoacetophenone with different types of olefinic systems other than cinnamic esters, in order to make a comparative study with that of the reactions which had been recorded earlier. In this connection, reaction of α-diazoacetophenone with methyl methacrylate and methyl crotonate were studied to see the effect of CH_3 group in the α or β position of methyl acrylate on the yield of cyclopropane derivative and it is observed that CH_3 group in the β position lowered the yield.

Reaction of cyclohexene with α-diazoacetophenone and α-diazoacetonaphthone were studied. The effect of the different keto carbenes and their steric hind~~e~~rance factor, on the yield of the cyclopropane derivative were made.

Reaction with diazo keto compounds with 3-4 dihydro α-methyl naphthalene were studied to see the steric effect exerted by this tri-substituted olefinic compound.



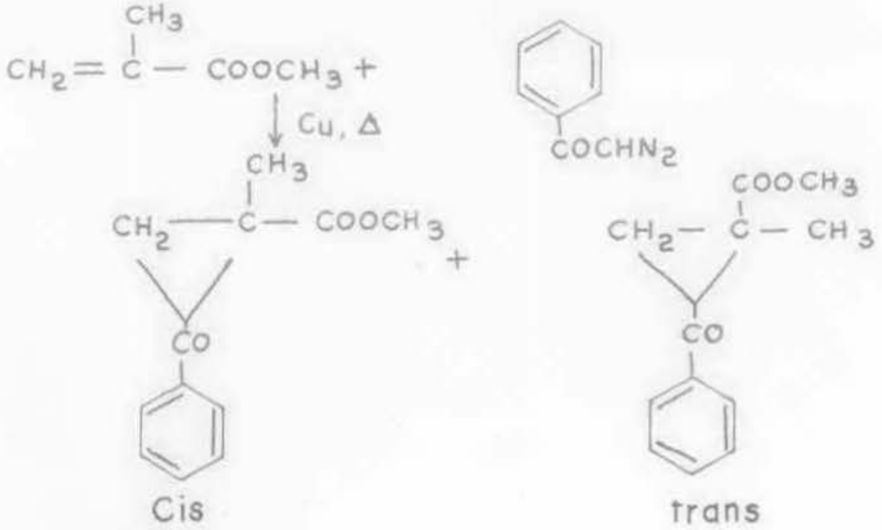
Reaction of o-methoxy methyl cinnamate and a diazo methyl cyclohexylketone was studied to see the effect of the aliphatic keto carbene on the yield of cyclopropane derivative to that of a aromatic diazo compound i.e. α-diazoacetophenone.



Section-B:

This section deals with the results of the reactions of diazo ketones and various olefinic systems involved in the previous section.

It was seen that CH_3 group when situated at the β position gave poor yield of the cyclopropane derivative than when it was in the α position of the methyl acrylate when reacted with α-diazoacetophenone in each. The structure of the reaction product of the α-diazoacetophenone and methyl methacrylate was confirmed by I.R., U.V. and N.M.R spectrum. Also G.L.C. showed that there were two products. The cis and trans adducts had been formed.



Reaction between cyclohexene with α-diazoacetophenone and α-diazoacetonaphthone showed that in the latter case, yield was poor and this is explained as due to the larger size of the keto carbene.

Reactions between α-methyl 3,4 dihydro naphthalene with diazo compounds were unsuccessful probably due to the tri substituted nature of the olefinic double bond. The reaction between α-diazo cyclohexanone with the olefinic double bonds also failed.

Reaction between an aliphatic diazo compound and cinnamic esters showed that it gave poor yield of cyclopropyl ketones.

The identification of these products were made by G.L.C. in the case of liquid product and the use of I.R., U.V. and elemental analysis made both in the cases of liquid and solid products.

I.R bands of some of the products at 1010 cm^{-1} to 1020 cm^{-1} indicated the presence of cyclopropane ring and band at 1655 to 1680 cm^{-1} indicated the presence of carbonyl group.

Section-C:

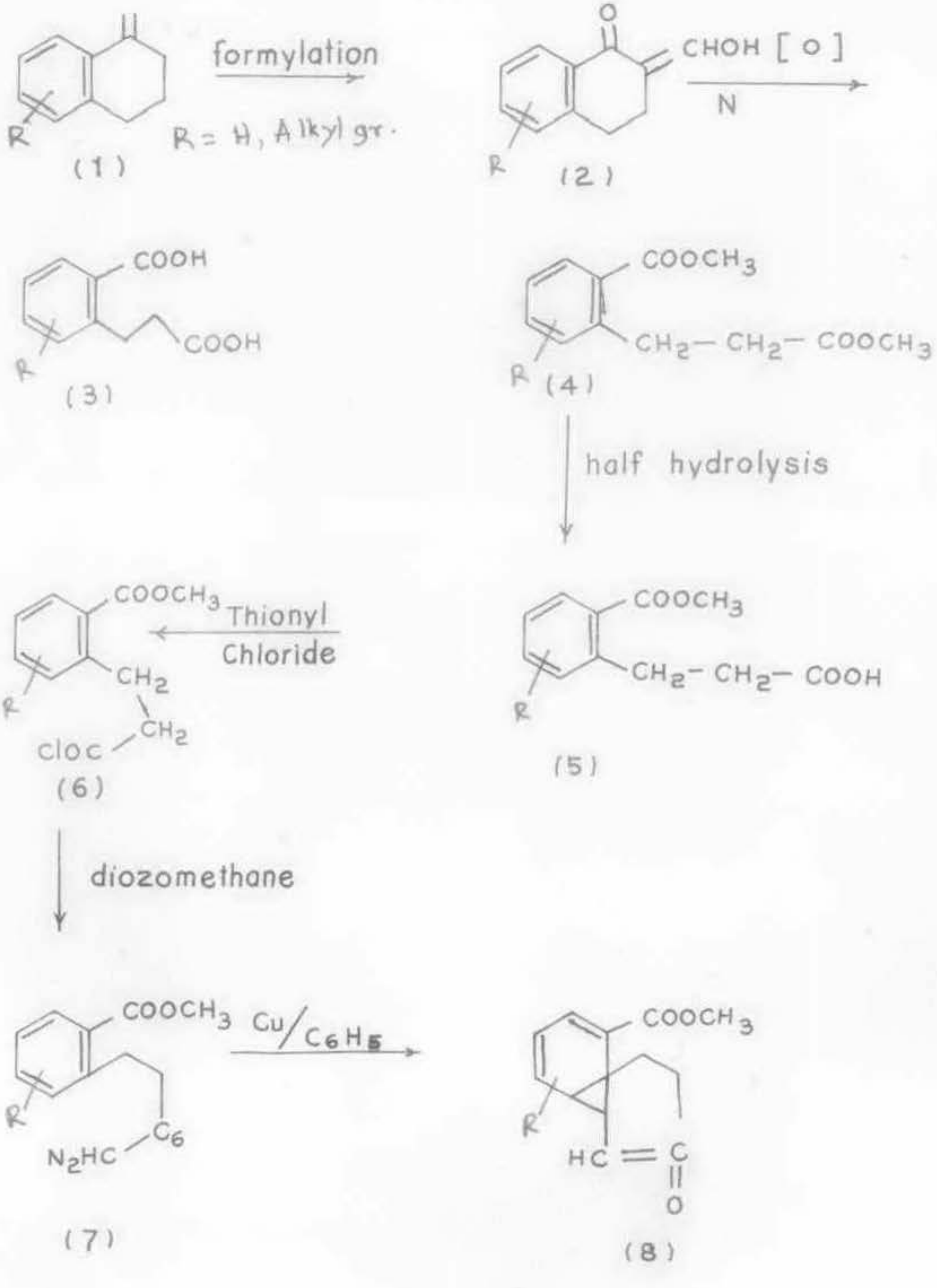
Experimental portion of this chapter has been described in this section.

Chapter-V:

This chapter deals with the intramolecular keto carbene addition to aromatic system.

Section-A:

In order to study the intramolecular keto carbene addition to some selected aromatic systems following reactions were attempted.

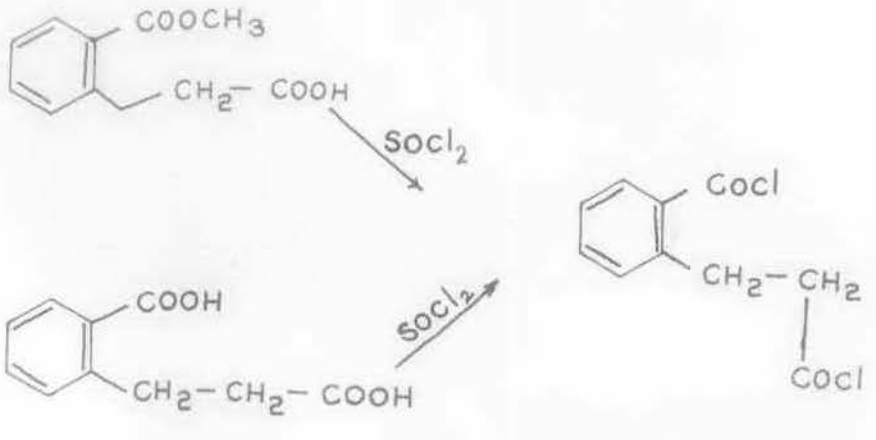


Section-B:

Formylation of α-tetralone gave hydroxy methylene (2) which on oxidation by $K9O_4/KMnO_4$ gave diacid [3] which was also prepared alternatively by oxidation with H_2O_2/CH_3COOH of β-naphthol. This on esterification gave diester [4] which on careful hydrolysis gave the half ester [5]. At this stage difficulty was experienced as [5] was treated with thionyl chloride diacid chloride [9] instead of [6] resulted. It was not possible to prepare [6]. The structure of [9] was confirmed to be the structure of the diacid chloride of the acid by the comparison of I.R. spectra.

The identification of the other compounds was done by elemental analysis and I.R.

Some cursory work to prepare [7] by alternative synthetic procedures have not as yet yielded fruitful results.



(9)

Section-C:

Experimental portion of this chapter is described in this section.

Chapter-VI:

This chapter deals with the relative catalytic activity of some metal ions in the reaction of α-diazoketones.

Section-A:

In this section the metal ion activity of some Cu salts i.e. CuCl, $CuSO_4$ (anhydrous), Cu and palladium acetate on the yield of cyclopropyl ketones were studied when the reactants were p-methoxy methyl cinnamate p-nitro methyl cinnamate and α -diazoacetophenone maintaining all the other experimental conditions as identical as possible. It was seen that Cu gave maximum yield where as palladium acetate did not catalyse the addition reaction.

Chapter-VII:

This chapter deals with the effect of potassium tert-butoxide on cyclopropyl ketones.

Section-A:

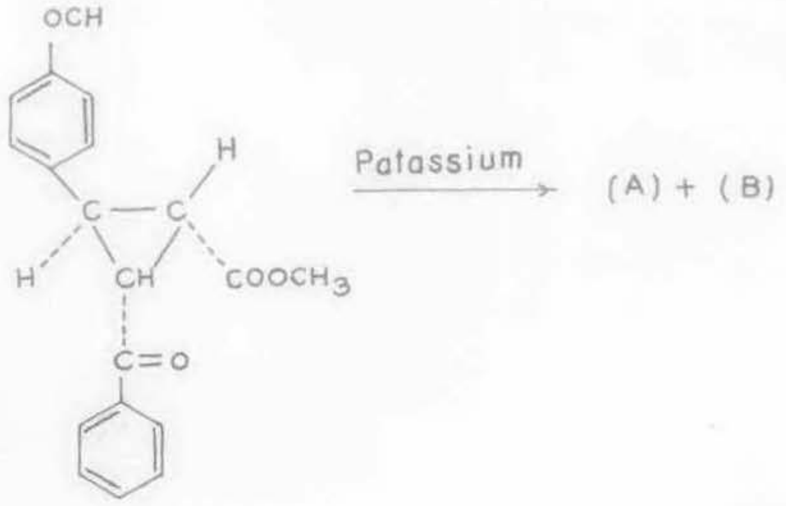
This section contains aims and objects of the above study. It is known that cyclopropyl ketones undergo different types of rearrangement when they are treated with liquid ammonia, perchloric acid, HCl and H_2SO_4.

It was an object to see what type of rearrangement took place when cyclopropyl ketones, prepared here, were treated with potassium-tert-butoxide. With this view 1-benzoyl-2-carbomethoxy-2'-(p-methoxy) phenyl cyclopropane was treated with potassium tert. butoxide.

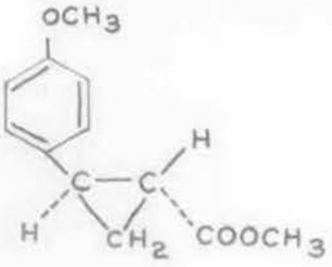
Section-B:

When 1-benzoyl-2-carbomethoxy-2'-(p-methoxy) phenyl cyclopropane treated with potassium t-butoxide gave two products, (A) and (B). (A) has been confirmed to be benzoic acid by elemental analysis, I.R, mass spectrum and also by the comparison of IR bands with that of benzoic acid.

The identification of (B) was done by elemental analysis. IR bands at 1010 cm^{-1} and 1700 cm^{-1} showed the presence of a cyclopropane ring and an ester function in this part. NMR spectrum in the region δ 1.2 to δ 2.5 showed the presence of cyclopropane hydrogens.



A =


The structure of B.


Section-C:

Experimental portion of this chapter has been described in this section.

PART - II

REACTION OF DIAZOMETHANE WITH CINNAMIC ESTERS.

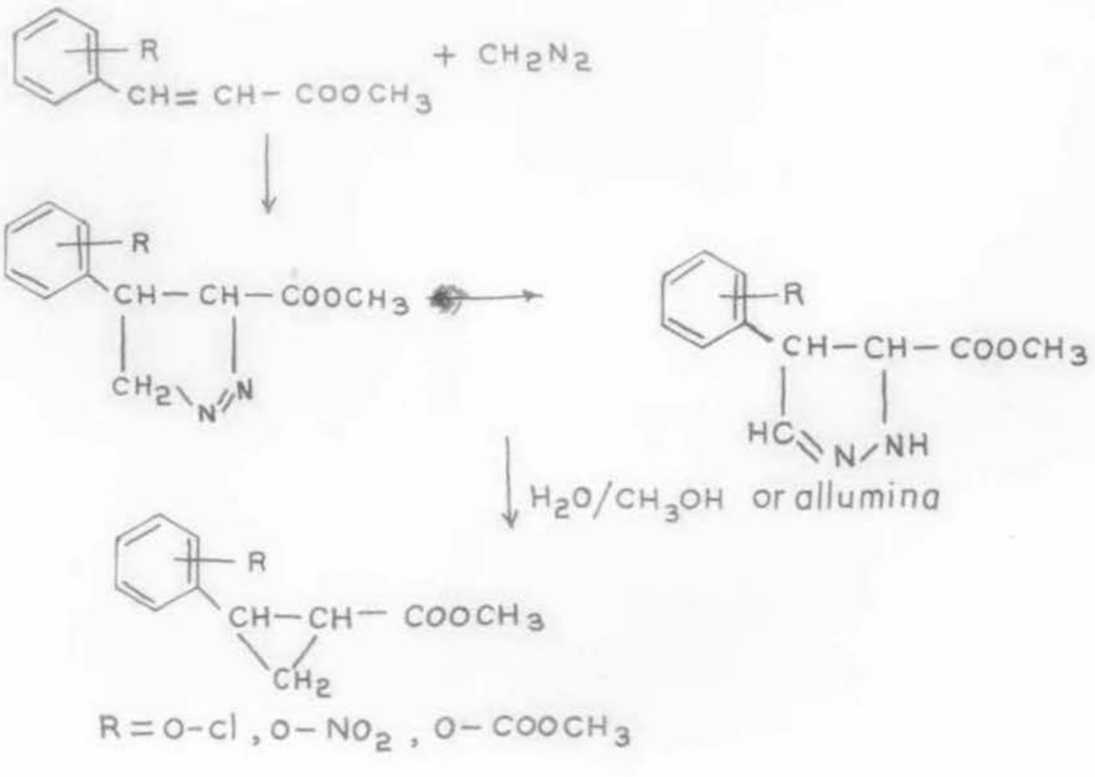
Chapter-I:

Section-A:

In this section a short review of the structure of diazomethane and 1,3 cyclo addition and various reactions of diazomethane with olefinic double bonds has been presented.

Section-B:

In this section the reactions of diazomethane with cinnamic ester in order to prepare 1 or 2-pyrazoline and thereby to prepare cyclopropane derivatives have been discussed.



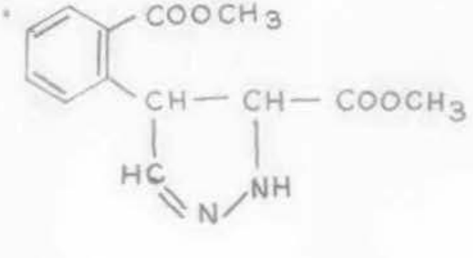
$R = o\text{-}Cl,\ o\text{-}NO_2,\ o\text{-}COOCH_3$

Section-C:

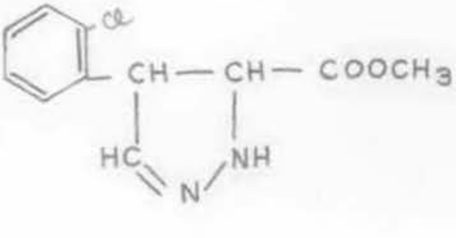
This section deals with the results and discussions of the reaction of diazomethane with o-chloro methyl cinnamate, o-carbomethoxy methyl cinnamate, o-nitro methyl cinnamate, p-nitromethyl cinnamate and mesityl oxide.

In most of the cases, 2-pyrazoline were isolated, whose structure were confirmed by elemental analysis, I.R., mass spectra and N.M.R spectra. In the case of liquid product G.L.C. was reported. IR spectrum in the region of 3300 to 3400 cm^{-1} of these compounds indicated the presence of secondary amine group.

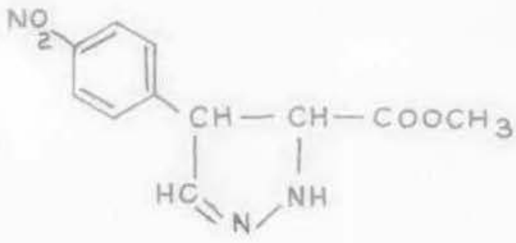
Mass spectrum of 3-carboxylate-4 (o-carbomethoxy)-2-pyrazoline showed peak at M^+(262) together with other peaks at Fig P14. These fragmentations could be explained arising to the following structure of the compound.



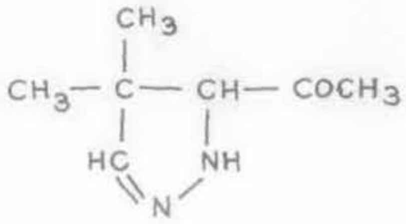
Mass spectrum 3-carboxylate-4 (o-chloro) phenyl 2-pyrazoline showed bands at M^+(232) and other bands. These fragmentations could be explained as arising due to the following structure:



This was further confirmed by N.M.R . N.M.R signals at δ 4.1 (broad) of 3-carboxylate-4 (p-nitro) phenyl 2-pyrazoline is accounted as due to the presence of NH proton. In addition it had signals due to $COOCH_3$ proton, phenyl proton, N = CH proton. All these observations were explained as arising due to the following structure of the compound.



Reaction product of diazomethane and mesityl oxide gave only one product as seen by G.L.C. This contained NH grouping. So the structure of this product is



These 2-pyrazoline when treated with alumina or CH_3OH or H_2O did not afford any cyclopropane derivative. So thermally 2-pyrazolines are more stable than 1-pyrazoline.

Section-D:

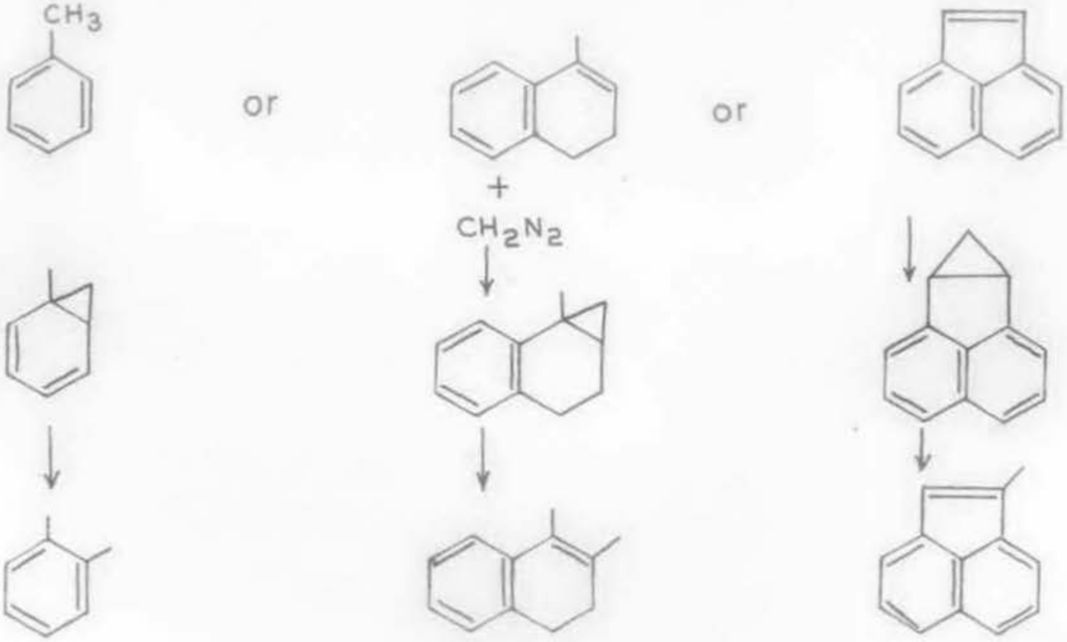
Experimental portion of this chapter has been described in this section.

Chapter-II:

This chapter deals with the decomposition of diazomethane with various copper salts.

Section-A:

This section deals with the aims and objects of this study when toluene, α-methyl 3,4 dihydro naphthalene and acenaphthylene were employed to be cycloproponated by means of diazomethane in presence of Cu and various copper salts. The aim being to derive an easy alkylation procedure or to prepare C-methyl derivative of these compounds by diazomethane.



Section-B:

This section contains the results and discussions of the previous reactions when solid product isolated other than C-methyl derivative of the reactants. This compound also prepared when ethereal solution of diazomethane alone was decomposed in presence of Cu or its salts.

This compound contained nitrogen but not Cu. It is highly alkaline in nature. When treated with KOH solution, it gave out a gas of ammonia like smell. It is not very stable in ordinary temperature. It melts at 112°C.

It showed following I.R. bands. (Fig 56)

Its molecular wt. by Beckmann depression of freezing point method was determined as also its nitrogen content to be 90.

It could not be hydrogenated. It does not contain any active olefinic double bond. No useful compound could be isolated when this oxygenated dimer was used in place of diazomethane itself in the various reactions indicated here.

Section-C:

Experimental portion of this chapter has been described in this section.

CONTENTS

PART - I

Some studies on keto carbenes addition to double bonds and related reactions.

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CHAPTER-IV Reactions of diazo ketones with some olefinic systems.

CHAPTER-V Intra molecular keto carbene addition to aromatic system.

CHAPTER-VI Relative catalytic activity of metal ions in carbene reactions.

CHAPTER-VII Potassium t-butoxide treatment on cyclopropyl ketones.

PART -II

Reactions of diazomethane with cinnamic esters and other olefins.

CHAPTER -I

CHAPTER-II

CHAPTER - I

A general introduction to Carbene Chemistry.

Section A : Historical Background

The possibility that divalent carbon compounds might be intermediates in certain chemical reactions was suggested more than hundred years ago to account for the products of the alkaline hydrolysis of chloroform (1). Divalent carbon intermediates were also involved from time to time during the first half of the present century, particularly as intermediates in the decompositions of diazoalkanes and of ketenes, but it was not until last decade that the 'carbenes' and their reactions were subjected to close scrutiny.

The generic name "carbene" was 'collaborately conceived by Doering, Winstein and Woodward (2), to be descriptive methylene (CH_2), in analogy with the derivation of "carbinols" methanol.

One of the major problems of carbene chemistry has been the determination of the configuration of the non-bonding electrons on the divalent carbon atom. It has now been established that in most, but not all divalent carbon intermediates which have been identified, these electrons are paired, i.e. their spin quantum numbers have opposite signs. It has been suggested that the term carbene should be reserved for those species, while those with unpaired electrons, and which exibit the reactions characteristic of free radicals, should be termed methylenes(3).

The current interest in the divalent carbon species seems to date from 1950, when Hine published his first paper on a reinvestigation of the alkaline hydrolysis of chloroform, **and** concluded that dichloro carbene ($:CCl_2$) was probably an intermediate in this reaction (4).

It was not until 1954 that Doering and Hofmann showed that dihalo carbenes from the haloforms could be trapped by addition to olifins to give cyclopropane derivatives (5).

Thus cyclohexene, chloroform (or bromoform) and Potassium t-butoxide gave 7,7-dihalo nor carane - (equation 1).

.. (1)

While α-elimination reactions have furnished a route to the dihalocarbenes, and more recently, to variety of other substituted carbenes, a second route to divalent carbon intermediates involves the thermal, photo chemical or catalytic decomposition of diazo alkanes and ketenes. Dyakanov (6) made an extensive study on the decomposition of diazomethane, and more particularly of ethyl diazoacetate, catalysed by copper or copper salts in the presence of olefin which resulted in cyclopropane derivatives.

The interest in divalent carbon may, perhaps, be divided into three main categories. Two of these are of a physiochemical nature; namely, the study of the energetics of methylene production and of its reactions, and the configuration of the non-bonding electrons.

The third major aspect of carbene chemistry concerns the synthetic utility of divalent carbon intermediates with olifins. A further synthetic application makes use of the "insertion reaction", in which methylene itself, and more reactive carbenes can directly insert into a carbon hydrogen bond (Equation-2).

.. (2)

Now attention is drawn to the electrophilic and nucleophilic character of divalent carbon species. Singlet carbenes are electron deficient species, comparable to carbonium ions; on the other hand they possess a non-bonding pair of electrons, comparable to that of carbanions.

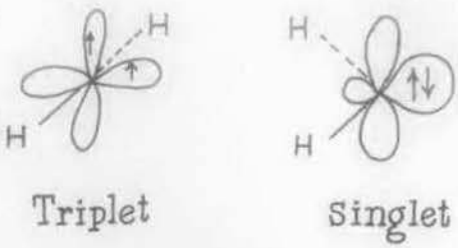
The electrophilic and nucleophilic character of singlet carbenes depends, therefore, largely on the ability of adjacent groups to withdraw electrons from or supply electrons to, the carbene carbon. Triplet carbenes may be considered as diradical. The formal relationship of carbenes to other simple intermediates is presented in table-1.

Table - 1

Name of the intermediates		Number of covalent bond	Nos. of valence Electrons.
Carbanions	$\geqslant C :^{(-)}$	3	8
Radical	$\geqslant C \cdot$	3	7
Carbonicumion	$\geqslant C^{(+)}$	3	6
Carbene	$> C:^{\ominus}$	2	6

Section B: Singlet and triplet state of Carbene.

Thus there are two chemically accessible kinds of carbene, singlet ($^{1}CH_2$) and triplet ($^{3}CH_2$). As constructed with carbon 2s and 2p and the orbitals of hydrogen, halogen etc., the triplet methylene is linear or near-linear species (X-C-X angle close to 180°) singlet methylene is a bent species (X-C-X) angle nearer 120° actually 103°. Triplet carbene has two unpaired electrons in mutually perpendicular p orbitals and singlet carbene has none (127). Studies by Hertzberg and associates demonstrated a linear triplet ground state for carbenes which, in the gas phase, is rapidly



Triplet Singlet

Fig- 1

formed by collisional quenching of the initial short lived bent or singlet carbene. ([illegible]).

Studies of carbenes have shown singlet ground state for halogeno and mixed halogenocarbene derivatives and triplet ground state for arylcarbenes. The latter are probably generated as singlets but trapped in a solid host at a very low temperature, they decay to their triplet ground state more rapidly than reacting with neighbouring molecules.

Studies at very low temperatures, verify singlet ground states for halogeno carbenes. The reaction of a triplet carbene gives dimeric product. Several aspect of carbene chemistry have fascinated a large number of chemists during the past quarter of a century. First, their reactions are novel insertions into σ bonds addition to π bonds, and the various carbene rearrangements are all sufficiently distinctive from the reactions of other species to excite curiosity about their scope, mechanisms and synthetic possibilities. Second, the electronic structures of carbenes are unusual in that most carbenes have two low-lying electronic states near enough to each other in energy both may participate in the chemistry of the intermediate. Third, many carbenes are small enough to be treated by a variety of quantum mechanical calculations that provide insight into carbene structure and reactivity.

Carbenes are, among the few simple molecules (O_2 is another) that have more than one accessible low-energy state. If we exclude the carbon 1s atomic orbital, which is not strongly involved in chemical bonding, there are four valence atomic orbitals of carbon, the 2s and the three 2p orbitals, that contribute to bonding in carbenes. Two combinations or hybrids of the valence atomic orbitals contribute to the bonds to the central carbon atom, whereas two other combinations of the valence orbitals accommodate the unshared electrons on the central carbon atom.

The two non-bonding molecular orbitals of a carbene are identical only if the H-C-H bond angle is 180°. For all other angles the non-bonding orbitals are non degenerate. The distribution of the non-bonding electrons of the carbene between the two valence shell non-bonding molecular orbitals has been an important theoretical problem. The distribution depends on a play off between the orbital energies and electron-electron repulsion. Three possibilities are displayed in Fig. 2.

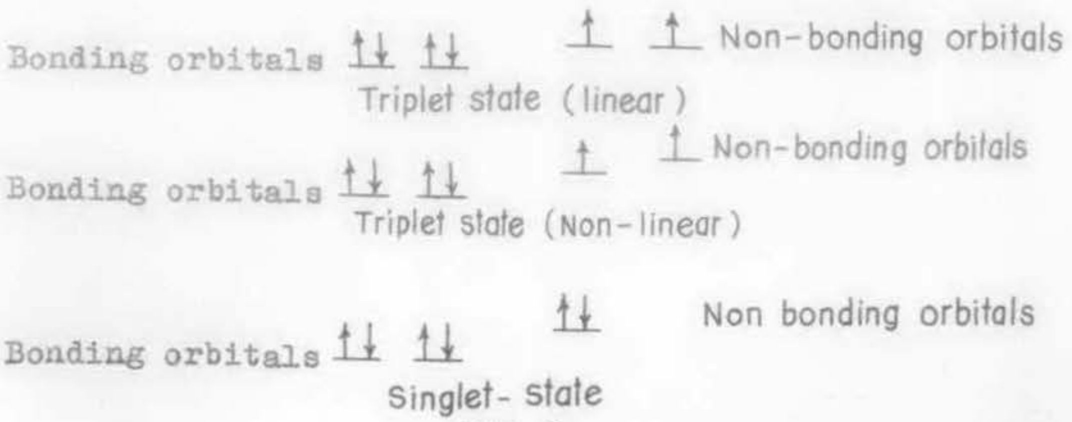
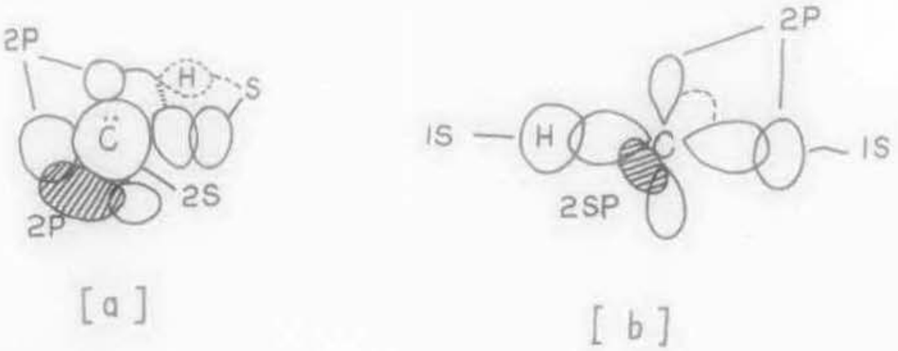


Fig-2

If the difference between the energies of the non bonding molecular orbitals is greater than the energy required to bring a pair of electrons together in a single molecular orbital then both electrons will occupy the lower energy non-bonding molecular electronic state. If, however, the difference in molecular orbital energies is less than the increase in electron-electron repulsion energy for the non-bonding electrons when they are brought together in the same special orbital, then the non-bonding electrons will occupy different orbitals. Hund's rule tells us that two electrons occupying different orbitals achieve minimum energy when their spin functions are the same, and thus a triplet electronic state results.

In this description we have used a simple picture of molecular structure which assumes that an acceptably accurate description of a molecule can be given in terms of the unique allocation of electrons to molecular orbitals (7). Even in this simple picture we should add that the energies of the four bonding electrons are affected by the non-bonding electrons. Therefore, we should be comparing the sum of all the orbital energies, bonding and non bonding, with the sum of all electron-electron repulsion energies, bonding and non bonding, to obtain estimates of the total energy for each allocation of electrons to carbene molecular orbitals.

Two extremes of carbene molecular structure are more easily described than the intermediate structures that belong to most real carbenes. As shown in Fig. 3 if CH_2 were linear, symmetry arguments demand that the two non bonding molecular orbitals must be degenerate, pure p atomic orbitals. Hence the lowest energy linear form of methylene must be a triplet state. However, as Walsh pointed out in 1953, this degeneracy is removed on bonding. As the H-C-H angle is decreased from 180°, one of two 2p orbitals which comprise the non bonding orbitals of the linear molecule takes on S character and is lowered in energy (8). At the other extreme, in perpendicular methylene one bonding orbital is a nearly pure 2s carbon orbital (plus some hydrogen 1s), and the other is pure P. The very large splitting between S and P would certainly lead to a double occupation of the S orbital, making the state a singlet.



(a) p^2-methylene (Perpendicular); (b) SP Methylene (linear).

Fig. 3

Walsh was the first to correlate the molecular orbitals of linear methylene (designated by the σ and π Symmetry classifications of the D_{2h} point group) with the molecular orbitals (designated by the a_1, a_2, b_1, b_2 irreducible representations of the C 2 point group) of the bent molecule. Such correlation diagrams are now called Walsh diagrams. Walsh presented qualitative arguments about the energy change for each orbital, with change in bond angle for AH_2 molecules. Comparison of Walsh's original diagram of 1953 Fig. 4 with one based on an <u>ab initio</u> calculation for CH_2 made in 1969 Fig. 5 shows considerable similarity. The b_2 (σ) orbital is antibonding between the hydrogens but bonding between carbon and hydrogen. Therefore an increase in H-C-H angle decreases repulsion between the bonding electrons and decreases the b_2 molecular orbital energy. The a_1 (σ) molecular orbital increases in S character as the bond angle increases, and this factor was believed by Walsh to lead to a decrease in energy, that is, a stronger σ bond.

The molecular orbital energies vary in derivatives of methylene (:CRR') depending on the groups attached to the divalent carbon atom (9). Therefore, the determination of the electronic structures of the lowest energy and first excited states of carbenes has been a problem requiring sophisticated theoretical calculations and elaborate spectroscopic experiments.

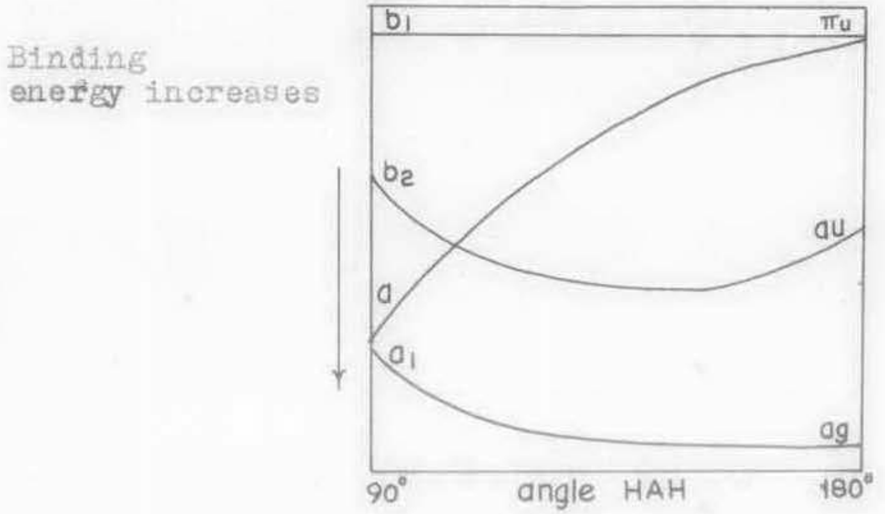


Fig-

Intuitively inferred orbital energies in methylene as a function of bond angle (A.D).

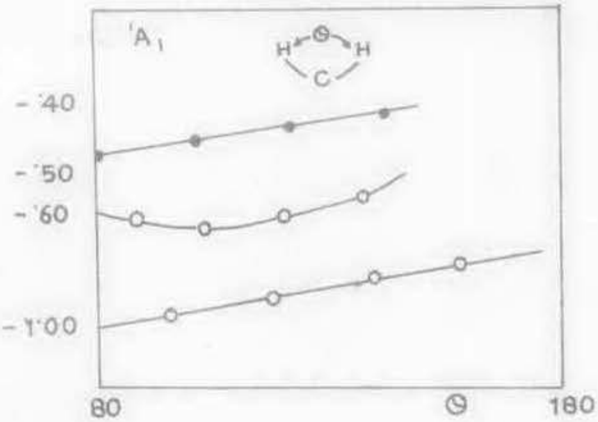


Fig- 5

Calculated variation of orbital energies with bond angle in 1_A, state of methylene.

According to the Frontier orbital theory if the carbene approaches the olefin in a straight line the HOMO/LUMO interactions would be antibonding. But as the reaction is common the anomaly is explained by the probability of a sideways approach at the initial stage when overlap begins to develop (12).

A lot of mechanistic work has been done which centres on correlation of reactivity and stereochemistry with spin multiplicity and excess energy of the divalent carbon unit. ( ). Moreover it is known that methylene produced in the phase photolyses of diazomethane adds stereospecifically to olefins and it has been shown to be in the singlet state. Under high pressure and in presence of inert gas intersystem crossing to the triplet state occurs (30).

Thus the nature of substituents, nature of medium, presence of catalysts and reaction conditions easily influence the course of reactions of these divalent carbon species.

SPECTROSCOPIC EVIDENCE

Observation and analysis of the spectra of a species as simple as methylene should give very detailed information concerning both ground and excited states of the molecule.

Assignment of a group lines at 4050 A^{o} in the spectra of comets to methylene (10) gave a great deal of useful guidance in early discussions of methylene even though it later turned out the lines were due to C_3 rather than CH_2 (11). In 1959 Herzberg (12,13) finished a 17 years hunt for the elusive methylene and obtained spectra of both the lowest singlet and triplet states. Straight forward observations show that, since the singlet state decays to the triplet, the latter must have the lower energy content.

Attempts to preserve CH_2 for spectroscopic observation by matrix isolation (14,15) have let to ambiguous results. Pimental and his co-workers (14,16) irradiated diazomethane in argon and nitrogen matrices at 20°K. ünder various conditions. They observed infrared absorption bands at 4182, 3968 possible methylene absorption bands.

A new band system spread from 5500 - 9500 A^{O} was observed when higher ratios of CH_2N_2/N_2 were used. Apparently the first product of photolysis has long wave length absorption but decays rapidly to the triplet absorbing at 1415 A^{O}. The rotational fine structure of the three bands indicated the absorbing species is bent with a bond angle of about 103° (C-H) distance = 1.12 A^{O}) and a linear upper state. No triplet splitting of spectral lines could be found.

It is interestingthat Herzberg also saw faint bands in the 3000 - 3500 A° region. **Appearance** of the lines was not favoured by condition which maximize the triplet absorption at 1415 Å. Consequently Herzberg feels species must be $^1A_1$. If the absorption is to be associated with the sharp lines found by Robinson and McCanly, and attributed to CH_2, a problem arises since the species seen at 4.2°K, was obviously long lived. Shortly before Harrison's paper was submitted for publication once again one of the periodic revolutions in the experimental view of the geometry of ground state methylene occurred. Schaefer has described ESR spectroscopic evidence for the structure of methylene as "an experimental break through" (17).

In the August 1, 1970, issue of the Journal of chemical physics Berrheim, Bernaard, Wang, Wood and Skell reported the detection of the ESR spectrum of triplet methylene observed from the photolysis of diazirine in solid Xenon at liquid helium (4.2°K) temperature (18). The D and E Zerofield parameters that measure the dipolar interaction of the unpaired electrons and their deviation from cylindrical symmetry, respectively, were deduced from the spectra. Since E was found to be non zero, ground state triplet methylene was certainly bent at least slightly in the xenon environment. Shortly thereafter in November 1970 Wasserman, Yager and Kuck also reported the ESR spectrum of triplet methylene from the photolysis of diazomethane and diazirine in xenon at 4.2°K. These workers deduced on H-C-H angle of 128-143° from the zerofield splitting parameters, with the most probable value. 136°, in splendid agreement with latest theoretical predictions. It should be pointed out that the bond angle is related in a quite complicate manner to the magnitude of E for a stationary unperturbed methylene molecule. Very soon Bernheim, Bernard, Wang, Wood and Skell deduced and even more precise bond angle, 137.7°, from the ^{13}C hyperfine interaction in CD_2 (20). It was noted that the isotopic shift in the zerofield splitting parameters observed in going from CH_2 to CD_2 might be due to either rotational motion or a matrix interaction.

In 1971 Herzberg and Johns cited the recent ESR work and also the theoretical studies of Harrison and Allen and Bender and Schaefer as indicating that the ground triplet is bent (21). On the assumption that the molecule is bent, reanalysis of the spectroscopic data gave a bond angle of 136° and bond length of 1.078A°, in splendid agreement with latest theoretical and ESR spectroscopic conclusion.

Such measurement has been used to characterize triplet states substituted carbenes also (21, 23, 24). These indicate that diphenyl carbene, phenyl carbene and fluorenylidene have triplet ground states. The magnitude of the triplet splitting at zerofield and the hyperfine interactions with protons indicate that in diphenyl carbene, the two phenyl groups lie close to, but not exactly, perpendicular planes. Surprisingly, the extent to which the unpaired electrons are constrained to stay at the central carbon atom is about the same in diphenyl carbene and in fluorenylidene despite their different geometry. Fig. 6.

Diphenyl methylene Fluorenylidene

Fig. 6

CHEMICAL EVIDENCE

Carbenes of all sorts have been **detected** by a variety of spectroscopic techniques, and valuable structural information has been obtained. The spectroscopic results have been reviewed recently (25).

Now attempts to draw inference concerning the spin state of methylene from chemical reactivity, and vice-versa, have a long and some times undistinguished history. Early attempts to characterize methylene in gas streams involved removal of tellurium, selenium, aresnic and antimony mirrors, and the tellurium-method (26) was favourite for detection until it was shown (27) that mirror removal was due largely to reaction with other species, at least when methylene was produced by photolysis of ketene. Methylene and its derivatives would probably react with many other materials if given the chance, since in either the singlet or triplet state, it is a highly reactive species. It is doubtful that any but the most detailed study of randomly chosen reactions would yield much information concerning the characteristic chemical properties of singlets and triplets. In retrospect, assumptions such as low reactivity of singlet methylene (28) or clearly "radical like reactivity" of the triplet seem either wrong or harmfully oversimplified.

Reactions which have been most studied insertion reactions (eqn. 3)

$$
\begin{aligned}
&:CH_2 + H_2 \longrightarrow CH_4 \\
&:CH_2 + RH \longrightarrow RCH_3
\end{aligned}
\qquad \ldots (3)
$$

and addition to carbon-carbon double bonds. (eqn. 4)

... (4)

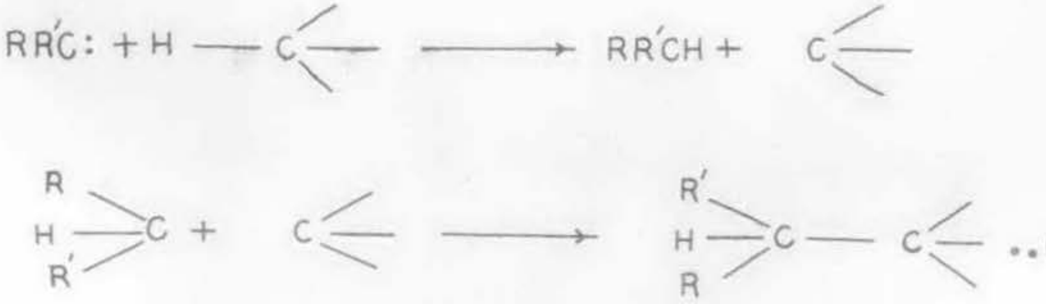
These reactions have been studied in great detail and much of the related discussions relate to chemistry of singlets and triplets. Singlet and triplet methylene show significantly different behaviour and that study of insertion and addition reactions can distinguish between the species. An opposite view was given by Demore and Benson (29).

Meerwein, Rathjen, and Werner reported in 1942 C-H insertion products from irradiation of diazomethane in diethyl ether, tetrahydrofuran, and isopropanol (31). It was not until 1956, however, when Doering, Buttery, Laughlin and Chaudhuri investigated the photolysis of diazomethane in the presence of alkanes, that the real nature was recognized (32). The addition of dichloro methylene to cyclohexane, reported in 1954, was the first authenticated cyclopropanation via carbene or carbenoid species (33). The addition of methylene to olefins was established in 1956 (34,35).

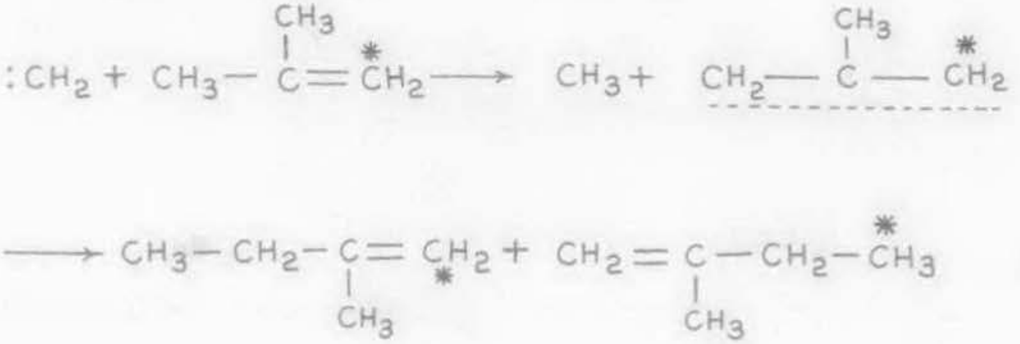
THE INSERTION REACTIONS

Stoichiometrically the C-H insertion reaction takes the form:

A mechanistic ambiguity in description of the reaction was recognised quite early (36,37). Abstraction of a hydrogen atom followed by coupling of the radical pair could give rise to the same products as concerted insertion. (eqn. 5).


..(5)

Doering and Prinzbach demonstrated that direct insertion is the major path was in the photolysis of diazomethane in the absence of moderators and sensitizers (37). Reaction of methylene with labeled isobutene gives the rearranged product expected from the radical path was in only 8% yield in the gas phase and 2% yield in the liquid phase. This means that a maximum of 16% of the methylenes follow the radical mechanism in the gas phase and 4% in the liquid phase. (eqn. 6)

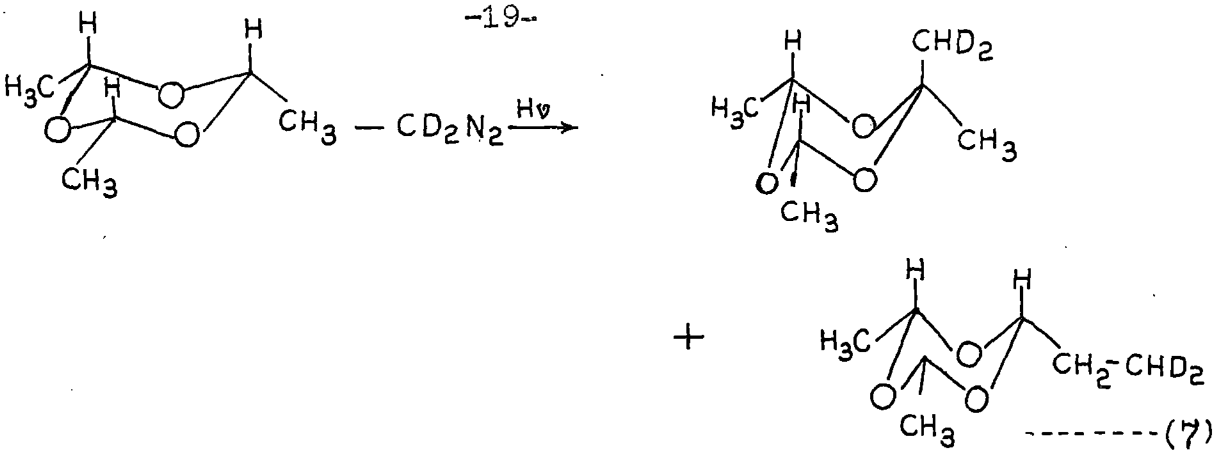


$$:CH_2 + CH_3-\overset{CH_3}{\overset{|}{C}}=\overset{*}{C}H_2 \longrightarrow CH_3 + \underline{CH_2-\overset{CH_3}{\overset{|}{C}}-\overset{*}{C}H_2}$$

$$\longrightarrow CH_3-CH_2-\underset{CH_3}{\underset{|}{C}}=\underset{*}{C}H_2 + CH_2=\underset{CH_3}{\underset{|}{C}}-CH_2-\overset{*}{C}H_3 \quad .. (6)$$

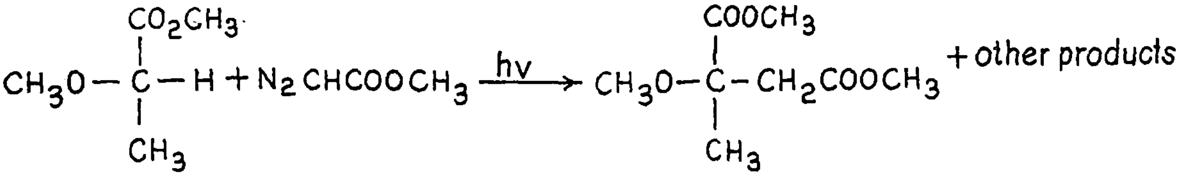
This is also supported by the work of Bell and Kistiakowsky who found $C_2H_2D_4$ to be the major product from the photolysis of diazomethane in the presence of methane - d_4 (38).

But insertion reaction mechanism is a concerted one which have shown by Kirmse and Buschoff who have demonstrated that the insertion into. C-H bonds retains steric configurations about the carbon atom (39). (Eqn. 7)



--------(7)

Another example of retention of configuration was given by Doering and Helgen (40). So retention of configuration is consistent with a one step insertion mechanism. (Eqn. 8)



$$CH_3O-\underset{CH_3}{\overset{CO_2CH_3}{C}}-H + N_2CHCOOCH_3 \xrightarrow{hv} CH_3O-\underset{CH_3}{\overset{COOCH_3}{C}}-CH_2COOCH_3 + \text{other products}$$

.. (8)

Even intramolecular 3° C-H insertion goes with retention of configuration (44). Although the evidence is strong that, at least in solution, methylene often inserts primarily in a concerted reaction, Frey showed some time ago that products derived from all possible radical coupling reaction are formed in gas phase experiments (41) /‾Eqn. 9_/

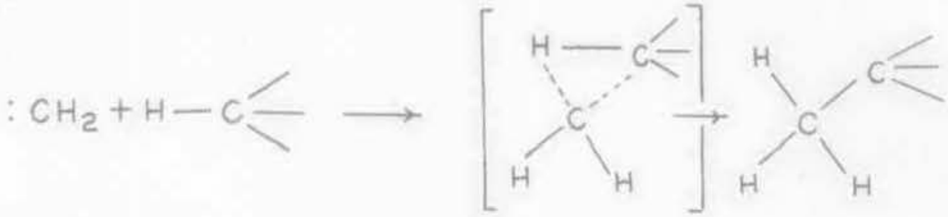
$$\begin{array}{lll}
CH_2 + RH & \xrightarrow{\qquad\qquad} \dot{C}H_3 + \dot{R} + \dot{R}' & \text{other radicals} \\
\dot{C}H_3 + \dot{R} & \xrightarrow{\qquad\qquad} CH_3R & \\
\dot{C}H_3 + \dot{R}' & \xrightarrow{\qquad\qquad} CH_3R' & \\
2\dot{C}H_3 & \xrightarrow{\qquad\qquad} CH_3CH_3 & \text{.. (Eqn. 9)} \\
2\dot{R}' & \xrightarrow{\qquad\qquad} R'R' & \\
\dot{R} + \dot{R}' & \xrightarrow{\qquad\qquad} R - R' &
\end{array}$$

Recent NMR experiments have reinforced the view that singlet methylene undergoes direct insertion into C-H bonds and that triplet methylene abstracts hydrogen atoms even in solution.

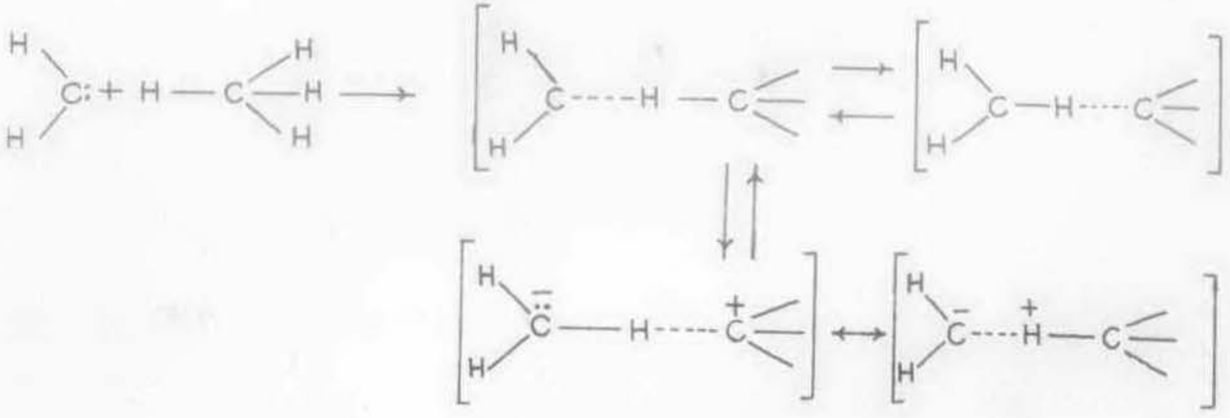
Observation in 1969 of emission and enhanced absorption in the NMR benzylic proton signal from an irradiated solution of diphenyl diazomethane in toluene was important both for the understanding of the chemically induced dyanamic nuclear polarization (CIDNP) phenomenon and for the verification of hydrogen abstraction by triplet carbenes (42).

Section-C : Nature of the transition state for C-H insertion and addition of carbene to double bonds.

Two hypothesis concerning the transition state for C-H direct insertion have been presented. Doering and Skell, having demonstrated that methylene is a vigorous electrophile, proposed a triangular transition state for direct insertion (43,44,45,37). The trianguler transition state accommodates the one step nature of singlet methylene insertion.



Demore and Benson on the other hand have proposed end on attack of the C-H bond. A transition state with diradical character is probably intended, with stabilisation due to contribution by ionic terms to the wave function (36).



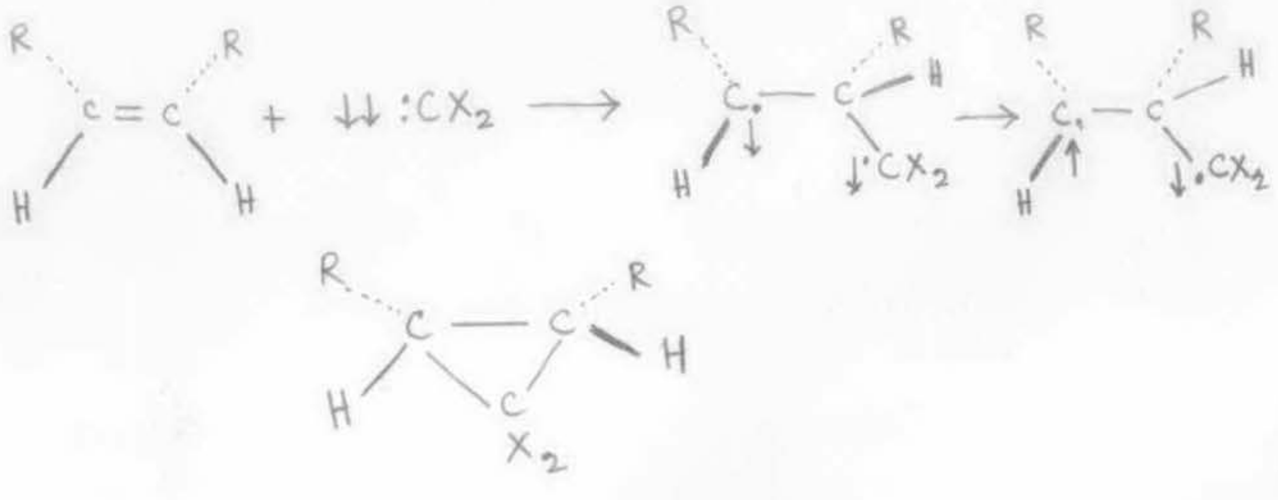
Some confusion has arisen as to whether an intermediate radical pair rather than a transition state was intended. Stereospecific insertion seems to preclude the formation of a radical pair of finite life time. The mechanism is much like that favoured by Hofmann on theoretical grounds (45). Three kinds of evidence have been brought to bear on the micro mechanism of concerted C-H insertion by singlet methylene (46,47,48). One step, three centre, direct insertion mechanism is common for singlet carbenes, ($^3CH_2$) reacts with two step abstraction recombination mechanism. Ylide mechanism is possible when atoms with one pair electrons are present at or near the substrates reactive site.

ADDITION TO DOUBLE BONDS

Soon after the discovery of the addition reaction it was proposed by Skell and co-workers that singlet and triplet carbenes could differ both in their selectivity (49) and in the stereospecificity of addition to olefins (43).

In 1956 Skell and Woodward proposed that the spin state of carbene can be deduced from the stereochemistry of cyclopropane formation (43). The generalization has come to be known as the Skell rule. The rule states that singlet carbenes are expected to add to a olefin in single step and therefore preserve the cis-trans stereochemistry of the olefin in the cyclopropane product. Conversely, it was argued that since a triplet carbene cannot give a singlet ground state cyclopropane in a single fast step, two step addition must occur. Rotation about single bonds in the diradical intermediate should be rapid compared with spin inversion followed by ring closer, and therefore non stereospecific addition by triplet carbenes was expected. Both these cases are shown in Fig. 7.

Empirically, Skell's rule has been found to be very successful. Although a singlet carbene may add to an olefin in a single step, there is no selection rule prohibiting spin conservation, step wise path. Conversely, although a triplet carbene very likely does add in two steps, the result could be stereospecific addition, if spin inversion and ring closure are sufficiently rapid. A two step reaction will indeed always give non stereospecific addition in the gas phase. Thus if stereospecific addition in the gas phase is observed, the reaction of a singlet carbene is indicated. The converse need not hold, nonstereospecific addition in the gas phase is not diagnostic of a triplet.



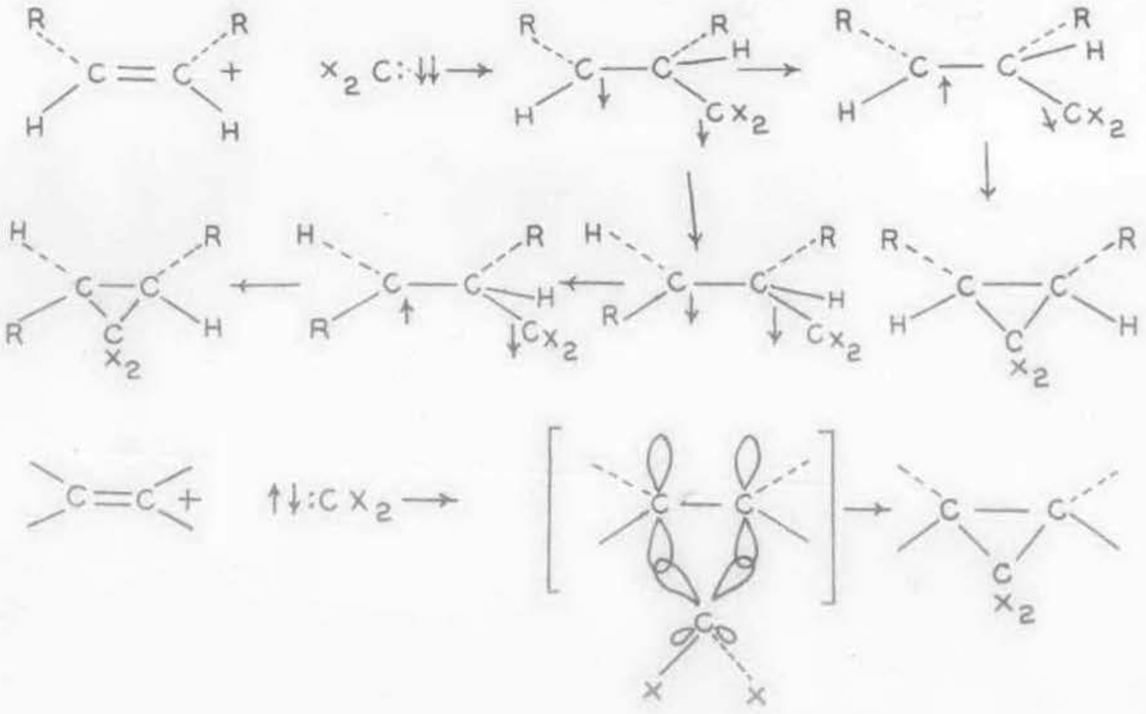


Fig. 7

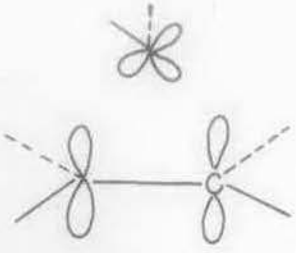
In solution predictions are more difficult because of wide variations in inter system crossing rates. To assign nonstereospecific addition to a triplet carbene, stereospecific addition by the singlet must also be demonstrated. Thus, for only in the cases of methylene itself, fluorenylidene, dicyano methylene and most recently dicarbomethoxy methylene and substituted cyclopenta dienyledenes has the stereospecificity of the addition of both singlet and triplet has been shown to conform to the Skell rule.

Stereospecific addition of methylene is obtained in the irradiation of gaseous mixtures of diazomethane and cis or trans-2-butene (50). In the liquid phase the stereospecificity is believed to be even higher, the "wrong" isomer in the gas phase coming principally from the geometrical isomerisation of the vibrationally excited primary adduct. This result was interpreted as indicating that methylene from diazomethane reacts while in its lowest singlet state, which was recognised as not necessarily being its ground state (35,51). This was the experimental basis for the Skell's rule.

Section-D : Effects of carbene reactions

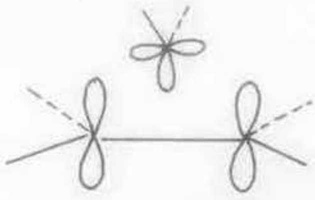
(a) Effects mainly electronic in origin:

Carbene addition to an olefin has been regarded as an electrophilic process. A theoretical analysis of the addition of $^1CH_2$ to ethylene suggests initiation of the reaction as in Fig. 8, a "   approach" in which the vacant P orbital of the carbene begins to overlap with theπsystem. As the reactants move along the reaction coordinate toward product geometry the π approach goes over to Fig. 9, a "δ approach" (52).



π approach

Fig- 8



σ- approach

Fig- 9

The important point is the nature of the initial stage, the π approach, in which transfer of electron density from the olefin's π -system to the carbenes P orbital occurs; this is an electrophilic addition. More recent calculation suggest that π- approach Fig. 10 is energetically preferable to π -approach Fig. 11, in the addition of $^1CH_2$ to ethylene (53). Addition of CF_2 is calculated to follow a similar course, with less charge transfer from olefin to carbene at the transition state.

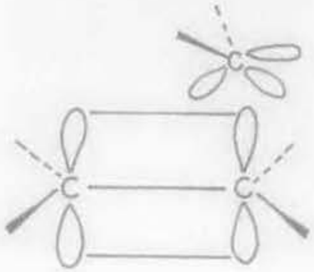


Fig. 10

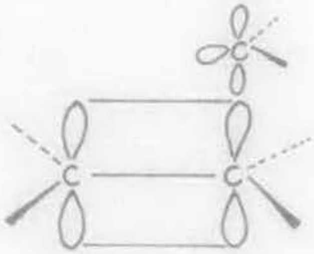


Fig. 11

Experimentally, the charge separation in generalised transition state Fig. 12 can be probed by variation of either olefinic substituents, R_1 - R_4 or carbenic substituents X and Y. This procedure, however, can alter both steric and electronic factors; the separation d changes in response to altered carbenic or olefinic reactivity.

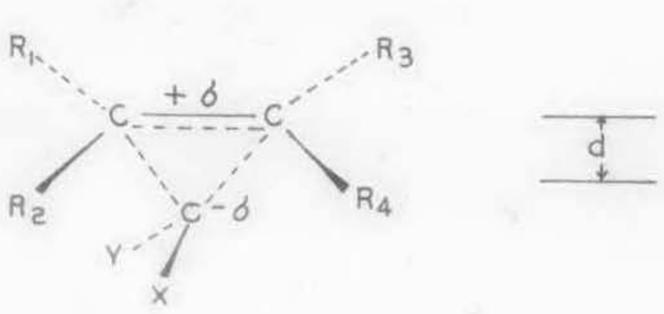
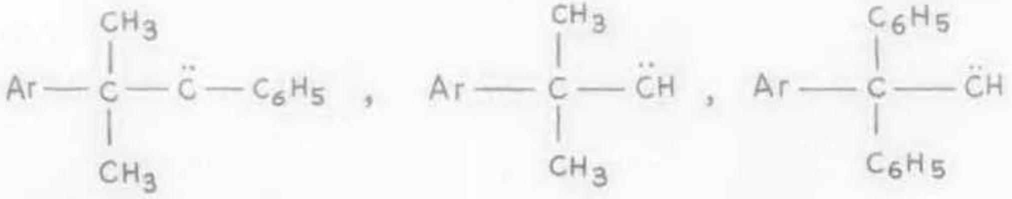


Fig. 12

It has been shown that 1,2 aryl migratory aptitude of the aryl group to an electron deficient centre, the carbenic P orbital is increased with a donating substituents on the aryl ring (54,55,56).



$$Ar-C(CH_3)_2-\ddot{C}-C_6H_5 \;,\quad Ar-C(CH_3)_2-\ddot{C}H \;,\quad Ar-C(C_6H_5)_2-\ddot{C}H$$

This reaction may be viewed as intramolecular attack by the carbenic P-orbital on the aryl π -system at C-1.

The intramolecular reactions of thermally generated carbethoxy carbene with benzene derivatives, are correlated by Hammet treatment, P = 0.38 (σ_p^+) (57). Here too the carbene acts as an electrophile, impinging on the aromatic π -system.

Expectations are clear for variation of olefinic substituents; olefin reactivity will parallel π -electron availability. The substrate ability to bear a positive charge in Fig. 12 will be paramount.

Additions of CCl_2 (80°C) to Fig. 13a, b and c are correlated by ρ ; values are -0.619, -0.53 and -0.378 respectively. These ρ values are much smaller than the observed in CCl_2 additions to alkenes (58). There, substituent variation is accomplished directly at the reaction centre; response is great.

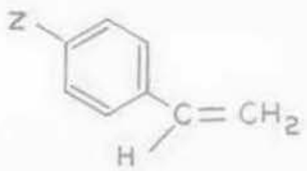


Fig- 13a

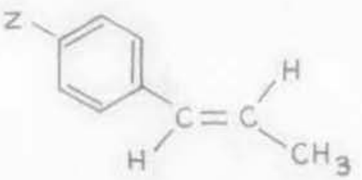


Fig- 13b

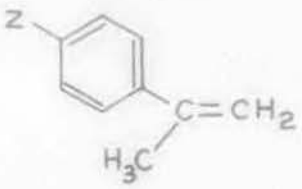


Fig- 13c

For 13a-c, the effect of substituent variation on reactivity is attenuated because it is mediated by the aromatic system. The order of increasingly negative ρ , $c < b < a$, which is the order of decreasing substrate reactivity. Substrate "a" should yield the most "advanced" transition state, with largest charge separation; the strongest response to substituent variation is expected. After incorporation the concept of Hoffmann (52,53) the transition for CCl_2 addition to 13 C is represented Fig. 14 (59).

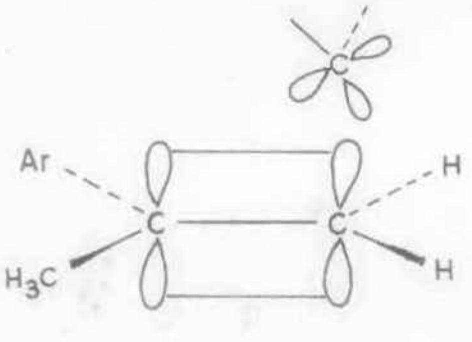


Fig- 14

Some carbenes like thioxanthenylidene (140) are nucleophilic also M.O calculations show nucleophilic character and triplet ground state for these carbenes (92).

Steric effect:

Both steric and electronic effects must be considered in order to correlate relative addition rates with substrate structure (60).

A 1-cyclohexyl substituent is 7.4 times less effective than a 1-methyl substituent at promoting the addition of CCl_2 to cyclohexene (61). Even phenyl, which should help electronically is less effective than methyl and 1-α-napthyl substitution retards the addition. These trends must be largely steric in origin. Similarly CBr_2 experience greater steric hindrance to addition than does CCl_2 (62). Relative to cyclohexene styrene, and 2,4,6-trimethyl styrene are equally reactive toward CCl_2. Toward CBr_2, styrene is more than three times as reactive. The hindrance arises at the ortho substituents.

Sadler cites a related effect of ortho substituents (63). The reactivity sequence for additions of $:CCl_2$ to α -methyl styrene derivatives is unsubstituted $>$ 2-methoxy $>$ 2-methyl $\approx$ 2,2-dimethoxy (63). A progressive twisting of the isopropenyl group from the plane of the aromatic ring is suggested. This steric inhibition of resonance decreases possible stabilisation of the transition state. Direct hindrance to $:CCl_2$ approach is also possible. The coplanarity of aryl and olefinic groups enforced on 1-methylenetetralin and 1-methylene indene by their fused ring structures maximises favourable resonance interaction. These olefins are more reactive than 1-methyl styrene toward $:CCl_2$.

Steric hindrance is responsible for the decreasing rates of addition of CCl_2 to various alkenes at the same substitution level as the chain of single substituent is lengthened (64). For example, replacement of methyl by ethyl halves the reactivity.

The low rate of addition of 2,2-diphenyl cyclopropylidene to tetramethyl ethylene (65) is attributed to steric hindrance caused by opposition of carbenes phenyl substituents and the olefinic alkyl groups. Cis-Butene and cyclohexene, which permit the phenyls to pair off with olefinic protons, react more rapidly than tetra methyl ethylene.

Dimethyl ethylidene carbene is most interesting. If the carbenic centre is Sp hybridized, then the vacant p-orbital is in the plane of the methyl carbons. In a transition state, Fig.16, these methyl groups impinge on the olefinic substituents. This picture rationalizes the very slow rate of addition of Fig. 15 to tetra methyl ethylene.

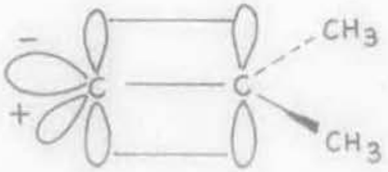


Fig. 15

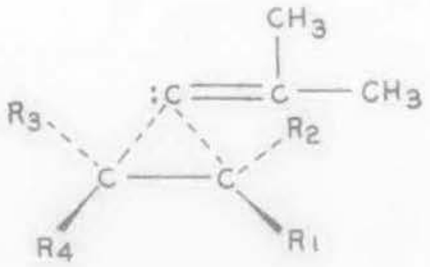


Fig. 16

Here no arrangement approximating to Fig. 16 avoids costly steric interactions. The more facile addition of 15 to cyclopentene, compared with 1-methyl cyclopentene can be similarly explained (66). However, it is not clear why addition of 15 to tetra methyl allene is 45 times more rapid than addition of 15 with tetra methyl ethylene.

Photolytically generated aryl carbenes (67) do not exibit characteristic steric effects with simple alkenes.

There appears to be a substantial over all selectivity difference between photolytically (68) and thermally (69) generated carbethoxy carbene. The former does not discriminate between cis and trans butene; the latter prefers cis-butene by a factor of 2.3. The role of steric effects here is not yet defined.

Effect of Carbenic Substituents

The second "handle" for probing Fig. 12 is variation of carbenic substituents properly. Substituted carbenes develop the olefins irrespective of their potential reactivity difference.

2,2 diphenyl cyclo propylidene (65) and dimethylethylidene carbene show far more selectivity of dimethyl vinylidene carbene (70) appears to lie between that at CCl_2 and CBr_2 . Resonance stabilization of the carbene Fig. 17 is suggested to account for its selectivity; the vacant carbenic P orbital is part of an allylic cation system.

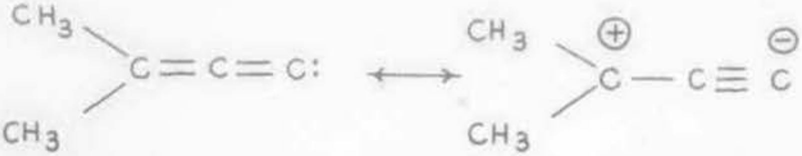


Fig. 17

Singlet carbonyl carbene (71) is perhaps more selective than $^1CH_2$, for it reacts, 2.17 times faster with tetra methyl ethylene than with ethylene (71).

The substituted Phenyl carbenes also show only modest ability to distinguish between simple alkenes (72). The isobutene trans-butene reactivity ratio varies with carbenic aryl substituent in the order, m-Cl $>$ p-Cl $>$ H $>$ p-CH_3 $>$ O-CH_3, which parallels the expected order of increasing carbene stability. Representing these carbenes as in Fig. 18, the system is seen to be isoelectronic with a benzylic cation. It follows that Fig. 18, Z = OCH_3, should be the most stabilised and selective species.

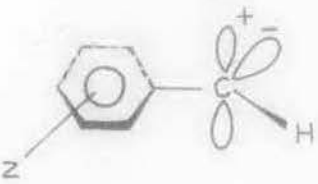


Fig. 18

The greater selectivity of bromo carboethoxy carbene compound with carboethoxy carbene, suggests stabilization as in Fig. 19 in addition to stabilization due to the carboethoxy substituent.

The latter factor Fig. 20 is presumably responsible for stabilising carbethoxy carbene relative to CH_2; that is it has somewhat greater selectivity in the C-H insertion reaction (73).

Fig. 19

Fig. 20

Little of this slectivity difference appears in the addition reactions, however, dicarbomethoxy carbene is more selective than either CH_2 or carboethoxy carbene toward the C-H bond (73). It is also more selective in addition reaction. The added selectivity presumably corresponds to extension of the stabilization depicted in Fig. 20 by the second carboalkoxy group.

In a sense, then, there is a "competition" between the substituents X and Y and the olefinic π bond over donation of electrons to the carbenic P-orbital; the balance of this competition changes during the course of addition of Fig. 21 to an olefin.

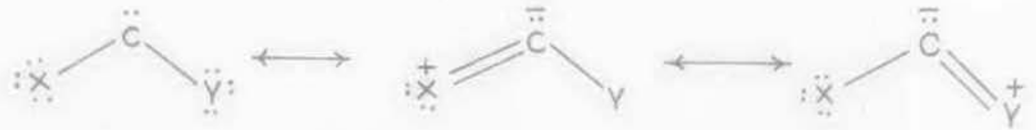


Fig. 21

The more strongly X and Y interact with the carbenic centre, the higher will be the activation energy for addition to a π bond. The transition state will be further advanced along the reaction coordinate, and more important will be the ability of the olefinic carbon atoms to support a positive charge. Thus strong resonance interaction in Fig. 21 will "develop" olefin structure reactivity sequence. Doering recognised this long ago when he spoke of relative relative carbene selectivity as reflecting the "internal stabilisation" of the carbene.

Section-E : General procedure for carbene generation

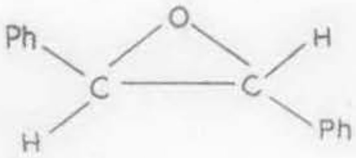
A variety of methods is available for the generation of carbenes, but for synthetic purposes they are usually obtained by thermal or photolytic decomposition of diazo-alkanes, or by α-elimination of hydrogen halide from a haloform or of halogen from a gem-dihalide by action of base or a metal. In many of these latter reactions it is doubtful whether a "free" carbene is actually formed. It seems more likely that in these reactions the carbene is complexed with a metal or held in a solvent cage with a salt, or that the reactive intermediate is, in fact, an organometallic compound and not a carbene. Such organometallic or complexed intermediates which, while not "free" carbenes, give rise to products expected of carbenes are usually called Simmons-Smith reactant. Dichloro carbene addition- Svia -Makosza reaction (129a,be,c, d) are also interesting. Thermal decomposition of diazoalkanes ([illegible]) often produces a less energetic and more selective, carbene, particularly in presence of copper powder or copper salts, copper carbene complexes are probably involved in these reactions. Another convenient and widely used route to alkyl carbenes is by thermal or photolytic. Decomposition of the lithium or sodium salts of toluene p-sulphonyl hydrazones (76). The diazo alkane is first formed and decomposes under the reaction conditions. Keto carbenes and alkoxy carbenes are usually produced by heating or photolysing diazoketones and diazoesters. Generally, the reactions for generation may be classed as : Decomposition reactions (thermal or radiative activation) and elimination reactions (Participation of a reactant such as base). Sources are diazoalkanes, Diazirnes, alkylhalides, ylides, olefins, tosyl hydrazones, organometallics and the like.

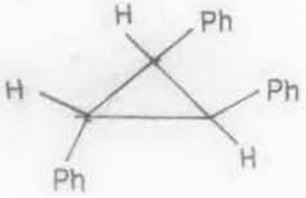
A common precursor is the diazo compounds $RR'CN_2$. These are obtained either from amines, by way of nitroso urethans nitroso amides or nitroso ureas or from carbonyl, via the oxidation of their hydrazones. Photolysis of these derivatives affords singlet carbenes. Except for diaryl species, they react in this state. Carbenes may also be generated by Bamford-Stevens reaction (130).

The decomposition of diazo compounds with copper or copper salts leads to carbene -copper complexes. These derivatives often add to olefins stereospecifically and are less energetic than the free carbenes.

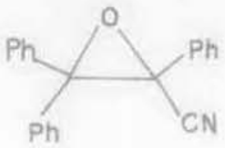
Diazirines, isomeric forms of diazo~~ethanes~~alkanes, afford carbenes less conveniently than the corresponding diazoalkanes (131a,b,c).

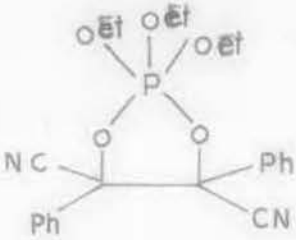
Photolysis of phenylbromodiazirine is a convenient source of phenylbromocarbene (Ph - C - Br) (132). Phenyl carbene may be generated by photolytic decomposition of following (133).





Cyanocarbene (Ph-C-CN) is produced by the photolysis of suitable oxirane(131 c) or from 1,3,2-dioxaphosph (v) alane (134).





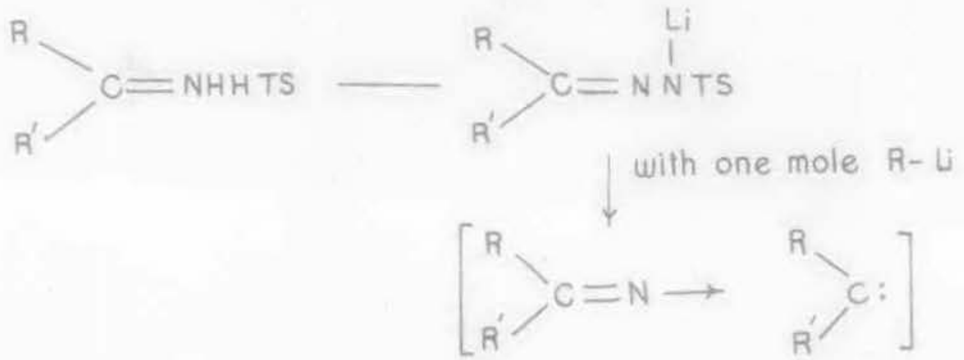
Singlet carbene is generated by the photolysis of arylcyclopropane. The reaction of esters of trichloro acetic acid with alkoxide produces dichloro carbene (78).

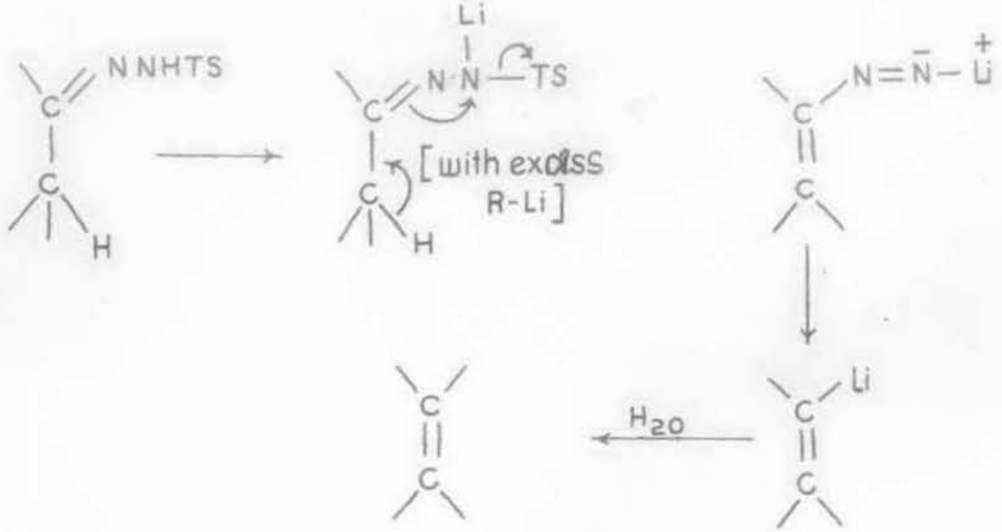
One of the most convenient method for generating halogenocarbenes is the thermal decomposition of organometallic precursors (135 a, b).

$$\phi H-Hg-CCl_2-Br \longrightarrow \phi H-Hg-Br+:CCl_2$$

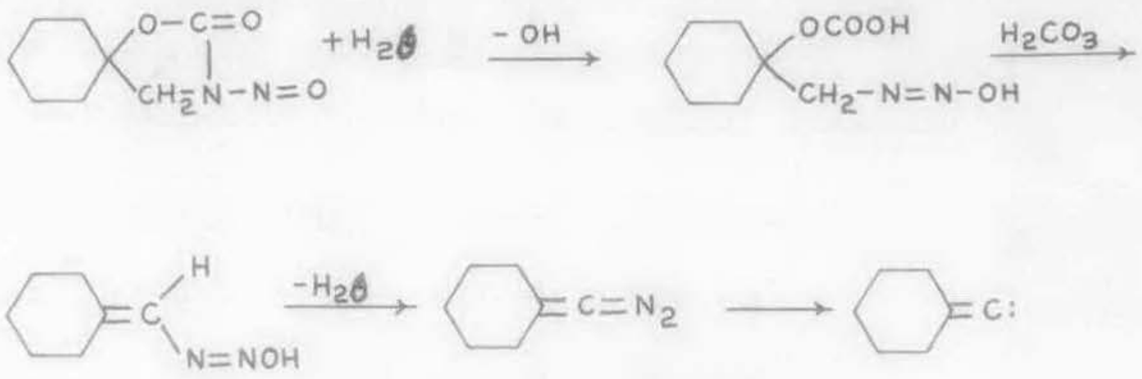
$$\phi H-Hg-CBr_3 \longrightarrow \phi H-Hg-Br+:CBr_2$$

Organolithium reagent gives ϕH-C-H carbene with ϕHCH I_2, whereas pH-C-Cl is obtained from pHCH Cl_2, in the latter reaction organolithium works as a base, removing a proton. Whereas with tosylhydrazone, organolithium compound react in two ways depending on whether it reacts with only one mole or with an excess of organolithium:





Vinyl carbenes can be generated in various ways the initial work by Newman which involves the reaction of bases with nitro oxazolidinones (136 a,b).



Basic hydrolysis of haloforms results in the generation of dialkylcarbenes *via* the intermediate carbanion (137).

$$\mathrm{CHCl_3} + :\mathrm{B} \longrightarrow :{}^{-}\mathrm{CCl_3} + \mathrm{BH}$$

$$:\mathrm{CCl_3} \longrightarrow :\mathrm{CCl_2} + \mathrm{Cl^-}$$

Olofson *et al* have reported interesting synthesis of carbene by treatment of stable cations, viz. $((\mathrm{Mes})_2\ \overset{+}{\mathrm{CH}}\ \overset{-}{\mathrm{BF_4}})$ with base (138).

$$\overset{+}{(\mathrm{MeS})}_2\ \mathrm{CH}\ {}^{-}\mathrm{BF_4} \xrightarrow{\text{Base}} (\mathrm{MeS})_2\ \mathrm{C}:$$

$$\overset{+}{(\mathrm{MeO})}_2\ \mathrm{CH}\ \mathrm{BF_4^-} \xrightarrow{\text{Base}} (\mathrm{MeO})_2\ \mathrm{C}:$$

d. Thermal and photo chemical reactions are also the generating source of dihalo carbene which are shown by the following reactions (79,80). [Eqn. 15]

$$Cl_3C-SiCl_3 \xrightarrow{250^{\circ}} SiCl_4 + :CCl_2 \qquad \ldots (15)$$

$$Ph-Hg-CX_3 \xrightarrow{80^{\circ}} Ph-Hg-X + :CX_2 \quad (X = Cl,\ Br)$$

CHAPTER - II

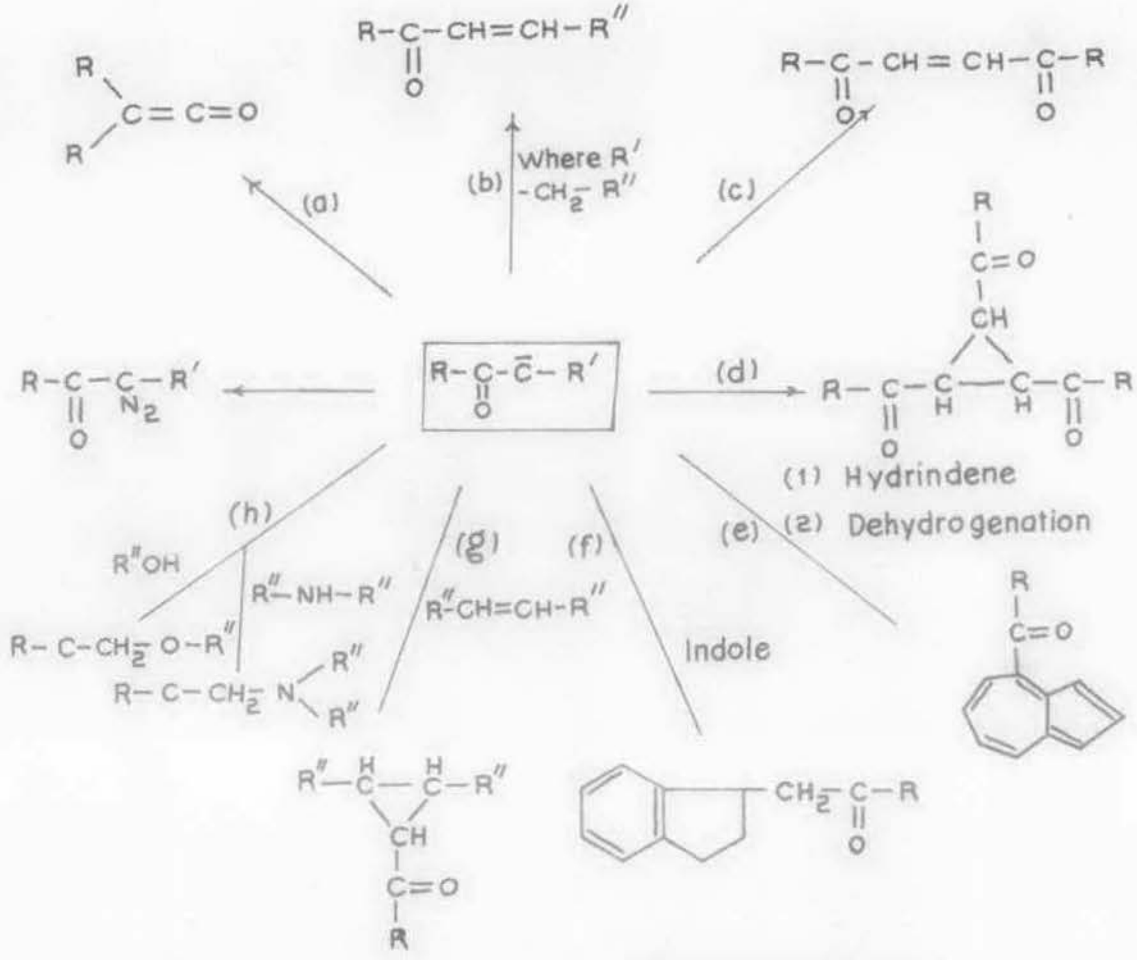
Some aspects of keto carbene reactions

Section-A: A short review on Keto carbene and their reactions.

Since the work of Arndt, Eistert and co-workers (81) followed by that of Bradley and Robinson (82), diazo ketones are readily accessible by the reaction between acid chlorides and diazomethane, these compounds have assumed increasing importance in the realm of preparative organic chemistry. The first review on the preparative significance of diazo-ketones was published by Eistert (83) and Huisgen (84). In view of the abundance of the recent publications in this field, which continually describe novel reaction sequences starting from diazo ketones the preparative aspect is not dealt in detail.

Diazoketones are decomposed by light, heat and various catalyst. The relationship between structure and quantum yield in photolysis has been studied with a variety of diazoketones (85). The quantum yields decreases with increasing polarisation of diazo group; i.e. with increasing contribution of resonance structure. Fig. 22 (which may be estimated from the infrared spectra).

Fig. 22



In a,c,d,e,f,g R=H

Scheme- 1

When a diazoketone los~~s~~es nitrogen a sextet of electrons remains on the carbon atom which was linked to the diazo group. The α -ketocarbene thus formed is capable of undergoing the most diverse reactions, depending on the conditions under which nitrogen elimination takes place (thermal, photolytic or metal catalysed) Scheme-1 summarizes the preparative possibilities employed to date.

(a) If the α -keto carbene stabilizes itself by an intramolecular rearrangement, a ketene is formed (86) (Wolff rearrangement) which can then react further, e.g. in the presence of water gives carboxylic acid.

(b) Intramolecular hydrogen displacement produces unsaturated ketones from carbenes of the form $R-CO-\underset{\cdot\cdot}{C}^{-}-CH_2-R'$ (87).

(c) Dimerisation and trimerization give 1,2,diacyl ethylenes and triacyl cyclopropane, respectively (88).

(d) At elevated temperatures, α -keto carbenes can enlarge the ring of hydrindene (89).

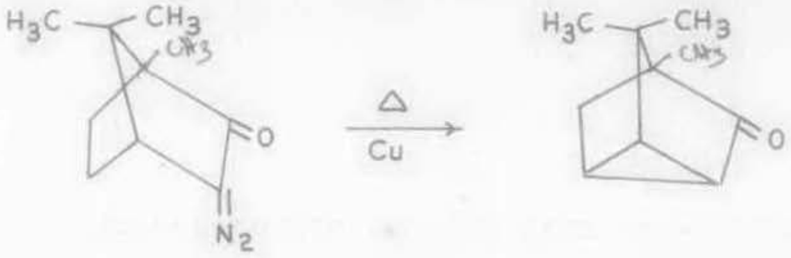
(e) Substitution of certain heterocyclic and isocyclic rings (90).

(f) α-Keto carbenes can react with compounds containing a double bond, to form derivatives of cyclopropane (91).

(g) Decomposition of diazoketones with copper powder in the presence of amines, alcohols, or mercaptans gives rise to α -amino ketones α-ketal ethers, or α-ketal thio ethers respectively (92). Other reactions proceedings in similar manner are discussed subsequently.

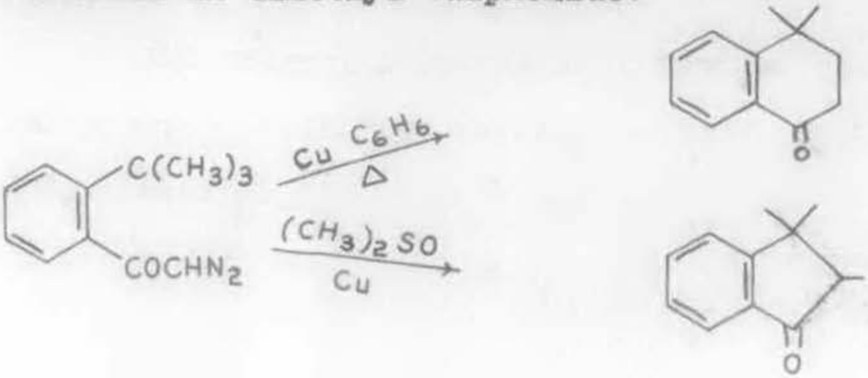
Insertion and addition reaction of carbenes
(<u>Keto-carbenes</u>)

Pyrolysis of diazocamphor leads to intramolecular insertion of the divalent carbon into neighbouring carbon-hydrogen bonds (Eqn. 16). The tricyclic structure of the product was established by Bredt and Holz (93).



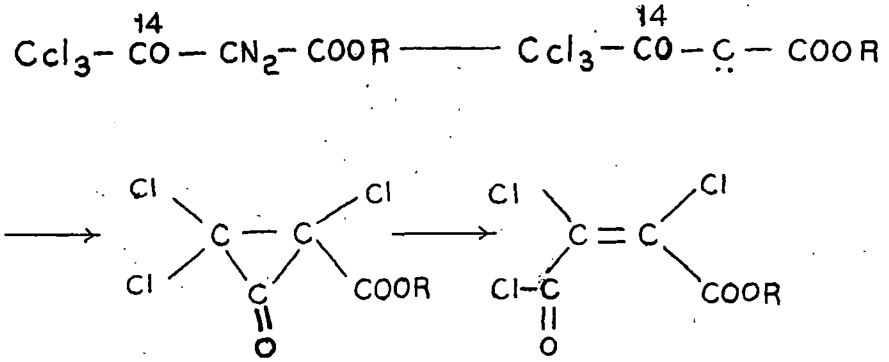
.. (16)

Intramolecular insertion has also been reported with ~~tert~~butyl diazo acetophenone (94) /‾Eqn. 17_/. In a nonpolar solvent, benzene C-H insertion occurred with formation of product where as a small amount of apparent C-C insertion was observed in dimethyl sulphoxide.



.. (17)

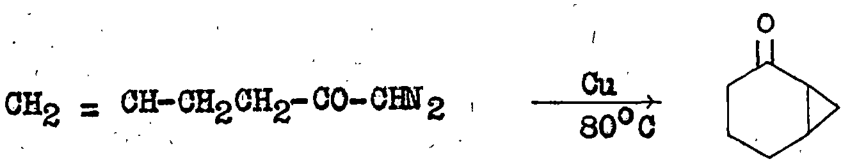
The photolysis of ethyl trichloro acetyl diazo acetate was found to proceed with intramolecular C-Cl insertion. The final product, a derivative of dichloromaleic acid, was shown by means of C^{14} - labelling to arise by way of an unstable cyclo propanone intermediate (95) [Eqn. 18].



.. (18)

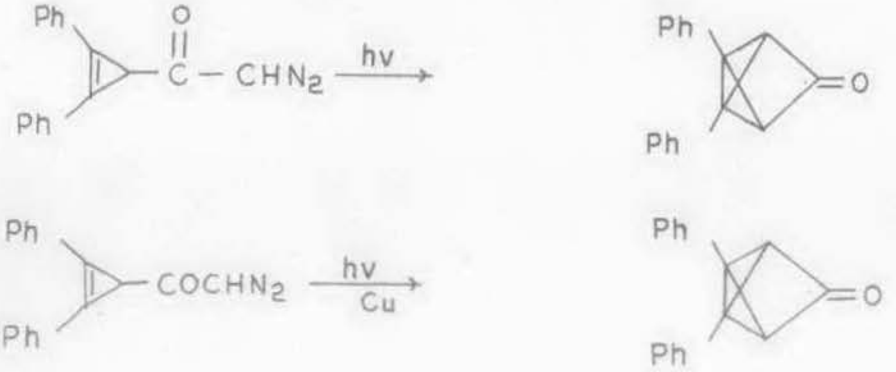
Intramolecular addition

Ketocarbenes derived from unsaturated diazoketones may undergo intramolecular addition rather than Wolf rearrangement. Thus α-diazo-6-hepten-2-one eqn. 19 affords the bicyclo (4, 1,0) heptanone which was identified by independent synthesis (96).



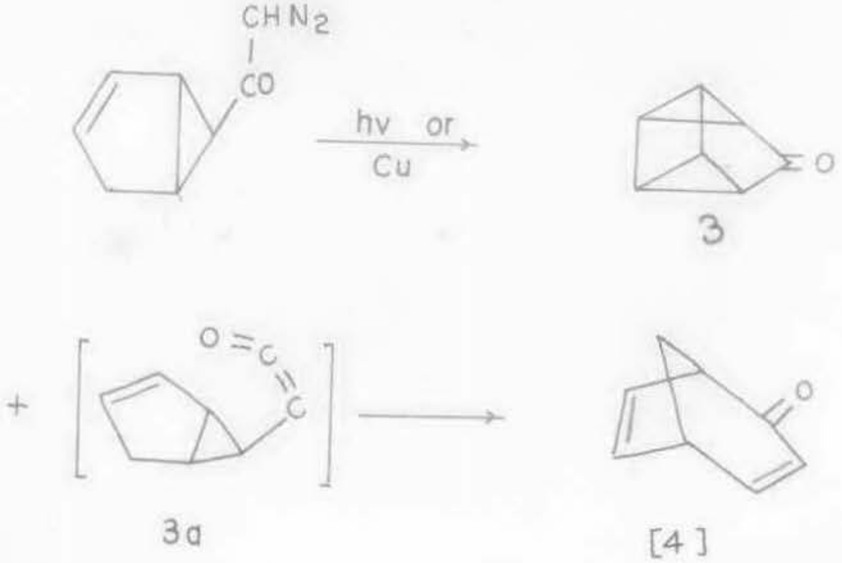
... (19)

The tricyclic ketone is formed on photolysis of 1 (97) and a copper catalysed version of this reaction also exists (98) [Eqn. 20].



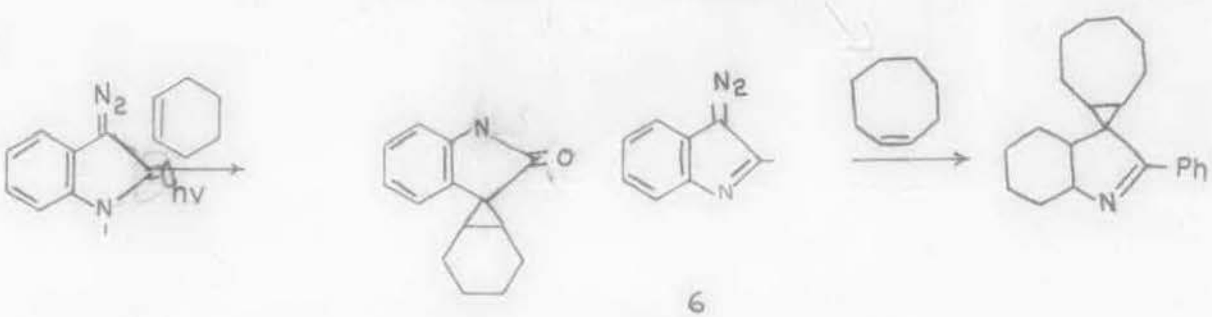
.. (20)

Freeman and Kuper observed a similar reaction 3 and also isolated 4 the product of rearrangement of 3a itself formed by Wolf rearrangement (99, 100) ∠Eqn. 21_7.



.. (21)

Photolysis of diazoketone 5 in cyclohexane or 1,1 diphenyl ethylene gives adducts presumably because the mobility of an amide in the Wolf rearrangement is low (101) and imine 6 gives a carbene which adds to cyclo~~hexene~~octene (102).



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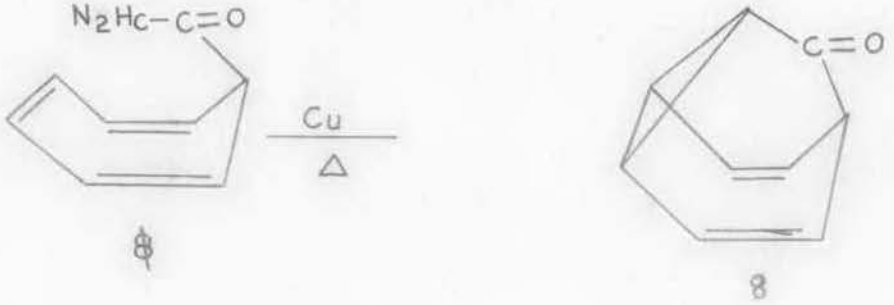
Additions are common when a copper catalyst is employed, but occasionally uncatalysed additions are successful. These are often suspect. For instance, addition of 7 to olefins was reported on thermal decomposition of diazo acenapthalene (103).

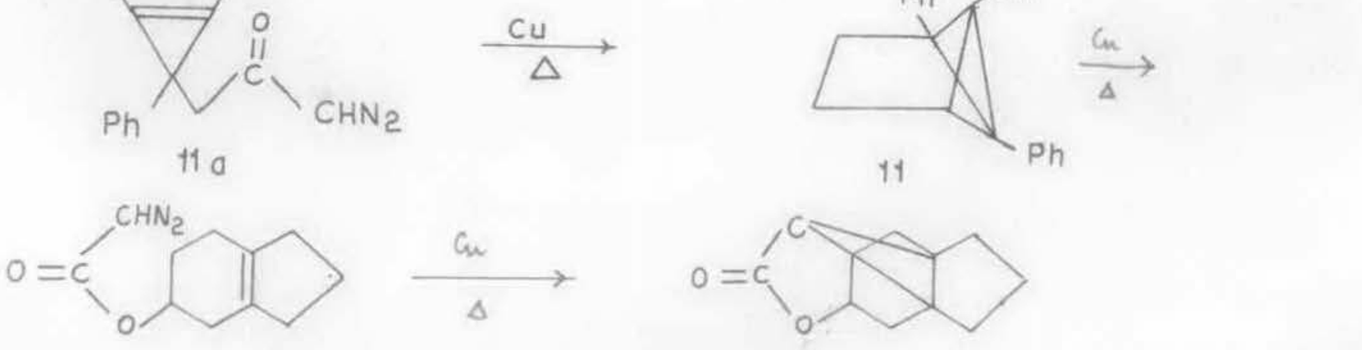
7

Olefins not bearing electron withdrawing groups do not form cyclopropanes. However, the intermediary of pyrazolines seems quite possible.

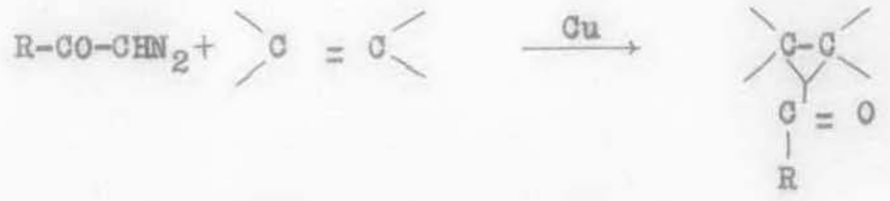
Doering et al (104) used the reaction to make barbalone 8, a precursor of bullvalene.



Mori and Matsui (105) achieved a 59% yield of epimers 10 and 10a the copper/copper sulphate - catalysed decomposition of 9 and the prebenzvalene 11 was made from the copper-catalysed decomposition of 11a by Monahan (106). Similar reactions were performed by House and Blankley (107).

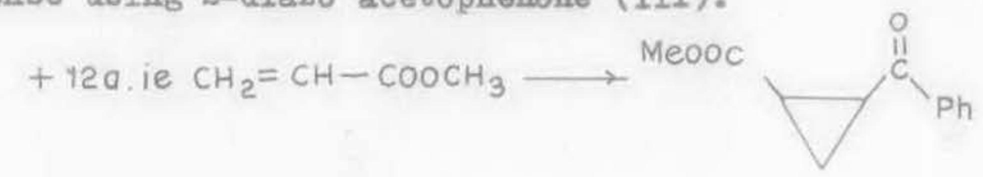


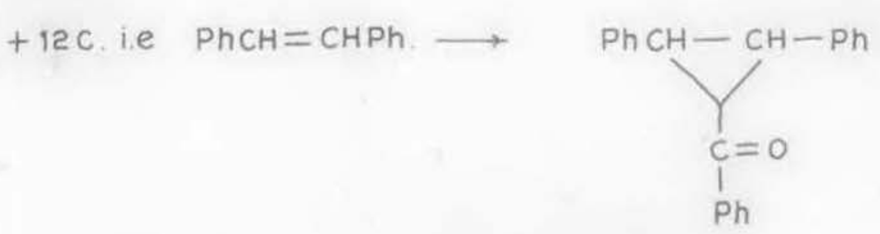
Acetyl carbene, generated by copper-catalysed decomposition of diazoacetone, added easily to olefins such as styrene, cyclo hexene, cyclopentene (108). The presence of acetoxy groups did not interfere with this reaction.



Benzoyl carbene (109) and p-phenyl benzoyl carbene (110) were found to react with olefins even in the uncatalysed pyrolysis of the related diazoketones, but the yields were considerably improved by the presence of copper powder.

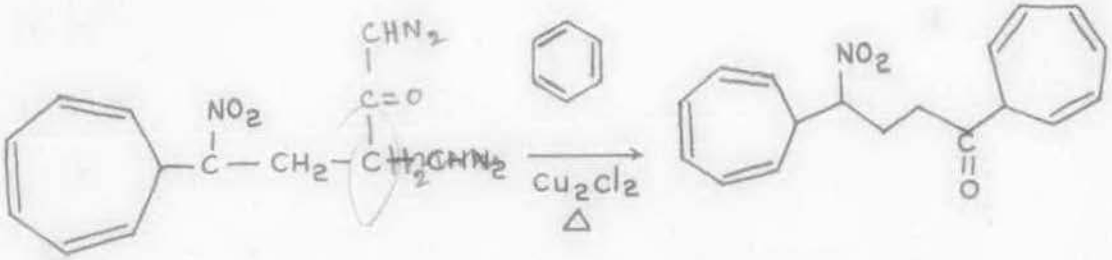
This reaction has been applied in an intermolecular sense using 2-diazo acetophenone (111).





Cis and trans product

Addition of keto carbenes to aromatic systems have generally failed, even copper catalysed. But it has recently been demonstrated that both intermolecular (112) and intramolecular (113) reactions are possible.



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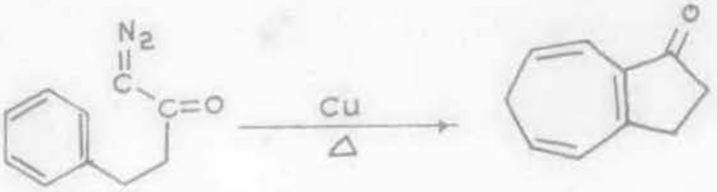

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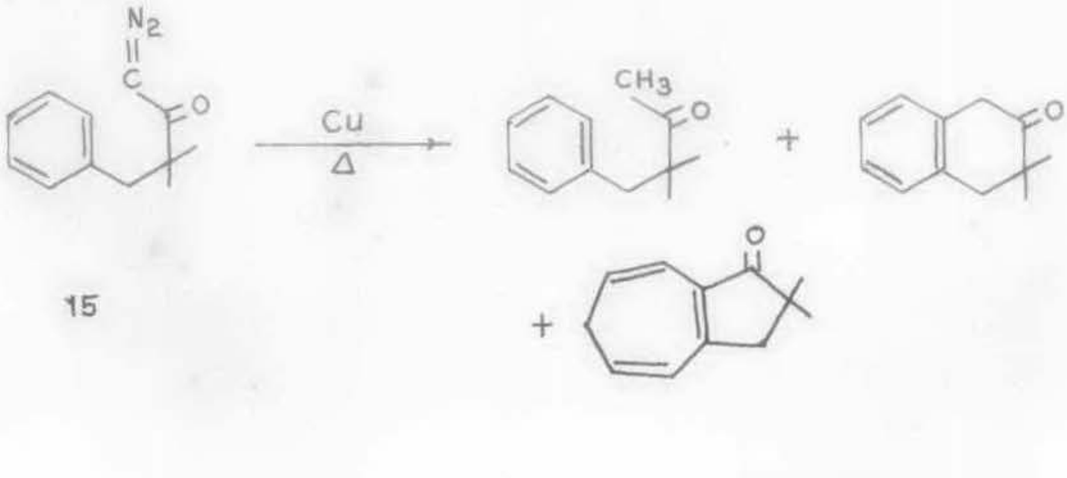

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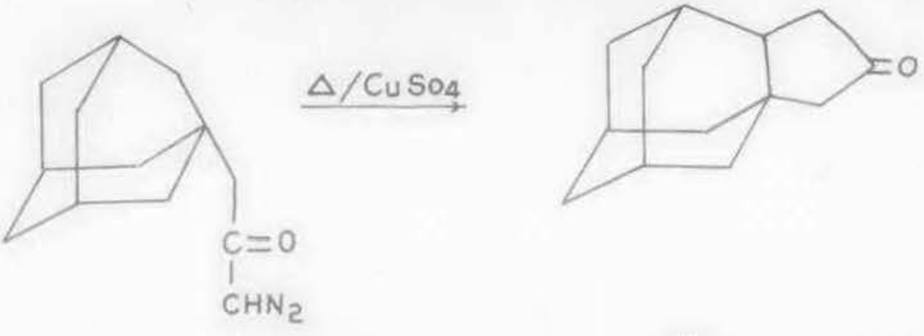
Copper sulphate-catalysed decomposition of 16 yields 17 which is the intramolecular insertion reaction.



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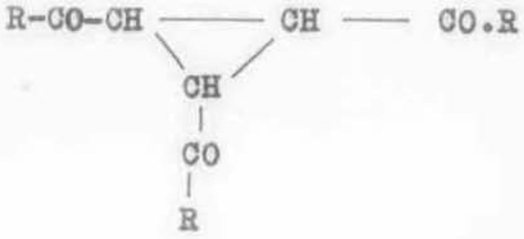
17

Diazoketones have been converted to diaceylethylene by treatment with cupric oxide in inert solvent, such as benzene, toluene (114).

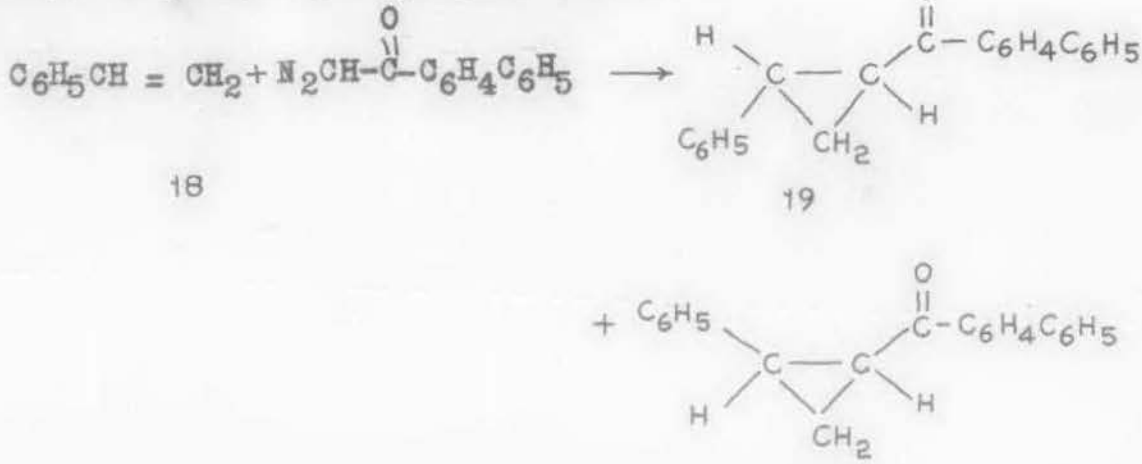
$$2R\ CO.CHN_2 \xrightarrow{CuO} R-CO-CH = CH-COR$$

Trimer is also formed with excess diazoketones.

$RCO.CH = CH.CO\ R + RCO\ .\ CHN_2$



α-diazo-4-phenyl acetophenone reacted with a large excess of styrene at 140° to yield cis and trans- 1-(4'-phenyl benzoyl)-2-phenyl cyclopropane (115).



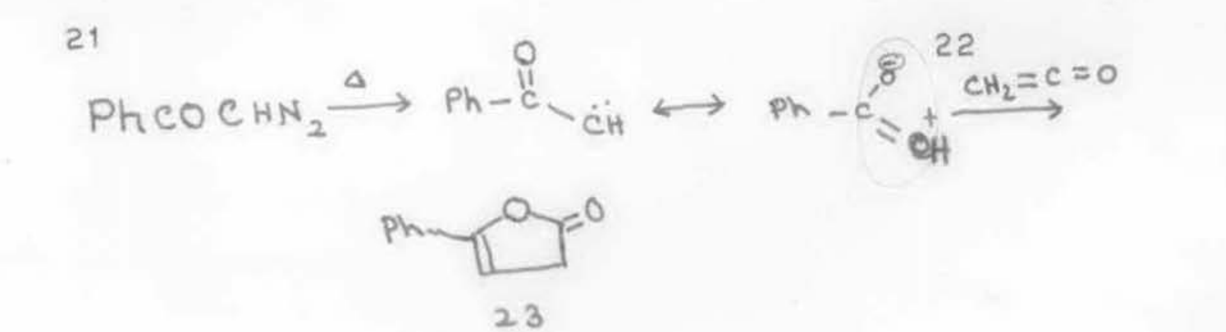
$C_6H_5CH = CH_2 + N_2CH-\overset{O}{\overset{\|}{C}}-C_6H_4C_6H_5 \longrightarrow$

18

19

20

Cyclic diazo keto carbene of the following type has been found to be trapped by the olefins in the following fashion and addition to stilbenes is nearly sterospecific (116).



21

22

23

1,3 dipolar additions are common and are often catalysed by copper (117). 1,3 dipolar addition is probably responsible for the formation of 23 (118).

Section-B : Mechanistic pattern of Keto carbene addition to double bonds.

External reactions are facilitated by copper catalyst (Probably by the formation of an olefin-carbene-copper complex).

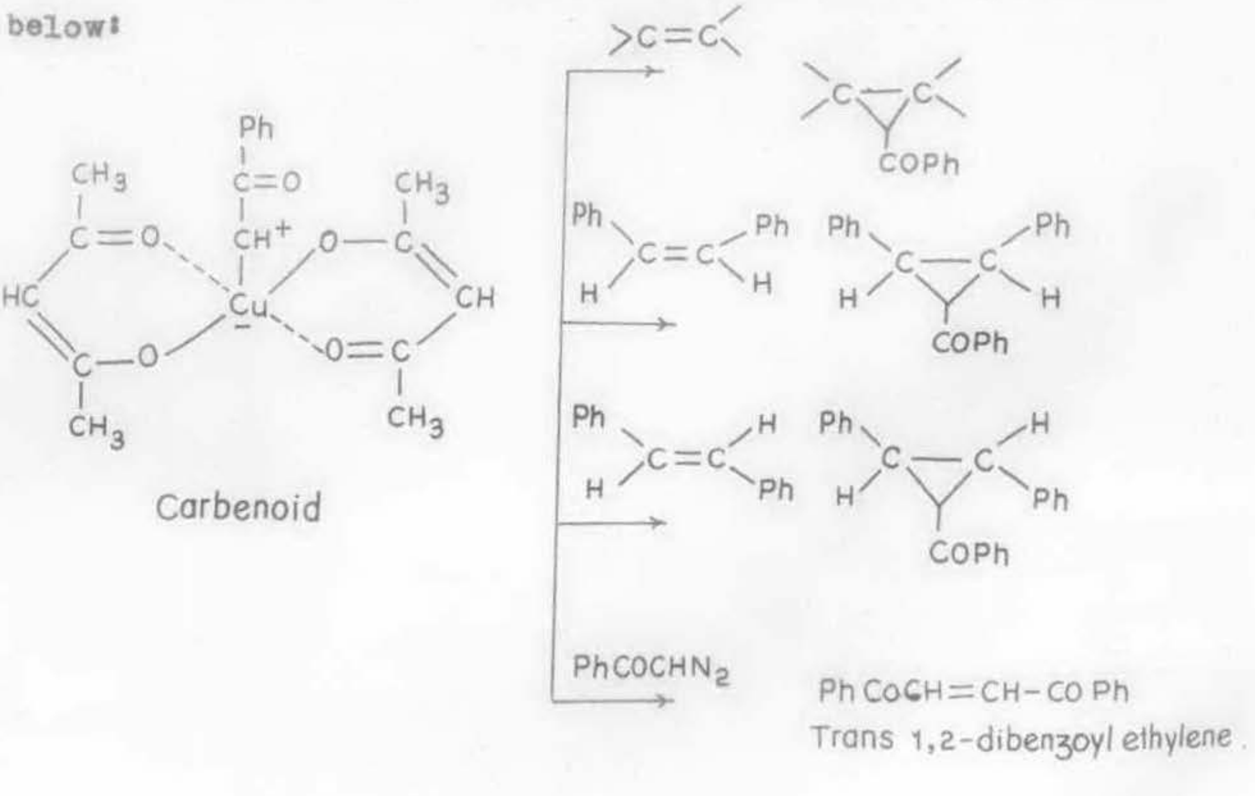
Mat Suje Takebayashi et al (111) found that when α-diazo acetophenone reacts with olefin such as vinyl acetate, cyclo hexene and cis and trans stilbenes, several products were being formed in presence of bis (acetyl acetonates) copper. The products are not only the Keto carbene addition products but also 1,2, trans dibenzoyl ethylene, 1,2 dibenzoyl ethane and dilactone. To explain these products they assumed a copper carbenoid intermediate. They also concluded that since no addition product to benzene was obtained, the reactivity of this carbenoid seems to be not so large.

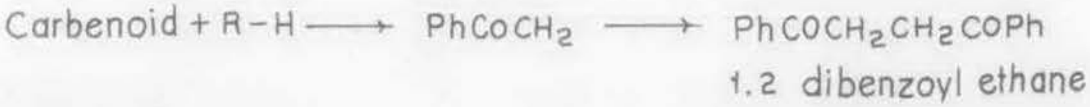
The cis and trans 1,2 dibenzoyl ethylenes may be formed by the reaction of α-diazo ketone with carbenoid species. In the case of "mixed method" when no substrate having enough reactivity to the carbenoid is present except α-diazo acetophenone in the reaction system. Groundmann, and Trischmann (126) have reported that the copper powder catalysed decomposition of α-diazo acetophenone in various solvents gives trans-1,2 dibenzoyl ethylene.

On the other hand, dilactone was observed in the reaction of α-diazo acetophenone with cis and trans stilbenes, which have much reduced reactivity towards carbenoid. In this case, the concentration of substrate reaction with the carbenoid is so small that a part of carbenoid releases benzoyl carbene, which lead to phenyl ketene by concerted phenyl migration. Phenyl ketene reacts with diazo acetophenone and finally affords dilactone.

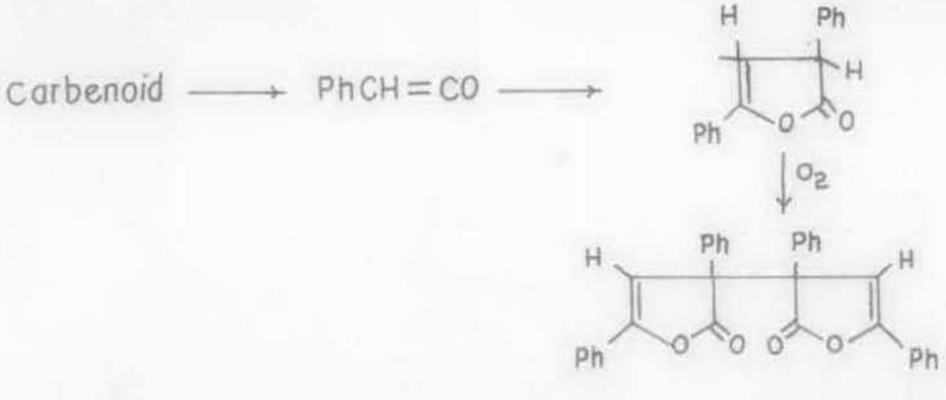
The formation of 1,2 dibenzoyl ethane is explained by the dimerization of relatively stable phenacyl radical, which is formed by the hydrogen abstraction of the carbenoid from the solvents or substrates.

The formation of the products obtained is summarised below:



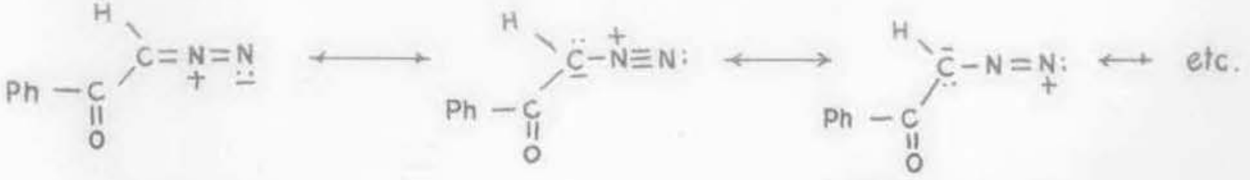


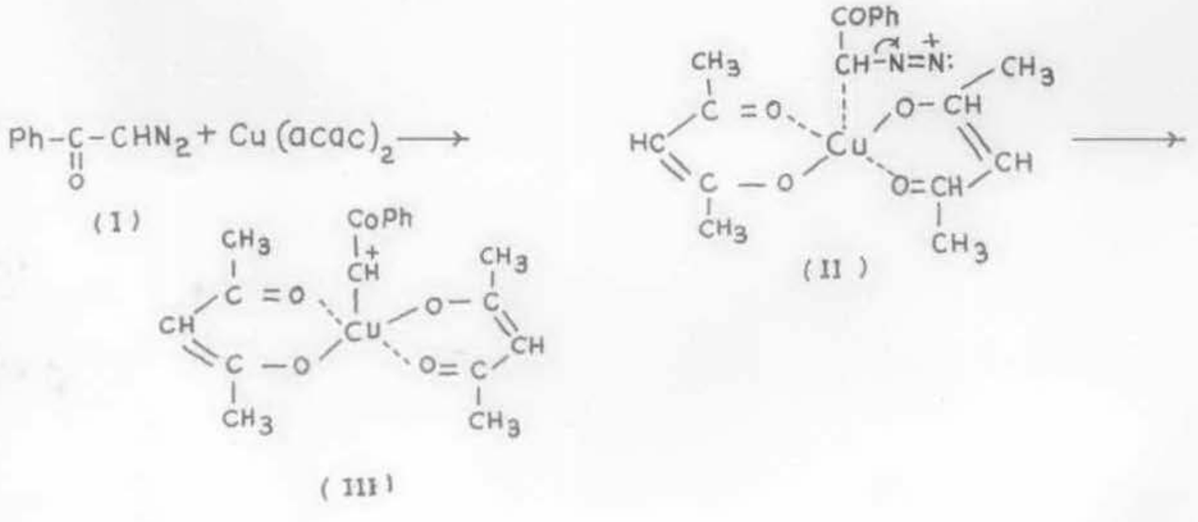
$$\text{Carbenoid} + R-H \longrightarrow PhCoCH_2 \longrightarrow \underset{\text{1.2 dibenzoyl ethane}}{PhCOCH_2CH_2COPh}$$



The following mechamism has been proposed for the formation of carbenoid intermediate. Copper chelates such as Cu(ac ac)$_2$ and Cu(DMG)$_2$ have been recognised to have a plane structure of 4 co-ordination.

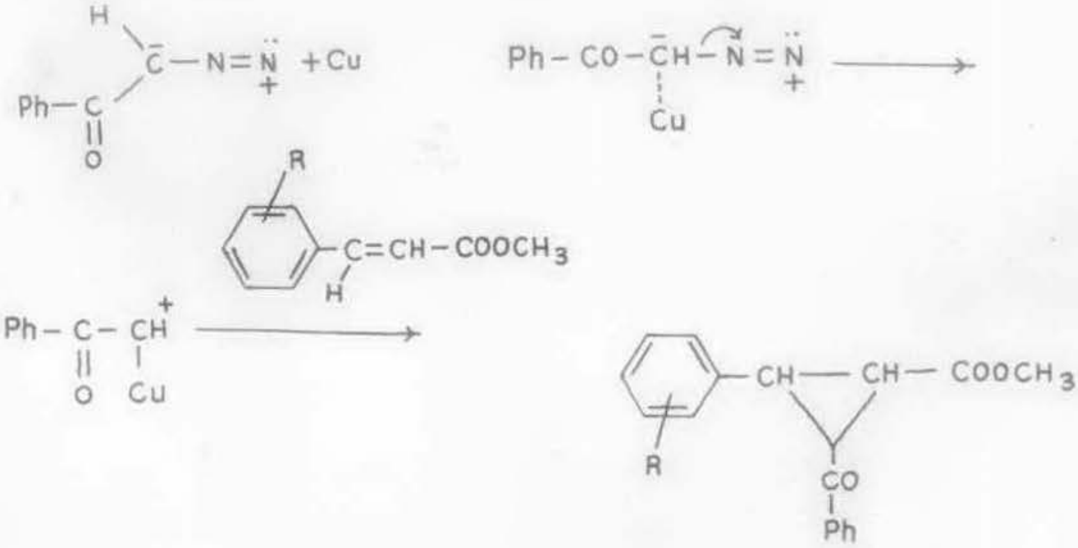
α-diazo acetophenone has the following resonance structure:





The diazo ketone coordinates with its α-carbon atom to the metal atom of copper chelates, thus giving an intermediate complex (II); the complex losses its nitrogen immediately to afford a keto carbene complex (III). The bond between the keto carbene and the copper atom of the complex is not so strong that the complex may react with olefins to give cyclopropyl ketones.

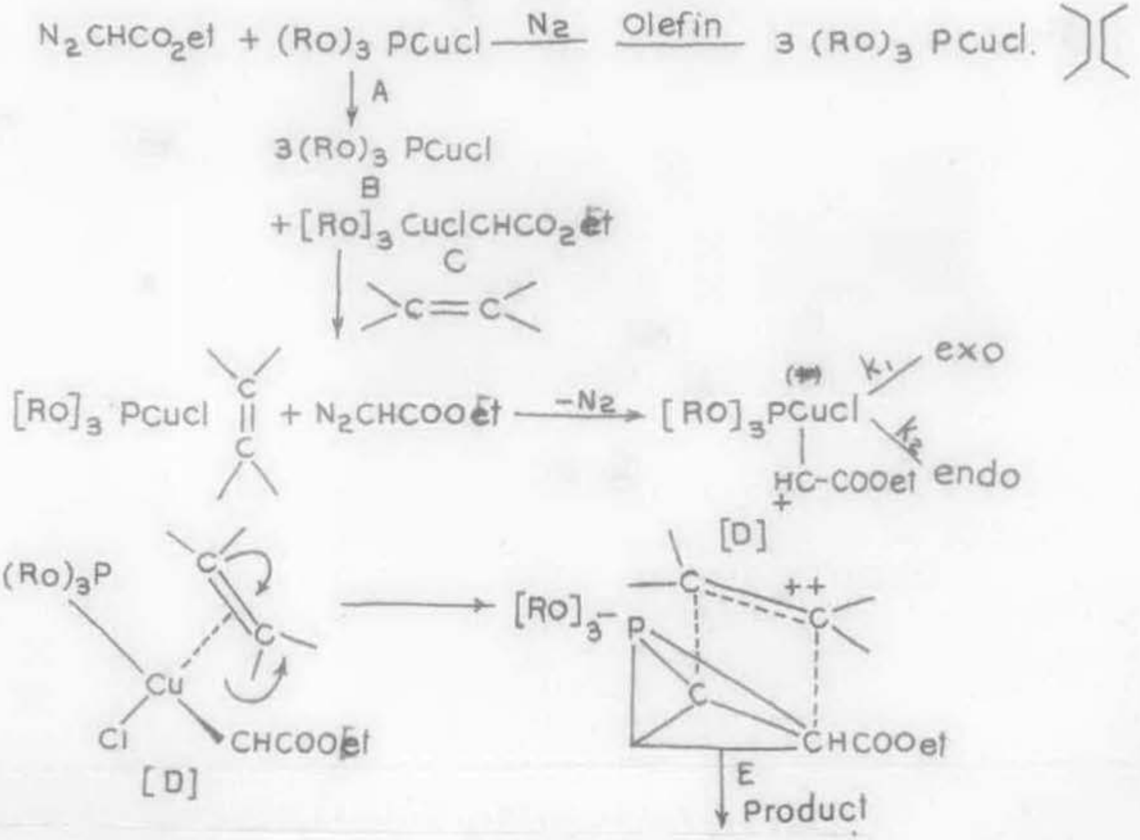
We have prepared cyclopropyl ketones with olefins of the following type and α-diazo acetophenone in presence of active copper powder, anhydrous copper sulphate and cuprous chloride. In all cases we observed cyclopropyl ketones together with trans-1,2 dibenzoyl ethylene, so it may be concluded that a paralel mechanism hold in these cases. Here the α-carbon atom of the 2-diazo acetophenone coordinates with the copper atom giving rise to keto carbene Cu-complex. This then reacts with olefinic double bond to give cyclopropyl ketones. The reaction mechanism can be depicted as follows:



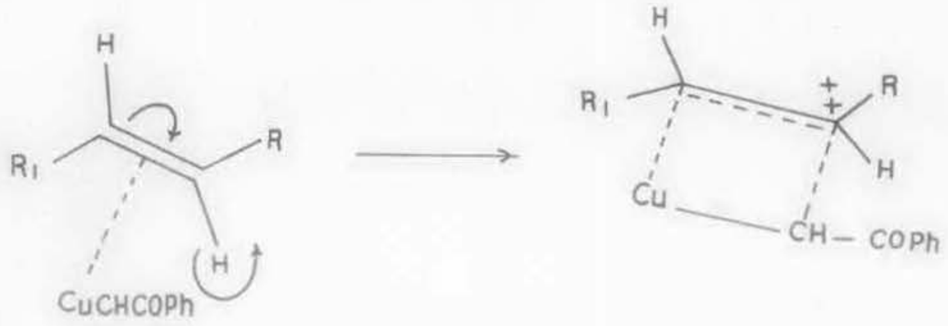
Dyakonov and co-workers (139) have shown Kinetically that the catalytic species in the type of reaction of cyclohexene and ethyl diazo acetate is not the starting copper complex, but an intermediate derived there. Of all the several mechanisms for the formation of cyclopropane product from the decomposition of ethyl diazo acetate in cyclohexene the overall path depicted in scheme 2(140) below best explains the experimental data.

Concerning the 1st step in the scheme it is quite reasonable that the coordinately satisfied tetrameric (141, 142) copper complex A is cleaved by diazo alkane to form 3 mole of coordinately unsaturated monomer, and 1 mole of mono saturated carbene-metal complex. Since the reactive monomer B is formed in a huge excess of cyclohexene and Cu(1) forms strong olefin complexes, the most reasonable step is to coordinate with either 1 or 2 mole of cyclohexene to form intermediate complex-C. This complex cannot form the product directly, therefore it is reasonable that it reacts further with ethyl diazo acetate to form the final intermediate D, before product formation. This intermediate D depicted in scheme 2 is tetra hedral and co-ordinately satisfied. Since the central metal atom is Cu(1) complexes is 4 and tetrahedral (143). In this complex D, the olefin as well as the carbene could be coordinated via a donation back donation type of bonding. This requires donation of 2-electrons in SP^2 orbital from a singlet carbene and a back donation of electrons from a dxz orbital of the metal into vacant Pz orbital of the carbene carbon. Stable carbene complex of this type with various metals as the central metal atom have been reported (144) and the X-ray study indicates Sp^2 hybridisation of the carbene carbon and dπ - pπ bonding (145).

Scheme 2



Hence in our study, exact transition state would be



$R_1 =$  $-R_3$, $R_3 =$ OMe, $-NO_2$, Cl, etc.

$R =$ $COOCH_3$

Mechanism of catalytic decomposition of diazo acetophenone in the presence of copper salts must be different from the photolytic processes. Cowan et al (124) showed that catalytic decomposition of α-diazo acetophenone in presence of cyclohexene leads to formation of norcaryl phenyl ketone, usually in much larger yield than was obtained by either direct or sensitized photolysis. Products expected from hydrogen abstraction from the alkene was not found. Catalytic decomposition in the presence of the butenes also let to higher yields of cyclopropyl ketones than were obtained in the photochemical experiments. They also observed that catalytic decomposition in presence of trans butene yields a trans product i.e. addition of keto carbene to the trans butene has taken place stereospecifically. But in the case cis-butene, no stereospecific addition was found. Phenacylchloride is also produced when cuprous chloride was used as the catalyst.

The relatively high stereospecificity of a keto carbene addition to 2-butenes might be indicative of the singlet keto carbene intermediary. The reagent involved seems to be more selective than triplet carbene believed to be the active intermediate photolysis. It is most probable that the active reagent is an organometallic compound such as PhCOCHCu or $C_5H_5COCHCuCl_2$. The latter reagent would be a logical precursor of phenacyl chloride which would be structurally analogous to the CH_2I_2 formed by the diazomethane and zinc iodide. The fact that the catalytic addition with cis-2-butene are not entirely stereo specific indicates that the catalysed reaction proceed with a mixture of mechanisms i.e. singlet keto carbene and triplet keto-carbene both being involved in the catalytic decomposition of diazo acetophenone.

Now as addition of keto carbene to trans olefins (E) is entirely stereo specific, we have taken trans (E) olefins in our studies as to avoid a greater number of products with cis olefin (Z type).

CHAPTER - III

Reaction of diazoketones with Cinnamic esters

Section-A: Aims and Objects

In our studies with carbenes, we have chosen olefins of the cinnamic ester type in which the olefinic double bond is not expected to be as active as simple olefins. No such reaction of a keto carbene addition to a olefinic double bond which is attached by a electron withdrawing carbomethoxy group and a phenyl group has yet been reported in detail. The double bonds of our olefinic substrates are of the type of vinylic double bond. On the other hand, there is a limited number of intermolecular addition reactions studied with keto carbene and olefins. In all cases we observed that mechanistic pattern and state of the keto carbenes are the main goal of their study. Keto carbenes are not so reactive like other carbenes like methylene. On the other hand, our choice of olefinic substrates is active towards electrophilic addition reactions. No studies have yet been done to correlate the product yields when the addition of a keto carbene occurred to a double bond in intermolecular sense. Different substituted diazoketones were taken and reaction conditions kept as identical as possible, the products yields were not the same in all cases. The keto carbenes containing electron donating group gave lesser percentage of product; on the other hand, electron withdrawing groups enhanced the percentage yield of the product. The correlation was made on the basis of the cyclopropyl ketones obtained after separating all other side products mainly by distillation and fractional crystallisation so this may be rough correlation. Our main goal was to synthesize the cyclopropyl ketones with different substituted olefins and substituted ketocarbenes. We have also substituted phenyl moiety over olefins by electron releasing or electron withdrawing group in the ortho, para, meta position.

The structure of the cyclopropyl ketones were confirmed by elemental analysis, ultraviolet, I.R., N.M.R. and mass spectra. In the case of liquid products the help of G.L.C. analysis was employed to determine purity.

Section-B: Results and Discussions

Reaction of α-diazo acetophenone with o-methoxy cinnamic ester (methyl).

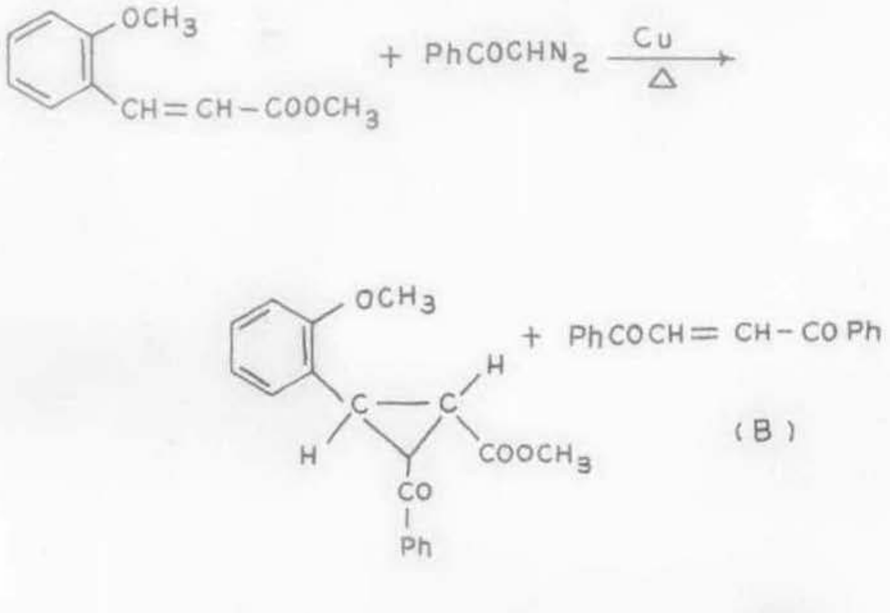
The copper catalysed decomposition of α-diazo acetophenone was carried out in a refluxing benzene solution of o-methoxy cinnamic ester (methyl). After usual work up of the reaction mixture, the products were separated by fractional crystallisations. The addition of α-diazo acetophenone was carried out "dropwise" as to avoid the formation of dimers of benzoyl carbene. Two products were separated by fractional crystallisation. One was A, cyclopropane derivative of o-methoxy cinnamic ester (methyl) i.e. 1-benzoyl-2-carbomethoxy-2'-(o-methoxy) phenyl cyclopropane and another was B, trans 1, 2 dibenzoyl ethylene.

By means of elemental analysis, I.R., U.V., N.M.R. and mass spectrum the structure of A was confirmed.

I.R. bands at 1720 cm^{-1}, 1680 cm^{-1}, 1010 cm^{-1} indicated that this compound contained ester, carbonyl group and a cyclopropane ring:

λ_{max} at 238 nm indicated phenyl conjugation to the cyclopropane ring:

B was confirmed to be trans-1- 2-dibenzoyl ethylene by means of identical I.R. with that of authentic one.



(B)

(A)

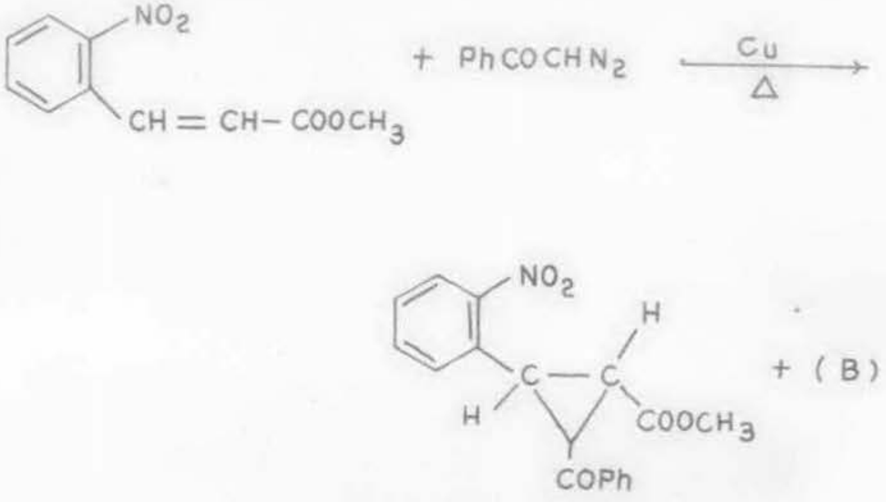
Reaction between o-nitro cinnamic ester (methyl) α-diazo acetophenone:

To a refluxing benzene solution of trans-o-nitro cinnamic ester, α-diazoacetophenone was added dropwise in presence of active copper powder. After usual work up of the reaction mixture, the product was separated by fractional distillation. The residue in the distilling flask, on crystallisation from light petrolium ether gave a solid compound B, m.p. 108°C.

The liquid fraction (C) was identified as 1-benzoyl-2'-(o-nitro) phenyl-2-carbomethoxy cyclo propane by elemental analysis, U.V., I.R.

λ_{max} at 240 nm indicated that there was a phenyl conjugation to a cyclopropane ring:

I.R. bands at 1700 cm^{-1}, 1680 cm^{-1}, 1010 cm^{-1} indicated that this compound contained ester, carbonyl group and a cyclopropane ring:



(C)

Reaction of p-chloro α-diazo acetophenone with ortho-methoxy cinnamic ester (methyl).

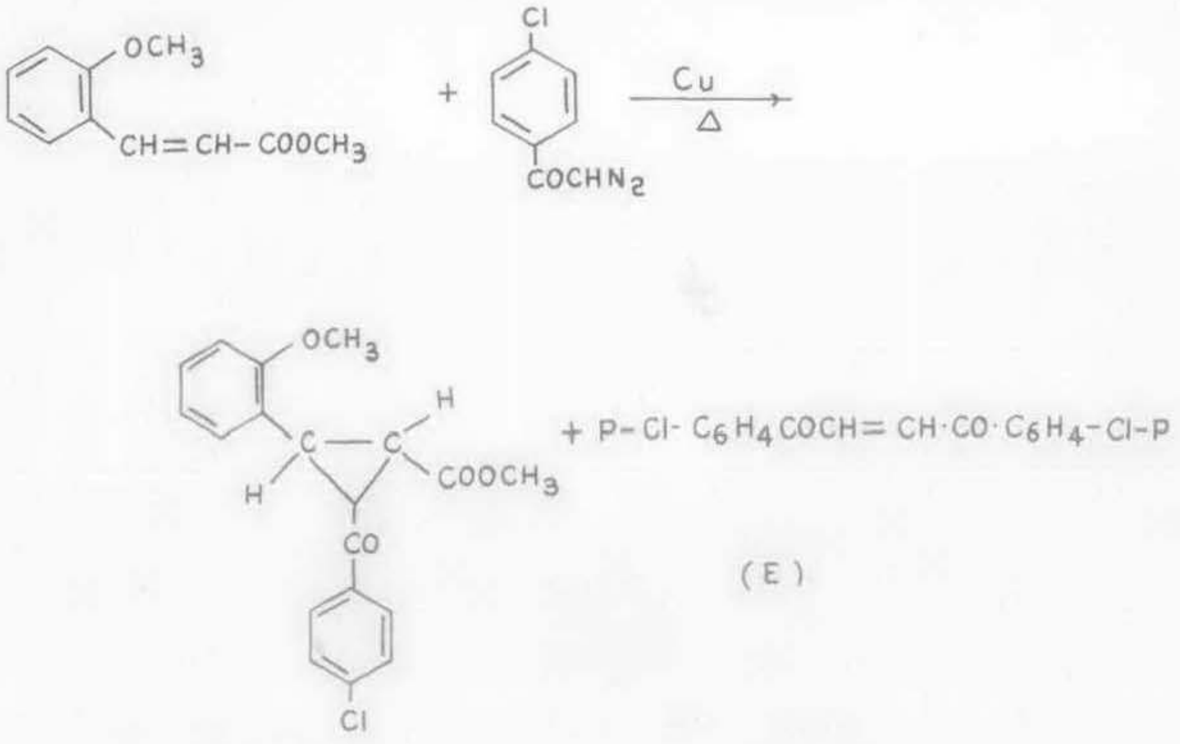
The copper catalysed decomposition of p-chloro α-diazo acetophenone was carried out in a refluxing benzene solution of ortho-methoxy cinnamic ester (methyl). After usual workup of the reaction mixture, the products were separated by fractional crystallisation. In this case also two products, were separated; one was [D] cyclopropane derivative of o-methoxy cinnamic ester and another was [E] trans-1,2, p-chloro dibenzoyl ethylene.

By means of elemental analysis, I.R. U.V. the structure of 1-p-chlorobenzoyl 2-carbomethoxy-2'-(o-methoxy) phenyl cyclopropane has been confirmed.

I.R. bands at 1715 cm^{-1}, 1660 cm^{-1}, 1010 cm^{-1} indicated that this compound contained ester, carbonyl and cyclopropane ring.

λ_{max} at 238 nm indicated that there was phenyl conjugation to the cyclopropane ring.

Another product [E] was found to be 1,2-p-chloro dibenzoyl ethylene. The structure of this compound was also confirmed by elemental analysis and I.R.



(E)

(D)

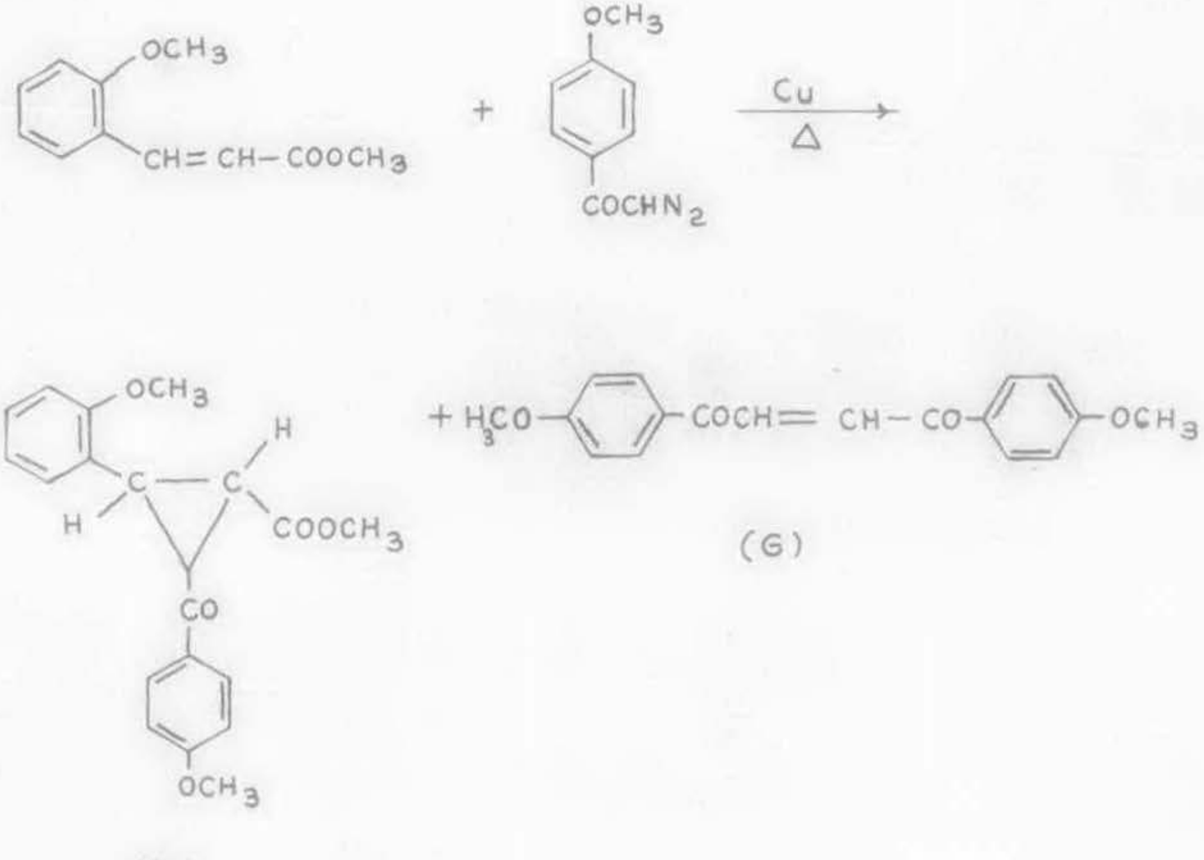
Reaction between p-methoxy α-diazo acetophenone with o-methoxy cinnamic ester (methyl)

The copper catalysed decomposition of p-methoxy α-diazo acetophenone was carried out in a refluxing benzene solution of o-methoxy cinnamic ester (methyl). After usual workup of the reaction mixture, the two products were separated by fractional crystallisation. One was 1-p-methoxy benzoyl-2-carbomethoxy-2'-(o-methoxy) phenyl cyclo propane and another was trans-p-methoxy 1,2 dibenzoyl ethylene.

By means of elemental analysis, I.R. U.V., the structure of cyclopropane derivative was confirmed. (The structure of trans-p-methoxy 1,2-dibenzoyl was confirmed by I.R. and elemental analysis).

I.R. bands at 1700 cm^{-1}, 1655 cm^{-1}, 1000 cm^{-1} indicated that this compound contained ester, carbonyl and a cyclopropane ring.

λ_{max} at 245 nm indicated that there was a phenyl conjugation to a cyclopropane ring:



(F)

(G)

Reaction of ∝-diazo aceto phenone with trans p-methoxy cinnamic ester (methyl).

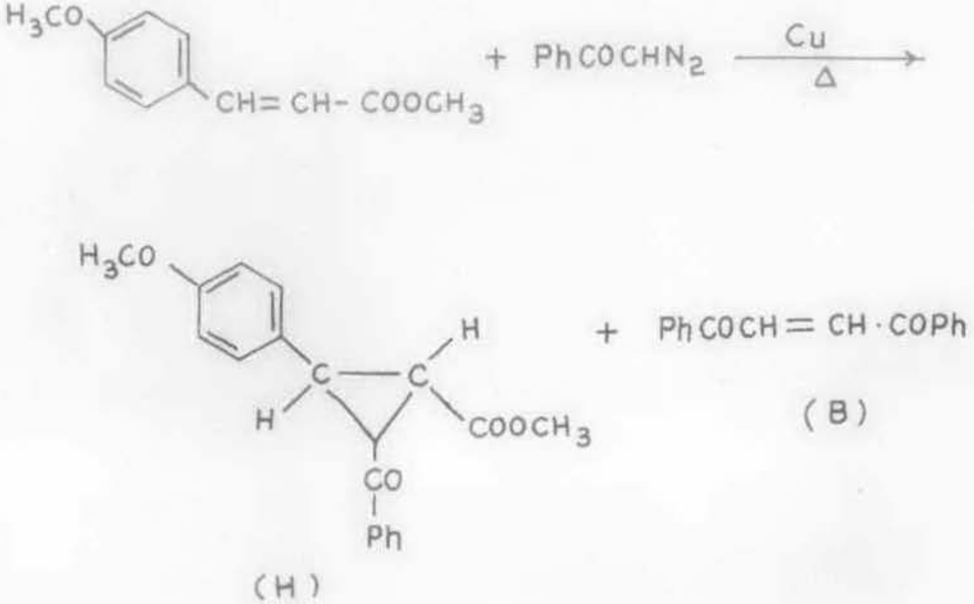
Copper catalysed decomposition of ∝-diazo acetophenone was carried out in a refluxing benzene solution of trans-p-methoxy cinnamic ester. After usual workup of the reaction mixture, the products were separated by fractional crystallisation. In this case, two products were separated, one was [H] cyclopropane derivative of trans-p-methoxy cinnamic ester and another [B] was trans 1,2-dibenzoyl ethylene.

By means of elemental analysis, I.R. U.V. the structure of cyclopropane derivative was confirmed.

I.R. bands at 1715 cm^{-1}, 1680 cm^{-1} and 1010 cm^{-1}, indicated that this compound contained ester, carbonyl group and a cyclopropane ring.

λ_{max} at 244 nm indicated that there was phenyl conjugation to the cyclopropane ring.

The structure of another product was confirmed by the comparison of I.R. bands and m.p. of those of trans-1,2 dibenzoyl ethylene.

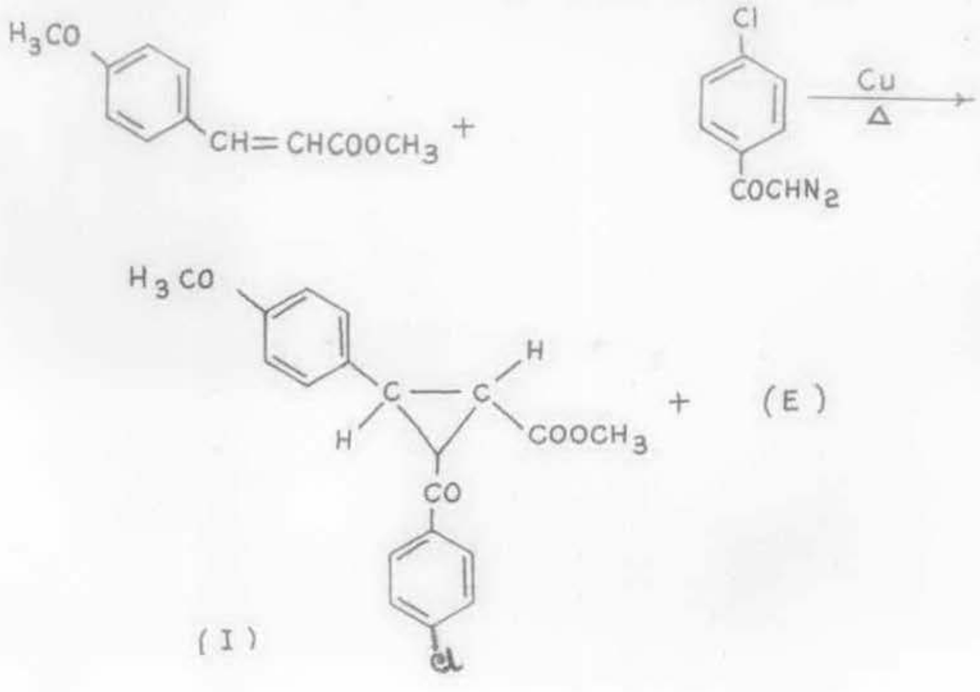


Reaction of α-diazo p-chloro acetophenone with trans-p-methoxy cinnamic ester (methyl).

Copper catalysed decomposition of α-diazo p-chloro acetophenone was carried out in a refluxing benzene solution of the ester. After usual work up of the reaction mixture, two products were separated by fractional crystallisation one was found to be 1-p-chloro benzoyl-2-carbomethoxy-2'-(p-methoxy) phenyl cyclo propane and another was trans 1, 2 p-chloro dibenzoyl ethylene. By means of elemental analysis, I.R. and U.V. the structure of the cyclopropane derivative [I] was confirmed.

I.R. bands at 1720 cm^{-1}, 1660 cm^{-1} and 1010 cm^{-1} indicated that this compound contained ester, carbonyl groups and a cyclo propane ring.

λ_{max} at 239 nm at indicated that there was a phenyl conjugation to the cyclopropane ring.



(I)

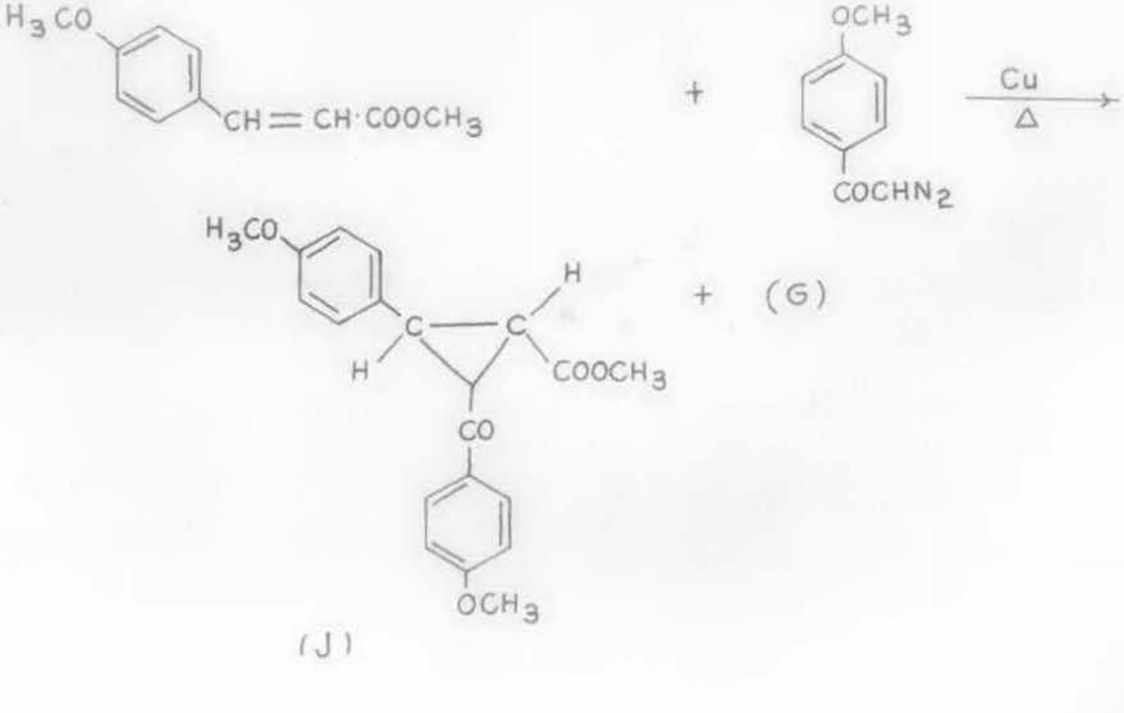
Reaction of ∝-diazo p-methoxy acetophenone with trans p-methoxy methyl cinnamate.

Copper catalysed decomposition of ∝-diazo p-methoxy acetophenone was carried out in a refluxing benzene solution of ester. After usual work up of the reaction mixture, two products were separated by fractional crystallisation. One was cyclopropane derivative of p-methoxy methyl cinnamate [J] and another was dimer of the keto carbene [G].

By means of elemental analysis, I.R.,U.V., N.M.R. and mass spectra, the structure of cyclopropane derivative was confirmed.

I.R. band at 1720 cm^{-1}, 1670 cm^{-1}, 1010 cm^{-1} indicated that this compound contained ester and a carbonyl group together with a cyclopropane ring.

λ_{max} at 246 nm indicated that there was phenyl conjugation to the cyclopropane ring.



(J)

Reaction of α-diazo p-nitro acetophenone with p-methoxy methyl cinnamate.

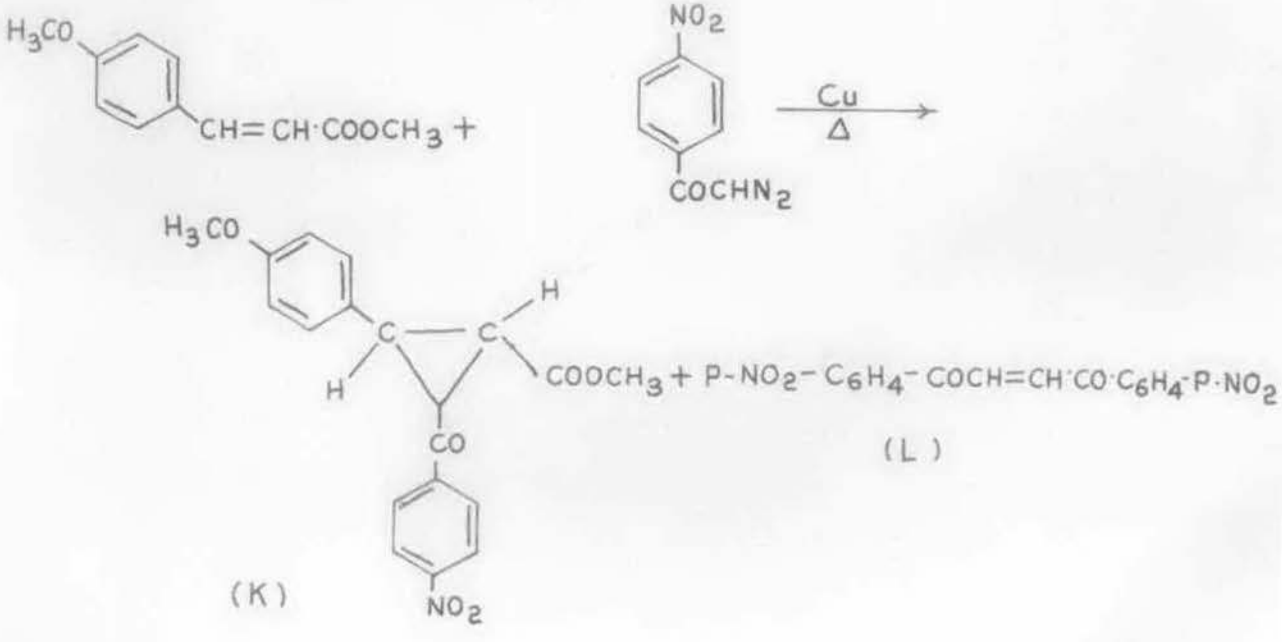
Copper catalysed decomposition of diazo compound was carried out in a refluxing solution of p-methoxy methyl cinnamate. After usual work up of the reaction mixture, two products were separated by fractional crystallisation. One of these two products was cyclopropane derivative of the ester /‾K‾/ i.e. 1-p-nitrobenzoyl-2-carbomethoxy-2'-(p-methoxy) phenyl cyclopropane . Another was /‾L‾/ trans 1,2 p-nitro-dibenzoyl ethylene.

The structure of the cyclopropane derivative was confirmed by means of elemental analysis, I.R., U.V.

I.R. bands at 1700 cm^{-1}, 1660 cm^{-1} and 1010 cm^{-1} indicated that this compound contained ester and carbonyl group together with a cyclopropane ring.

$\lambda_{max} = 235$ nm.

The structure of /‾L‾/ was confirmed by elemental analysis and I.R. band at 1645 cm^{-1} indicated that this compound contained a carbonyl group.



(K)

(L)

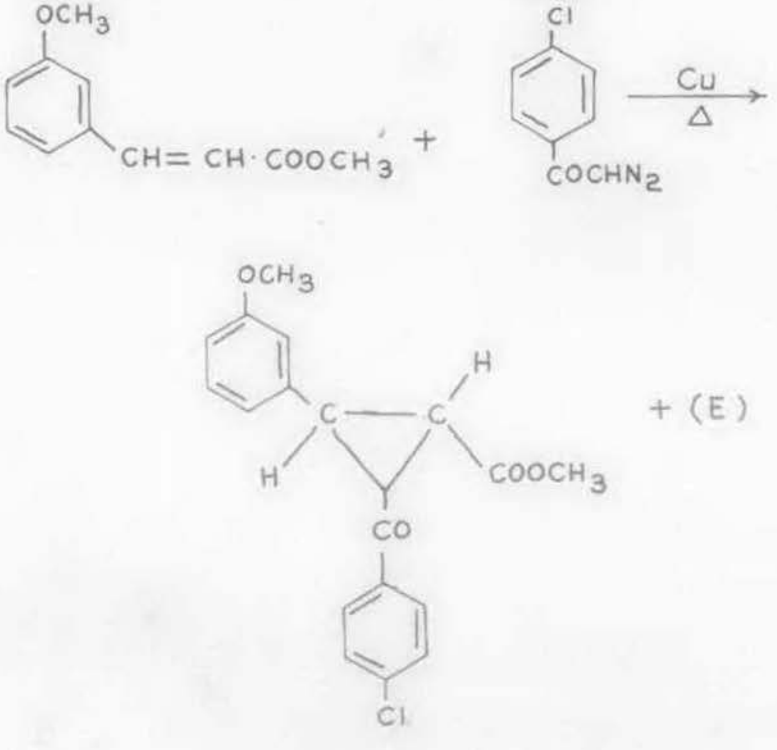
Reaction of α-diazo p-chloro acetophenone with m-methoxy methyl cinnamate.

Copper catalysed decomposition of diazo compound was carried out in a benzene refluxing solution of meta methoxy cinnamic ester (methyl). After usual work up of the reaction mixture, the two products were separated. One of these products was identified as 1-benzoyl-2-carbomethoxy-2'-meta-methoxy phenyl cyclopropane [M] and another was trans 1,2 p-chloro dibenzoyl ethylene [E]. In this case the yield of the cyclo propane derivative was very low.

By means of elemental analysis, I.R. and U.V. the structure of the products was confirmed.

I.R. bands at 1710 cm^{-1}, 1665 cm^{-1} and 1010 cm^{-1} indicated that the compound contained ester, and carbonyl group together with cyclopropane ring. U.V. λ_{max} at 238 nm indicate that the compound contains a phenyl group to the cyclopropane ring.

I.R. band of [E] at 1645 cm^{-1} indicated that this compound contained a carbonyl group.



(M)

Reaction of α-diazo acetophenone with

a) meta methoxy cinnamic ester (methyl)

b) α-cyano methyl cinnamate.

c) O-carbomethoxy methyl cinnamate

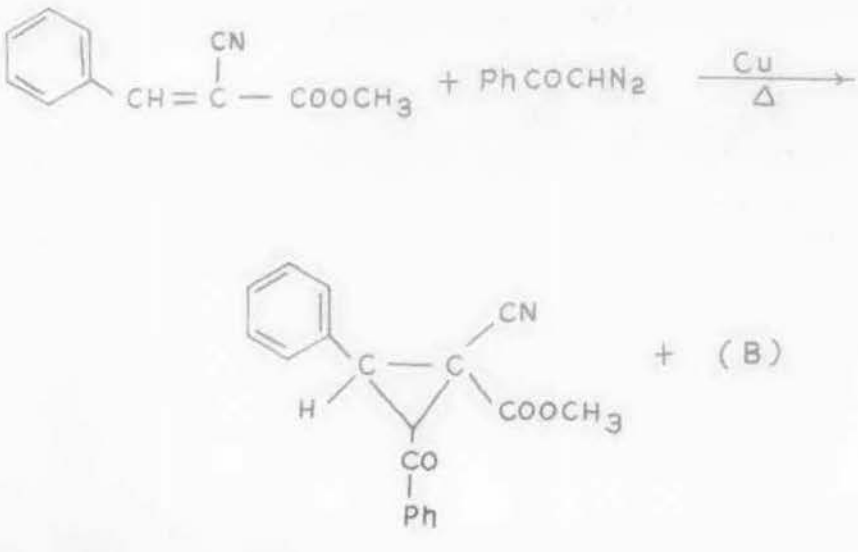
d) Dimethyl ester of o-carboxy cinnamic acid.

Copper catalysed decomposition of α-diazo acetophenone carried out in refluxing benzene solution of (a) or (c) or (d). After usual work up of the reaction mixture and separating the products by fractional crystallisation the starting esters were recovered together with trans-1, 2 dibenzoyl ethylene.

Main reason behind this is that with these olefinic substrates reactivity with the keto carbene is much reduced and the carbene reacts among themselves.

In the case of (b), the electron withdrawing groups facilitates the keto carbene addition to the olefinic double bond.

But in the case of (b), we were able to isolate the cyclopropane derivative [N], i.e. 1-benzoyl-2-carbomethoxy-2-cyano-2'-phenyl cyclopropane and the structure of this product was confirmed by elemental analysis, I.R.



(N)

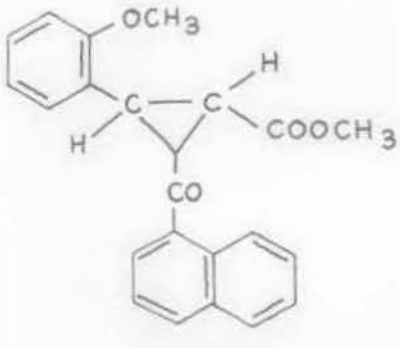
Reaction of diazo methyl naphthyl ketone with o-methoxy cinnamic ester (methyl).

The copper catalysed decomposition of α-diazo acetonapthone was carried out in a refluxing benzene solution of trans o-methoxy cinnamic ester (methyl). After usual work up of the reaction mixture the products were separated by fractional crystallisation. In this we were able to separate only a trace amount of napthoyl ketocarbene addition product [O] with olefinic double bond of the ester.

By means of elemental analysis I.R. and U.V. the structure of cyclopropane derivative was confirmed.

I.R. bands at 1710 cm^{-1}, 1660 cm^{-1} and 1010 cm^{-1} indicated that this compound contained ester and a carbonyl group and a cyclopropane ring.

λ_{max} at 240 nm indicated that there was a phenyl conjugation to the cyclopropane ring:



(o)

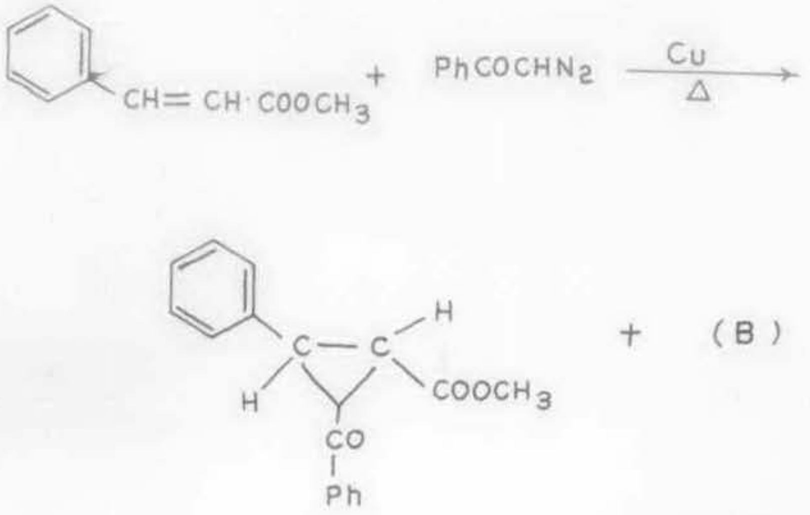
Reaction of α-diazo acetophenone with methyl cinnamate.

Copper catalysed decomposition of diazo compound was carried out in a refluxing benzene solution of methyl cinnamate. After usual work up of the reaction mixture, the products were separated by fractional distillation. One was found to be starting ester and another of higher b.p was identified to be cyclopropane derivative of methyl cinnamate.

The structure of this product was confirmed by elemental analysis I.R., U.V. and N.M.R.

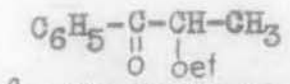
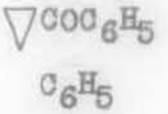
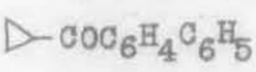
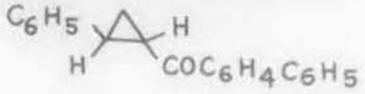
λ max 234nm indicated phenyl conjugation to the cyclopropane ring.

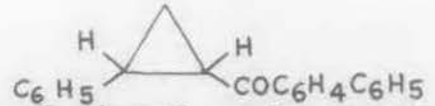
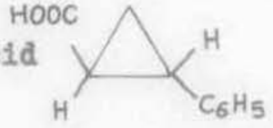
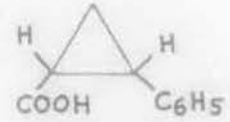
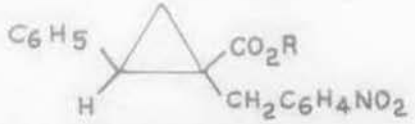
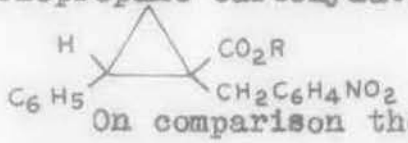
I.R. bands at 1715 cm^{-1}, 1670 cm^{-1} and 1010 cm^{-1} indicated that this compound contained ester and carbonyl function together with a cyclopropane ring.



STRUCTURAL ELUCIDATION BY SPECTROSCOPIC METHOD.

Ultraviolet and infrared absorption spectra of some cyclopropyl carbonyl compounds and precursors have been studied by Richard J. Mourbacher and Norman II. Cromwell (115) and their results are given in the table below:

	Ultraviolet		Infrared bands	
 $C_6H_5-\underset{\underset{O}{\|}}{C}-\underset{\underset{oet}{\vert}}{CH}-CH_3$	n.m.	6×10^{-3}		
β-ethoxy-4-phenyl propiophenone	278	22.9	C = 0 Phenyl	1617 1600
β-methoxy-4-phenyl propiophenone	277	23	C = 0 Phenyl	1668 1598
4-phenyl acrylophenone $C_6H_5-C_6H_4-CO-CH = CH_2$	291	22.2	C = 0 phenyl	1660 1604
2-phenyl benzoyl cyclopropane 	242	18.2	C = 0 phenyl cyclopropane	1668 1603 1025
4-phenyl benzoyl cyclopropane 	276	26.0	C = 0 phenyl cyclopropane	1664 1605 1035
trans-1-(4'-phenyl benzoyl)-2-phenyl cyclopropane 	280	28.0	C = 0 phenyl cyclopropane	1655 1605 1036

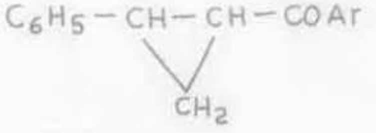
cis-1-(4'-phenyl benzoyl)-2-phenyl cyclopropane	280	23.0	C = 0	1664
			phenyl	1605
			cyclopropane	1027
trans-2-phenyl cyclopropane	232	2.92	C = 0	1685
			phenyl	
carboxylic acid 	267	0.033		1602
			cyclopropane	1025
cis-2-phenyl cyclopropane	227	2.83	C = 0	1680
			phenyl	
carboxylic acid 	261	0.018		1608
			cyclopropane	1024
trans-p-nitrobenzyl-2-phenyl cyclopropane carboxylate	258	12.2	C = 0	1712
			phenyl	1601
			cyclopropane	1033
cis-p-nitrobenzyl-2-phenyl cyclopropane carboxylate	260	10.6	C = 0	1725
			Phenyl	1602
			cyclopropane	1030

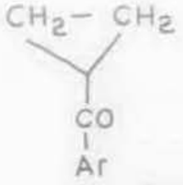
On comparison the spectra of the above table, it may be observed that anomalous results were obtained in both the ultra violet and infrared ranges of the spectrum of 4-phenyl acrylophenone.

Now Woodwards' rule (119) states that aroyl band maxima are shifted longer wave lengths as a double bond is introduced into the position and further to a longer wave lengths upon alkylation of the carbon-carbon double bond. Following table shows the shift of length.

		$ex\ 10^{-3}$
$CH_3CH_2\overset{O}{\overset{\|}{C}}-Ar.$	238	11.5
$CH_2 = CH-\overset{O}{\overset{\|}{C}}-Ar.$	247.5	10.5
$CH_3CH = CH-\overset{O}{\overset{\|}{C}}-Ar.$	250.5	10.5

It is also observed by the same authors that compound (Fig. 23) absorbs ultra violet light at a slightly longer wave length than does (Fig. 24).

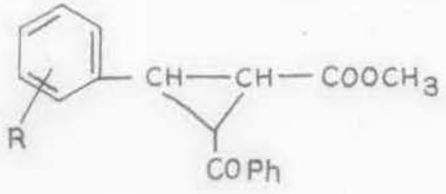

[Fig. 23]


λ max 238
[Fig 24]

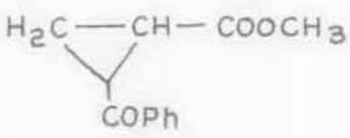
On this observation, they concluded that in β-substituted three membered carbon ring carbonyl compounds there is an electrical interaction, especially in the excited state, of the β-substituent with the carbonyl group through three membered carbon ring.

Substitution of a phenyl group into the β-position of the cyclopropane ring (Fig. 23) causes a small bathochromic shift in the wave length of maximum absorption compared to the unsubstituted cyclopropyl ketones. This effect can be attributed to a transmission of the phenyl ring unsaturation through the cyclopropane ring into the aroyl chromophore, causing a smaller energy difference between the ground and excited states of the two phenyl cyclopropyl ketones as compared to the analogous energy difference in unsubstituted cyclopropyl ketones. But Eastman (120) suggested that the cyclopropyl ring lacks the ability of transmitting of conjugative effects between continuous unsaturated groups. Eastman's conclusion were based on studies of substituted acetyl vinyl cyclopropane (121) and derivatives of the bicyclic umbellulone. In molecules containing a bicyclic arrangement of the cyclopropane ring one might not expect to detect a significant transmission of conjugative effects through the three ring as there is steric restriction of a free orientation of a β-substituted phenyl group and a carbonyl group about their respective bonds to the three ring. Evidence for an electrical interaction between a vinyl group, cyclopropane ring and a carbonyl group has been claimed by others (122) for the 1-acetyl-1-carboethoxy-2-vinyl cyclopropane.

In our work we have prepared the following cyclopropyl ketones and recorded their U.V. absorption maxima and our conclusion is that there is an electrical interaction with a β-substituted phenyl group and cyclopropane ring. We are in agreement with the conclusions of Richard and Cromwell that though the effects are small, yet they are definitely present.



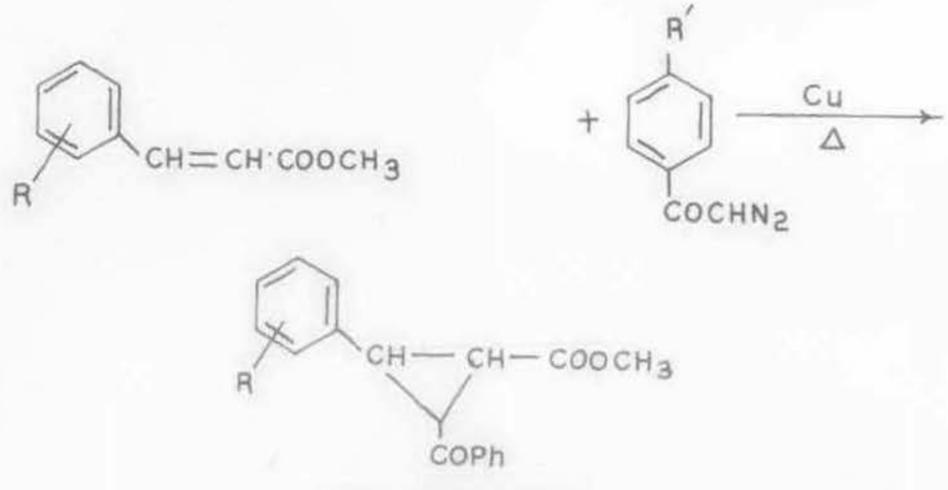
(25)



(26)

It is also observed that in a given pair of isomers, the isomer which exhibits a carbonyl associated absorption maximum at an equal or lower frequency and greater intensity in the ultraviolet ranges of spectrum is the one to which the trans configuration is assigned. Spectral methods (123) may be used to determine the configurations to cis and trans three ring compound of the type,  $R\text{-}CH\overset{X}{\diagdown\diagup}CH\text{-}\underset{O}{\overset{\|}{C}}\text{-}R$. It was also suggested previously (123) that in the trans form atom aryl-aroyl cyclopropanes the π -orbitals of the formally unsaturated groups (Carbonyl, phenyl) can be arranged to provide for maximum overlap with the bent bond orbitals of the three ring. This trans arrangement provides a more extensive polycentric molecular orbital than is possible with the more sterically hindered cis isomer. These theoretical hypothesis have been well supported by the spectral studies.

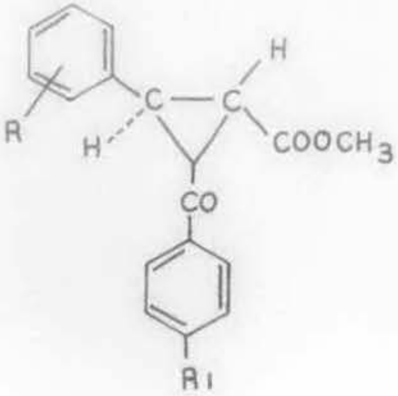
We prepared cyclopropyl ketones in the following way.



cis and trans

D'yakonovs' (123) studied extensively the reaction of diazo-compounds and olefins. They had employed copper powder as a catalyst and a lower reaction temperature to give only trans isomer. No trace of cis isomer was isolated.

In our reactions also, we isolated only one type of olefin addition product. So the product might have the following structure which is definitely trans one.



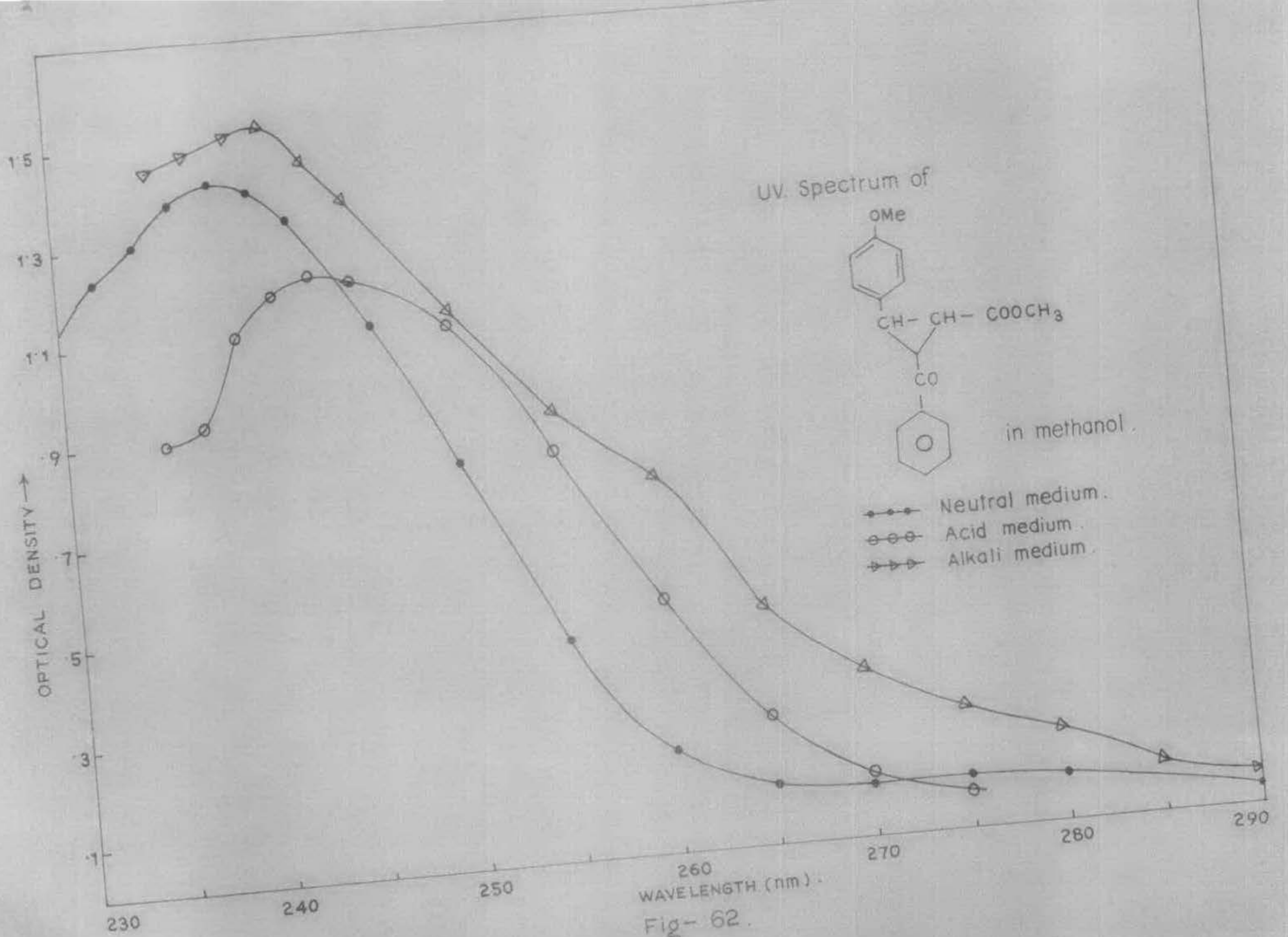
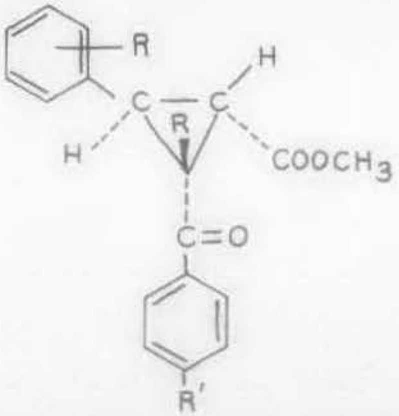

UV. Spectrum of
OMe
CH- CH- COOCH3
CO
in methanol.
Neutral medium.
Acid medium.
Alkali medium.
OPTICAL DENSITY →
1·5
1·3
1·1
·9
·7
·5
·3
·1
230
240
250
260
270
280
290
WAVELENGTH (nm).

Fig- 62.

In our compounds, phenyl/aroyl are in trans, phenyl and carbomethoxy are also trans, so aroyl and carbomethoxy are in cis position. So the structure is



The olefins, prepared by us showed a marked variation in the U.V. spectra, in the acid or basic medium. But the addition product did not show any variation in the U.V. spectra in the acid or basic medium which further indicates that a cyclopropane ring has been formed with the olefinic double bond which has decreased the acidity of the olefinic hydrogen atom. This study in analogy with the work of Nagai and Hurata (150) somewhat confirms the presence of a cyclopropane moiety in our compounds. No effect in the λ_{max} of the U.V. spectra of the keto carbene addition product of o-methoxy methyl cinnamate and p-methoxy methyl cinnamate has been observed due to the presence of base or acidic substances (Fig.62,64).

U.V. spectral absorption maximum of the addition product of cis and trans butene with α-diazo acetophenone was observed by Dwaman(124), O.Cowsan et al, at 244 , 280 nm and shoulder

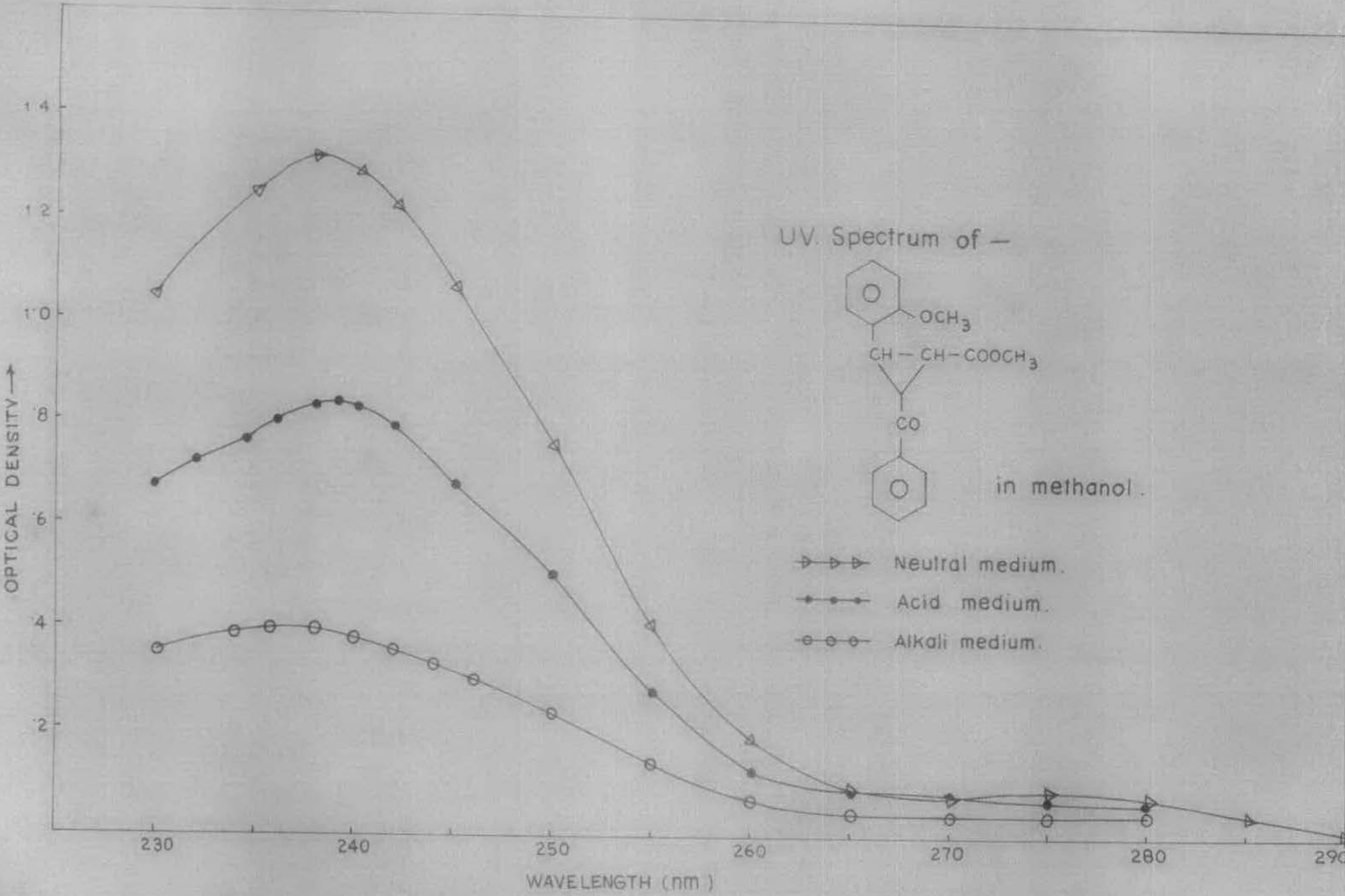

UV. Spectrum of —
OCH3
CH — CH — COOCH3
CO
in methanol.
Neutral medium.
Acid medium.
Alkali medium.
OPTICAL DENSITY →
1·4
1·2
1·0
·8
·6
·4
·2
230
240
250
260
270
280
290
WAVELENGTH (nm)

Fig- 64.

at 310, 315 nm. Our compounds also showed a shoulder at 310-315 nm.

All these discussions strongly support the presence of cyclopropane rings in our prepared carbene addition products.

Hammett equation$^{(6)}$ curve showing λ_{max} in nm along the y axis and δ values (substituent constants) along the x axis of the reactions products of p-methoxy methyl cinnamate and α-diazo acetophenone and different p-substituted α-diazo acetophenones shows a linear relationship (Fig. p.22)

I.R. studies

Slabey (125), from a study of 34 cyclopropane derivatives concluded that a moderately strong absorption band in the 1000 to 1050 cm^{-1} region of the infrared could be used to determine the presence of the cyclopropane ring. It is interesting to note that in the infrared spectra of all the cyclopropyl compound reported in this present study, there is strong absorption in the 1000 to 1020 cm^{-1} region (Nujol mull). In general the infrared spectra in nujol of the trans isomers have more fine structure in 1000 to 1400 cm^{-1} region than do the corresponding cis isomers.

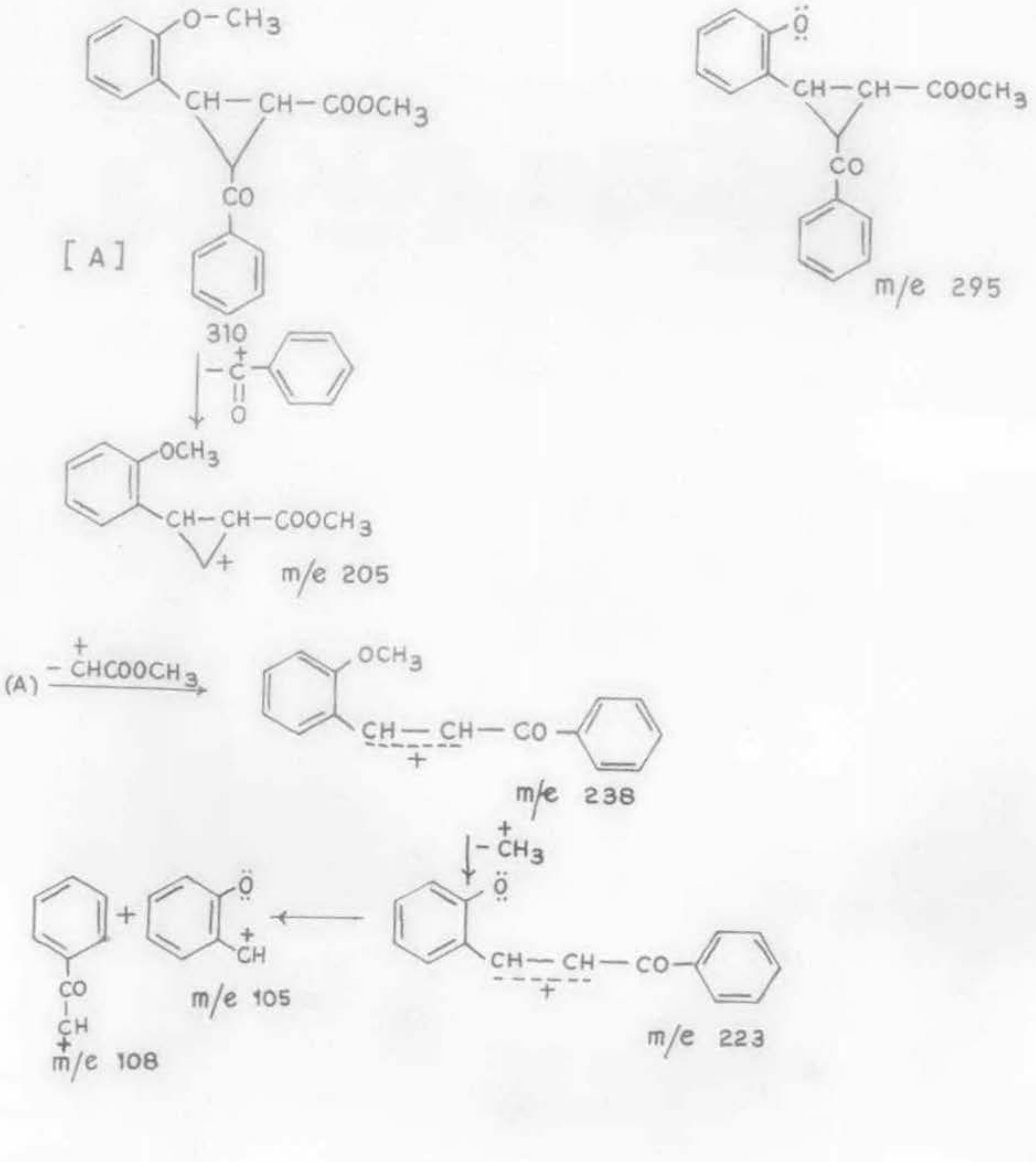
Our compounds have also a fine structure in the above region of infrared spectra which further indicates that aryl-aroyl are in trans configuration in a cyclopropane ring.

Other bands of the I.R. spectrum have been discussed in individual cases.

Mass spectrum of cyclopropyl ketone.

Mass spectrum of 1-benzoyl-2-carbomethoxy 2'-(o-methoxy) phenyl cyclopropane shows prominent peaks at 295,238,223,205,120,118,108,105,92,77,76,64 and 44 (Fig.P.1.).

So the decompositions had occured in the following path way.



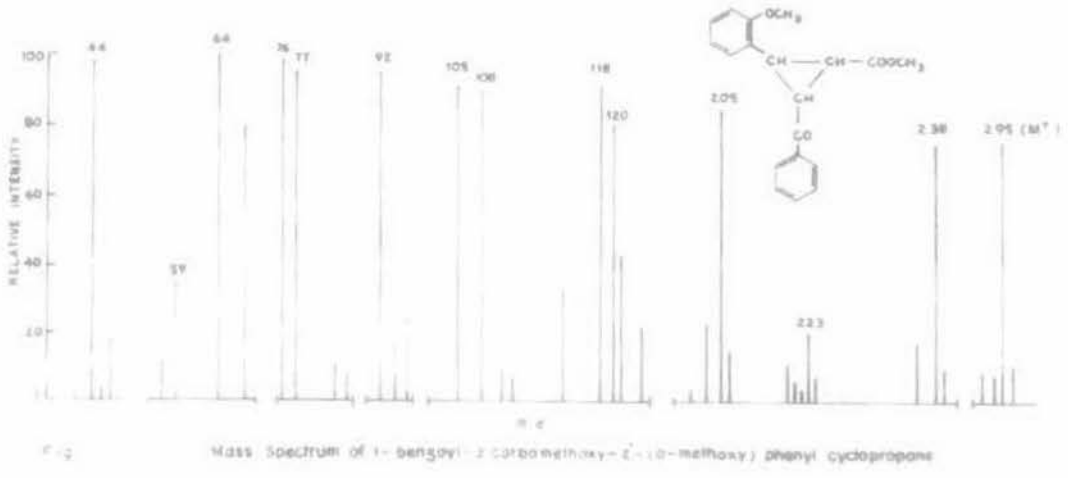


Fig. P.1. Mass spectrum of 1-benzoyl-2-carbomethoxy-2'(o-OCH$_3$) phenyl cyclopropane.

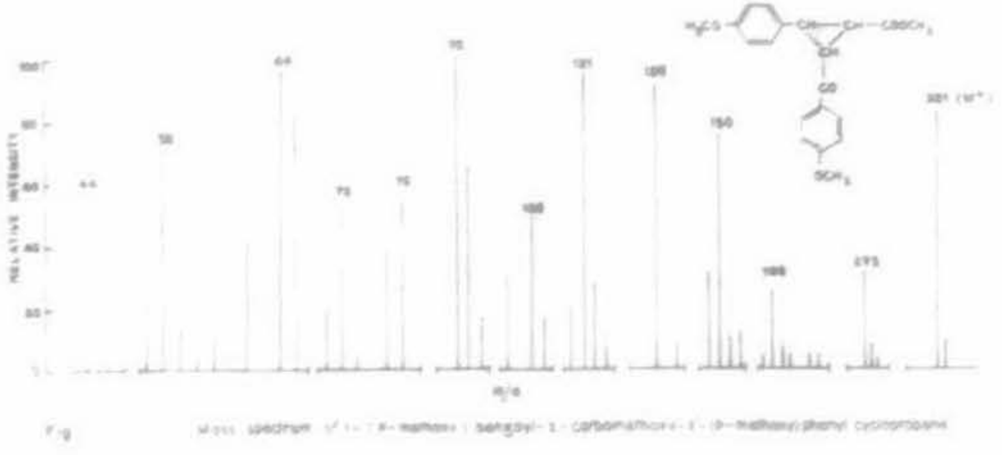
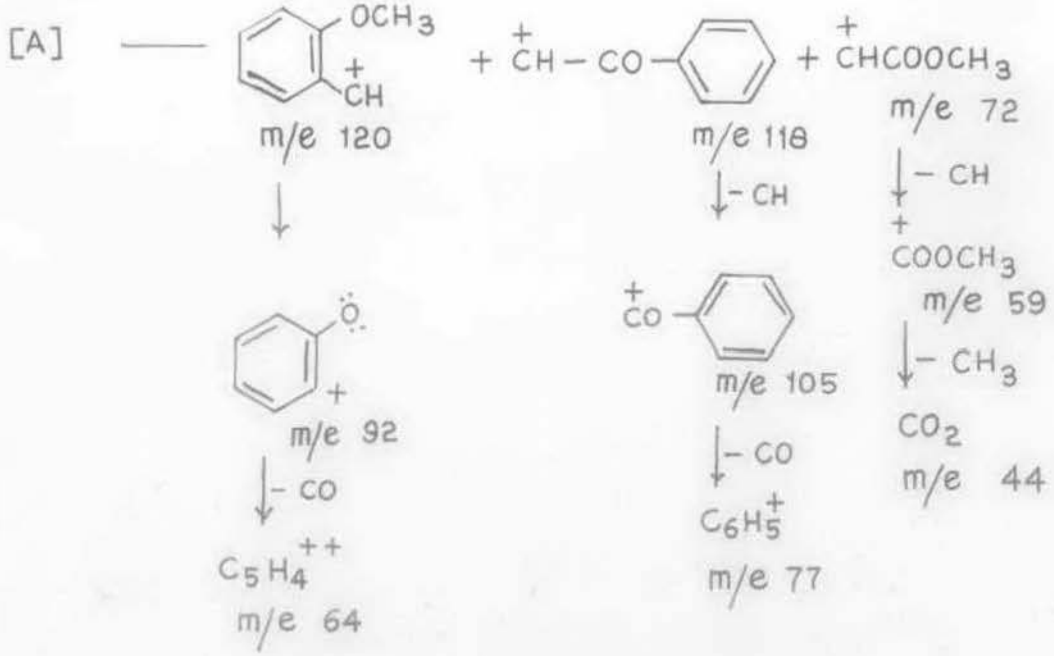


Fig. P.2. Mass spectrum of 1-(p-OCH$_3$) benzoyl-2-carbomethoxy-2'-(p-OCH$_3$) phenyl cyclopropane.

Again



M^+ in the figure is the peak of the ion resulting from the molecular ion losing one methyl group.

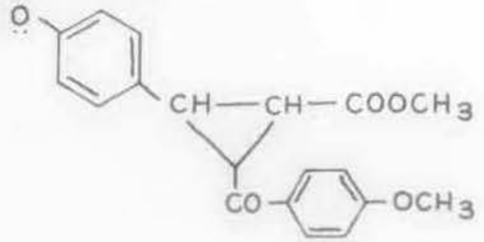
These fragmentations confirmed the structure of 1-benzoyl-2-carbomethoxy-2'-(o-methoxy) phenyl cyclopropane which is as follows and whose mol. wt. is 310.

Mass spectrum of 1-p-methoxy benzoyl-2-carbomethoxy-(p-methoxy) phenyl cyclopropane shows following peaks.

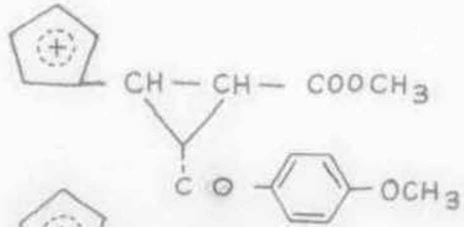
325,297,188,150,135,121,108,92,75,72,44 ⌈Fig. P.2.⌉.

If the decomposition path depicted above has been followed by this compound also, the fragmentations which are responsible for the above peaks are given below:

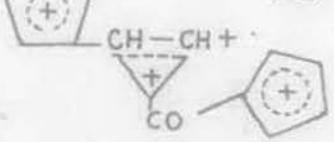
m/e 325



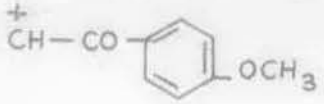
m/e 297



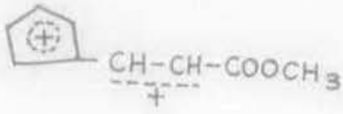
m/e 188



m/e 150

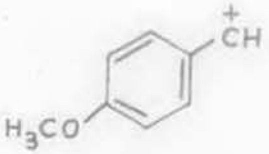


or

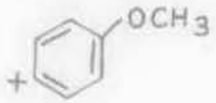


m/e 135

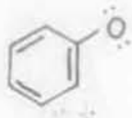
m/e 121



m/e 108



m/e 92



m/e 75 $C_6H_4^{++}$

m/e 72 $\overset{+}{C}H - COOCH_3$

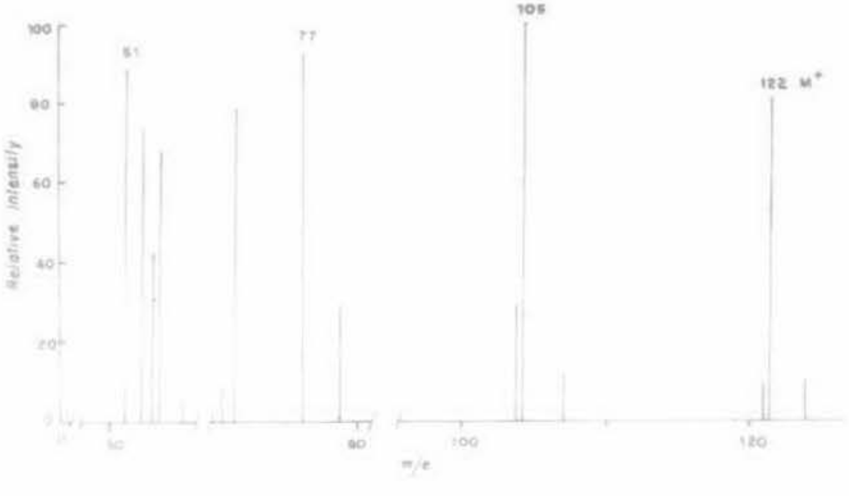


Fig. Mass spectrum of A part of potasium tert-butoxide treatment on 1-benzoyl-2-carbomethoxy-2'-(p-OCH$_3$) phenyl cyclopropane.

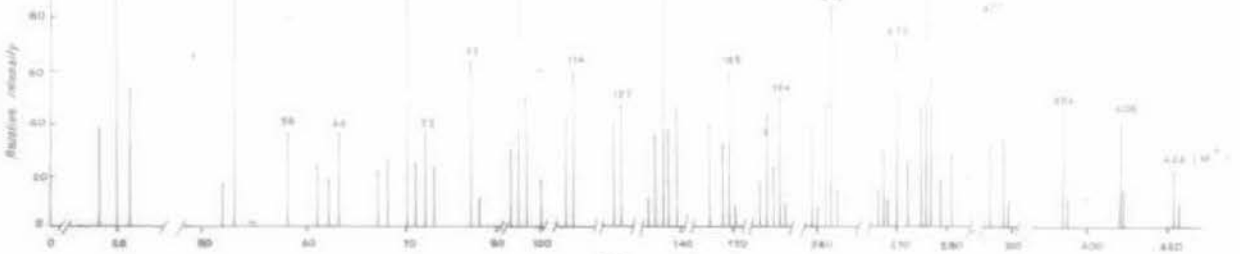


Fig. Mass spectrum of the lactone.

m/e 64	$C_5H_4^{++}$
m/e 58	$\overset{+}{C}OOCH_3$
m/e 44	CO_2

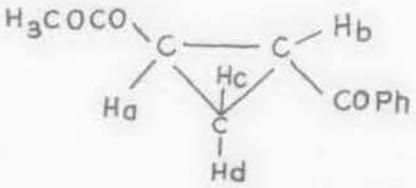
M^+ in the figure is the peak of the ion resulting from the molecular ion losing one methyl group.

So from the molecular fragmentations, the structure of this compound is further confirmed to be as fig.P.2. whose mol. wt. is 340.

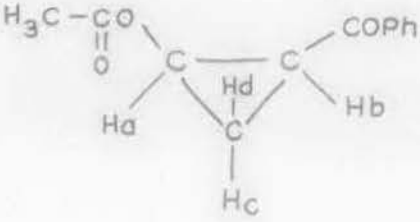
N.M.R. Spectrum of Cyclopropyl Ketones.

The proton signal of ordinary cyclopropane is reported at δ .9 (167). But in the case of substituted cyclopropane, the position of the proton signal shifted and the extent of shifting largely depends on the group which is attached to the carbon atom bearing the studied proton.

N.M.R. signals of one of the reaction products of α-diazo acetophenone and vinyl acetate of whose structure was established as follows (111) were at τ 8.05 (acetoxy proton methyl), τ 5.77 (H_a) and τ 7.23 (H_b).

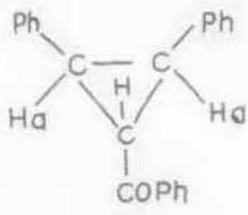


But for the other form of this compound was established to have the following structure and whose proton signals were at τ 8.16 (CH_3 of acetoxy), τ 5.72 (H_a) and τ 7.18 (H_b).

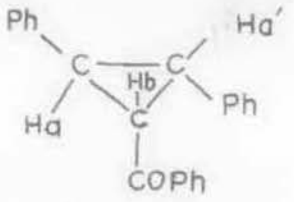


It is seen from this observation that the position of the proton signal of cyclopropane hydrogens (H_a and H_b) has been shifted to a downfield and this is due to the group attached to it. It is also observed that the proton signal of cyclopropane occurs at the higher field in the case of trans form than that of the cis form.

In the case of the reaction of α-diazo acetophenone and trans or cis stilbene, two products were identified (111).



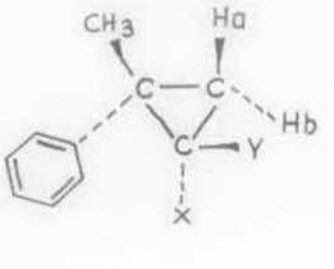
[a]

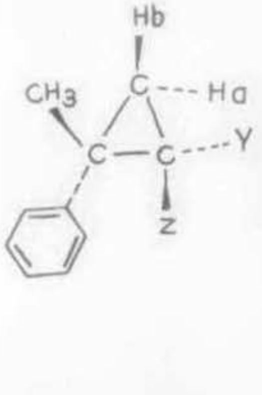


[b]

The N.M.R. spectrum of [a] has a singlet signal at τ3.00 (ten protons of phenyl group). On the other hand, the N.M.R. spectrum of [b] has two singlet signals at τ 2.78 and τ 2.87 attributed to two phenyl groups which are magnetically non-equivalent and quasi triplet of one proton at τ 6.42 and also quasi doublet at two protons at τ 6.74 of ABB' type. The orthoproton signal of benzoyl group of [b] appears higher field that at [a].

Wakatu Nagai et al (150) observed the N.M.R. spectra of the following two types of compounds and their proton signals of the cyclopropane ring appear at δ 2.40 and δ 2.01.

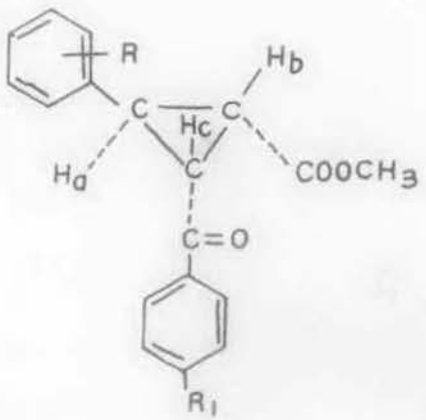




All these data indicate that proton signals of the substituted cyclopropane occurs at the downfield in comparison to the proton signal of a ordinary, rather unsubstituted cyclopropane. It can be concluded from this observation that more the electron withdrawing effect of the group attached the cyclopropane ring, the signal will be shifted more downfield. It is also seen that a trisubstituted cyclopropane prepared from trans olefin gives quasi doublet at the downfield region.

We have prepared cyclopropyl ketones from trans-cinnamic esters and α-diazo acetophenone and their structure have been confirmed by elemental analysis, U.V., I.R. and mass spectrum. The structure of these cyclopropyl ketones have been further confirmed by the observation of N.M.R. spectrum in some selected cases.

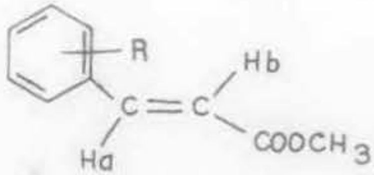
By the observation of U.V. studies, it has been previously confirmed that the reaction between a trans olefin and a diazo ketone resulted only a single addition product and the addition product was also a trans one. In the previous discussion, it is shown that the structure of the addition product is as follows.



If this structure is correct for the cyclopropyl ketones, then it is natural to expect quasi doublet for H_a, H_c, H_b at the downfield and other proton signals would easy to detect and assign. As all the groups which are substituted at cyclopropane adjacent to the hydrogens are considerably electron withdrawing, the position of the quasi doublet will be at the considerable downfield.

In the reactions of diazo acetophenone with olefins, most of the olefins are cinnamic esters or substituted cinnamic esters. N.M.R. studies are also made by a comparison of the signals of starting esters and the products which we have isolated.

These esters which are phenyl conjugated $\alpha\beta$ unsaturated ester possess styrene system. So it can be hoped that their olefinic hydrogen will give signals at δ 6.64 to δ 5-6.3 (166), and these have been proved by the observation of N.M.R. spectrum of some starting esters which are described below.



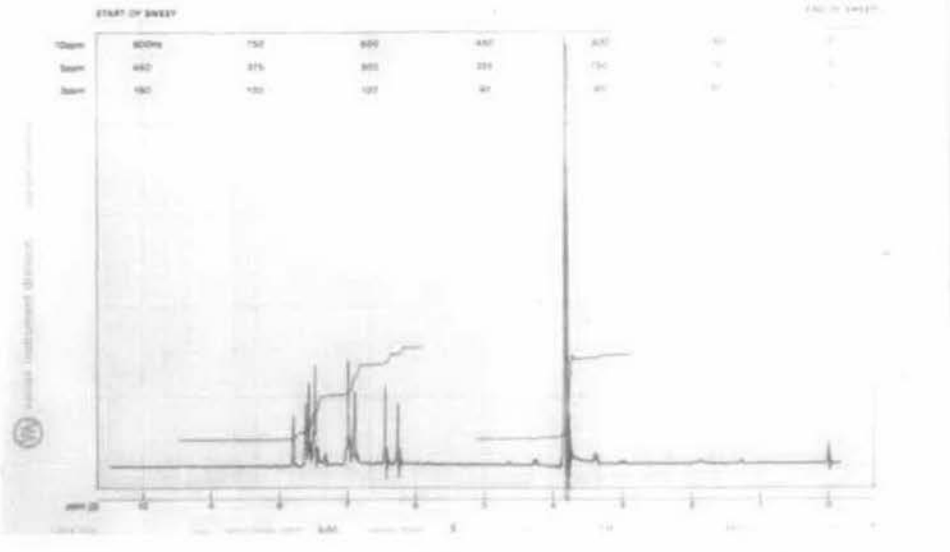


Fig. P3. N.M.R. spectrum of P-methoxy methyl cinnamate.

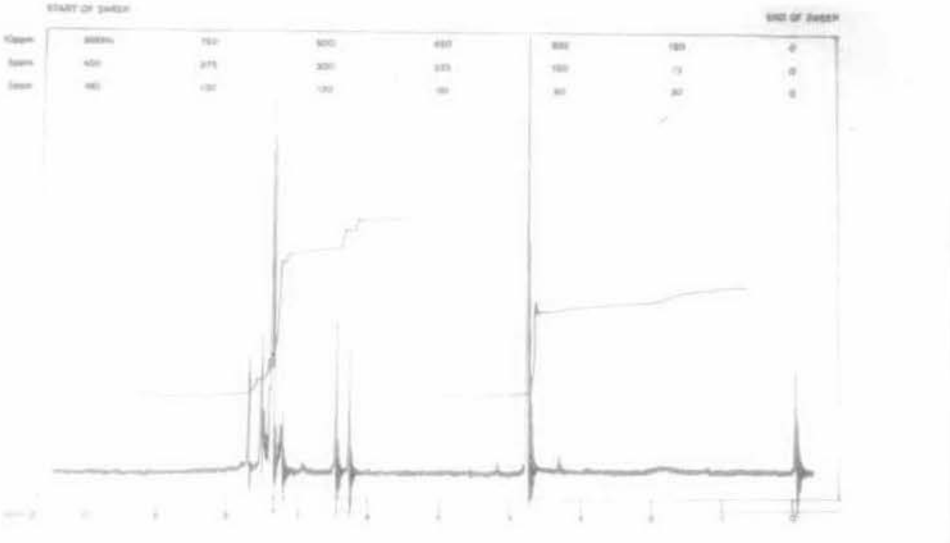


Fig. P4 N.M.R. spectrum of P-chloro methyl cinnamate.

N.M.R spectrum of trans p-methoxy methyl cinnamate in $CDCl_3$ (Fig.P.3).

δ 3.8 (CH_3 of carbomethoxy group), δ 3.9 (CH_3 of methoxy group), δ 6.22 (H_a), δ 6.43 (H_b) and δ 6.85 to δ 7.30 (phenyl). These results are in consistent with the structure of trans p-methoxy methyl cinnamate.

N.M.R spectrum of p-chloro methyl cinnamate in $CDCl_3$ (Fig.P.4).

δ 3.85 (CH_3 of carbomethoxy group), δ 6.42 (H_a), δ 6.64 (H_b) and δ 7.4 to δ 7.9 (phenyl).

These results have been incorporated so as to **make** a comparative study with those of the products. N.M.R spectrum of the reaction product of trans-p-methoxy methyl cinnamate with α-diazo acetophenone in $CDCl_3$ shows the N.M.R signals at δ 3.85 (CH_3 of carbomethoxy group), δ 3.9 (CH_3 of methoxy group) and δ 6.9 to 7.1 (phenyl group). In this spectrum there are no signals at δ 6.22 (H_a) and δ 6.43 (H_b) which indicates that there is no double bond in conjugation to the phenyl group in this compound. In addition we have signals at δ 7.3 to δ 8.1 (benzoyl) and quasi doublet at δ 4.25 (Fig.P.6).

So the above results for this compound i.e. 1-benzoyl 2-carbomethoxy-2'-(p-methoxy) phenyl cyclopropane are in harmony with the structure shown below.

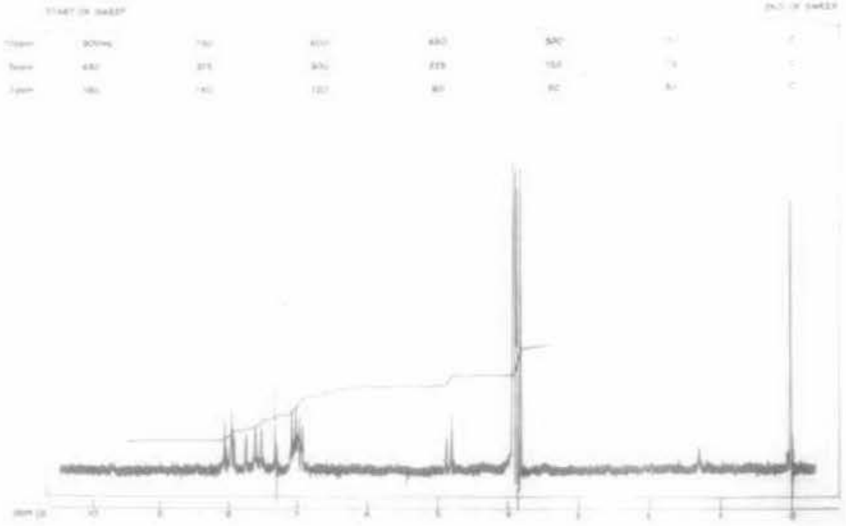


Fig. P.5. N.M.R. spectrum of 1-(p-methoxy) benzoyl-2-carbomethoxy-2'-(p-methoxy) phenyl cyclopropane.

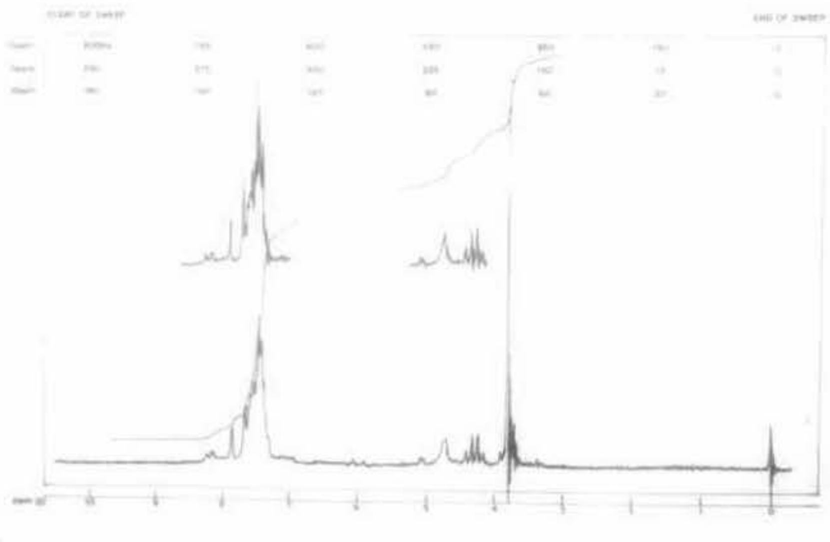
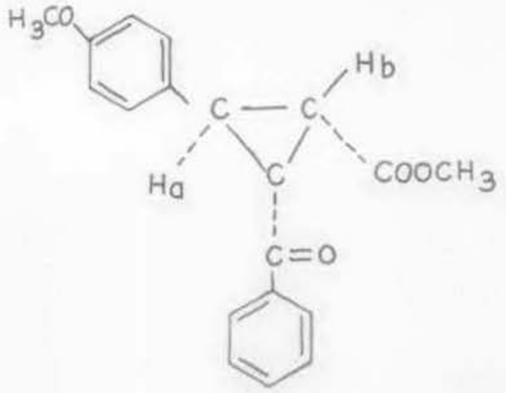
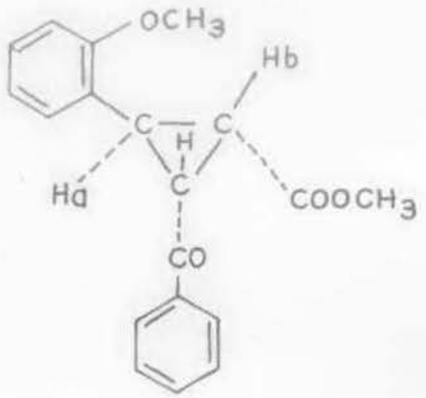


Fig. p.7. N.M.R. spectrum of 1-benzoyl-2-carbomethoxy-2'-phenyl cyclo propane.



N.M.R spectrum of the reaction product of trans o-methoxy methyl cinnamate with α-diazo acetophenone shows the proton signals δ3.8 (CH_3 of carbomethoxy group), δ 3.95 (CH_3 of methoxy group) δ 7.52 (phenyl) and δ 7.9 to 8.2 (benzoyl proton). No olefinic hydrogen signals are observed in this case also. In addition it has a quasi doublet peak at δ 4.9 (Fig.). These results are consistent with the following structure for the compound i.e. 1-benzoyl-2-carbomethoxy-2'-(o-methoxy cyclopropane).



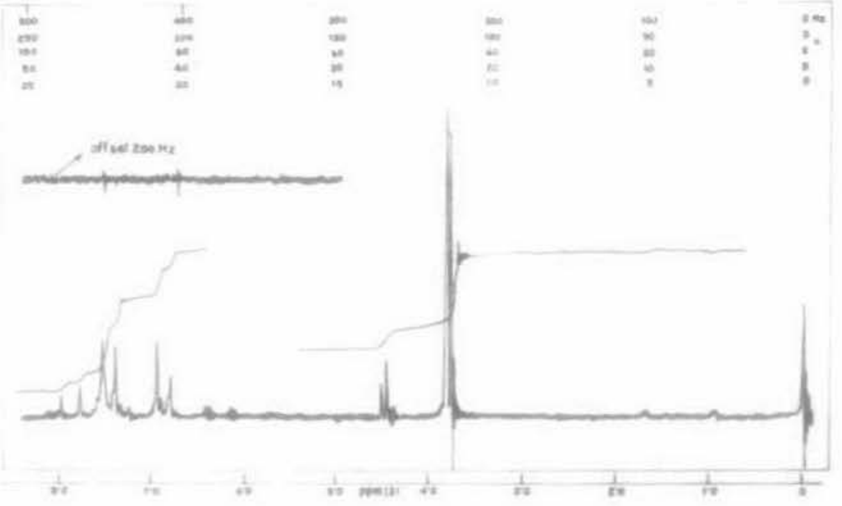


Fig.p.6. N.M.R. spectrum of 1-benzoyl-2-carbomethoxy-2'-(p-OCH_3) phenyl cyclopropane.

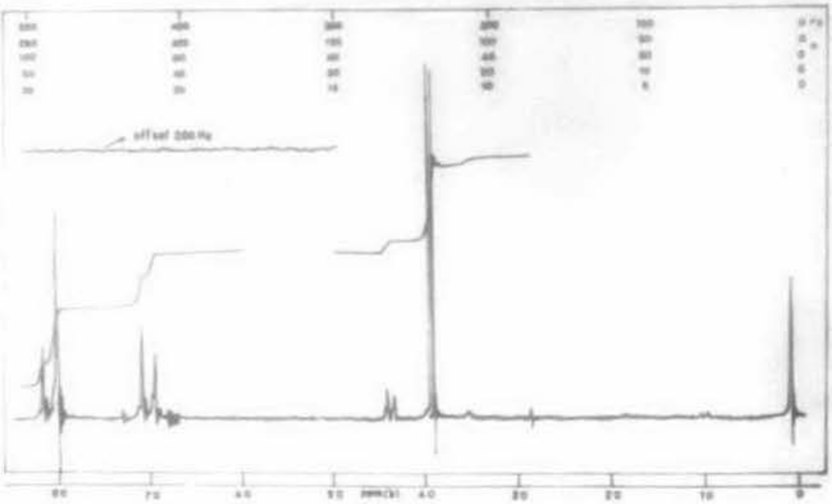
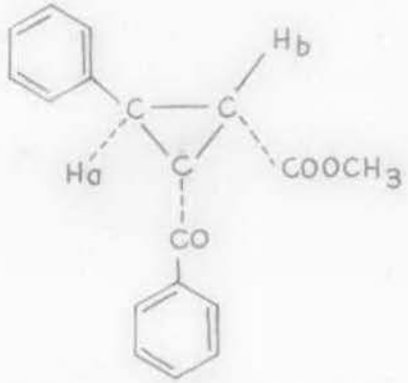


Fig.P 8. N.M.R. spectrum of 1-(P-OCH_3) benzoyl-2-carbomethoxy-2'-(0-OCH_3) phenyl cyclopropane.

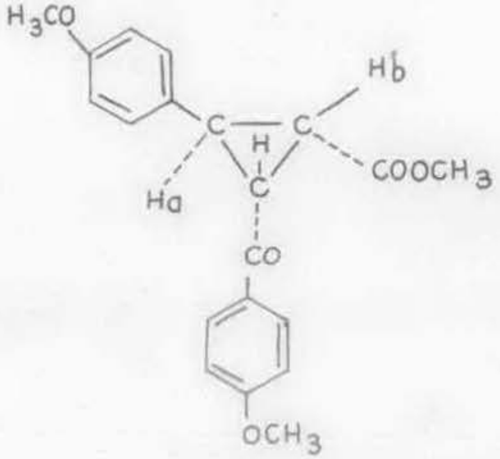
N.M.R spectrum of the reaction product of methyl cinnamate and α-diazo acetophenone in $CDCl_3$ shows the proton signals at δ 3.8 (CH_3 of carbomethoxy group), δ7.5 (phenyl), δ7.9 (benzoyl), a quasi doublet at δ 4.3.

(Fig.P.7).

These results will satisfy the following structure for this compound i.e. 1-benzoyl-2-carbomethoxy-2'-phenyl cyclopropane.

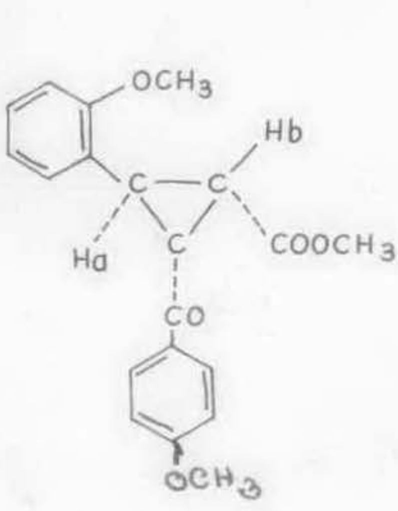


N.M.R spectrum of the reaction product of trans p-methoxy methyl cinnamate and p-methoxy α-diazo acetophenone in $CDCl_3$ shows signals at δ 3.82 (CH_3 of carbomethoxy group) δ 3.93 (CH_3 of methoxy group), δ 6.9 toδ8.1 (phenyl and benzoyl group) and a quasi doublet at δ 4.1. No signals at δ6.43 and δ6.22 (olefinic proton) are observed in this case also. So the above results are consistent with the following structure of 1-p-methoxy benzoyl-2-carbomethoxy-2'-(p-methoxy) phenyl cyclopropane (Fig.P.5).



N.M.R spectrum of the reaction product of o-methoxy methyl cinnamate and p-methoxy α-diazo acetophenone in $CDCl_3$ gives the following signals. (Fig.P.8)

δ 3.8 (CH_3 of carbomethoxy group), δ 3.93, δ 3.95 (CH_3 of methoxy groups), δ 6.95 to 7.15 (phenyl), δ 8.00 toδ8.2 (benzoyl) and a quasi doublet at δ 4.3. No signal at δ 6.22 and δ 6.43 (for olefinic proton) is observed in this case also. These results show that this compound i.e. 1-p-methoxy benzoyl-2-carbomethoxy-2'-(o-methoxy) phenyl cyclopropane has the following structure.



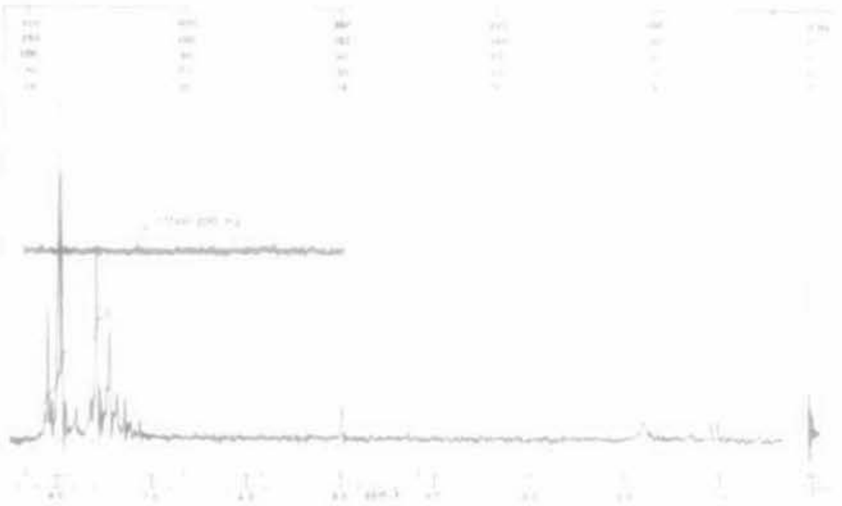
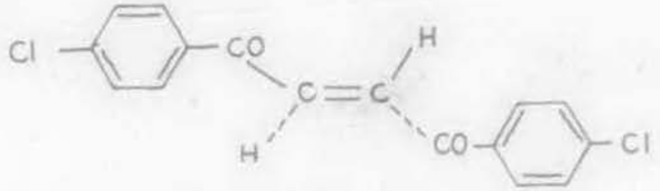


Fig. P.9 N.M.R. spectrum of trans 1,2 (p-chloro) di benzoyl ethylene.

The N.M.R spectra of one dimer of p-chloro 2-diazo ketone in $CDCl_3$ also recorded. The signals for the dimeric product are as follows. (Fig.P.9.)

δ 4.9 (doublet olefinic proton) and δ 7.42 to 8.2 (benzoyl). This results show the following structure for this dimeric product.



The reactions which were carried out are depicted in Table 2. It can be observed from the table that in all the cases the desired product i.e. cyclopropane derivatives could not be isolated. In almost all the cases a dimer of keto carbenes could be isolated. It has been observed in these cases that if the phenyl moiety of the cinnamic ester contains an electron donating group afforded greater proportions of keto carbene addition products. It may also be seen that almost all the tri substituted olefins [exception-α-cyano methyl cinnamate] do not give keto carbene addition products. In this connection, it is to be noted that when phenyl moiety of the cinnamic esters contains substitution in the meta position it did not give any keto carbene addition products (exception in the reaction with p-chloro-α-diazo acetophenone).

We have studied the reactions of meta-methoxy methyl cinnamate with various diazoketones [mentioned in the table-2] and isolated only dimer of the keto carbenes. It should also be mentioned that reaction of p-chloro-α-diazo acetophenone with o-carbomethoxy cinnamic ester or o-nitro cinnamic ester did not afford any keto carbene addition products. Reactions of various diazo ketones with p-chloro cinnamic ester also did not afford any cyclopropane derivative.

Table - 2

Sl. No.	R_1	R_2	R_3	Products addition	Proportion self condensation
1.	H	$O-OCH_3$	H	65%	5%
2.	H	$O-NO_2$	H	15%	10%
3.	P-Cl	$O-OCH_3$	H	20%	8%

Contd..

Table - 2 (Contd..)

Sl. No.	R_1	R_2	R_3	Products addition	Proportion self condensation
4.	P-OCH_3	O-OCH_3	H	30%	5%
5.	H	P-OCH_3	H	45%	10%
6.	P-Cl	P-OCH_3	H	32%	8%
7.	P-OCH_3	P-OCH_3	H	35%	7%
8.	P-NO_2	P-OCH_3	H	18%	12%
9.	H	H	H	10%	10%
10.	P-Cl	m-OCH_3	H	10%	20%
11.	H	m-OCH_3	H	--	25%
12.	P-OCH_3	m-OCH_3	H	--	30%
13.	H	H	CN	10%	12%
14.	H	H	COOMe	--	15%
15.	H	O-COOMe	H	--	15%
16.	P-Cl	O-COOMe	H	--	20%
17.	P-Cl	H	H	10%	12%
18.	P-Cl	O-NO_2	H	--	15%
19.	P-Cl	P-Cl	H	--	15%

Section-C EXPERIMENTAL

Melting points and boiling points remain uncorrected. Absolutely dry solvents were used where necessary. I.R. spectra were recorded in Beckmann IR-20 Spectrophotometer. U.V. absorption spectra were taken in Beckmann DU-2 Spectrophotometer. N.M.R spectra were recorded by Varian 60 MH_z and EM 90 MH_z using chloroform-d solution and carbon tetra chloride containing trimethyl silane as reference. Mass spectra were recorded by National Chemical Laboratory, Poona and C.D.R.I, Lucknow . Gas Liquid chromatography were recorded by National Chemical Laboratory, Poona.

1. Preparation of trans-o-Chloro Cinnamic acid (146):

14 gms o-chlorobenzaldeyde, 11.5 gms malonic acid, 25 ml of 95% ethanol and 2.5 ml of Pyridine were taken in a 100 ml round bottomed flask which was fitted with a condenser. Reaction mixture was then heated on a water bath for 10 hrs. Then the reaction mixture was cooled in a ice bath and the yellow coloured solid thus separated was collected on a Buchner funnel and washed with 10 ml of cold ethanol and then with two 10 ml of ether. The solid was crystalised from ethanol. Yellowish crystals m.p. 210°C. (Lit. 212°C) Yield 14 gms (80%).

2. Preparation of methyl ester of trans-O-chloro cinnamic Acid:

10 gms of acid were taken in a 250 ml round bottomed flask fitted with a condenser and a guard tube fitted with anhydrous Calcium Chloride. To the flask 200 ml dry methanol and 5 drops of Conc. Sulfuric acid were taken and the reaction mixture was refluxed for 6 hours. Solvent methanol was removed completely and the residue in the flask was treated with 150 ml ether. Ether solution was washed with Sodium bicarbonate solution and then with water till the washing was neutral to pH paper. Ethereal layer was dried on anhydrous sodium salphate. Solvent was removed and the liquid residue left behind was distilled at high vacuum (0.5 mm) at 180°C. (Lit. b.p. 278°C to 290°C). Yield : 9.5 gms (90%).

3. Preparation of trans o-nitro cinnamic acid (147):

In a 100 ml round bottomed flask fitted with a reflux condenser were placed 15.1 gms of o-nitrobenzaldehyde, 11.5 gms of malonic acid, 25 ml of 95% ethanol and 2.5 ml of Pyridine. The mixture was heated on a steam bath under gentle reflux for 6-8 hours and cooled. The large masses of crystals were broken up with a spatula, and the reaction mixture was cooled in an ice bath. The solid was collected on a Buchner funnel and the residue was washed with 10 ml cold ethanol and then with two 10 ml portions of ether. The crude acid was crystallised from ethanol. Needle crystals. M.P. 240°C. (Lit. 240°C) Yield: 12.5 gm (65%).

4. Preparation of methyl ester of trans o-nitro cinnamic acid:

In 250 ml R.B. Flask fitted with a condenser and a Calcium Chloride guard tube, 14 gms of acid, 200 ml dry methanol and 5 drops conc. sulfuric acid were taken and the reaction mixture was refluxed for 6 hrs. Removing almost all the methanol the residue in the flask was treated with ether and ether solution was washed with sodium bicarbonate solution and then with water till the washing was found neutral to pH paper. Then ether solution was dried over anhydrous sodium sulphate and ether was removed. Solid residue was crystallised from water when needle shaped crystals were separated. M.P. 74°C. (Lit. 73°C) Yield 11 gm (85%).

5. Preparation of methyl ester of cinnamic acid:

20 gms of acid, 300 ml dry methanol, 5 drops of conc. sulphuric acid were taken in a 500 ml R.B. flask fitted with a condenser and a guard tube. Reaction mixture was refluxed for 6 hrs and after that period all most all the methanol was removed and the residue left behind was treated with ether. Ethereal solution was treated with Sodium bicarbonate solution and then washed several times with water until the washing was found neutral to pH paper. Ether was removed and the liquid left was distilled at low pressure b.p. 150°C/20 mm. (Lit. 261.9) Yield 17 gm.

6. Preparation trans-o-methoxy cinnamic acid (147):

In a 100 ml round bottomed flask fitted with a condenser, 13.5 gms of o-methoxy of benaldehyde, 11.5 gms of malonic acid, 25 ml of 95% ethanol and 2.5 ml of Pyridine were taken and the reaction mixture was refluxed for 8 hrs on a water bath and then cooled. It was then cooled in a ice-bath and solid thus separated was collected on a Buchner funnel. It was washed with ice-cooled 10 ml of ethanol and then with two 10 ml portions of ether. Colourless solid dried in air and crystallised from ethanol. M.P. 185^{o}C (Lit. 185^{o}-6^{o}C) Yield. 14 gms (80%).

7. Preparation of methyl ester of trans-o-methoxy cinnamic acid:

10 gms of acid, 200 ml of dry methanol and 5 drops of conc. sulphuric acid were taken in a 250 ml R.B. Flask fitted with a condenser and a guard tube. Reaction mixture was then refluxed for 6 hrs. Methanol was removed completely. Residue dissolved in 150 ml of ether and ether solution was first treated with sodium bicarbonate solution and then washed with water several times to make the washing neutral to litmus paper. Ethereal solution was then dried on anhydrous sodium sulphate and filtered. Ether was removed and the liquid residue was distilled at low pressure. Boiling point was found to be 180^{o}C/ (10 mm) Yield 13.6 gm (90%).

8. Preparation of methyl p-chloro cinnamate (147):

a) p-chloro cinnamic acid -14 gms of p-chloro benzaldehyde, 11.5 gms of malonic acid, 25 ml of 95% ethanol and 2.5 ml Pyridine were taken in a 100 ml R.B. flask fitted with a condenser and the reaction mixture was refluxed on a water bath for 8 hrs. It was then cooled in an ice bath and the yellow coloured solid separated was collected on and then with 10 ml of ether twice. Yellowish crystal was dried on air and the melting point was found to be 242°C. (Lit. 242°C) Yield 11.2 gms (65%).

(b) In a 250 ml R.B. flask fitted with a condenser and a guard tube, 10 gms of acid and 200 ml of dry methanol and 5 drops of conc. sulphuric acid were taken and the reaction mixture was refluxed for 6 hrs. Methanol was removed completely and the residue was treated with 150 ml of ether. Ethereal solution was first treated with sodium bicarbonate solution with water until washing became neutral to pH paper. It was then dried over anhydrous sodium sulphate and filtered and ether was removed. A light yellow coloured solid left behind. It was crystallised from water and melting point was found to 75°C. Yield. 9 gms (85%).

Analysis found	C = 58.3%, H = 3.62%
Calculated for $C_9H_7O_2Cl$	C = 59.07% H = 3.86%.

9. Preparation of trans-meta methoxy cinnamic acid: (a) Preparation of m-methoxy benzaldehyde (148):

12 gms of m-hydroxy benzaldehyde was dissolved in about 55 ml of 2N sodium hydroxide in 250 ml three-necked flask equipped with a mechanical stirrer, a thermometer, and a dropping funnel. The dark coloured solution was stirred while 12.6 gm of dimethyl sulphate was added drop-wise and the temperature was maintained at 40°-45°. When the addition was complete the mixture was stirred for 5 to 10 minutes. A 27.5 ml portion of 2N sodium hydroxide was added in one lot and then 6.3 gm of methyl sulphate was added in one lot and then 6.3 gm of methyl sulphate was added as before, but the temperature was allowed to rise to 50°C. Stirring at 50°C was continued for 30 minutes, this was cooled and the organic layer was extracted with ether. The ether solution was dried over anhydrous sodium sulphate for 10 hrs then filtered and concentrated by distillation. The residue was distilled under reduced pressure. b.p. 110°C/20 mm.

(b) Trans-m-methoxy cinnamic acid (165):

In a 100 ml R.B. flask fitted with a condenser, 7 gm m-methoxy benzaldehyde, 6 gm malonic acid, 15 ml 95% of ethyl alcohol and 1.5 ; of pyridine were taken and the reaction mixture was allowed to reflux gently for 8 hrs on a water bath. No solid acid separated from the reaction mixture. Reaction mixture was then cooled and poured into 300 ml of acidified water when a solid separated out. This was filtered on a Buchner funnel and washed with water till the washing was found neutral to pH paper. This solid was crystallised from large volume of hot water. M.P. 116°C (Lit. 117-18°C) Yield . 5.5 gm (60%).

(c) Methyl ester of trans m-methoxy cinnamic acid:

4 gm acid, 50 ml dry methyl alcohol and 3 drops of conc. sulphuric acid were taken in a 100 ml R.B. Flask fitted with a condenser and a guard tube. The reaction mixture was refluxed for 6 hrs and then methanol was removed completely. Residue in the flask was treated with ether and ether solution was treated as usual. An oily liquid remained on removal of ether. (Lit. oily liquid b.p. 305-7°C/740 mm) Yield. 4 gm.

10. Trans p-methoxy cinnamic acid (149):

In a 100 ml R.B. flask fitted with a condenser, were placed 15 gm of p-methoxy banzaldehyde, 11.5 gm of malonic acid, 50 ml of 95% ethanol and 2.5 ml of Pyridine and the reaction mixture was kept under gentle reflux on a water bath for 8 hrs. Mixture was then cooled and placed in an ice bath. Colourless solid separated was collected on Buchner funnel and washed first with 10 ml of ice-cold ethanol and then twice with 10 ml portions of ether. It was crystallised from ethanol. M.P. 172°C (Lit. 174°C) Yield. 10.5 gm (60%).

11. Trans-p-methoxy methyl cinnamate:

10 gm of acid, 200 ml of dry methanol and 5 drops of conc. sulphuric acid were taken in a 250 ml R.B. flask fitted with a condenser and a guard tube and the reaction mixture was refluxed for 6 hrs. Methanol was removed completely and the residue in the flask was treated with ether. Ethereal solution was then washed and dried as usual and a solid was left behind was crystallised from ethanol. M.P. 90°C (Lit. 90°C) Yield. 10 gm (90%).

12. Preparation of 1-Cyano acrylate (150):

In a 100 ml R.B. flask with a reflux condenser a mixture of 10 gms (0.1 mole) of methyl cyano acetate, 10 gm of para formaldehyde, and 1 drop of piperidine was heated and stirred on a oil bath at 80°C for 1 hr. The contents of the flask became a pale yellow resinous material. The material was cooled down to room temperature and was dissolved into 150 ml of dichloromethane, into which 50 gms of anhydrous sodium sulphate was added. This solution contained 0.47 gm of methyl 1-cyano acrylate per 10 ml.

13. α-Cyano methyl cinnamate (151):

To a 100 ml R.B. flask with a reflux condenser a mixture of 10 gm (0.1 mole) of methyl cyano acetate, 10.6 gm of benzaldehyde, and 1 drop of piperidine was heated and stirred on a oil bath at 80°C for 1 hr. The content of the flask was taken in ether and washed with first very dil. Hydrochloric acid solution and then with sodium bicarbonate solution. Finally washed with water till neutral. The ether solution was dried over anhydrous sodium sulphate. Ether was removed and the solid material was crystallised form methanol. M.P. 87°C (Lit. 89°C) Yield. 17 gm (90%).

Analysis found	D, 70.34, H, 4.61
Calculated for $C_{11}H_9O_2N$	C = 70.56, H = 4.85

14. Dimethyl benzal malonate (152)

To a 100 ml R.B. flask, which was fitted with a water separator and surmounted by a reflux condenser, were placed 13.2 gm (0.1 mole) of dimethyl malonate, about 11 gm of benzaldehyde, 0.2 gm benzoic acid, 0.5 ml piperidine and 20 ml of benzene. The mixture was refluxed vigorously in an oil bath at 130°-140° until no more water (total calculated 2 ml) was collected; this operation required nearly 10 hours. After the mixture had been cooled, 100 ml of benzene added and the solution washed with two 10 ml portions of water, with to 10 ml portion of 1N Hydrochloric acid, and then with 10 ml of a saturated solution of sodium bicarbonate. The aqueous washings were shaken with a single 5 ml portion of benzene, the benzene extract was added to the original organic layer, and the organic solution dried over anhydrous sodium sulphate. After benzene had been removed under reduced pressure on a steam bath, the residue distilled with 25 ml fractionating column. The yield of the colourless methyl benzal malonate b.p. 168-70°C/10 mm was 11 gm (50 %).

15. Active Copper powder (153):

10 gm of recrystallised copper sulphate dissolved in 35 ml of hot water in a 250 ml beaker, a mechanical stirrer was provided. After cooling to room temperature, then with vigorous stirring 3.5 gm (or more, if necessary) of high grade Zinc powder added slowly until the solution was decolourised. The precipitated copper was washed by decantation with water. Dilute hydrochloric acid (5%) was added to the precipitate in order to remove the excess of zinc, and stirring was continued until the evolution of hydrogen ceases. The copper powder was filtered, washed with water and kept in moist condition (as a paste) in a stoppered bottle.

16. Cuprous chloride (154):

Hydrated copper sulphate (12.5 gm) and sodium chloride (3.2 gm) were dissolved in water (40 ml), an alkaline solution of sodium sulphite (from 2.6 gm of sodium bisulphite and 1.3 gm of sodium hydroxide in 20 ml of water) was added to the resulting hot solution during about 5 minutes with constant shaking. The solution would be decolourised or nearly so. It was then cooled to room temperature and the supernatant liquid was decanted from the white cuprous chloride. The precipitate was washed twice by decantation with water containing little dissolved sulphurous acid to prevent oxidation. The moist solid cuprous chloride was washed several times by decantation with dilute sulphurous acid, collected in a Buchner funnel, washed several times with small portions of glacial acetic acid, and dried in an evaporating dish until the odour of acetic acid disappeared. The white cuprous chloride was kept in a stoppered bottle.

17. Ortho carboxy cinnamic acid (155):

In a 1 lit. three-necked flask was taken 250 c.c of hydrogen peroxide (30% by volume) and the flask was kept in a ice-salt bath while 200 c.c. of glacial acetic acid was added dropwise to hydrogen peroxide. Then a 150 ml dropping funnel was mounted so that the stem entered the flask to within about 4 c.m. of the liquid surface. With mechanical stirring, a cold solution of 20 gm of 2-napthol in 100 ml of glacial acetic acid was added dropwise over a period of 4 hours to the peracid. With the appropriate rate of addition, the temperature of the reaction mixture slowly to 30°-35° and did not exceed 40° solid material began to attain from the orange solution when one third or more of the Naphthol solution had been added. When the addition was complete, the mixture was stirred for 1 hour and the flask allowe to stand in the water bath until the exothermic reaction ceased, then at room temperature for 4 days. The solid material was collected by filtration and washed on the filter with sufficient (10-20 ml) acetic acid to remove coloured impurities. Drying in the air gave 16 gm of crude o-carboxy cinnamic acid as a pale yellow crystalline solid.

The crude acid was purified by dissolving in 360-400 ml of cold 5% sodium bicarbonate solution, filtering, acedifying the filtrate with sufficient excess of mineral acid. The product was separated by filtration, washed with water to remove mineral acid, and air dried. Material thus obtained weighed 13 gm m.p. 204°C (Lit. 202°-205°C).

18. Dimethyl o-carboxy cinnamate:

6 gm of acid, 150 ml of dry methanol and 5 drops of conc. sulphuric acid were taken in 250 ml R.B.flask fitted with condenser and a calcium chloride guard tube. The reaction mixture was refluxed for 6 hrs. Then all the remaining methanol was removed at reduced pressure heating on a steam bath. Residue was treated with 200 ml of ether and washed with saturated sodium bicarbonate solution and then with water. It was dried on anhydrous sodium sulphate and ether removed. The semi solid residue distilled at b.p. 180°C/2 mm which solidified on keeping at 0°C. Yield- 4.8 gms.

PREPARATION OF DIAZO KETONES

19. α-diazo acetophenone (156):

A solution of 0.1 mole of diazomethane in 300 ml of ether was placed in a 1 litre three-necked flask with a magnetic stirrer. One neck of the flask was fitted with a calcium chloride guard tube, another with a pressure equalising dropping funnel and the other outlet was stoppered. 17 ml triethyl amine was added and the flask contents were cooled to -10° to -15°C. To To the stirred mixture added a solution of 17 ml of redistilled benzoyl chloride in 100 ml of dry ether over a period of 2 hrs. An additional 20 ml of dry ether over a period of 2 hrs. An additional 20 ml of ether was finally rinsed through the dropping funnel. Stirring was continued for one hour at 0° and then kept over night at room temperature.

The resulting ppt of triethyl amine hydrochloride filtered and washed with 30 ml of dry ether. The solvent was removed from the combined filtrate at room temperature under reduced pressure. The semi-solid residue crystallised to an orange red solid after keeping in the cold for several hrs. Crystallisation from n-hexane afforded yellow square plates crystals. m.p. 47°C. (Lit. 48°C) Yield-5.8 gm (40%).

20. p-methoxy-α-diazo-acetophenone (157):

15 gm of anisoyl chloride was added to an ice-cold ethereal solution of diazomethane prepared from 20 gm of

nitosomethyl urea. The reaction mixture was allowed to stand overnight. Sovent ether was removed at room temperature with a help of a rotatary pump. This left behind a yellow solid which was crystallised four times from benzene-pet-ether solvent mixture. The yield of the diazoketone (p-methoxy 2-diazoacetophenone) of m.p. 90-91° was 10 gm. (Lit. 90°C).

21. p-chloro-α-diazoacetophenone (158):

17 gm of p-chloro benzoyl chloride was added to an ice-cold ethereal solution of diazomethane prepared from 40 gm of nitrosomethyl urea. The reaction mixture was allowed to stand overnight. Solvent ether was removed at room temperature which left behind a yellow solid which on crystallisation in benzene-pet ether four times afforded yellow crystals of p-chloro- -diazoacetophenone, m.p. 115°C (Lit. 115°C) Yield- 5 gms.

22. (Diazomethyl) naphthyl ketone (159):

19 gms of α-naphthoic acid chloride in anhydrous ether was added to an ice-cold ethereal solution of diazo methane prepared from 35 gm of nitrosomethyl urea and 500 ml of ether. The reaction mixture was kept at room temperature overnight. Ether was removed completely at room temperature. The yellow crystals were found after recrystallisation from benzene-pet ether m.p. 55°C. (Lit. 57°C).

23. p-nitro-α-diazo acetophenone (160); (a) p-nitro benzoyl chloride:

10 gm of pure p-nitro benzoic acid and 13 ml of redistilled thionyl chloride was taken in a 100 ml R.B. flask which was fitted with a double surface condenser carrying a calcium chloride guard tube and latter was connected to a gas trap. The flask was heated on a water bath with occasional shaking for 1 hour. The reaction mixture cooled, excess thionyl chloride was distilled off completely and the residual liquid in the flask distilled at 130° under vacuum. The liquid distilate solidified. M.P. 65-70°C. (Lit. 70°).

(b) 9 gms of p-nitro benzoyl chloride in anhydrous ether was added to an ice-cold ethereal solution of diazomethane prepared from 15 gms nitrosomethyl urea and 200 ml ether. The reaction mixture was kept at room temperature overnight. Ether was removed. Yellow solid left behind was crystallised four times from benzene-pet-ether. M.P. 116°C. (Lit. 117°C) Yield-1.8 gm.

24. 2-hydroxy methylene cyclo hexanone (161)

A mixture of 6 gm of molecular sodium metal 500 ml of dry ether, 24.5 gm of redistilled cyclo-hexanone, and 27.5 gm of ethyl formate was introduced successively into a 1 lit. three-necked flask. The reaction was initiated by the addition of 1.5 ml of ethyl alcohol the flask placed in a cold water bath.

Stirring continued for 6 hrs. After standing overnight, 6.5 ml of ethyl alcohol was added, and the mixture was stirred for an additional hour. After the addition of 50 ml of water, the mixture was taken in one litt. separatory funnel. The ether layer was washed with 15 ml of water and the combined aqueous extracts were washed with 25 ml of ether. The aqueous layer was acidified with 42 ml of 6N hydrochloric acid, and the mixture was extracted twice with 100 ml of ether. The ether solution was washed with 6 ml of saturated sodium chloride solution and then was dried on anhydrous sodium sulphate. Filtered ether solution taken and the ether was removed. The residue was distilled at 80-90°C/ 6 mm. Yield 129 (Lit. 70-72/5 mm).

25. 2-diazo cyclo hexanone (133):

In a 500 ml wide-necked Erlenmayer flask were mixed 6 gm of 2-hydroxy methylene cyclo hexanone, 70 ml dichloromethane and 18 gm of triethylamine. The flask was cooled in an ice salt bath at 15°C and 16.3 gm of p-toluene sulphonyl azide was added with vigorous mechanical stirring over a period of approximately 1 hr., at such a rate that the temperature of the reaction mixture did not arise above -5°C. Stirring was continued for an additional two hours as the cooling bath melts. A solution of 5.2 gm of potassium hydroxide in 400 ml of water was added, and the mixture was stirred for 15 minutes at room temperature. The resulting emulsion was placed in 500 ml separatory funnel, the dichloromethane layer was separated after standing and the aqueous layer was washed with two 20 ml portions of dichloromethane. The combined dichloromethane solutions were washed with a solution of 0.5 gm of potassium hydroxide in 40 ml water, and then with 40 ml of water and dried over anhydrous sodium sulphate. The solvent was removed on a rotary evaporator at 35°C. The yield of orange 2-diazocyclo hexanone was 7 gm. This was not further purified.

36. p-toluene sulphonyl azide:

A solution of 12 gm of sodium azide in 35 ml of water was placed in a 500 ml R.B. Flask and diluted with 70 ml of 90% aqueous ethanol. To this solution was added with stirring a warm (45°C) solution of 32 gm of p-toluene sulphonyl chloride in 170 ml of 99% ethanol. During this addition sodium chloride separated and the reaction mixture took on a brown colour. The reaction mixture stirred at room temperature for 2.5 hrs, then most of the solvent was removed at 35° (15 mm). The residue was mixed with 500 ml of water in a separatory funnel, and the oily p-toluene sulphonyl azide separated. This oily product was washed with two 20 ml portions of water and dried over anhydrous sodium sulphate. Filtration with suction gave 24 gm of pure colourless p-toluene sulphonyl azide which completely crystallised on standing in the freeze.

27. Diazo methyl cyclohexyl ketone:

14.5 gm of cyclohexane carboxylic acid chloride was added to an ice-cold ethereal solution of diazomethane prepared from 35 gm of nitrosomethyl urea. The reaction mixture was allowed to stand overnight. Solvent ether was removed at room temperature. A yellow liquid product remained this was dried under vacuum. This was not further purified.

I.R. peak at 2215 cm^{-1} showed the presence of diazo keto group.

This was used for reaction purpose without further purification.

28. Reaction of α-diazo acetophenone with o-methoxy Cinnamic ester (methyl):

A benzene solution of 5 gm of α-diazo acetophenone was added dropwise, to a refluxing benzene solution of 6 gm o-methoxy cinnamic ester (methyl) in which 1 gm of active copper powder was placed. The addition was done in nitrogen atmosphere. After refluxing for 6 hrs, the copper was filtered out and benzene was removed completely at reduced pressure. It was then treated with ether and washed first with sodium bicarbonate solution and then with water till neutral. It was dried over anhydrous sodium sulphate and ether was removed. A semi solid residue was fractionally crystallised from methanol. A colourless needle shaped

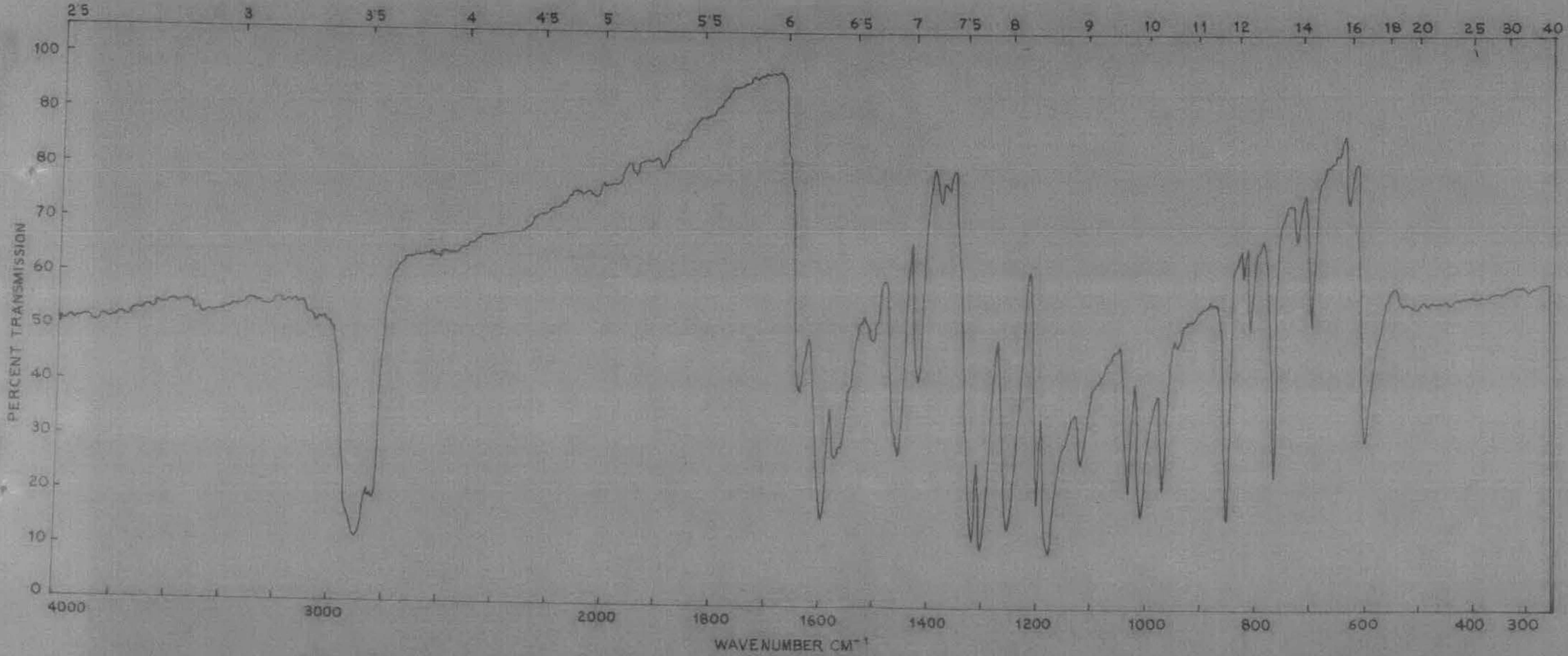


Fig- 27. Trans 1,2 (P-methoxy) dibenzoyl ethylene.

crystals separated out. This was recrystallised from the same solvent. The m.p. of this compound was found to be 117°C. Yield was found to be 3.5 gm.

Analysis found: C, 72.98%; H, 5.5%

Calculated for $C_{19}H_{18}O_4$: C, 73.61%; H, 5.85%

I.R. (neat): 1715 cm^{-1} (ester 1680 cm^{-1} (carbonyl) 1010 cm^{-1} (cyclopropane) Fig. 24

U.V. λmax = 238 nm.

The remaining mother liquor on concentration and keeping in the freezing chamber for several days did not give any crystal. So the solvent was removed and the residue was fractionally crystallised from light pet ether which gave yellow crystals. M.P. 110°C. So this was trans 1,2 dibenzoyl ethylene. Further concentration did not give any crystal.

The 2,4 dinitro phenyl hydrazone derivative of 1-benzoyl-2 (carbomethoxy)-2'-(o-methoxy) phenyl cyclopropane was prepared and recrystallised from methanol/chloroform and m.p. was found to be 177°C.

Analysis found: N, 11.32%

Calculated for $C_{25}H_{22}O_7N_4$: N, 11.44%

29. Reaction of p-chloro α-diazo acetophenone with o-methoxy cinnamic ester (methyl):

50 ml benzene solution of 6 gm of p-chloro diazo acetophenone was added dropwise to a refluxing benzene solution

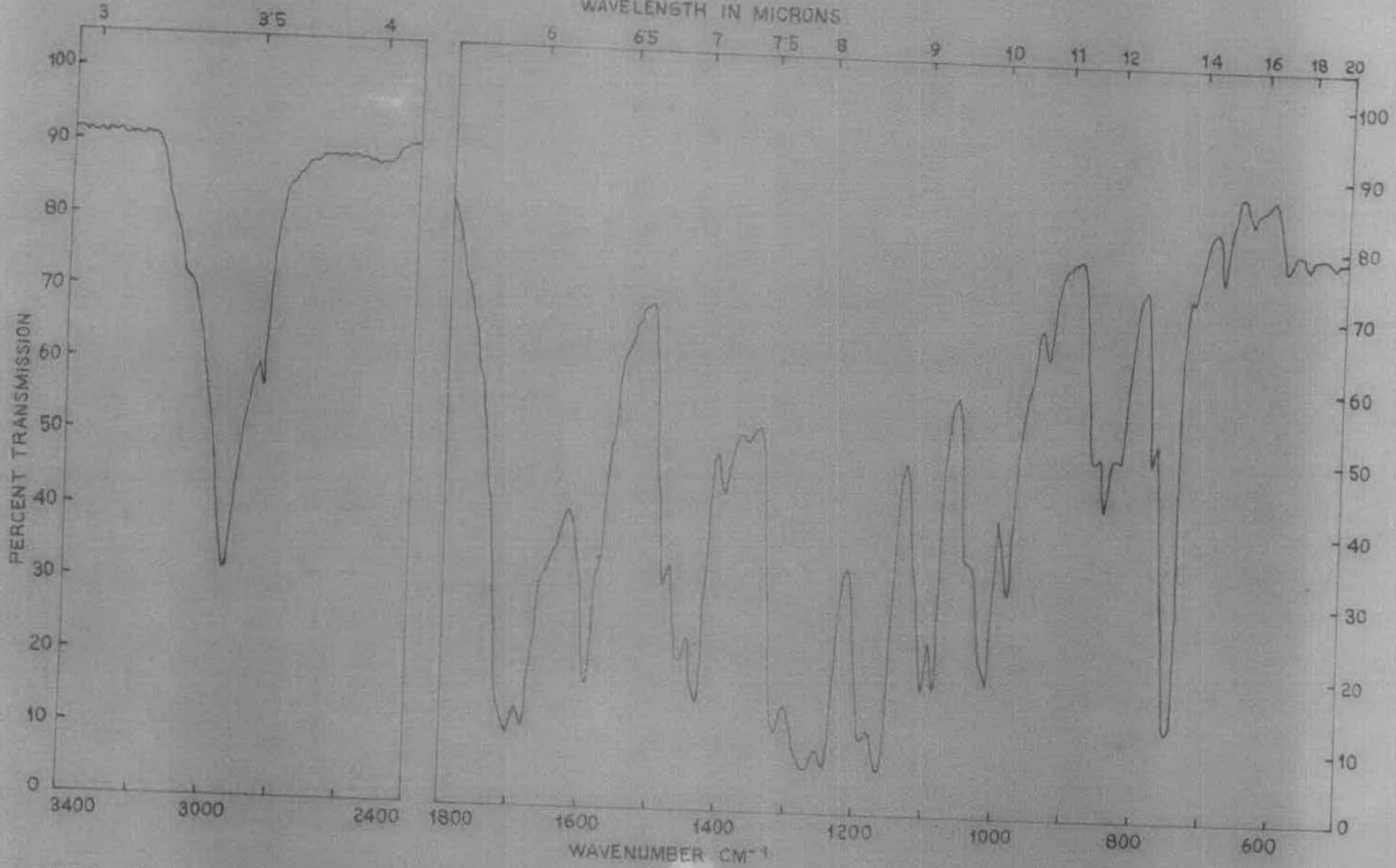


Fig- 25. 1-p-chlorobenzoyl-2-carbomethoxy-2'-(o-methoxy) phenyl cyclopropane.

(200 ml) of 6 gm o-methoxy cinnamic ester in presence of 0.1 gm of active copper powder in nitrogen atmosphere. Reaction mixture was refluxed for 6 hrs and then copper powder was filtered out. Benzene was removed completely and the semi solid residue was worked up in the usual way and crystallised from methanol. The colourless crystal is further recrystallised from methanol, m.p. 122°C. Yield of this product was found to be only 500 mg.

Analysis found: C, 66.05%; H, 5.0%
Calculated for $C_{19}H_{17}O_4Cl$ C, 66.3%; H, 4.98%
I.R. (neat)- Fig. 25
U.V. λmax - 245 nm.

Mother liquor of the above further conc. and kept in the cold, a yellow crystalline product was separated. This was recrystallised from methanol. The yellow compound of melting point 170°C was identified as trans 1,2 para chlorodibenzoyl ethylene in good agreement with I.R. spectrum and analysis. Mother liquor on further concentration and keeping at 0°C did not afford any solid material.

2:4 dinitro phenyl hydrozone derivative 1-p-chloro benzoyl-2(carbomethoxy)-2'-(o-methoxy) phenyl cyclopropane was prepared and recrystallised from mathanol/chloroform solvent mixture of whose m.p. was found to be 208°C.

Analysis found: N, 10.42%
Calculated for $C_{25}H_{20}O_7N_4Cl$: N, 10.69%

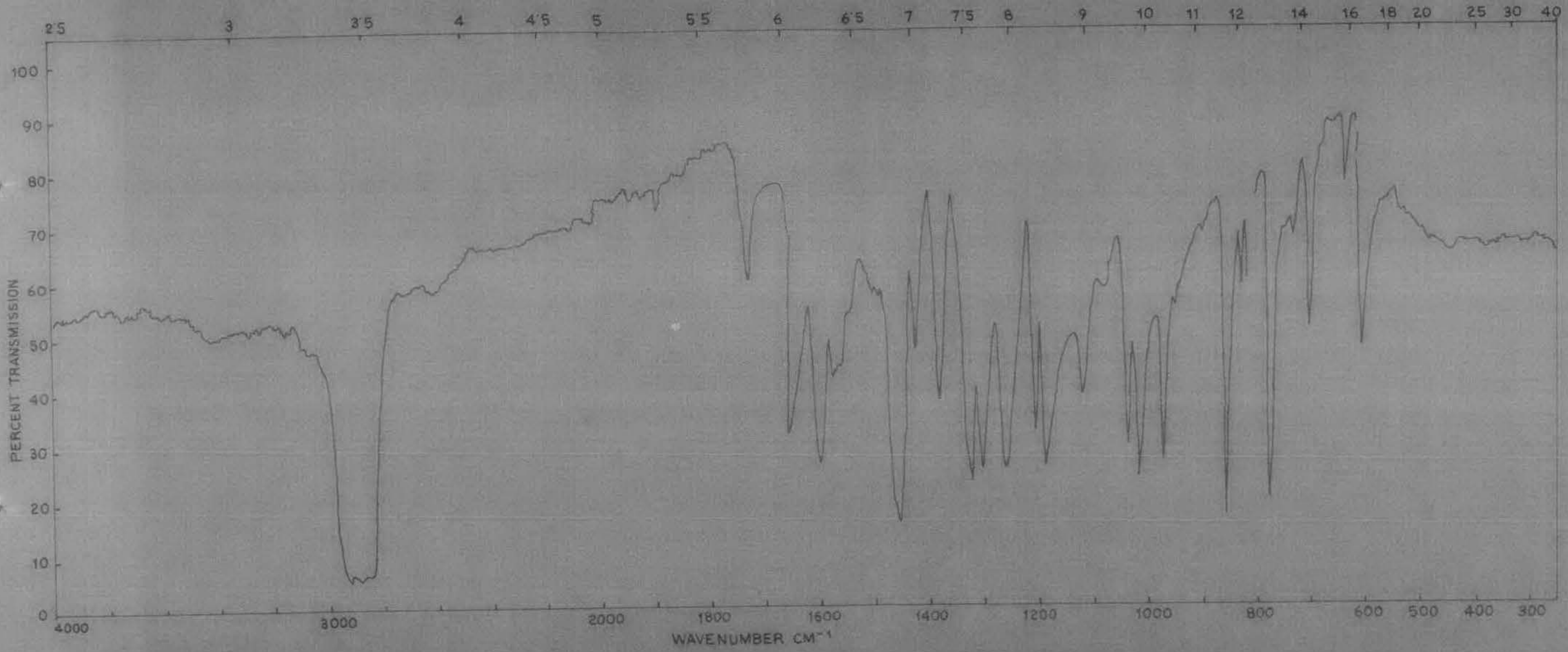


Fig- 26. 1-(P- methoxy) benzoyl-2-Carbomethoxy-2′-(o-methoxy) Phenyl Cyclopropane

30. Reaction of p-methoxy α-diazo acetophenone with o-methoxy cinnamic ester (methyl):

50 ml benzene solution of 6 gm of p-methoxy α-diazo acetophenone was added dropwise in nitrogen atmosphere to 200 ml benzene solution of 6 gm o-methoxy cinnamic ester while the solution was refluxed in presence of 0.1 gm active copper powder. After refluxing for 6 hrs copper was filtered out and benzene was removed, and the semi-solid residue was taken in ether and washed first with sodium bicarbonate solution and then with water till the solution become neutral. Ether was removed and the residue was crystallised from methanol. Colourless crystals were separated out of which m.p. was found to be 155°C. Yield-500 mg.

Analysis found:	C, 70.13%; H, 5.5%
Calculated for $C_{20}H_{20}O_5$:	C, 70.65%; H, 5.93%
I.R. (neat)-	Fig. 26
U.V. λmax	245 nm.

The mother liquor was further concentrated but did not afford any crystals so solvent was removed and the residue was fractionally crystallised from light petrolium-ether when yellow coloured crystals, were separated out m.p. 165°C. This was identified as trans-1,2-p-methoxy dibenzoyl ethylene in good agreement with I.R. spectrum and elemental analysis.

I.R.	Fig. 27
Analysis found:	C, 72.81%; H, 5.28%
Calculated for $C_{18}H_{16}O_4$:	C, 73.03%; H, 5.45%

Mother liquor on further concentration and keeping in the cold did not give any crystalline product.

2:4 -dinitro phenyl hydrozone derivative of 1-p(OCH_3) benzoyl-2-(carbomethoxy)-2'-(o-methoxy) phenyl cyclopropane was prepared and crystallised from chloroform/methanol solvent mixture. m.p. of the derivative was found to be 250°C-51°C.

Analysis found: C, 59.51%; H, 4.8%

Calculated for $C_{26}H_{24}O_8N_4$: C, 60.05%; H, 4.65%.

31. Reaction between trans-o-methoxy methyl cinnamate and diazo methyl naphthyl ketone:

50 ml of benzene solution of 3.3 gm (0.17 mole) of the diazo ketone was added drop by drop to a refluxing 150 ml of benzene solution of 3.2 gm(0.017 mole) of trans-o-methoxy methyl cinnamate and 0.5 gm active copper powder in a nitrogen atmosphere. After refluxing for 6 hrs (the reaction mixture was cooled to room temperature). The copper powder was filtered out and the solvent benzene was removed completely. The residue in the flask was treated with 200 ml of ether and etherreal solution was treated first with 5% sodium bicarbonate solution and then with water till neutral. It was dried over anhydrous sodium sulphate and solvent ether was removed when a gummy solid was left behind. This residue was recrystallised from methanol when a pale yellow coloured crystals of m.p. 95°-97°C separated out. The wt. of this product was 300 nm.

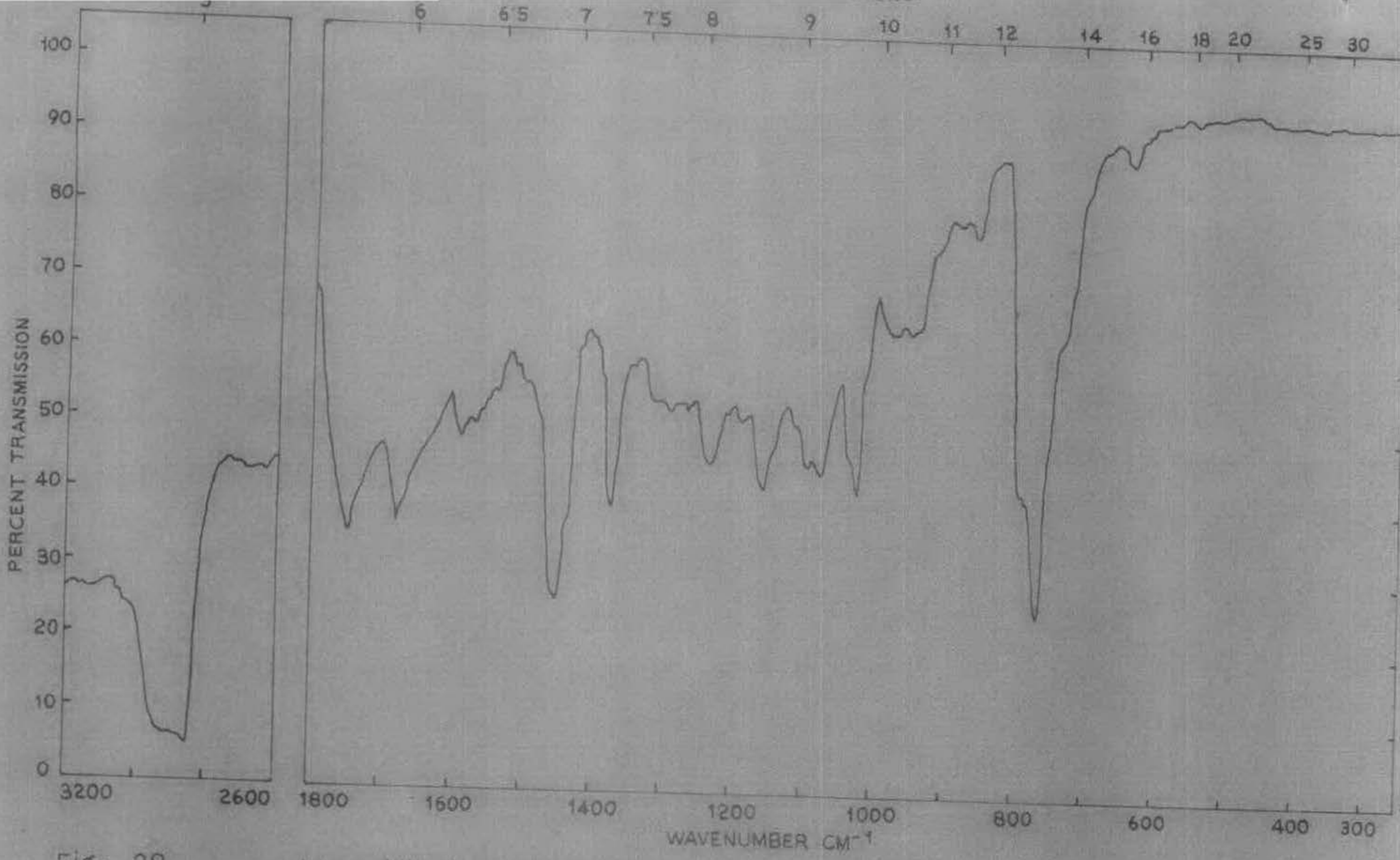


Fig- 28. 1- naphthoyl- 2- Carbomethoxy- 2'- (o- methoxy) phenyl cyclopropane.

Analysis found: C, 77.12%; H, 5.41%

Calculated for $C_{23}H_{20}O_4$: C, 76.65%; H, 5.60%

I.R (neat 3050, 1710 (ester), 1655 (naphthoyl), 1450 and 1230, 1010 cm^{-1} (cyclopropane) - Fig. 28.

Further concentration of the mother liquor did not afford any crystalline solid. A gummy solid was left behind, which was not further explored.

32. Reaction of α-diazo acetophenone with trans-p-methoxy methyl cinnamate:

50 ml of benzene solution of 2.5 gm (0.017 mole) of α-diazo acetophenone was added drop by drop to the 100 ml of a refluxing benzene solution of 3.2 gm (0.017 mole of trans-p-methoxy) methyl cinnamate and .5 gm active copper powder in the nitrogen atmosphere. After refluxing for 7-8 hrs the reaction mixture was cooled to room temperature and copper powder was filtered out. Benzene was removed completely when a semi-solid product was left behind. This was extracted with 200 ml ether and treated with 5% sodium bicarbonate solution and then washed with water till neutral. Ehtereal solution was dried over anhydrous sodium sulphate and ether was removed. The solid residue was first crystallised from methanol (excess) when about 1 gm of the ester starting material was separated. Mother

liquor on further concentration and keeping in the cold gave colourless crystals. This was further recrystallised from methanol when colourless crystal of m.p. 138°C was separated out. The wt. of the product was found to be 2 gm (40%).

Analysis found: C, 74%, H, 5.5%
Calculated for $C_{19}H_{18}O_4$: C, 73.68%; H, 5.85%
I.R. (neat) Fig. 29.

Mother liquor was concentrated further and kept in the cold for some days. But no crystalline solid product was separated. So solvent was removed and the residue was crystallised from low boiling pet-ether, while a yellow crystal of m.p. 108°C was separated. This was identified as trans-1, 2-dibenzoyl ethylene in good agreement with I.R. spectrum and the mixed m.p. (Lit. 110°C) with authentic sample. Wt. of this product 200 mg (10%).

33. Reaction of p-methoxy-α-diazo acetophenone with trans-p-methoxy methyl cinnamate:

50 ml of benzene solution of 2.95 gm (0.17 mole) of diazo compound was added drop by drop to the 100 ml of refluxing benzene solution of 3.2 gm (0.017 mole) of trans-p-methoxy methyl cinnamate and 0.5 gm of active copper powder in the nitrogen atmosphere. After refluxing for 7-8 hrs the reaction mixture was cooled to room temperature and copper powder was filtered out. Benzene was removed completely at reduced pressur

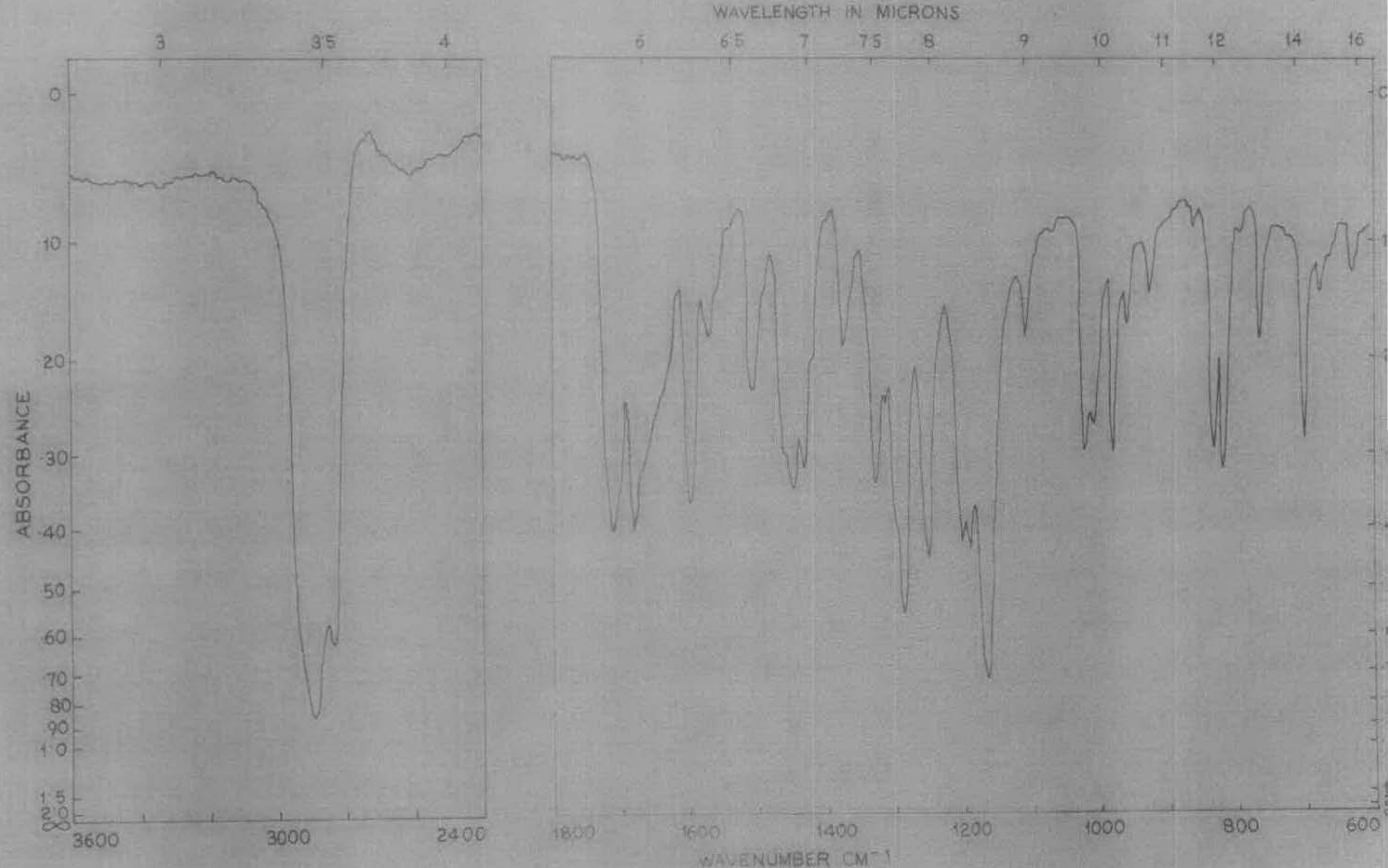


Fig- 29. 1- benzoyl- 2- Carbomethoxy- 2'-(P- methoxy) phenyl cyclopropane .

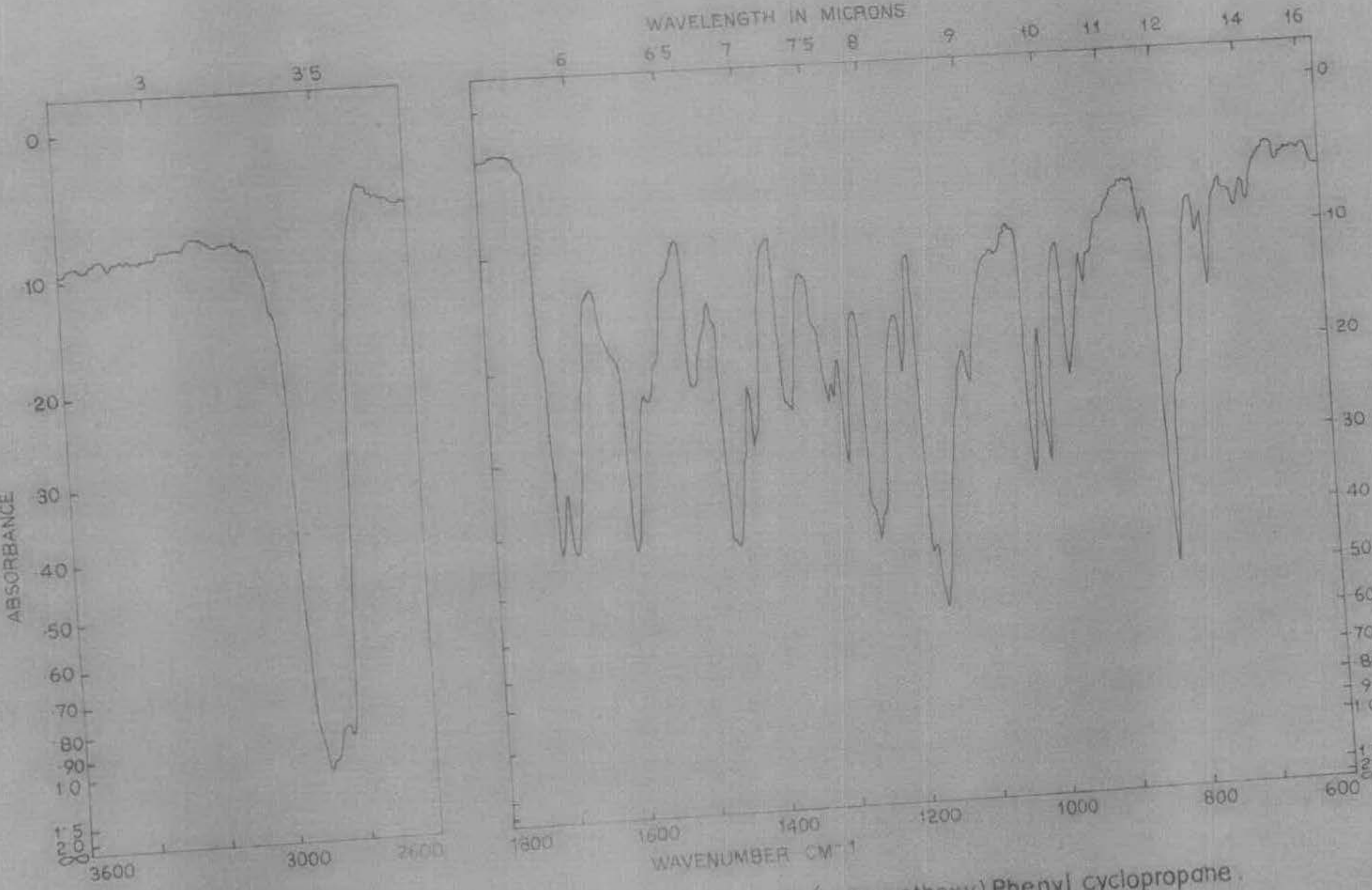


Fig- 30. 1-(P-methoxy) benzoyl-2-Carbomethoxy-2'-(P-methoxy) Phenyl cyclopropane.

and the residue in the flask was extracted with 200 ml ether and treated with 5% sodium bicarbonate solution and this was washed with water till neutral to pH paper. Ethereal solution was dried over anhydrous sodium sulphate and ether was removed. After fractional crystallisation from methanol gave two substances. One was identified as unreactive ester of wt. 1.2 gm and another a colourless crystal was identified as 1-p-methoxy benzoyl-2-carbomethoxy-2'-(p-methoxy) phenyl cyclopropane of m.p. 140°C. Yield -1.5 gm (25%).

Analysis found: C, 70%; H, 5.64%
Calculated for $C_{20}H_{20}O_5$ C, 70.67%; H, 5.93%
I.R. (neat) Fig. 30.

2:4 dinitrophenyl hydroazone derivative was prepared and recrystallised from methanol/chloroform solvent mixture. m.p. was found to 196°C.

Analysis found: N, 10.23%
Calculated for $C_{26}H_{24}O_8N_4$: N, 10.44%.

Mother liquor on further concentration and keeping at below 0°C for 6 days gave 300 gm yellow coloured crystals of m.p. 163° which was identified as trans-1,2-p-methoxy dibenzoyl ethylene from it's I.R. spectrum and elemental analysis.

Analysis found: C, 69.14%; H, 4.5%
Calculated for $C_{18}H_{14}O_4$: C, 69.52%; H, 4.80%
I.R. (neat) Fig. 27.

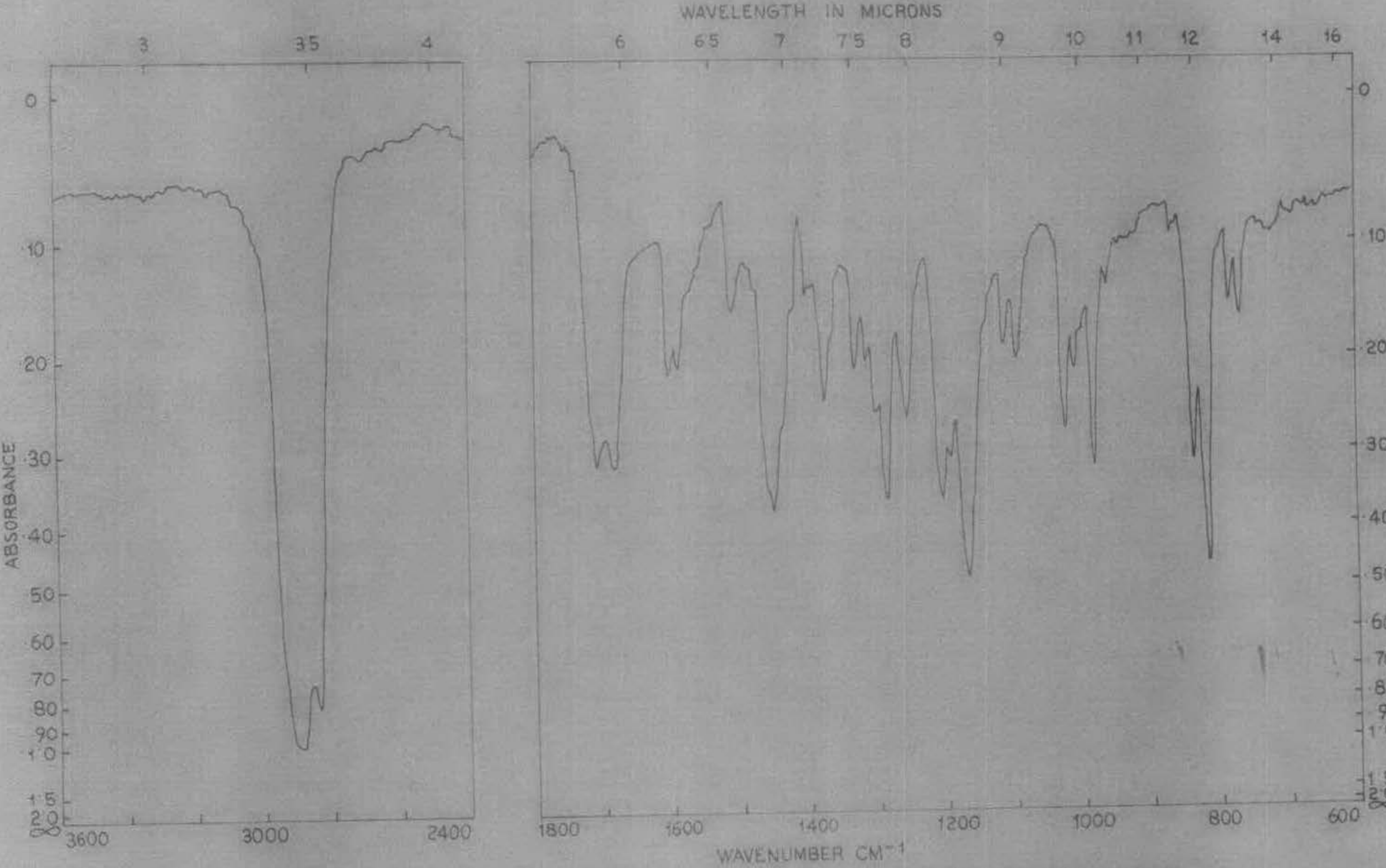


Fig- 31. 1-(P-chloro) benzoyl-2-Carbomethoxy-2′-(P-methoxy) phenyl cyclopropane.

34. Reaction of p-chloro-α-diazoacetophenone with trans-p-methoxy methyl cinnamate:

50 ml benzene solution of 3 gm (0.17 mole) of the diazo-ketone was added dropwise to a refluxing 100 ml benzene solution of 3.2 gm (.017 mole) of ester and 0.5 gm of copper powder, in the presence of nitrogen atmosphere. After refluxing for 7-8 hours the reaction mixture was cooled to room temperature and the copper was removed by filtration. Benzene was removed at reduced pressure and the residue was extracted with 200 ml of ether. This was treated with 5% sodium bicarbonate solution and washed with water till neutral. This was dried over anhydrous sodium sulphate and ether was removed. The solid residue on fractional crystallisation from methanol gave two fractions. One contained the starting ester (1 gm) and another, a colourless crystal was identified as 1-p-chloro benzoyl-2-carbomethoxy-2'-(p-methoxy) phenyl cyclopropane. m.p. 67°-69°C. Yield-2 gm.

Analysis found: C, 66.1%; H, 5.3%
Calculated for $C_{19}H_{17}O_4Cl$: C, 66.36%; H, 4.98%
I.R. (neat) Fig. 31.

Mother liquor was concentrated and kept in the cold for several days when yellow coloured crystals of m.p. 172°C was separated out. This was identified as trans-1,2-p-chloro

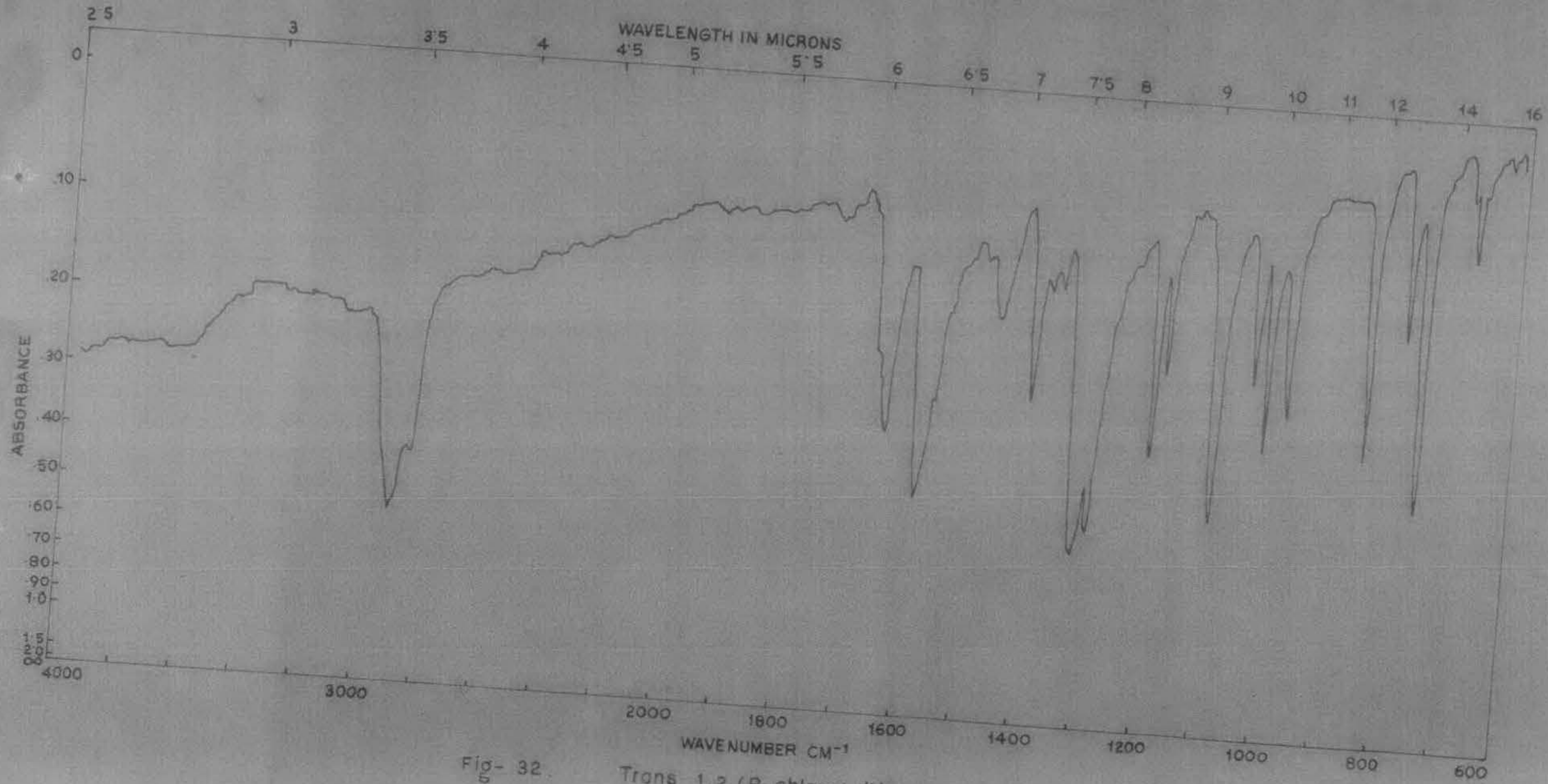


Fig- 32. Trans 1.2 (P-chloro) dibenzoyl ethylene.

dibenzoyl ethylene from it's I.R. spectrum and elemental analysis.

Analysis found: C, 62.38%; H, 3.31%

Calculated for $C_{16}H_{10}O_2Cl_2$: C, 63%; H, 3.30%

I.R. (neat) Fig. 32.

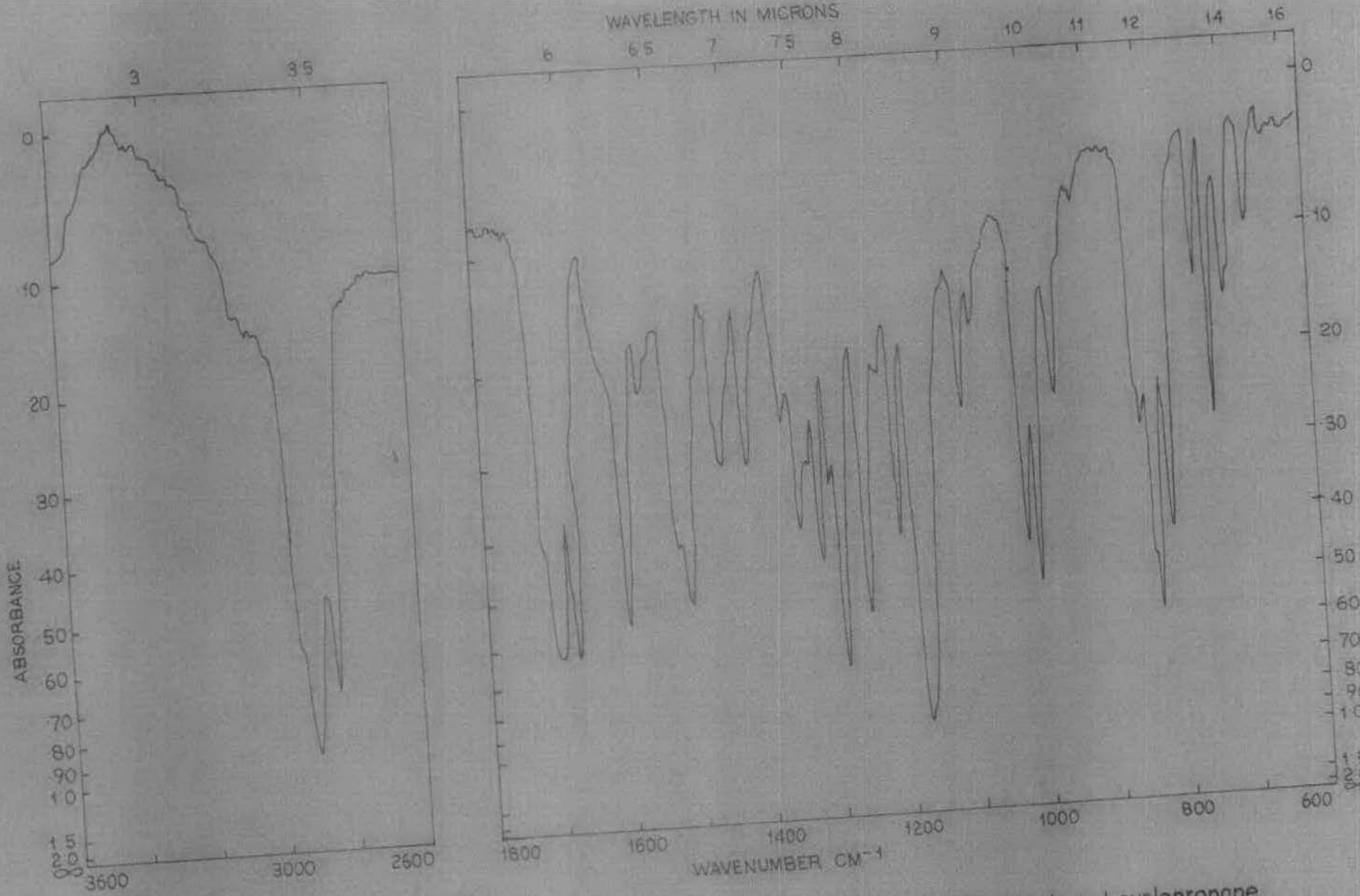
35. Reaction of p-nitro- α -diazoacetophenone with trans-p-methoxy methyl cinnamate:

50 ml benzene solution of 3.2 gm (.017 mole) of diazo compound was added dropwise to 100 ml refluxing benzene solution of 3.2 gm (.017 mole) of ester and .5 gm of active copper powder in the nitrogen atmosphere. The reaction mixture was refluxed for 8 hrs. It was then cooled to room temperature and copper powder was filtered out. Benzene was removed at reduced pressure and the solid residue was extracted with 200 ml of ether and it was treated with 5% sodium bicarbonate solution and washed with water till neutral to pH paper. Ethereal solution was dried over anhydrous sodium sulphate and ether was removed. On fractional crystallisation from chloroform/methanol solvent mixture gave a product which on recrystallisation gave colourless crystals m.p. 173°C. The wt. of the product was found to be 2 gm (30%).

Analysis found: C, 65%; H, 5.13%

Calculated for $C_{19}H_{17}O_6N$: C, 64.22%; H, 4.83%

I.R. (neat) Fig. 33.



1-p-nitrobenzoyl -2-Carbomethoxy-2-(p-methoxy) phenyl cyclopropane.

Fig- 33.

From the mother liquor, solvent was removed and the residue was treated with n-hexane, concentrated and kept in the cold yellow coloured crystals were separated out m.p. 161°C.

Analysis found: C, 59.1%; H, 3.13%
Calculated for $C_{16}H_{10}O_6N_2$: C, 58.90%, H, 3.09%
I.R. and elemental analysis showed that this was trans 1,2, p-nitro dibenzoyl ethylene.
I.R. Fig. 34.

36. Reaction of p-chloro-α-diazo acetophenone with trans-meta-methoxy methyl cinnamate:

50 ml benzene solution of 3 gm (0.017 mole) of diazo compound was added dropwise to a refluxing benzene solution of 3.2 gm (0.017 mole) of ester and 0.5 gm copper powder in the nitrogen atmosphere. After refluxing for 8 hrs the reaction mixture was worked up as before. Yellow crystals which was separated out after several recrystallisation from methanol melted at 170°C. I.R and elemental analysis data showed that this compound was trans 1,2 p-chloro dibenzoyl ethylene. Yield-2 gm.

Analysis found: C, 63.09%; H, 3.48%
Calculated for $C_{16}H_{10}O_2Cl_2$: C, 62.93%; H, 3.29%
I.R. (neat) Fig. 32.

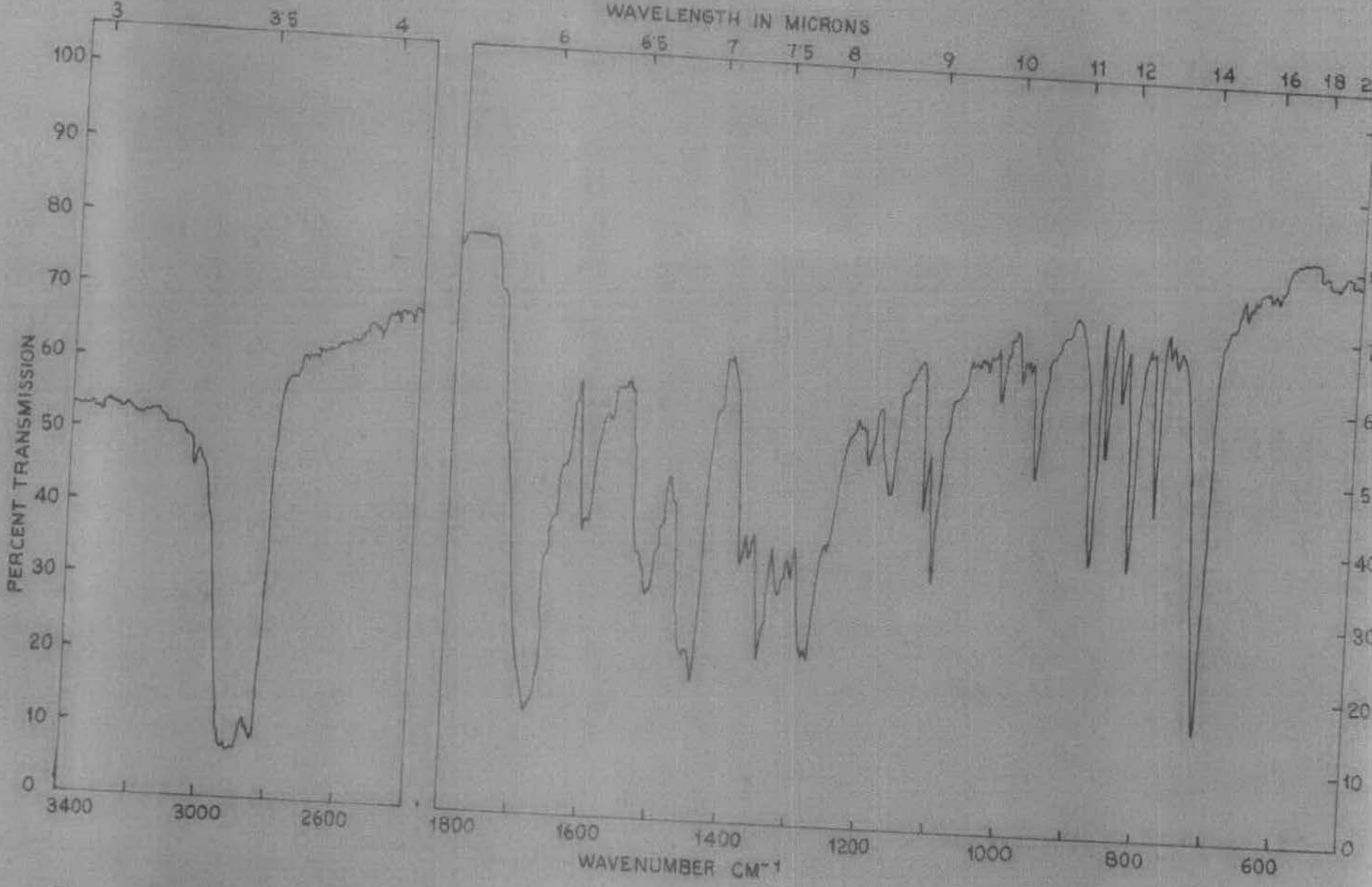

WAVELENGTH IN MICRONS
3
3·5
4
6
6·5
7
7·5
8
9
10
11
12
14
16
18
PERCENT TRANSMISSION
100
90
80
70
60
50
40
30
20
10
0
3400
3000
2600
1800
1600
1400
1200
1000
800
600
WAVENUMBER CM⁻¹

Fig- 57.

Mother liquor was further concentrated and kept in the freeze for several days when colourless crystals of m.p. 162°C were separated. Yield-100 mg.

I.R. and elemental analysis of this part showed that this compound was 1-p-chlorobenzoyl-2-carbomethoxy-2'-(m-methoxy) phenyl cyclopropane.

Analysis found: C, 66.8%; H, 5.1%

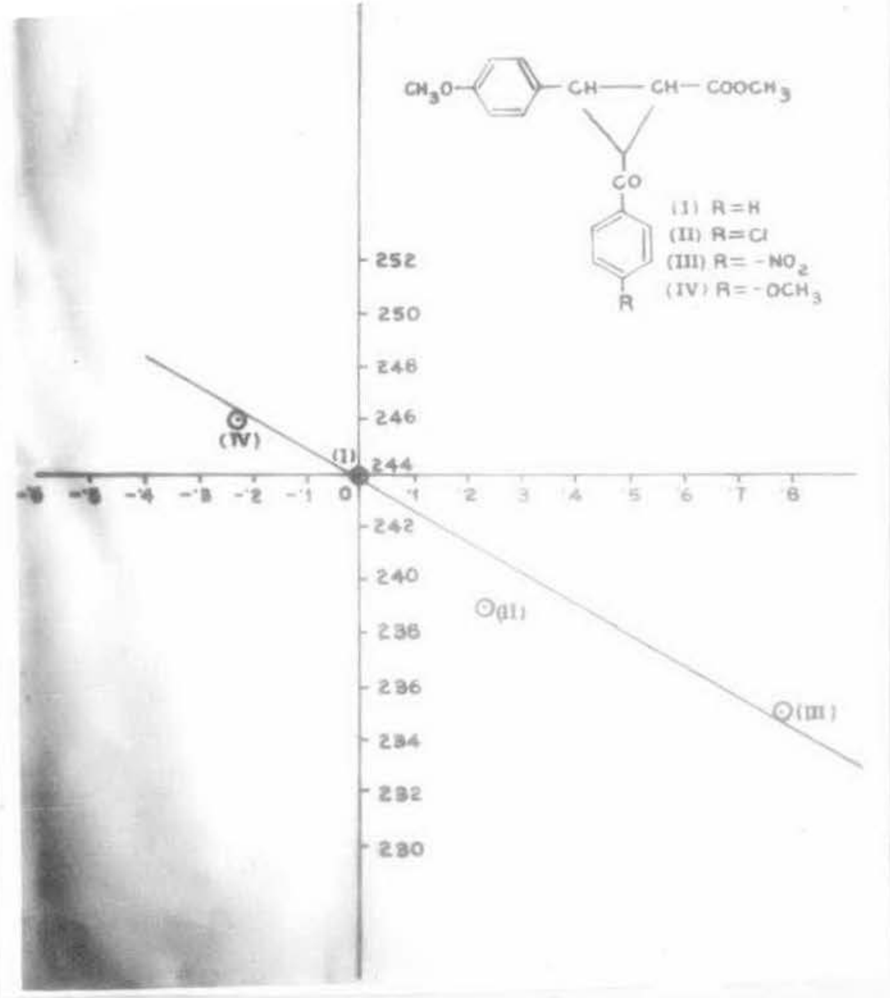
Calculated for $C_{19}H_{17}O_4Cl$: C, 66.36%; H, 4.98%

I.R. (neat) Fig. P.21

37. <u>Reaction of α-diazo acetophenone with trans meta-methoxy cinnamic ester (methyl)</u>:

50 ml benzene solution of 2.5 gm (0.017 mole) of diazo compound was added to a 100 ml refluxing benzene solution of 3.2 gm (0.17 mole) of ester and 0.5 gm of active copper powder in nitrogen atmosphere. The reaction mixture was refluxed for eight hours and then it was cooled to room temperature. After working up usually yellow coloured solid obtained after several recrystallisation from low boiling pet-ether m.p. 110°C. It was identified as trans-1,2, dibenzoyl ethylene by comparison of I.R. and m.p. with those of authentic samples. Wt. of this dimer was 1.5 gm.

Mother liquor was further concentrated, but no crystalline product could be separated. Solvent was removed, and semi-solid residue left behind whose I.R. shows that it was trans-meta-methoxy methyl cinnamate.



Benzoic acid

Fig. P22

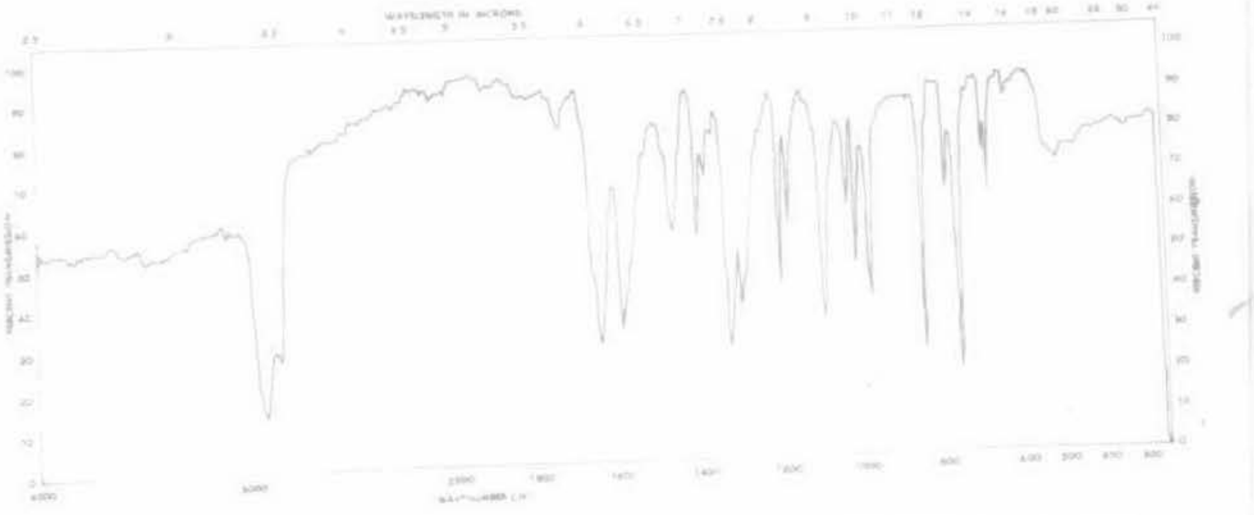


Fig- P.21.

38. Reaction of p-methoxy α-diazo acetophenone with trans-m-methoxy methyl cinnamate:

50 ml benzene solution of 3 gm (.017 mole) of diazo compound was added to 100 m refluxing benzene solution of 3.2 gm (.017 mole) of ester and 0.5 gm of active copper powder in presence of nitrogen atmosphere. After refluxing for 8 hrs the reaction mixture was cooled to room temperature and worked up as usual. The residue was crystallised from methanol when a yellow coloured solid was separated. This on several recrystallisations gave yellow crystals m.p. 165°C. From the observation of I.R. spectrum and elemental analysis and m.p. it was identified as trans-1,2, p-methoxy dibenzoyl ethylene. Yield-1.5 gm.

Analysis found: C, 73.13%; H, 5.28%
Calculated for $C_{18}H_{16}O_4$: C, 72.96%; H, 5.40%
I.R. (neat) Fig. 32.

Mother liquor was further concentrated. But no crystal was observed. So solvent was removed; when a semi-solid compound remained, whose I.R. showed that this fraction was the ester, starting material.

39. Reaction of p-chloro-α-diazo acetophenone with trans methyl cinnamate:

50 ml of benzene solution of 3 gm (0.017 mole) of diazo compound was added to 100 ml refluxing benzene solution of

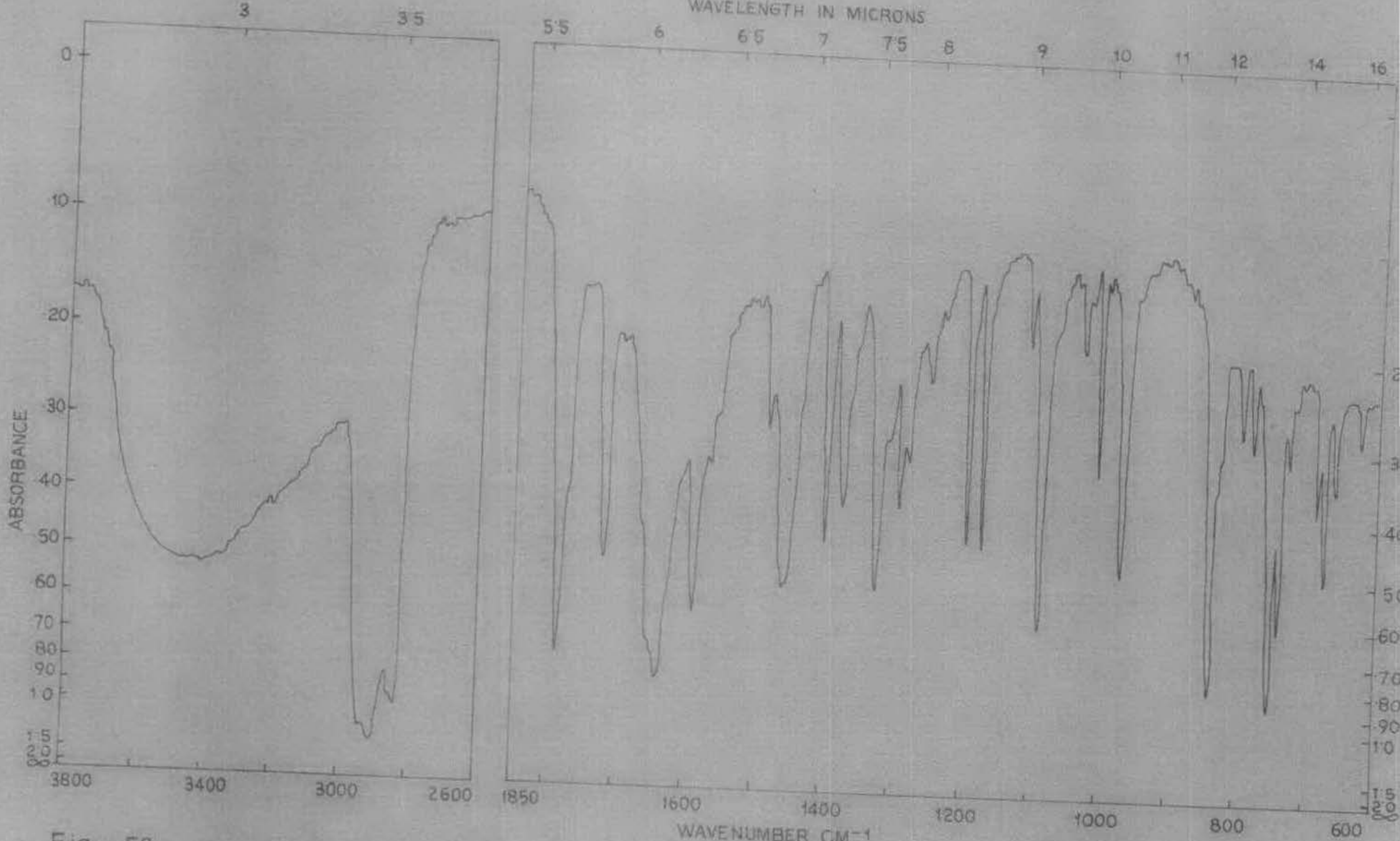

WAVELENGTH IN MICRONS
3
3·5
5·5
6
6·5
7
7·5
8
9
10
11
12
14
16
ABSORBANCE
0
·10
·20
·30
·40
·50
·60
·70
·80
·90
1·0
1·5
2·0
∞
3800
3400
3000
2600
1850
1600
1400
1200
1000
800
600
WAVENUMBER CM-1

Fig- 59

2.7 gm (0.017 mole) of methyl cinnamate and 0.5 gm active copper powder in the nitrogen atmosphere. After refluxing for 8 hrs the reaction mixture was cooled to room temperature and worked up as usual. The solid residue was fractionally crystallised from methanol when yellow coloured crystals were separated. This was further recrystallised from methanol. About 1.2 gm yellow crystals, m.p. 172°C was isolated. This was identified as 1,2(E) bis p-chloro benzoyl ethylene from the comparison of I.R. spectra and m.p. (determined earlier of this compound).

Mother liquor from above was concentrated and kept in the cold for two days. When yellow coloured crystals m.p. 158°C were separated out. This was recrystallised from methanol several times when its m.p. was raised to 161°C. I.R. peaks are different from that of 1,2, (E) bis p-chloro benzoyl ethylene.

I.R. (neat) Fig. 59. Mass spectrum .(Fig. P.18.)

Mother liquor of the first crystallisation was concentrated and kept in the cold for several days. A light yellow coloured solid separated and this was recrystallised several times from methanol when colourless crystals of m.p. 95°C were separated out.

Yield-100 mg. From elemental analysis and I.R. data it was identified as 1, p-chloro benzoyl-2-carbomethoxy-2'-phenyl cyclopropane.

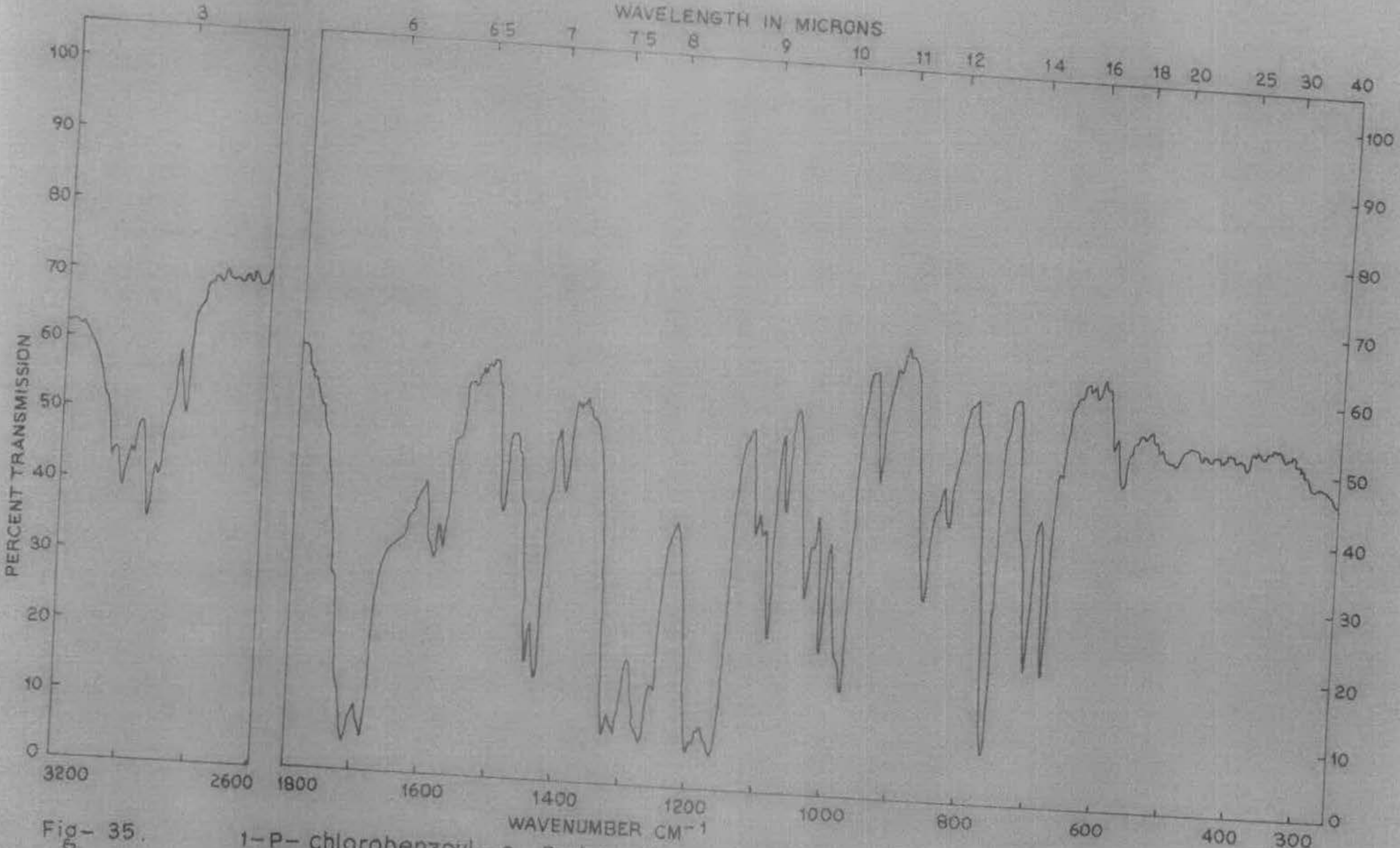


Fig- 35. 1-P- chlorobenzoyl- 2- Carbomethoxy- 2'- phenyl cyclopropane

Analysis found: C, 65.85%; H, 4.78%

Calculated for $C_{19}H_{17}O_4Cl$: C, 66.20%; H, 4.98%

I.R. (neat) Fig. 35

40. Reaction of p-chloro α-diazo acetophenone with methyl o-carbomethoxy cinnamic ester (methyl):

50 ml of benzene solution of 3 gm (0.17 mole) of diazo compound was added to 100 ml refluxing benzene solution of 3.7 gm (.017 mole) of ester and 0.5 gm active copper powder in the nitrogen atmosphere. Reaction mixture was allowed to reflux for 8 hrs and then it was cooled to room temperature, and the reaction mixture was worked up as usual. The residue after crystallisation from methanol afforded yellow crystalline product, m.p. 172°C. Mixed m.p. with this found to be identical with 1,2(E) bis-p-chloro dibenzoyl ethylene, I.R. comparison confirmed this. The amount isolated was 1.8 gm.

Mother liquor was further concentrated; but no crystalline product separated. So solvent was removed when a heavy liquid was left behind. This was distilled b.p. 178°C/2 mm whose I.R. showed that this fraction was the ester, starting material.

41. Reaction of α-diazo acetophenone with the above ester (dimethyl ester of o-carboxy cinnamic acid):

Following above procedure, in this case only trans 1,2 dibenzoyl ethylene of m.p. 108°C and the stating ester could be isolated. The yield of the dimer from diazo compound was found to be 1.4 gm.

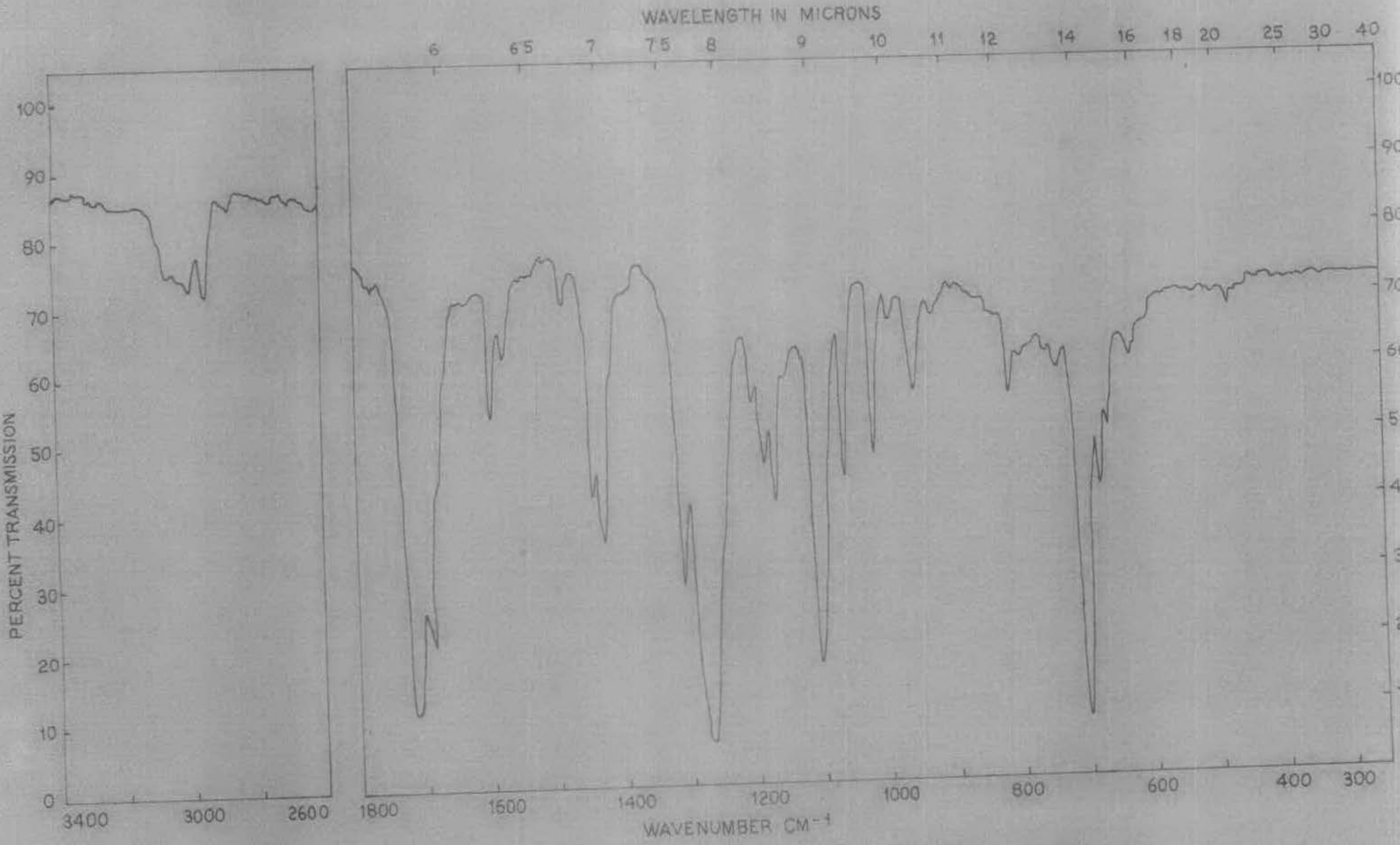


Fig- 36. 1-benzoyl-2-Carbomethoxy-2′-(o-nitro) phenyl cyclopropane.

42. Reaction of α-diazo acetophenone with trans-o-nitro methyl cinnamate:

50 ml benzene solution of 2.5 gm (0.017 mole) of diazo compound was added dropwise to 100 ml refluxing benzene solution of 3.5 gm (0.017 mole) of ester and 0.5 gm active copper powder in the nitrogen atmosphere. Reaction mixture was refluxed for 8 hrs and copper was removed at reduced pressure. The semi-solid residue was extracted with ether and treated with 5% sodium bicarbonate solution and washed with water till neutral. Ethereal solution was dried over anhydrous sodium sulphate and ether was removed. Residue was crystallised from methanol. The yellow coloured solid was further recrystallised from low boiling pet ether when crystalline product of m.p. 110°C was separated. No depression of m.p. was observed when mixed m.p. of this compound and trans-1, 2, dibenzoyl ethylene was observed. So this is trans 1,2 dibenzoyl ethylene.

The mother liquor was concentrated; but no solid product could be separated out on removal of the solvent a liquid product was left behind which after removal of the first distilate gave a fraction which was distilled at 180°C/ 3 mm. Yield (200 mg). This was identified as 1-benzoyl 2-carbomethoxy-2' (o-nitro) phenyl cyclopropane.

I.R. (neat) Fig. 36.

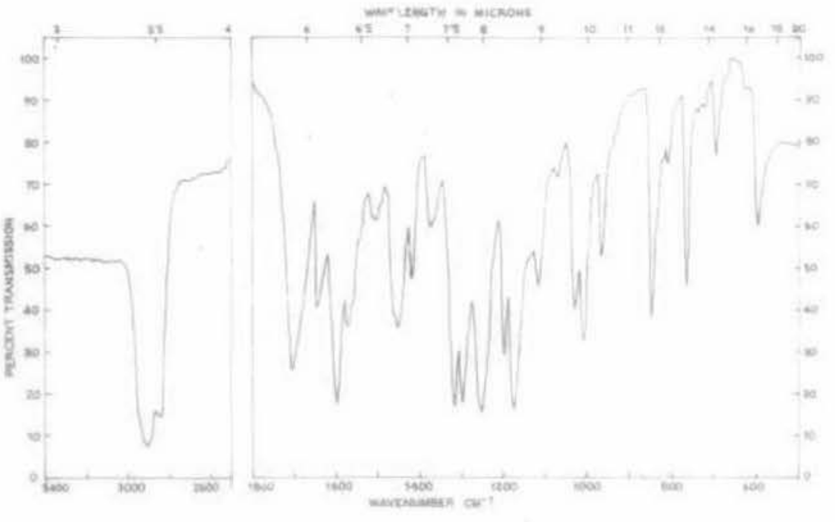


Fig. P.19. I.R. spectrum of 1-benzoyl-2-carbomethoxy -2-methyl cyclopropane.

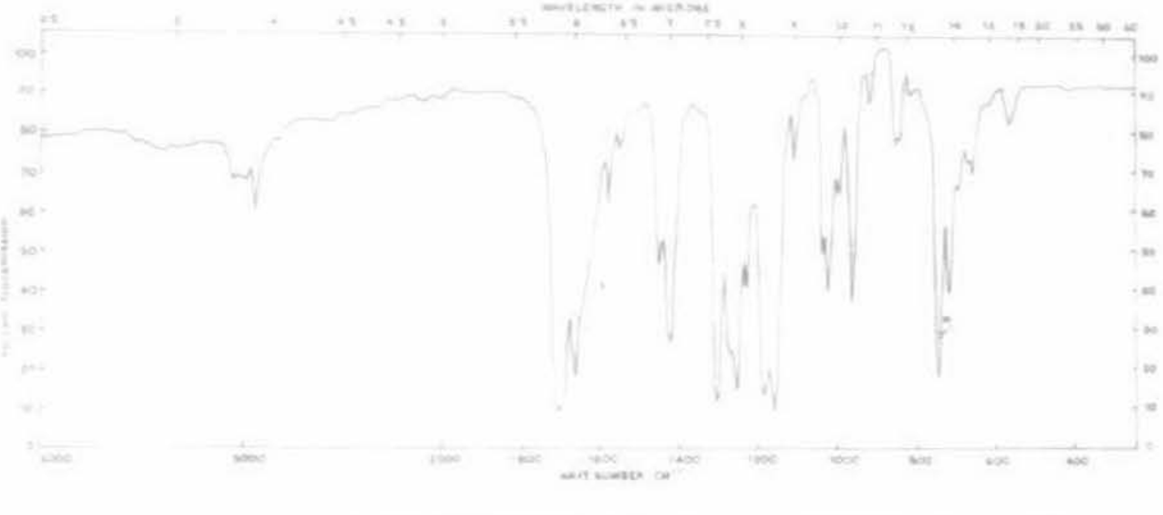


Fig. P.20. I.R. spectrum of 1-benzoyl-2-carbomethoxy-2'-phenyl cyclopropane.

2:4 dinitrophenyl hydrozone derivative of this product was prepared and crystallised from methanol/chloroform solvent mixture. m.p. 218°C.

Analysis found: N, 14.2%

Calculated for $C_{24}H_{19}O_8N_5$: N, 13.86% .

43. Reaction of α-diazo acetophenone with o-carbomethoxy methyl cinnamate:

50 ml benzene solution of 2.5 gm (0.17 mole) of the diazo compound was added dropwise to a refluxing benzene (100 ml) solution of 3.7 gm (0.017 mole) of the ester and 0.5 gm active copper powder in presence of nitrogen atmosphere. After refluxing for 8 hrs the reaction mixture was cooled to room temperature and worked up as usual. Yellow solid separated on recrystallisation from pet ether (low-boiling) several times and afforded a crystalline, yellow solid of m.p. 110°C. This was found to be trans-1, 2 dibenzoyl ethylene.

Mother liquor was concentrated but no crystalline product could be separated. After removal of the solvent the liquid product was identified as the ester starting material.

44. Reaction of α-diazo acetophenone with α-cyano methyl cinnamate:

50 ml benzene solution of 2.5 gm (0.017 mole) of diazo compound was added drop by drop to 100 ml refluxing benzene solution of 3.15 gm (0.017 mole) of ester and 0.5 gm of active copper powder in the nitrogen atmosphere. After refluxing for 8 hrs the reaction mixture was cooled to room temperature and worked up as usual. The solid residue on fractional crystallisation from methanol gave 1.4 gm. Yellow solid which on recrystallisation from low boiling pet-ether afforded yellow crystalline compound of m.p. 110°C. This was identified as trans 1,2, dibenzoyl ethylene by comparison of m.p. and I.R. spectra with those of authentic sample.

Mother liquor was further concentrated and kept in the cold when a colourless compound separated out these on recrystallisation from methanol several times gave colourless crystalline compound of m.p. 34°C which was identified as the stating ester by mixed m.p. and I.R. comparison.

Mother liquor was further concentrated and kept in the cold for 7 days when a trace amount of solid compound separated. This on recrystallisation from methanol gave only 50 mg of solid crystalline compound whose m.p. was found to be 68°C. It was identified as 1-benzoyl-2-carbomethoxy-2-cyano-2'-phenyl cyclopropane by means of I.R. spectra and elemental analysis. Yield-50 mg.

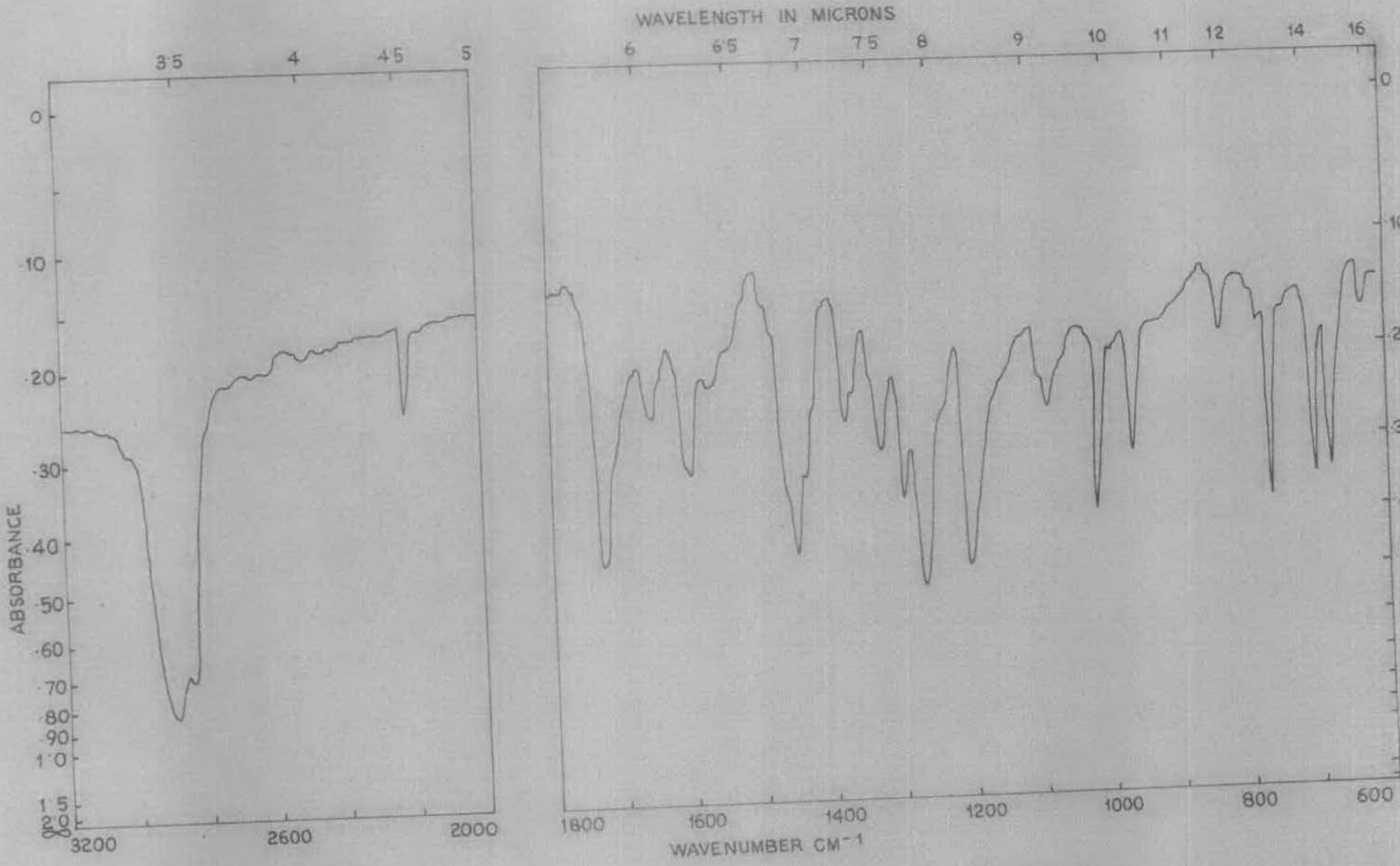


Fig- 37 . 1- benzoyl - 2 - Carbomethoxy - 2 - cyano - 2′ - phenyl cyclopropane .

Analysis found: C, 73.5%; H, 5.5%

Calculated for $C_{19}H_{16}O_3N$: C, 74.41%; H, 5.26%

I.R. (neat) Fig. 37.

2:4 dinitrophenyl hydrazone derivative of this product was prepared which was recrystallised from methanol/chloroform solvent mixture m.p. 207°C.

Analysis found: N, 14.18%

Calculated for $C_{25}H_{\underset{19}{\cancel{28}}}O_6N_5$: N, 14.30%.

~~Analysis found: N, 11.13%~~

~~Calculated for $C_{25}H_{28}O_7N_4$: N, 11.56%~~

I.R. (neat) Fig.

45. Reaction of Diazo methyl naphthyl ketone with o-methoxy methyl cinnamate:

A solution of 6 gm of diazo ketone in 50 ml of dry benzene was decomposed at its refluxing temperature in presence of 0.1 gm of copper powder and a solution of 100 ml benzene solution of 5 gm o-methoxy cinnamic ester. Addition of the diazo ketone was removed by filtration and benzene was distilled out completely. The residue was treated with 200 ml of ether and treated sodium bicarbonate solution and then with water until the solution became neutral to pH paper. It was dried over anhydrous sodium sulphate. Ether was removed. Oily residue was crystallised from methanol. Light yellow crystals were separated out. This was further recrystallised from methanol which afforded crystals of m.p. 95°C. The yield of this product was found to be 300 mg.

Analysis found: C, 77.13%; H, 5.30%

Calculated for $C_{23}H_{20}O_4$: C, 76.8%; H, 5.6%

I.R. (neat) Fig. 28

46. Reaction of α-diazo acetophenone with methyl cinnamate:

50 ml benzene solution of 2.5 gm (0.017 mole) of diazo compound was added drop by drop to 100 ml refluxing benzene solution of 2.75 gm of ether and 0.5 gm of active copper powder in the nitrogen atmosphere. After refluxing for 8 hrs the reaction mixture was cooled to room temperature and worked up as usual. Liquid residue in the flask was distilled fractionating. The heavy liquid b.p. 180°C/2.5 gm was identified as 1-benzoyl-2-carbomethoxy-2'-phenyl cyclopropane by I.R. and elemental analysis and N.M.R. Yield-150 mg.

Analysis found: C, 76.83%; H, 5.58%

Calculated for $C_{18}H_{16}O_3$: C, 77.14%; H, 5.71%

I.R. (neat) Fig. P.20.

Residue in the flask was crystallised from low boiling pet ether and this afforded yellow crystals of m.p. 110°.

CHAPTER - IV

Reactions of diazo ketones with some olefinic systems.

Section-A : Aims and Objects

In the previous chapter we have studied the reactions of different diazo ketones with cinnamic esters largely. In this chapter a comparative study regarding the reactivity of keto carbene with some olefins is recorded. Our want of examination is to isolate the amount of cyclopropane derivatives after reaction according to the procedure adopted earlier.

For the study we selected methyl methacrylate and methyl crotonate to see the effect of methyl group in the position of the methyl acrylate towards keto carbene addition. We have taken cyclohexene and α-methyl 3,4 dihydronaphthelene to see their reactivity towards keto carbene. Reaction of cyclohexene with α-diazo acetophenone and diazo methyl naphthyl ketone have been studied to account for the reactivity of keto carbene towards the same olefin.

Reactions of diazo cyclohexyl ketone with o-methoxy methyl cinnamate and 2-diazo cyclohexanone with α-methyl 3,4 dihydronaphthalene have been studied to see their reactivity.

The structure of the cyclopropyl ketones were confirmed by elemental analysis, I.R. and G.L.C and N.M.R in one case.

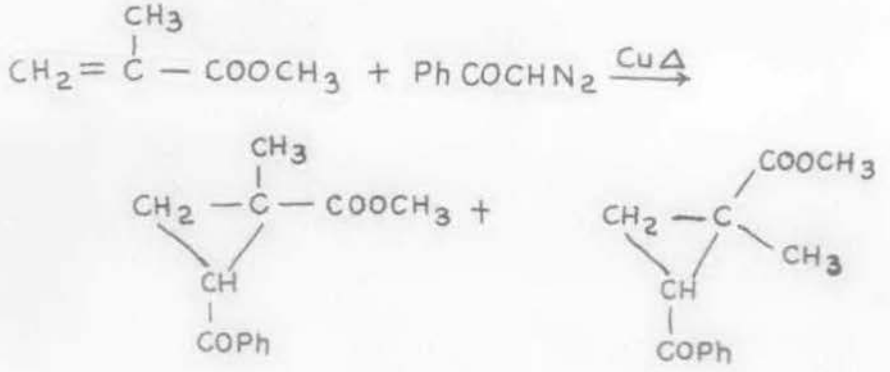
Section-B: Results and Discussions.

Reactions of α-diazo acetophenone with methyl methacrylate.

The copper catalysed decomposition of α-diazo acetophenone was carried out in a large excess of methyl methacrylate. Exothermic reaction occurred and evolution of nitrogen observed. The reaction product was separated into two fractions by vacuum distillation.

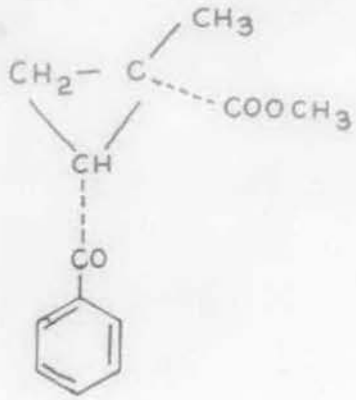
By means of elemental analysis, I.R., G.L.C and N.M.R. spectra, the lower boiling fraction was confirmed to be a mixture of cis and trans-1-benzoyl-2-carbomethoxy-2-methyl cyclopropane, the addition products of benzoyl carbene to methyl methacrylate. G.L.C showed two peaks with different retention time. I.R. at 1735 cm^{-1}, 1670 cm^{-1}, 1010 cm^{-1} indicated that the compound contain one ester, carbonyl group and a cyclopropane ring.

The higher boiling fraction was identified as 1,2, dibenzoyl ethylene. The structure of this compound was confirmed by the comparison of melting points and I.R. spectra with those of the authentic samples prepared according to known methods as well as those isolated earlier.

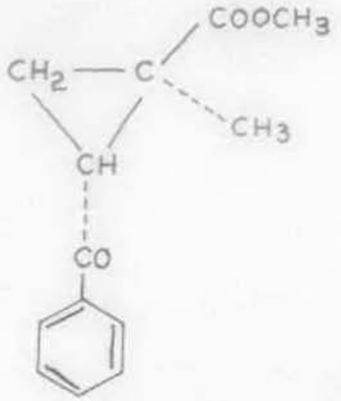


N.M.R spectrum of the reaction product of methyl methacrylate and α-diazo acetophenone.

G.L.C of the reaction products of methyl methaacrylate and α-diazo acetophenone shows a mixture of two products. This is also confirmed by the observation of their N.M.R spectra. One component is confirmed as cis-1-benzoyl-2-carbomethoxy-2-methyl cyclopropane and another as trans isomer.



Cisform



Transform

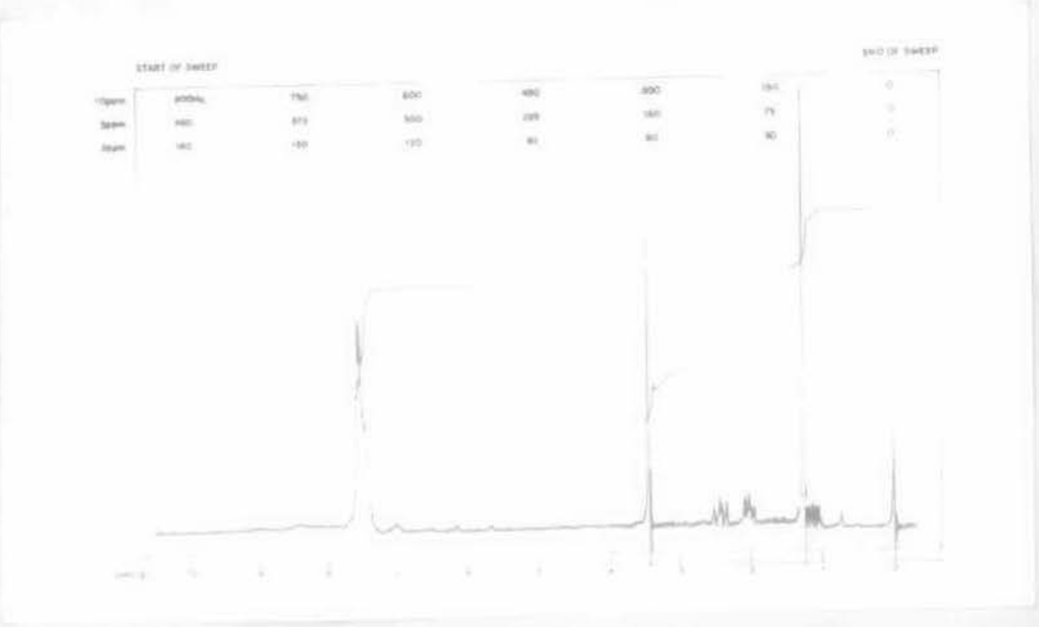


Fig. P.10. N.M.R. spectrum of cis form of the reaction product of methyl metha acrylate and -diazo acetophenone.

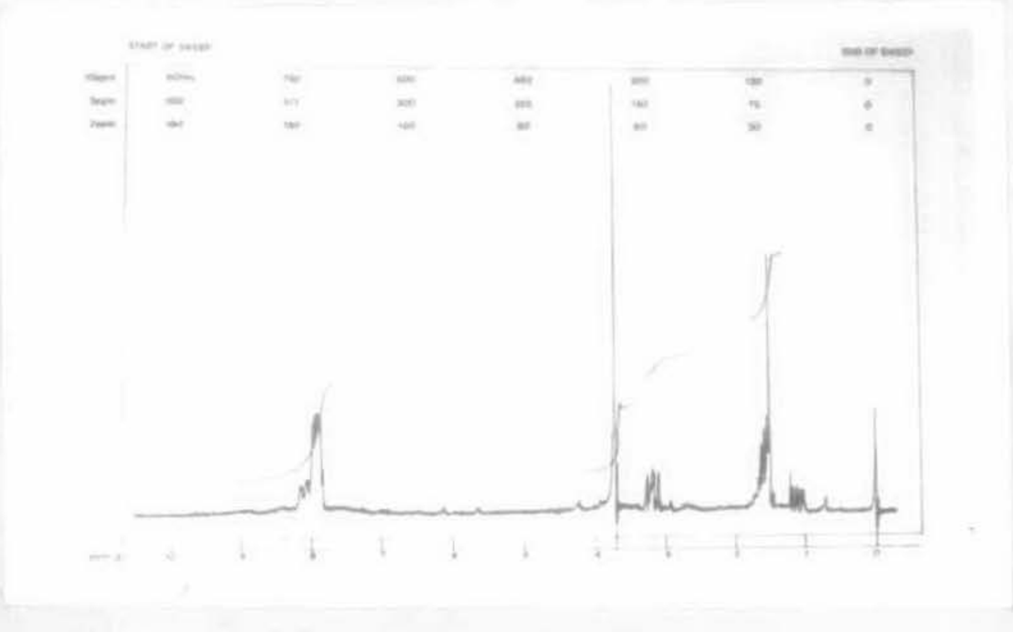


Fig. P.11. N.M.R. spectrum of trans form of the reaction product of methyl metha acrylate and -diazo acetophenone.

N.M.R signals in CCl_4 of the cis form are as follows. Fig. P.10

δ 2.43 (H_a), δ 2.00 (H_b), δ 1.2 (CH_3), δ 3.5 (CH_3 of carbomethoxy group) and δ 7.5 (aromatic proton of benzoyl group). This results are consistent with structure of the cis form shown above.

N.M.R signals in CCl_4 of the trans form are as follows.(Fig. (P.11) δ 3.2 (H_a), δ 1.7 (H_b), δ 1.52 (CH_3), δ 3.75 (CH_3 of carbomethoxy group) and δ 7.9 (aromatic proton of benzoyl group). This results are consistent with the structure of trans form.

It is also observed that a singlet signal of carbomethoxy proton of the cis form appears at higher field than that of trans form. In addition it may be mentioned here that there is no signal in the region of the olefinic proton which definitely indicates that the reaction products are not contaminated with the starting olefin.

Reaction of α-diazo acetophenone with methyl crotonate.

Copper catalysed decomposition of α-diazo acetophenone was carried out in a refluxing benzene solution of methyl crotonate. After usual work up of the reaction mixture, two products were separated by fractional crystallisation. One of these two products was 1-benzoyl, 2-carbomethoxy-2'-methyl cyclopropane and another was trans 1, 2, dibenzoyl ethylene.

In this case the yield of the cyclopropane derivative was considerably poor.

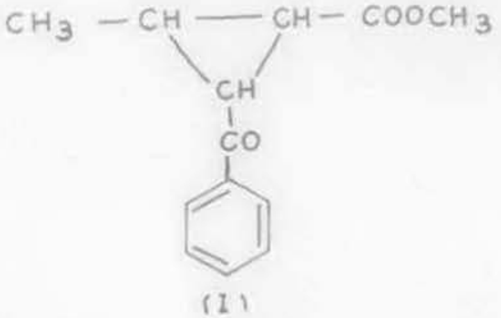
By means of elemental analysis, I.R., U.V., the structure of (1) was confirmed.

I.R. bands at 1710 cm^{-1}, 1660 cm^{-1} and 1010 cm^{-1} indicated that the compound contained ester and carbonyl group together with a cyclopropane ring.

λ_{max} at 280 nm indicate that there was no phenyl conjugation to the cyclopropane ring.

The structure of (II) was confirmed by the comparison of m.p. and I.R. spectra with those of the authentic sample as earlier.

$CH_3-CH=CH-COOCH_3 + PhCOCHN_2 \xrightarrow{Cu\ \Delta}$



(I)

$+ PhCOCH=CH \cdot COPh$

(II)

<u>Reaction of α-diazo acetophenone with cyclohexene</u>.

The reaction of α-diazo acetophenone with cyclohexene in the presence of copper solution and Cu(acac)$_2$ to give 7-benzoyl norcarane was reported by Cowan etal and Matsuji Takebayashi et al (111).

Product was found to be a mixture of syn and anti isomers by elemental analysis, melting point test and I.R. absorption spectra of their 2,4-dinitro phenyl hydrozones. G.L.C. shows two peaks for this product.

We also studied the copper catalysed decomposition of α-diazo acetophenone carried out in a refluxing benzene solution of cyclohexene. After usual work up of the reaction mixture, the product was separated by fractional distillation into its constituents.

Oven temp. 170°C
Injector temp. 230°C
Detector temp. 250°C

Fig- 63. G.L.C. of

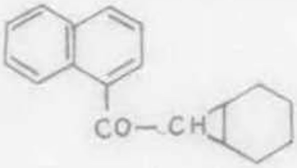
Reaction of α-diazo methyl naphthyl ketone with cyclohexene.

Copper catalysed decomposition of diazo compound was carried out in a refluxing benzene solution of cyclohexene. After usual workup of the reaction mixture, the main product i.e. cyclopropane derivative of cyclohexene was separated by fractional distillation.

The structure of this product was confirmed by elemental analysis, and I.R.

I.R. peaks at 1680 cm^{1}, 1010 cm^{-1} indicated that the compound contained a carbonyl group and a cyclopropane derivative.

G.L.C. showed two peaks which indicated that syn and anti both the isomers were formed. Fig. 63.



Reaction of diazomethyl cyclohexyl ketone with o-methoxy cinnamic ester (methyl).

Copper catalysed decomposition of diazomethyl cyclohexyl ketone was carried out in a refluxing solution of o-methoxy cinnamic ester (methyl). After usual work up of the reaction mixture, attempt was made to separate the constituents by fractional distillation but was not successful. 2:4 dinitro phenyl hydrazone derivative prepared from the product and this

Oven temp. 170°C

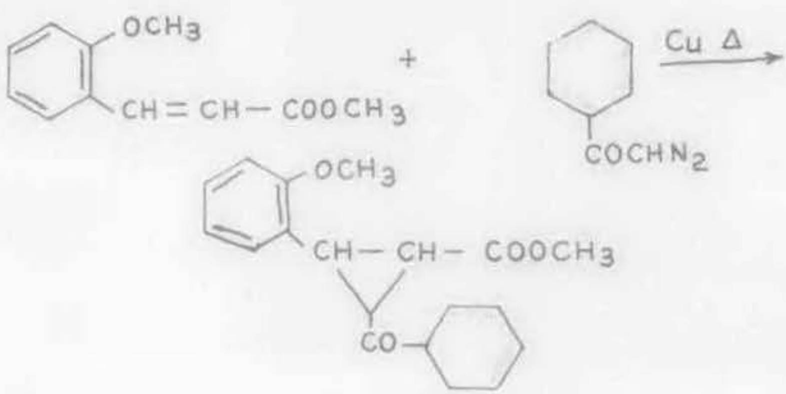
Injector temp. 230°C

Detector temp. 250°C

Fig- 61. G.L.C. of

derivative was crystallised. Elemental analysis is in good agreement with the structure of 1-cyclohexyl-carbonyl-2-carbomethoxy-2' (o-methoxy) phenyl cyclopropane.

I.R. bands of the reaction mixture was taken and it was seen that there was a band at 1010 cm^{-1} which showed that the compound contains one cyclopropane ring. G.L.C. of the product showed only one peak.



Reaction of α-diazo acetophenone with α-methyl 3,4 dihydro naphthalene.

Copper catalysed decomposition of α-diazo acetophenone was carried out in a benzene refluxing solution of α-methyl dihydro naphthalene. After usual work up of the reaction mixture, the liquid product was separated by fractional distillation which was found to be the starting olefin. Residue in the distilling flask on crystallisation gave product which was identified as trans 1,2 dibenzoyl ethylene by means of m.p. and I.R. comparison of those of the authentic sample.

In this case, no keto carbene addition product was formed as the olefinic double bond is trisubstituted and the methyl group which sterically inhibits the approach of the keto carbene to the double bond.

It may be noted that the reactivity of these olefins towards keto carbenes is not large in comparison to the reactivity of the cinnamic ester type compounds (which had been studied).

So it is to be concluded that though cinnamic ester type olefins contain a phenyl moiety attached to the double bond does not affect untowardly the reactivity of the keto carbenes.

Inspection of the table 3, it is seen that methyl methacrylate is more reactive than methyl crotonate. So it may be concluded that olefinic ester unsubstituted in the position will give more cyclopropane derivatives than substituted olefinic esters.

Inspection of the table 4, it is observed that cyclohexene gives ketocarbene addition product whereas α-methyl 3,4-dihydro naphthalene does not react at all under the conditions adopted. The reason probably is that in the latter case the olefinic double bond is trisubstituted which prohibits the formation of any cyclopropane derivative easily under the reaction conditions.

But one interesting observation that stands out is that though cyclohexene does not contains any electron withdrawing or donating group attached to its double bond gives rise to lesser amount of cyclopropane derivatives to that of cyclopropane derivatives recovered in the case of o-methoxy methyl cinnamate and p-methoxy methyl cinnamate. So the reactivity of these two esters perhaps is increased due to the presence of methoxy group in the ortho or para positions.

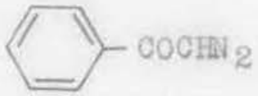
In table 5 , is recorded the reactions of aliphatic diazoketones with cinnamic ester type olefins and aromatic diazoketones with cyclohexene. In the two cases a poor yield of addition compound noted. But one thing that is clear is that the reaction between α-methyl 3,4 dihydronaphthalene and 2-diazo cyclohexanone does not give any cyclopropane derivatives. A trisubstituted double bond adjoining the aromatic ring is considerably less reactive towards the ketocarbenes. This unreactivity somewhat parallels the unreactivity of α-tetralones, acenaphthenone to cyanohydrins formation by the usual routes. Thus steric as well as electronic factors govern the reactivity in the reactions recorded here.

Table - 3

$R_1HC = \overset{R_2}{\overset{|}{C}} - COOCH_3$

Sl. No.	R_1	R_2	Products	Proportion
			Addition Product	Self condensation
1.	H	CH_3	Cis/trans addition 42%	7%
2.	CH_3	H	15%	10%

Table - 4

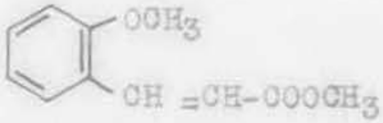
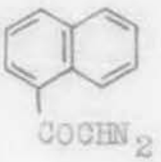
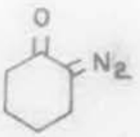
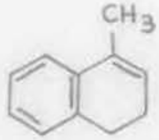


(X Olefin)

Sl. No.	X	Product	
		Addition product	Self condensation
1.	Cyclohexene	27%	8%
2.	α-Methyl 3,4 dihydro naphthalene	-	15%

Table - 5

Y (Diazo ketone) X (Olefin)

Sl. No.	Y	X	Product Addition product	 Self condensation
1.			25%	--
2.			20%	--
3.			--	--

Section-C : Experimental

Melting points and boiling points are uncorrected. Dry solvents were used where necessary. The I.R. spectra were recorded in a Beckmann IR-20 Spectrophotometer. UV absorption spectrum were taken in a Beckmann DU-2 Spectrophotometer. N.M.R spectrum was determined on a spectrophotometer using chloroform -d solution. Containing tetramethyl silane as

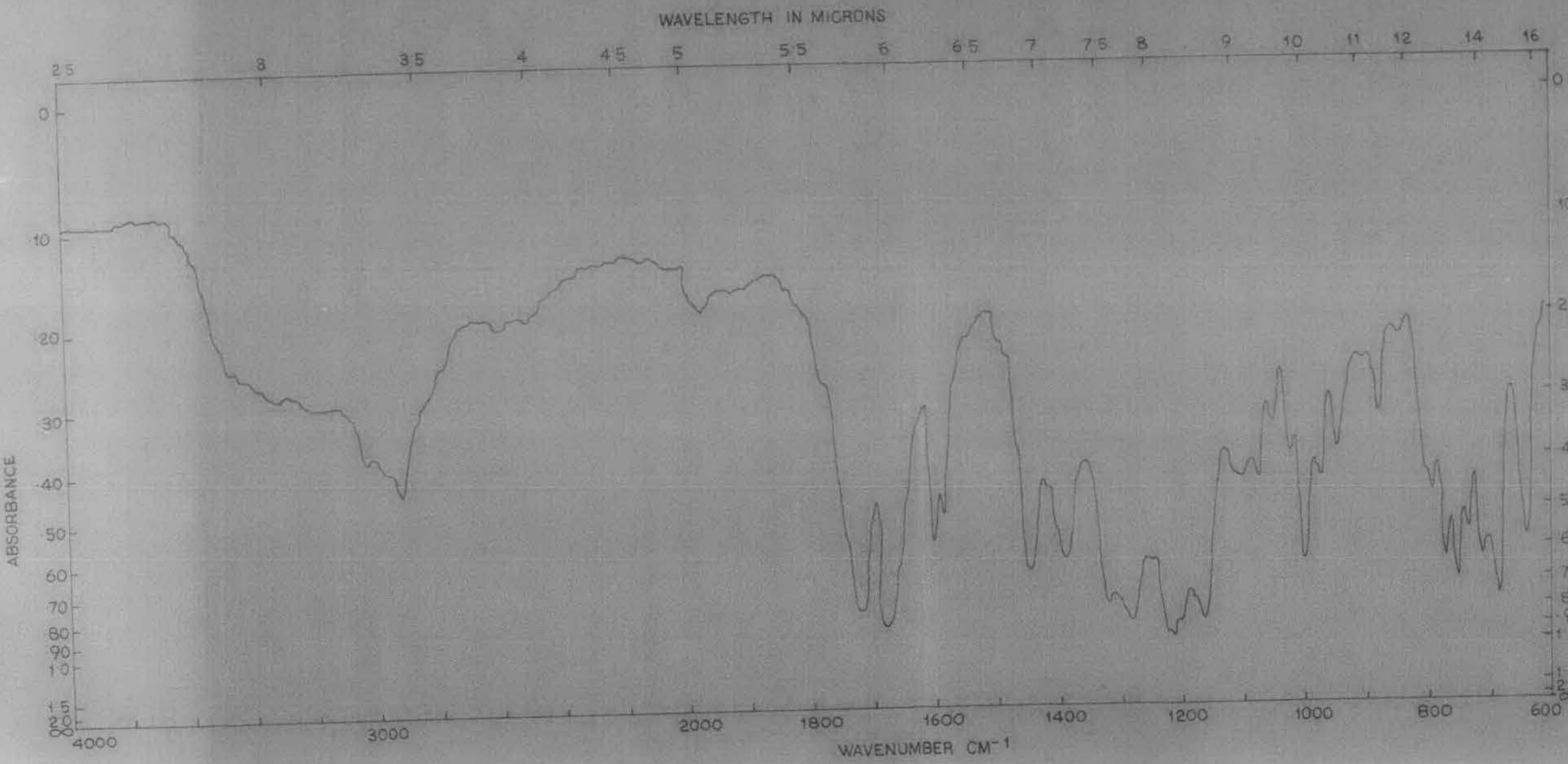


Fig- 38. 1-benzoyl-2-carbomethoxy-2-methyl cyclopropane.

internal reference. G.L.C. were taken in Chemical Laboratory, Poona.

1. Reaction of α-diazo acetophenone with methylmethacrylate:

A solution of 5 gm of α-diazo acetophenone and 0.1 gm of copper powder in 100 ml of methylmethacrylate was warmed gradually under an atmosphere of nitrogen. The evolution of nitrogen was observed at 60°C and then the temperature rose. After two hours when there was no evolution of nitrogen, the excess methyl methacrylate was removed by ordinary distillation. Then the reaction mixture was treated with 200 ml of methanol to remove the polymer of methyl methacrylate. It was filtered and methanol was removed completely. The residue was distilled under reduced pressure b.p. 135°C/2.5 mm. The wt. of the product-2 gm.

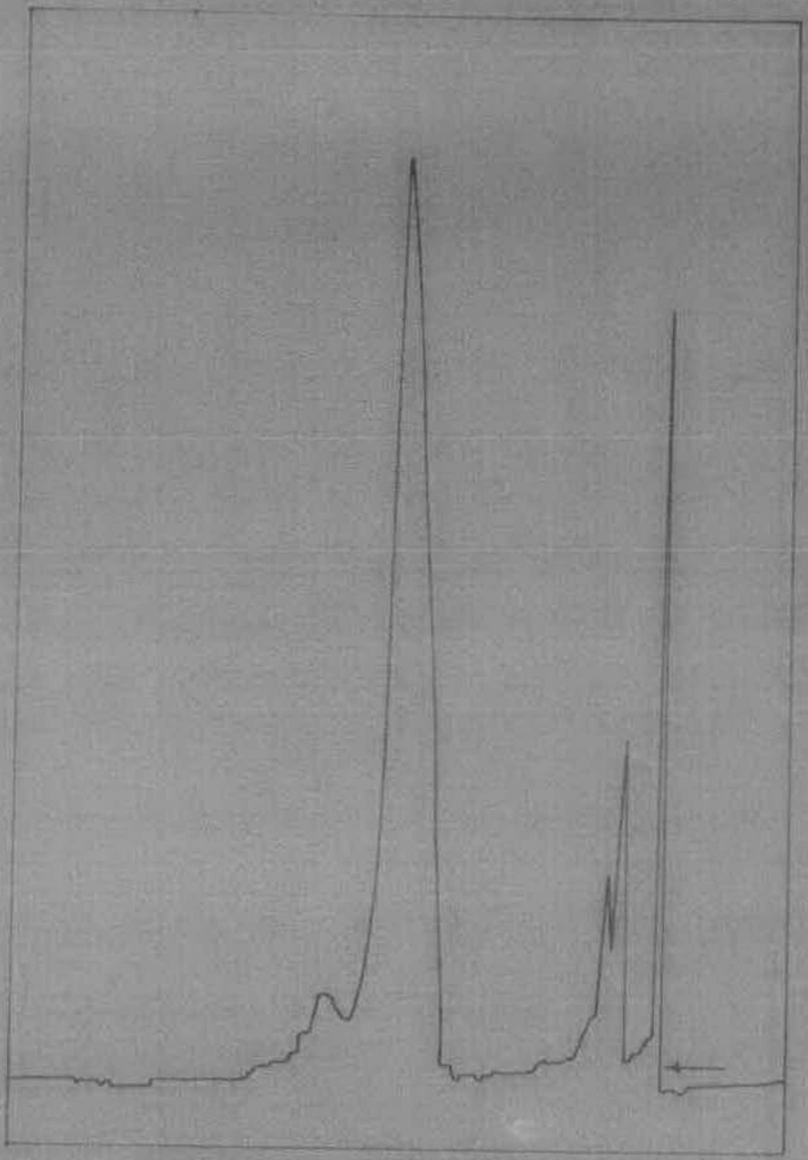
Analysis found: C, 71.13%; H, 6.1%

Calculated for $C_{13}H_{14}O_3$: C, 71.62%; H, 6.47%

I.R. (neat) Fig. 38.

The G.L.C of this fraction showed two peaks ... Fig. 60.

The residue in the flask on fractional crystallisation from light petroleum (60-80°C) gave a yellow crystal. The yellow compound of melting point 110°C was identified as trans 1,2 dibenzoyl ethylene in good agreement with I.R. spectrum and



Oven temp. 190°C
Thermal Conductivity Detector.

G.L.C. of

Fig- 60.

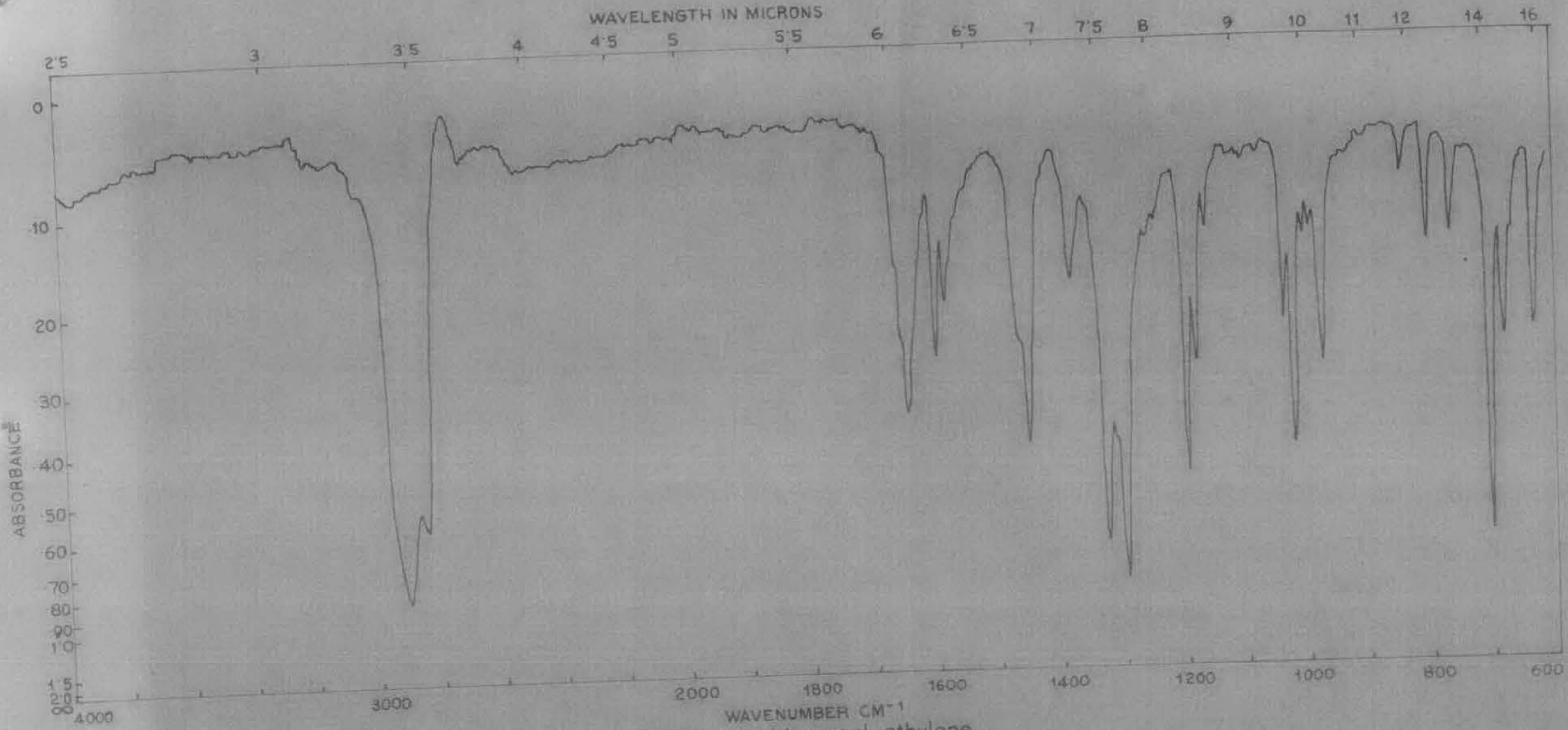


Fig- 40. Trans 1,2 dibenzoyl ethylene.

the m.p. with the authentic sample (Fig. 40) prepared by the copper bronze catalysed decomposition of α-diazo acetophenone.

2. Reaction between α-diazo cyclohexanone and α-methyl 3,4 dihydronaphthalene.

To a benzene solution of 7.2 gm (0.05 mole) of α-methyl 3,4 dihydronaphthalene was added dropwise a benzene solution of 9.3 gm (0.075 mole) of α-diazo cyclohexanone in presence of 0.1 gm active copper powder. The solution was refluxed for 6 hrs. The reaction mixture was cooled to room temperature added copper was filtered out. Benzene was removed completely and the liquid residue was treated with 200 ml of ether and washed first with 5% sodium bicarbonate solution and then with water until the washing became neutral to pH paper. Ethereal solution was dried over anhydrous sodium sulphate and filtered. Ether was removed completely. The liquid residue was distilled at 124°/12 mm. Yield-6 gm.

I.R. of this product is the same as that of α-methyl 3,4 dihydronaphthalene.

From the residue in the distilling flask attempt was made to isolate any product formed, but no identifiable product could be separated in any amount.

Similar reactions of 2-diazo cyclohexanone with trans-o-methoxy methyl cinnamate, or trans-o-nitro methyl cinnamate also failed. In all cases starting olefin was isolated in almost quantitative amount.

3. Reaction of α-diazo acetophenone with α-methyl-3,4 dihydronaphthalene.

50 ml benzene solution of 2.5 gm (0.017 mole) of -diazo acetophenone was added drop by drop to a 100 ml refluxing benzene solution of 3 gm of α-methyl-3,4-dihydro naphthalene and 0.5 gm active copper powder in presence of nitrogen atmosphere. After refluxing for 3 hrs copper powder was filtered out and benzene was removed completely at reduced pressure. The remaining solid residue was extracted with ether and treated with 5% sodium bicarbonate solution and washed with water till neutral. Ethereal solution was dried over anhydrous sodium sulphate and ether was removed. The liquid residue was fractionally distilled, b.p. 120°/7 mm about 2.5 gms of liquid product distilled over and this was identified as starting olefin by comparison of I.R. and boiling point.

The residue in the flask was dissolved in boiling pet ether and this was concentrated and kept in the cold when yellow coloured crystals separated. This was recrystallised from pet-ether and the yellow crystals thus separated was identified as trans-1,2-dibenzoyl ethylene from its I.R. and melting point comparison with those of an authentic compound.

4. Reaction of diazo methyl cyclohexyl ketone with o-methoxy methyl cinnamate.

50 ml benzene solution of diazo ketone prepared from 5 gm cyclohexyl carboxylic acid chloride was added dropwise to a refluxing benzene solution of 6 gm o-methoxy methyl cinnamate and 0.1 gm active copper powder in the presence of nitrogen atmosphere. After refluxing for 6 hrs the copper powder was removed by filtration and benzene was removed completely and residue was treated with ether which was washed first with sodium bicarbonate solution and then with water till neutral. Ether removed and liquid left behind did not crystallise out from common solvents. So this was distilled b.p. 170°/10 mm G.L.C of the product gives only one peak- Fig. 61.

Its 2:4 dinitro phenyl hydrazone derivative was prepared and crystallised from chloroform/methanol solvent mixture. m.p. of this derivative was found to be 216°C. Elemental analysis of this derivative is in good agreement of the derivative of 1-cyclohexyl carbonyl-2-carbomethoxy-2'-(o-methoxy) phenyl cyclopropane.

Analysis found:	N, 11.03%
Calculated for $C_{25}H_{28}O_7N_4$:	N, 11.31%.

5. Reaction of α-diazo acetophenone with methyl crotonate.

50 ml benzene solution of 5 gm of α-diazo acetophenone was added dropwise to 100 ml refluxing benzene solution of

3 gm of methyl crotonate and 1.00 gm active copper powder in presence of nitrogen atmosphere. After refluxing for 6 hrs. Copper powder was filtered out and benzene was removed completely at reduced pressure. The residue was extracted with ether and treated 5% sodium bicarbonate solution and washed with water till neutral. Ethereal solution was dried over anhydrous sodium sulphate and ether was removed. The liquid residue was fractionally distilled, b.p. 135/2.5 mm. This was identified as cyclopropane derivative of methyl crotonate by elemental analysis and I.R. Yield-1 gm.

Analysis found:	C, 71.21%; H, 6.16%
Calculated for $C_{13}H_{14}O_3$:	C, 71.56%, H, 6.42%

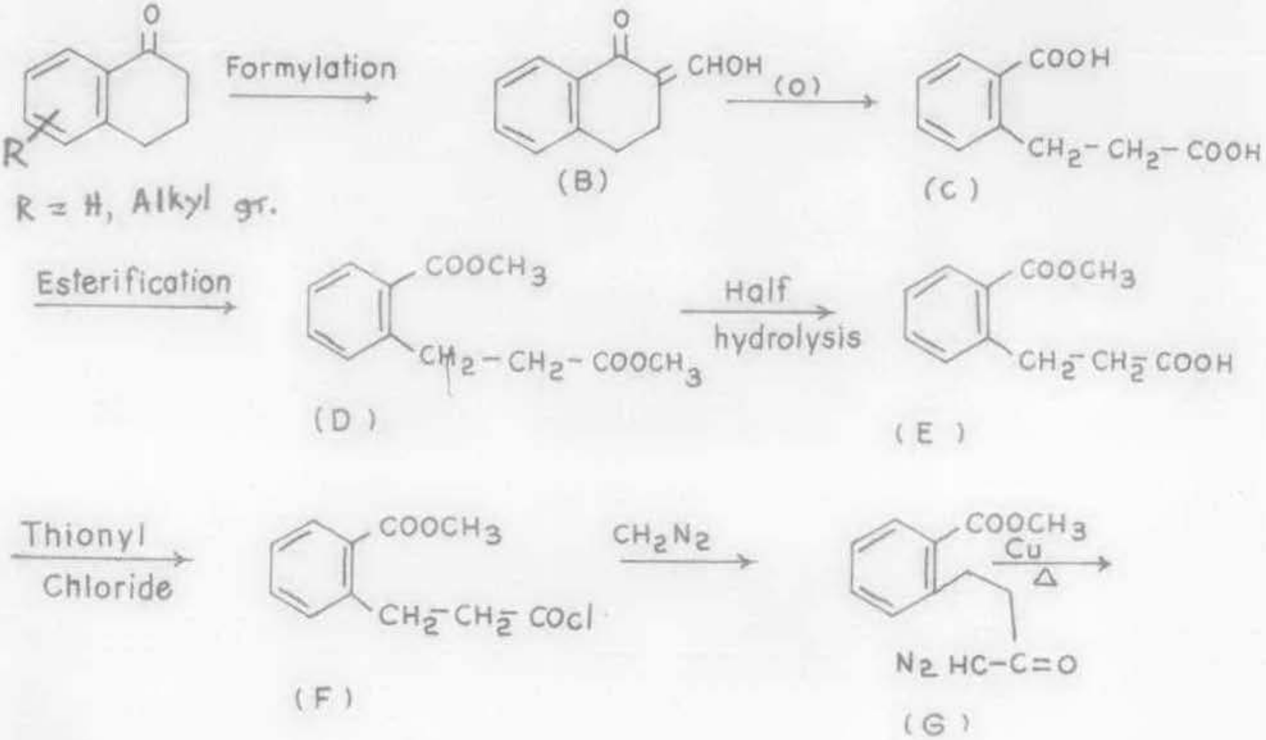
I.R. (neat) Fig. P.19

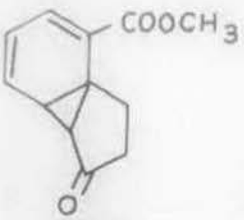
Residue in distilling flask was crystallised from pet ether and the yellow coloured solid was identified as trans 1,2 dibenzoyl ethylene by mixed m.p. method.

Intra molecular ketocarbene addition to aromatic system.

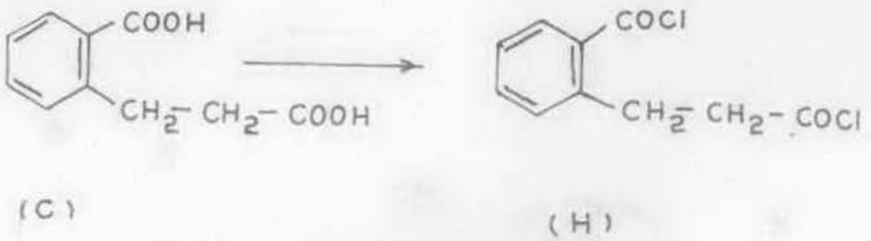
Section-A : Aims and Objects

With a view to study the carbene addition in the intramolecular sense to benzylic hydrogen, the following course of reactions was contemplated.





[A]



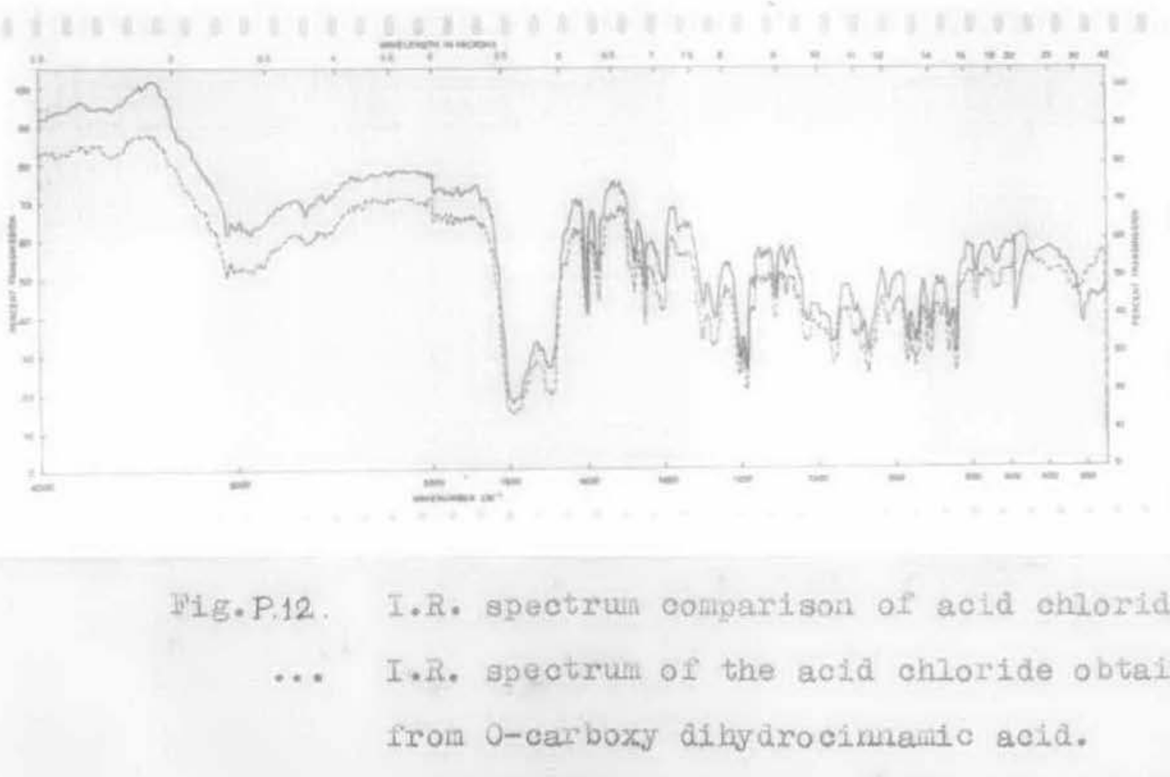


Fig. P.12. I.R. spectrum comparison of acid chlorides

... I.R. spectrum of the acid chloride obtained from O-carboxy dihydrocinnamic acid.

____ I.R. spectrum of the acid chloride obtained from O-carbomethoxy dihydro cinnamic acid.

Section-B: <u>Results and discussions</u>.

In order to prepare the product [A] and others via carbene α-tetralone was chosen first as the starting material. Formylation was done resulting [B]. This on oxidation by potassium periodate and potassium permanganate gave [C] named o-carboxy dihydro cinnamic acid. This is also prepared by another route i.e. by the oxidation and thereby hydrogenation of β-naphthol. This diacid on esterification by methanol and conc. sulphuric acid gave diester [D]. This diester on half-hydrolysis compound [E] was resulted. On treatment of thionyl chloride on [E] instead of giving compound [F] our desired product, diacid chloride [H] of the acid was isolated. We attempted to prepare F with other reagent of preparing acid chloride; but in all cases we were able to isolate only [H]. Some other alternatives were tried which led to more complications.

The structure of [F] was confirmed to be the structure of the diacid chloride [H] of the diacid by comparison of I.R. spectra Fig-P.12. The identification of the other compounds was done by chemical analysis and I.R. spectra.

Some cursory work to prepare [G] by alternative synthetic procedures have not as yet yielded fruitful results. So we could not complete our scheme.

Section-C: Experimental.

Melting points and boiling points are uncorrected. Dry solvents were used where necessary. I.R. spectra were recorded in a Beckmann IR-20 Spectrophotometer.

1. α-tetralone (161):

(a) 2-Benzoyl propionic acid: In a 1 litre three-necked flask, which was fitted with a mechanical stirrer and two efficient reflux condensers, was taken 200 c.c. sodium dried benzene (A.R) and 34 gm of succinic anhydride. The reaction mixture was stirred and in it 100 gm powdered anhydrous aluminium chloride was added at a time. The reaction had started immediately and then the reaction mixture was allowed to reflux gently. On an oilbath with continued stirring for half an hour. The flask was cooled, placed in an ice bath and 150 ml of water was added from a separatory funnel inserted into the top of one of the condensors followed by 50 ml of conc. Hydrochloric acid. Benzene was removed by steam distillation. The hot mixture was transferred to a beaker; The 2-benzoyl propionic acid separate as a colourless oil, which soon solidified. It was cooled and the acid filtered at the pump and washed first with 100 ml of cooled dilute. Hydrochloric acid (1:3)v/v and then with 100 ml of cold water. The crude acid was dissolved in a solution of 50 gm anhydrous sodium carbonate in 275 ml of water. The solution was filtered. The coloured filtrate decoloured with active charcoal. The hot filtrate was acidified with 80 ml of concentrated hydrochloric acid and the mixture was cooled to 0°. The acid filtered and washed thoroughly with cold water and air dried. The m.p. 115°C (Lit. 115°C) Yield-

(b) γ-phenyl butyric acid: Amalgamated zinc from 120 gm of zinc was prepared in a 1 lit. round bottomed flask. In it 75 ml of water, 180 ml of concentrated Hydrochloric acid, 100 ml of pure toluene and 50 gm of 2-benzoyl propionic acid were taken. The flask was fitted with a reflux condenser connected to a gas absorption device. The reaction mixture was refluxed vigorously for 30 hours and during this period, 50 ml of concentrated Hydrochloric acid was added to the reaction mixture of approximately six hours intervals to maintain the concentration of the acid. It was then allowed to cool to room temperature and the two layers separated. The acquous layer diluted with about 200 ml of water and extracted with three 100 ml portions of ether. Toluence layer an ether extracts were combined and washed with water till neutral and dried over anhydrous sodium sulphate. Solvents were removed under diminished pressure on a water bath and the liquid residue was distilled at the vacuum pump. The colourless distillate solidified on cooling which melts at 48°C (Lit. 48°).

(c) α-tetralone: In a 500 ml R.B. flask which fitted with a reflux condenser, and a calcium chloride guard tube which was connected with a tube leading to gas absorption trap, were taken 32 gm of pure and redistilled thionyl chloride and 32 gm of n-phenyl butyric acid. The reaction mixture was heated continuously on a water bath until the acid melts, and it was kept aside. After when hydrogen chloride no longer evolved, the reactions was completed by heating on a water bath for 10 minutes. Excess thionyl chloride was removed completely by distilling on water bath under reduced pressure. The resulting γ-phenyl butyryl chloride used as such for the subsequent step.

To the cold acid chloride, 175 ml of pure carbon disulphide added. The flask cooled in an ice-salt bath. To it, 30 gm of powdered anhydrous aluminium chloride added in one lot, and immediately a reflux condenser with a calcium chloride guard tube fitted to the flask. When the evolution of hydrogen chloride ceased, the reaction mixture warmed slowly to its boiling point on a water bath. It was refluxed for 10 minutes with shaking. The reaction mixture was then cooled to 0°C and the aluminium complex decomposed by the cautious addition with shaking 100 gm of crushed ice and 25 ml of conc. Hydrochloric acid. The mixture was transferred to a R.B. flask and then steam distilled (calcium chloride) first and then tetralone. Oil was separated; and the aqueous layer extracted thrice with 100 ml portions of benzene. Oil and benzene extract combined and dried over anhydrous sodium sulphate. Solvent removed, liquid residue distilled at the pump at 140-45°/15 mm. (Lit. 117-20/10 mm).

2. <u>2-hydroxy methylene tetralone (162)</u>:

A mixture of 4.7 gm molecularised sodium 400 ml of dry benzene, 29.2 gm of 1-tetralone, and 22 gm (-24 ml) of redistilled ethyl formate was placed in a 1 lit. three-necked flask equipped with a mechanical stirrer, stopper and a bent tube. The reaction was initiated by the addition of 1.3 ml of ethyl alcohol. The flask was then placed in a cold water bath and stirred for 6 hrs. After standing over night, 5 ml of ethyl alcohol added and the mixture was stirred for an additional hour. After addition of 40 ml of water, the mixture was shaken in a 1 lit. separatory funnel. The benzene layer washed with 20 ml of water and the combined aqueous layer was extracted with 25 ml of benzene. The aqueous layer acidified with 33 ml of 6N hydrochloric acid, and the mixture was extracted with 100 ml of benzene. The benzene solution washed with 5 ml of saturated sodium chloride solution was dried over anhydrous Na_2SO_4. Solvent was removed at reduced pressure on a water bath. The liquid residue distilled at the pump at 140/10 mm. Yield-15 gm.

The 2:4 dinitro phenyl hydrozone derivative of the above compound prepared which was crystallised from chloroform-methanol solvent mixture. Methanol solvent m.p. 218-20°.

Analysis found: C, 57.34%; H, 4.00%

Calculated C, 57.6%; H, 3.99%.

3. Oxidation of 2-hydroxy methylene tetralone (163):

To a solution of 1.74 gm 2-hydroxy methylene tetralone and 10 ml water solution 0.5 gm NaOH, a solution of 1 gm $KMNO_4$ and 15 gm $Na\ 10_4$ (700 ml water) was added. The mixture was agitated for 5 hours at room temperature.

The oxidants were destroyed with SO_4 and the solution rendered acidic with aqueous HCl. The products were extracted with ethyl acetate. Removal of the solvent after washing of the combined extracts left light yellow crystals. Traces of elemental S were eliminated by dissolving the material in a dil. $NaHCO_3$ aq. and filtering and recovering of the organic acid. This was crystallised from benzene. Yield-450 mg (25%) m.p. 165°C.

4. Preparation of o-carboxy dihydro cinnamic acid (155):

In an open 1 lit. wide mounted R.B. flask were placed 189 (0.094 mole) of o-carboxy cinnamic acid and 550 ml of 10% sodium hydroxide solution. The mixture was warmed to 90° on a steam bath and stirred mechanically. The steam bath was then removed while 54 gm of Nickel Aluminium alloy powder was added through the open neck of the flask in small portions at frequent

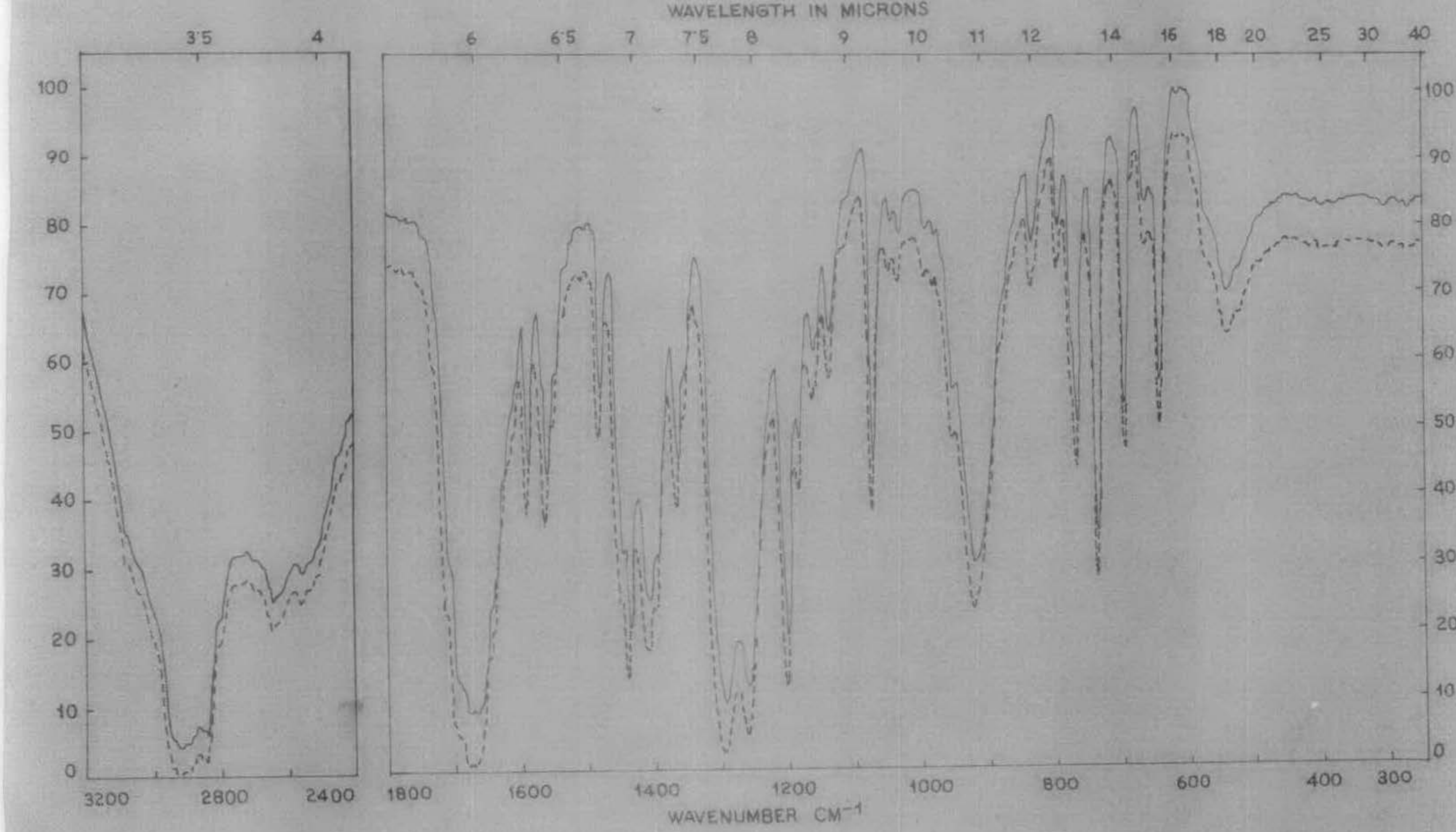


Fig- 44. O- Carboxy dihydro cinnamic acid.

intervals. When the addition of the alloy was complete, the mixture was stirred and maintained at 90°-95°C for 1 hour by warming on a steam bath. Distilled water was added as needed to maintain the total volume at approximately 550 ml. The hot mixture was filtered with suction, and the metallic residue was washed with 50 ml portions of hot water in such a manner that the solid residue was never exposed to air. The cooled filtrate and washings were added dropwise with mechanically stirring to 300 ml of conc. Hydrochloric acid in a beaker at such a rate that the temperature did not exceed 80-85°C. Separation of crystals started immediately when the contents of beaker cooled. The o-carboxy dihydro cinnamic acid was separated by filtration, washed with water and air dried. Yield 14 gm, m.p. 164° (Lit. 165.5 - 167°C).

Gave no depression in melting point on mixed melting point determination with above sample i.e. Oxidation product of 2-hydroxy methylene tetralone. I.R. of this acids prepared from the two route is identical. Fig. 44.

5. Dimethyl o-carboxy dihydro cinnamate:

4.3 gm of acid was dissolved in 100 ml of dry methanol and then adding 5 to 6 drops of conc. Sulphuric Acid, the reaction mixture was refluxed for 6 hrs. It was cooled and methanol was removed completely. The liquid residue was treated with 200 ml solvent ether and washed with 5% sodium bicarbonate

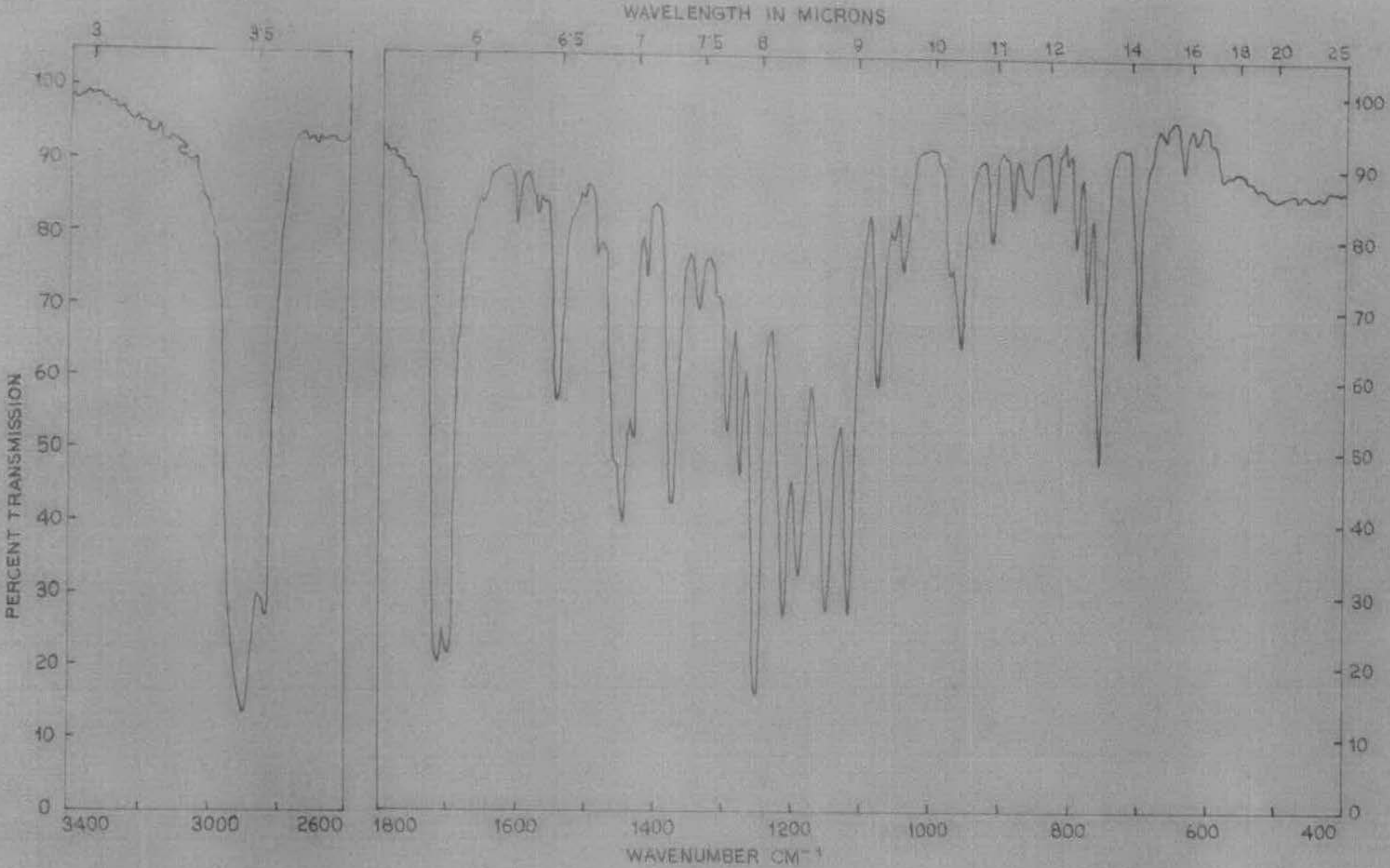


Fig- 45. o- Carbomethoxy dihydro cinnamic acid.

solution and then with water till the solution became neutral to pH paper. It was dried on anhydrous sodium sulphate and it was filtered. Ether was removed completely when a liquid product remained. I.R. peak - at 1710 cm^{-1} which showed ester function. Yield-4 gm. B.P. 180/2 mm.

6. <u>o-carbomethoxy - dihydro cinnamic acid (Half hydrolysis):</u>

3 gm of the ester was treated 5% 16 ml methanolic potassium hydroxide and the reaction mixture was kept overnight. Then the reaction mixture was neutrallised with 5 ml hydrochloric acid and the excess methanol was removed at low temperature. The liquid residue was treated with 100 ml ether and washed with water to remove any free acid. When washing was found to be neutral, to pH paper, the ether solution was dried on anhydrous sodium sulphate and filtered. A liquid residue left behind which solidified on cooling. m.p. 68°C (Crude). This was recrystallised from pet-ether m.p. 74°C. Yield- 1.8 gm I.R. peak at 1710 cm^{-1} and 1680 cm^{-1} showed one ester function and one acid function. (Fig. 45).

Analysis found: C, 63.48%; H, 5.78%

Calculated for $C_1H_{12}O_4$: C, 63.51%; H, 5.82%.

This was identified as o-carbomethoxy-dihydromethyl cinnamic acid.

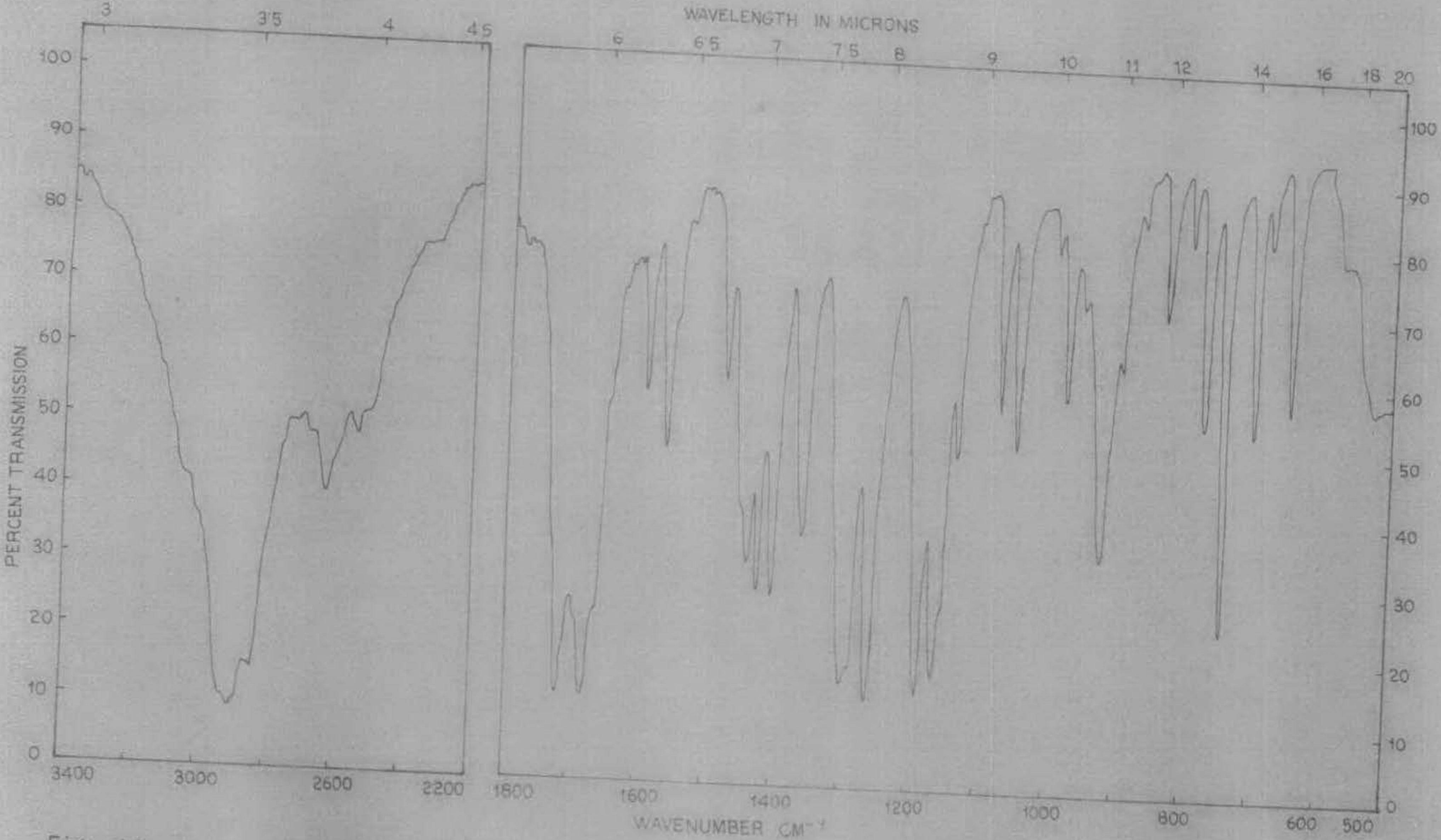


Fig- 46 o- Carboxy di hydro methyl cinnamate

7. Preparation of o-carboxy dihydro methyl cinnamate from o-carboxy dihydro cinnamic acid (141):

A mixture of 0.5 gm diacid in excess dry methanol and 3 drops of conc. sulphuric acid was kept overnight at room temperature. Then excess methanol was removed at 30°. Residue was treated with ether and washed with water to free the mineral acid. The organic layer dried on anhydrous sodium sulphate and filtered. Ether was removed. Residue recrystallised from pet-ether. Colourless needle shaped crystals. m.p. 86°C. Yield - 0.3 gm.

I.R. peak at 1710 cm^{-1} and 1680 cm^{-1} showed that this compound contains one ester and acid group. Fig. 46.

Gave a depression in melting point on mixed melting point determination with the above half ester (6). So these two compounds were different.

Analysis found:	C, 63.45%; H, 5.71%
Calculated for $C_1H_{12}O_4$	C, 63.51%; H, 5.82%.

8. α-methyl 3,4 dihydro naphthalene ( ):

4.15 gm of clean magnesium fillings dried in vacuum covered with 25 c.c. dry ether in a three necked R.B. flask, then 15 c.c. Methyl Iodide in 100 c.c. ether added dropwise; first lot rapidly, while the condenser was cooled with ice-cooled water and addition of the methyl iodide slowed down to maintain refluxing. The flask was warmed on steam bath for 5-6 hrs when all magnesium dissolved. The flask was placed in a ice-bath. 20 gm of 1-tetralone in 70 c.c. ether was added dropwise. After standing 1.5 hr. (first in ice-bath, then at room temperature) the flask was heated on water for half an hour. Reaction mixture was kept overnight. The reaction product decomposed with 17 ml conc. sulphuric acid in 70 c.c. water in the cold. The aqueous layer washed with ether and combined extract dried on anhydrous sodium sulphate and ether was removed and distilled at 115°/10 mm. The distillate was then taken in 200 c.c. ether and washed with 10% hyposolution and washed with water till neutral. Ether was removed and the residue was distilled at 110-15°/10 mm. Yield-10 gm. I.R. of this product showed no carbonyl band.

9. Preparation of trans-o-chloro-(α-naphthyl) cinnamic acid (182):

A mixture of 14 gms (0.1 mole) of o-chlorobenzaldehyde 28 gms (0.15 mole) of 1-naphthyl acetic acid, 50 ml (0.54 mole) of acetic anhydride and 10 gms (0.1 mole) of trimethyl amine was refluxed for 30 minutes in a 250 ml flask. The solution was cooled to 90°C, and 50 ml of cold water was added over a period of 5 mins, at a rate that maintained the temperature above 90°C. Trans-o-chloro-(1-naphthyl) cinnamic acid precipitated out. It was separated by filtration and washed with

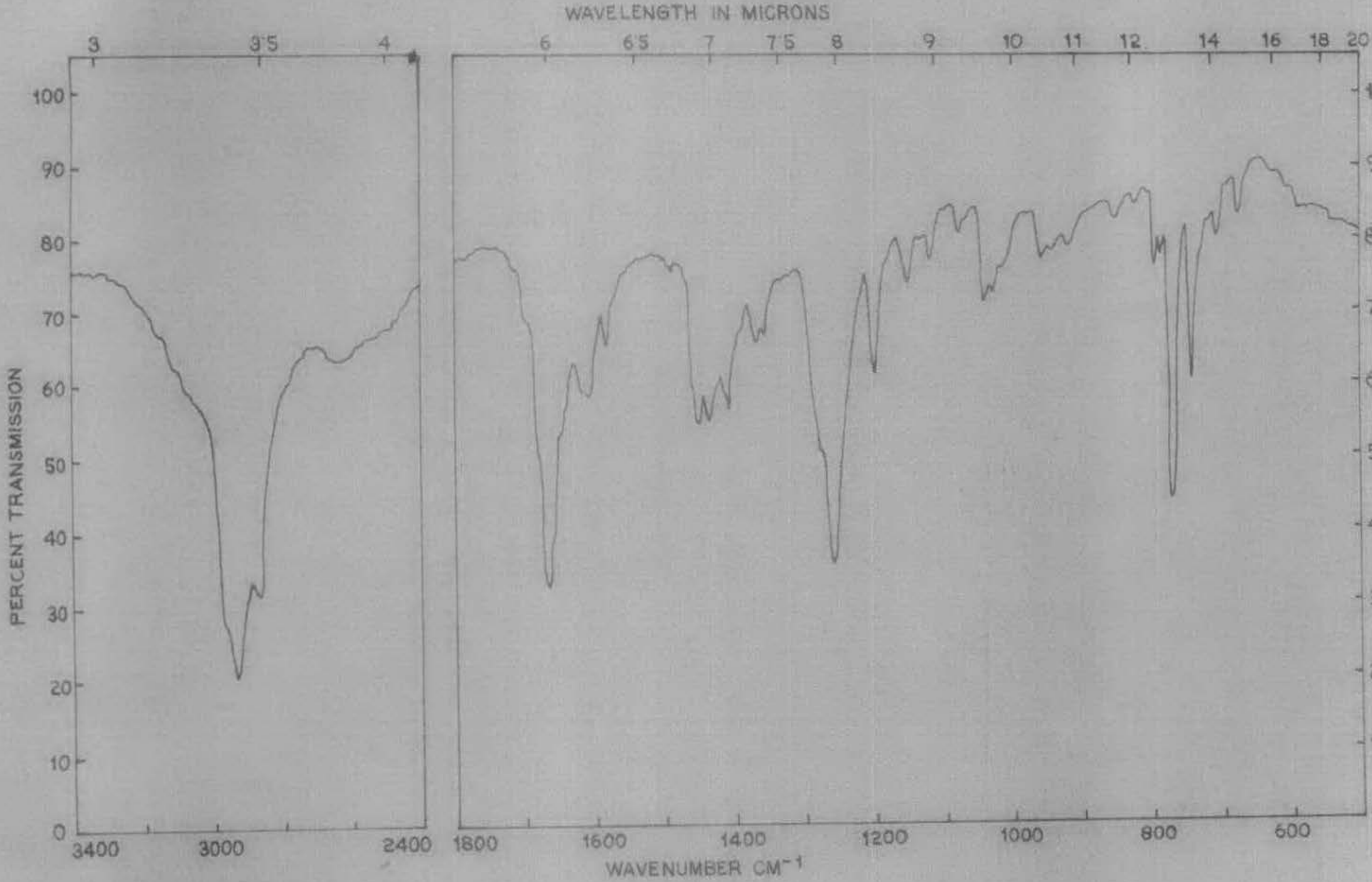


Fig- 47. Trans-o-chloro-α naphthyl cinnamic acid.

30 ml of 50% acetic acid and with water. It was air dried and recrystallised from methanol several times giving a light yellow coloured crystals of m.p. 160-161°C. I.R. peak at 1680 cm^{-1} showed that this is a conjugated acid and also gave positive test for an acid function. Yield-18 gms.

Analysis found: C, 73.28%; H, 4.13%

Calculated for $C_{19}H_{13}O_2Cl$ C, 73.91%; H, 4.24%

I.R. (neat) Fig. 47.

CHAPTER - VI

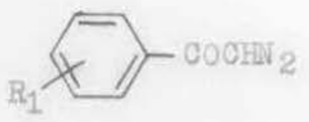
Relative catalytic activity of metal ions in carbenes reactions.

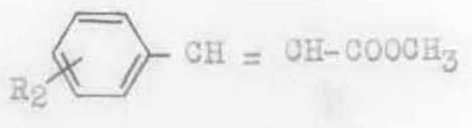
Section-A : Objects, Results and Discussions.

In the carbene chemistry of ketocarbene addition to olefinic double bond is catalysed by copper poweder or it's salts. With a view to see the effectiveness as a catalyst of the copper powder or it's salts in our system, we have taken the same reac ting substrates but different catalysts. Other condition of the reaction was maintained the same as possible.

The result obtained is given in table 6 . It is seen that in our system of ketocarbene addition, the active copper powder was more effective than the other copper salts. In this study active copper powder, anhydrous copper sulphate, cuprous chloride, CuO/Cu and palladium acetate were used as catalysts. Among these, active copper powder gave rise to larger amount of ketocarbene addition product. But in the case of palladium acetate no trace of addition product isolated. So we can conclude that in these reactions, palladium acetate did not help in decomposing diazoketones as we could not isolate also the dimer of ketocarbene.

Table - 6





Sl. No.	Catalyst	R_2	R_1	Refluxing time	Product	
					Addition	Self Condensation
1.	Cu-powder	p-OCH_3	H	10 Hrs.	45%	10%
2.	Anhydrous Copper sulphate	"	H	"	30%	12%
3.	Cuprous chloride	"	H	"	32%	10%
4.	CuO/Cu	"	H	"	35%	8%
5.	Palladium acetate	"	H	"	-	-
6.	Cu-powder	P-No_2	H	"	18%	12%
7	$CuSO_4$(anhydrous)	"	"	"	15%	10%
8.	CuCl	"	"	"	18%	10%
9.	Palladium acetate	"	"	"	-	-

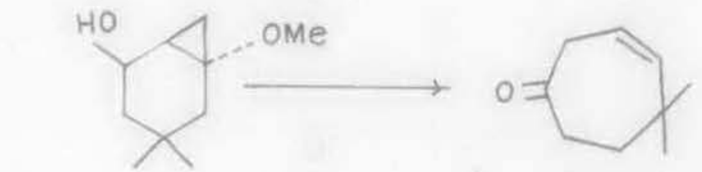
CHAPTER - VII

Potassium t-butoxide treatment on cyclopropyl ketones.

Section-A : Aims and objects:

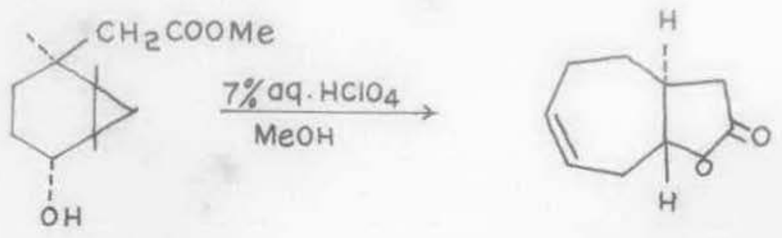
It is reported that cycloprane derivatives undergo different type of rearrangements when these were treated with basic or acidic substances and even with some solvent or by heating only.

E.Wenkart et al (168) found that cyclopropane derivative [A] produced [B] in presence of HCl



[A] [B]

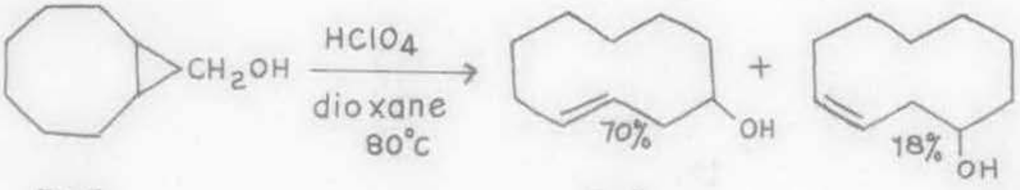
When [C] (169) suffered a rearrangement to produce [D] in presence of aqueous $HClO_4$.



[C]

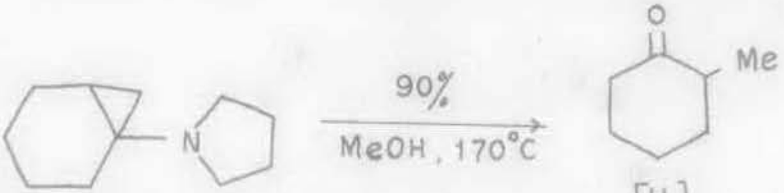
[D]

Similarly when [E] (170) was treated with $HClO_4$, F was produced.



[E] [F]

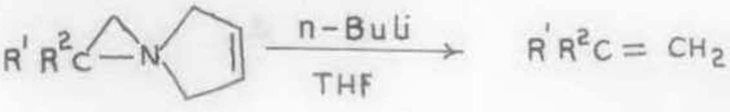
M.E.Kuchne and J.C.King (171) found that at 170°C in presence of 90% methanol, the cyclopropane derivative [G] produced [H]



[H]

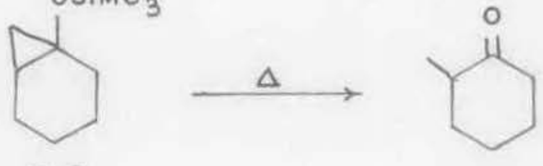
[G]

When [I] (172) was treated with n-BuLi in THF [J] was formed.



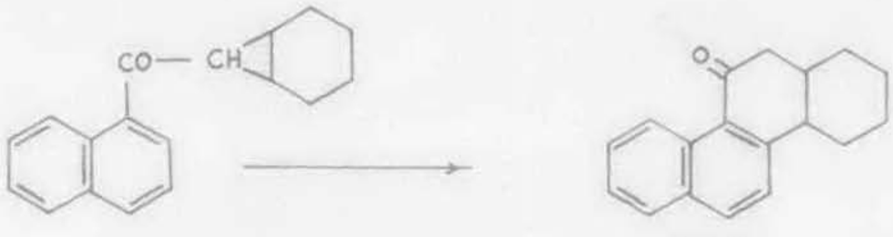
[I] [J]

Simple heating of [K] produced [L]



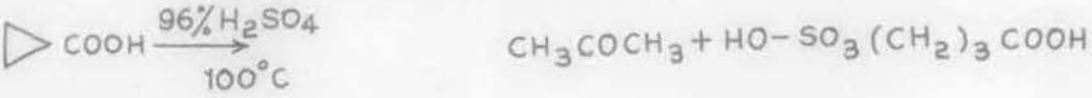
[K] [L]

In presence high boiling solvent compound [M] was converted into [N].



[M] [N]

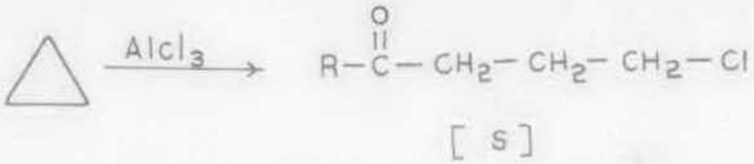
Treatment of 96% H_2SO_4 on [O] and [P] (173) produced [Q] and [R] respectively.



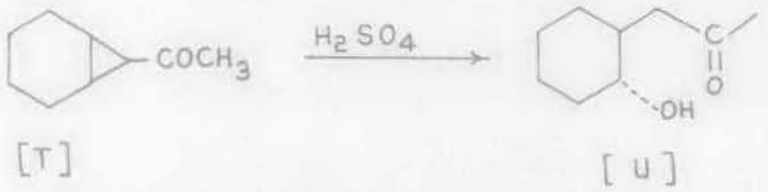
[o] [q]

[P] [R]

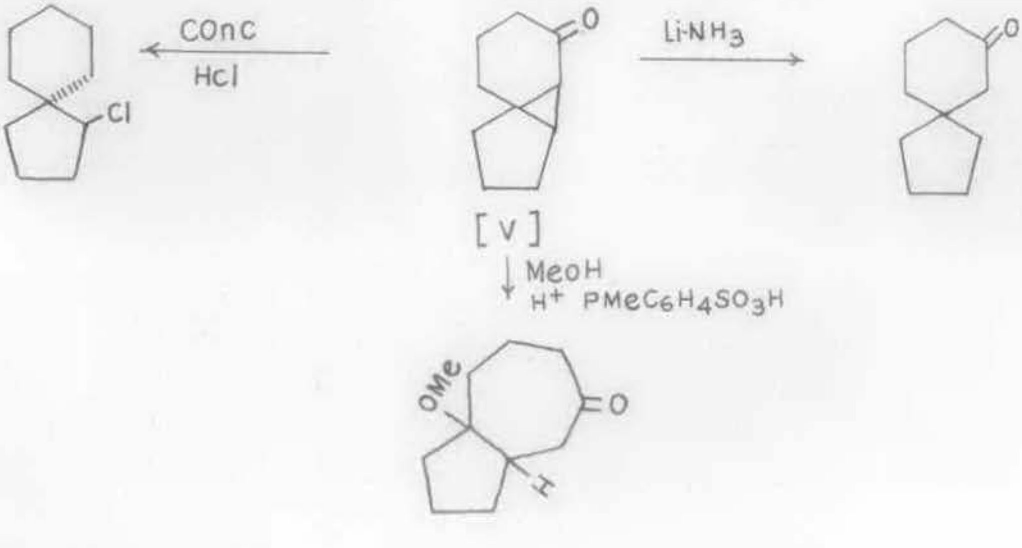
When simple cyclopropane was treated with $AlCl_3$, it was rearranged to /¯S_7 (174).



When cyclopropyl ketone /¯T_7 was treated with H_2SO_4, /¯U_7 was formed.



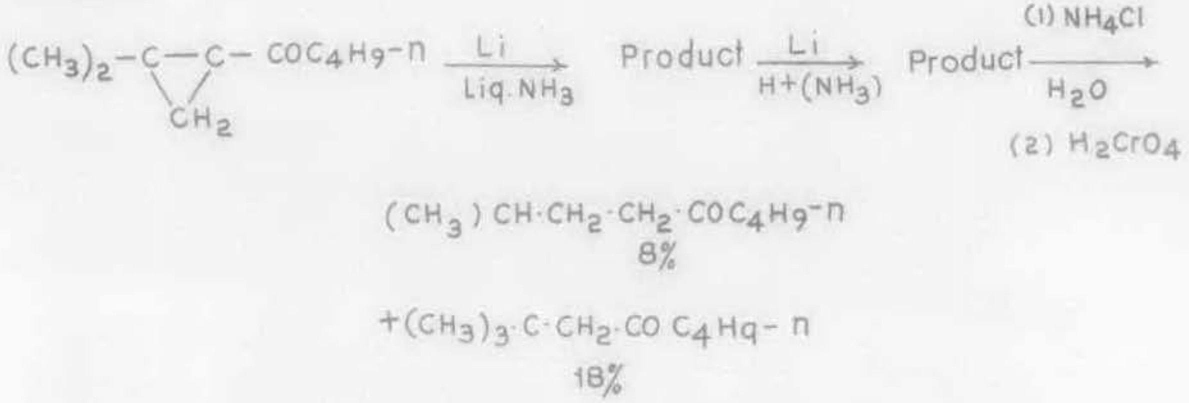
When cyclopropane derivative /¯V_7 (175) was treated $LiNH_3$, methanolic solution of p-toluene sulphonic acid or conc. HCl, it rearranged to different products.



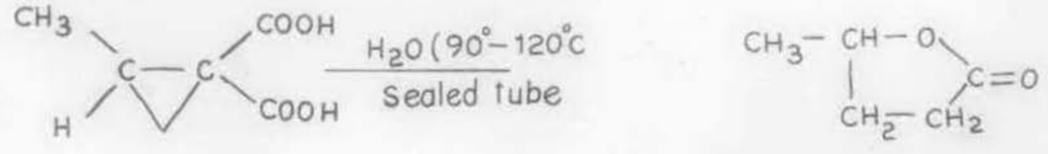
A simple reductive cleave of cyclopropyl ketones has been (176) effected by irradiating a methanolic solution of a cyclopropyl ketone and tri-n-butyl hydride with ultraviolet.

Metal reductions have also been used to cleave C–C bonds in the case of cyclopropane derivatives (177), specially cyclopropyl ketones (178).

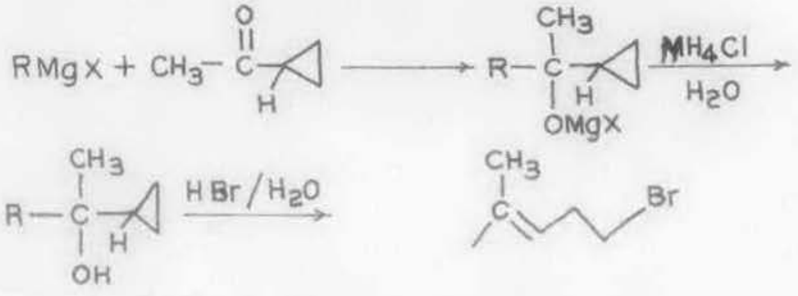
When following cyclopropyl ketone (179) was subjected to Li in liquid NH_3 and thereby other reagents it broke into two parts.



When following cyclopropane (180) was treated with H_2O at 90°–120°C in a sealed tube it suffered rearrangement.



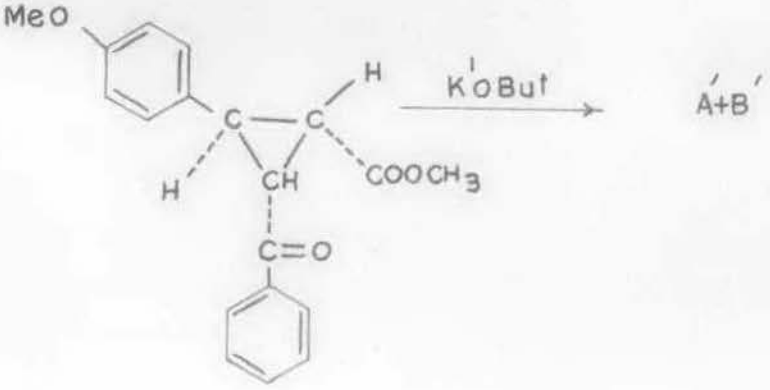
By the cleavage of cyclopropane derivative (181) Homollylic bromides and iodides were prepared.



So we were proposed to see the effect of potassium tert. butoxide on the cyclopropyl ketones. It was our attempt to note what type of change occurred when cyclopropyl ketones were treated with potassium t-butoxide. With this view in mind we treated potassium tert. butoxide on 1-benzoyl-2-carbomethoxy-2' (p-methoxy) phenyl cyclopropane.

Section-B: Results and discussion:

When 1-benzoyl-2-carbomethoxy-2'-(p-methoxy) phenyl cyclopropane in presence of potassium t-butoxide gave two products A' and B'



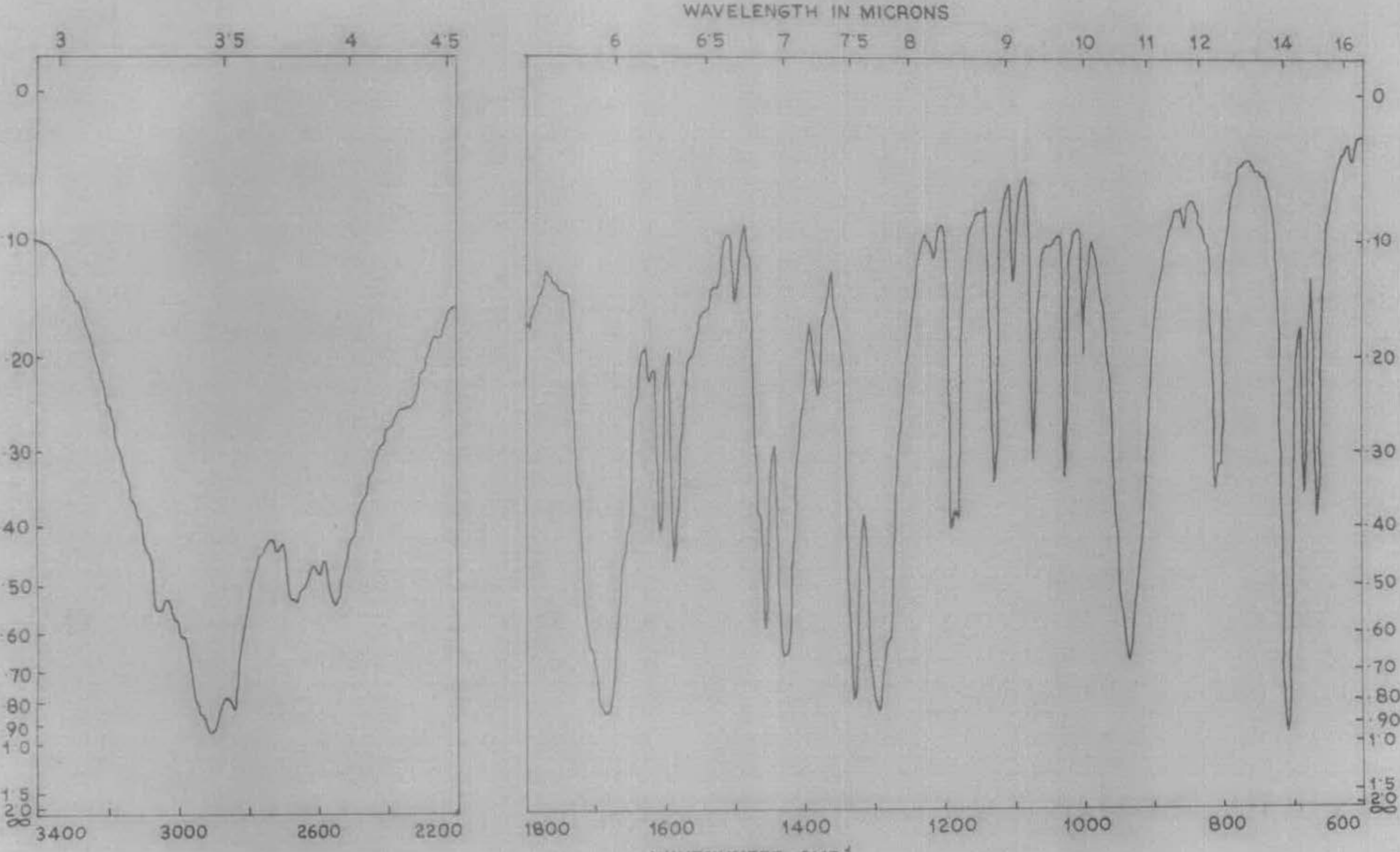

WAVELENGTH IN MICRONS
3
3·5
4
4·5
6
6·5
7
7·5
8
9
10
11
12
14
16
0
·10
·20
·30
·40
·50
·60
·70
·80
·90
1·0
1·5
2·0
∞
3400
3000
2600
2200
1800
1600
1400
1200
1000
800
600
WAVENUMBER CM⁻¹

Fig- 58.

A' was confirmed to be an acid by the usual test of an acid function. The structure of A' was confirmed to be the structure of benzoic acid from the observation of melting point, mixed m.p. I.R. bands, elemental analysis and mass spectrum.

The possible structure of B' was established on the observation of elemental analysis, I.R. and N.M.R. spectrum.

I.R. bands of this part at 1710 cm^{-1} and 1010 cm^{-1} indicated in presence of an ester function and a cyclopropane ring.

N.M.R spectrum of the compound [B'].

From the I.R observation of the part B', it is seen that this fraction contains an aromatic system having an ester function and a cyclopropane ring.

N.M.R spectrum of this component also shows signals at δ 6.8 to δ 7.15 (phenyl proton), δ 3.75 (CH_3 of carbomethoxy group) 3.85 (CH_3 of methoxy group), δ 2.5 (cyclopropane proton), δ 1.8 (cyclopropane proton), δ 1.55 (cyclopropane proton) and δ 1.25 (cyclopropane proton).

The signals δ 2.5 for H_a, δ 1.55 for H_c and δ 1.25 for H_d can be assigned.

So from the studies of elemental analysis, I.R. and N.M.R, the probable structure of this part [B'] is as below.

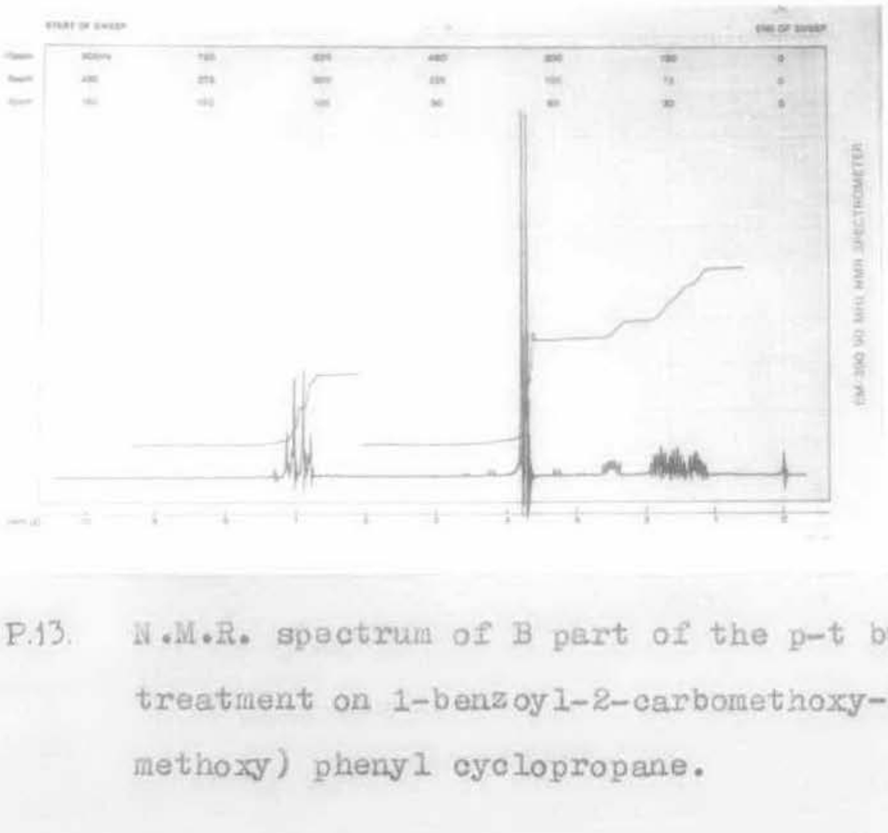


Fig. P.13. N.M.R. spectrum of B part of the p-t butoxide treatment on 1-benzoyl-2-carbomethoxy-2' (p-methoxy) phenyl cyclopropane.

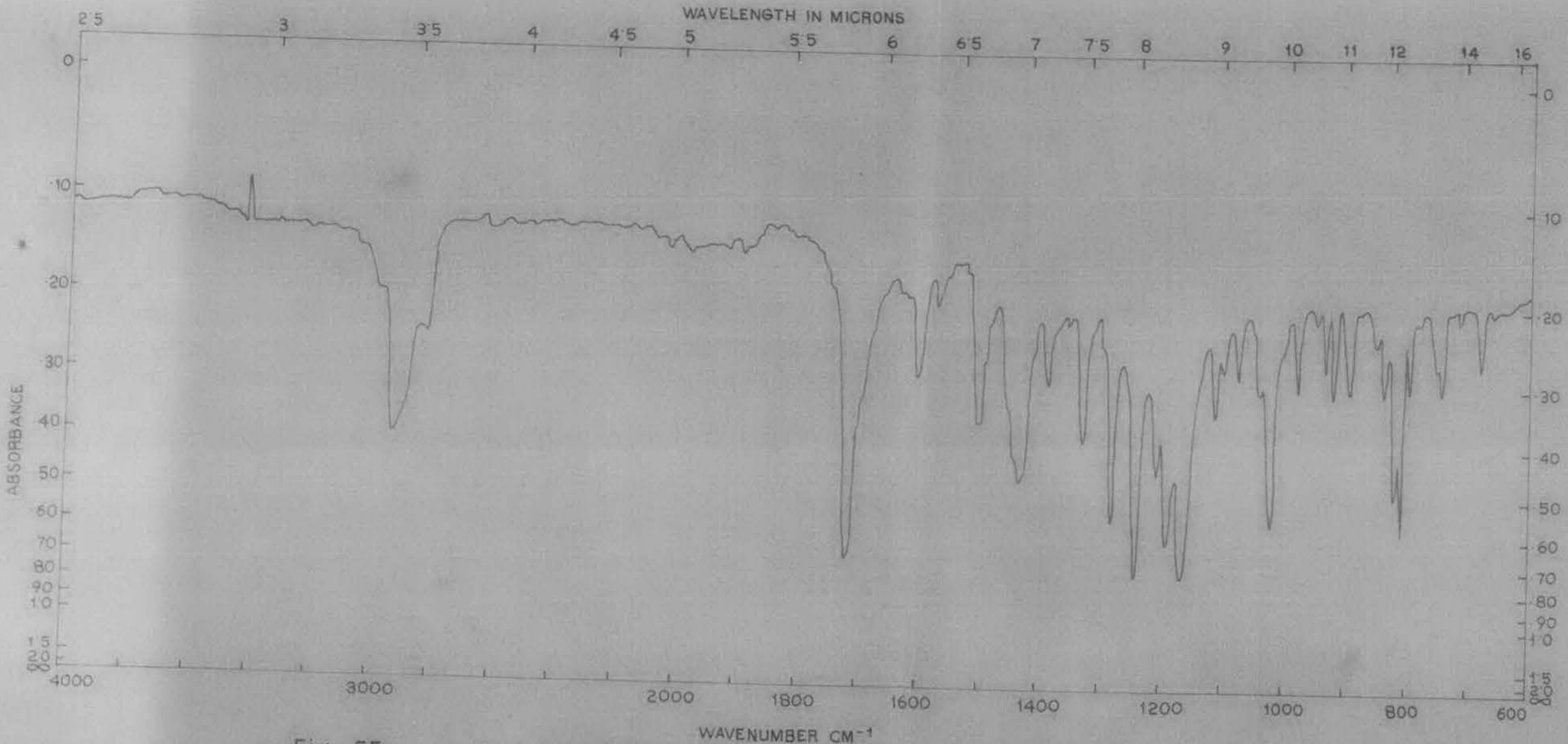


Fig- 55. 1- Carbomethoxy-2-(p-methoxy) phenyl cyclopropane.

crystallised from low boiling pet-ether. Yield-75 mg m.p. 121°C. No depression of m.p. was found when mixed m.p. with benzoic acid was seen Its I.R spectrum was identical with that of benzoic acid. (Fig.58)

Analysis found : C, 68.53%; H, 5.17%

Calculated for $C_7H_6O_2$: C, 68.85%; H, 4.91%

M/e = 122 (Fig.p 17)

(b) Ether portion: Ethereal solution was treated with dil. aqueous ammonium solution and then it was washed with water till neutral. It was dried over anhydrous sodium sulphate and ether was removed. Solid residue was crystallised from low boiling pet-ether. Colourless crystals of m.p. 46°C was filtered.Yield - 80 mg I.R. (neat) (Fig.55.).

Analysis found: C, 69.70%; H, 6.47%

Calculated for $C_{12}H_{14}O_3$: C, 69.99%; H, 6.79%

N.M.R spectrum (Fig.P13.)

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PART - II

Reactions of diazomethane with cinnamic esters and other olefins.

CHAPTER - I

Section-A : A short review on the structure of diazomethane and 1,3 cyclo additions and various reactions of diazomethane with olefinic double bonds.

Diazomethane is an extremely useful reagent principally employed for the methylation of compounds containing active hydrogen. The reaction of diazomethane with aldehydes and ketones can be used as a method for chain or ring homologation for epoxidation. The homologation of carboxylic acids, the Arndt Eistert reaction, is a particularly valuable synthetic procedure.

Diazomethane has been found to add to certain types of unsaturated bonds to give pyrazoles and pyrazolines and some aromatic compounds give cyclopropane derivatives. The catalytic decomposition of diazomethane by cuprous salts or by irradiation in the presence of olefins or aromatic compounds gives cyclopropanes or cycloheptatriene derivatives. Various other insertion reactions have also been reported.

The structure of diazomethane may be expressed by the following mesomeric forms.

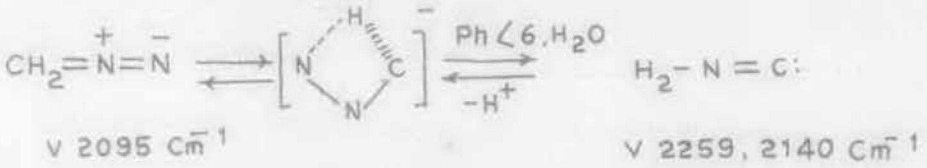
$$\underset{Ia}{H_2\overset{+}{C}-N=\overset{-}{N}} \longleftrightarrow \underset{Ib}{H_2C=\overset{+}{N}=\overset{-}{N}} \longleftrightarrow \underset{Ic}{H_2\overset{-}{C}-\overset{+}{N}=N} \longleftrightarrow \underset{Id}{H_2\overset{-}{C}-N=\overset{+}{N}}$$

$$\longleftrightarrow \underset{Ie}{H_2C=N\equiv N}$$

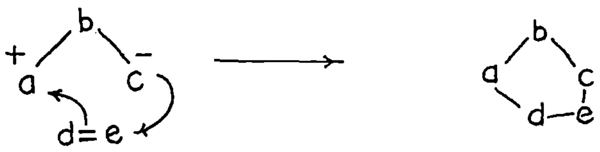
Undoubtedly, the ground state of the molecule is well represented by the two structures 1b and 1c, while 1a, 1d and 1e are less significant. However, it is just these higher energy (less contributing forms) which govern the electrophilic and neucleophilic character of these compounds.

Inspection of these 1a, 1d, 1e structures also disclose that the formal charges are inherent by interchargeable forms. Therefore it is in general, not meaningful to ascribe to certain centre electrophilic activity and to the second one nucleophilic activity.

The tautomerism of diazomethane has been discussed by Muller and Ludsteck



1,3-dipole may be defined as a system a-b-c, in which carries a formal positive charge (more or less vacant orbital) and (c) is an anionic centre having free electron pair. In the union of such a 1,3-dipole with a multiple bond system d = e, the so called dipolarophile, a cyclic shift of electrons accompanies and consummates closure of a five membered ring.

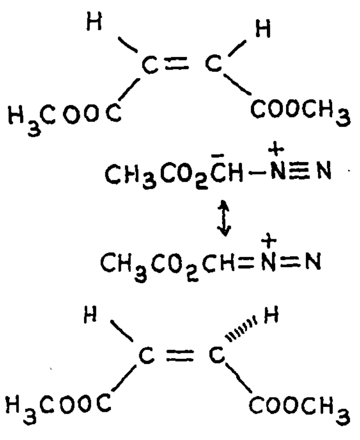


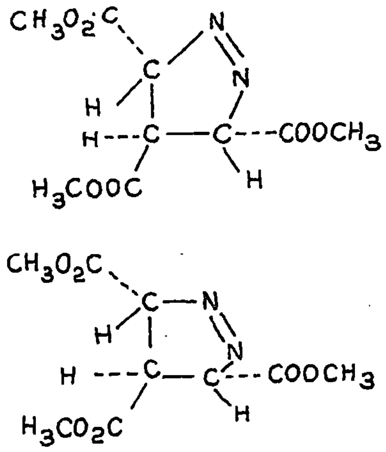
Compounds in which the positive centre a is an electron deficient carbon, nitrogen or oxygen atom are not capable of long lived existence. When the 1,3-dipole is an isolable substance, then the symbol employed above can only refer to a resonance structure of minor weight. Stabilisation of the reactive system is possible if a lone pair at fills the electron gap at a by forming an additional bond.

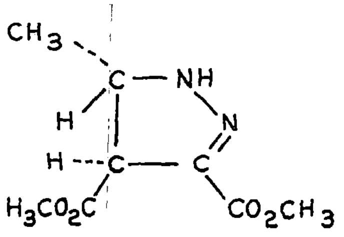
R.Carrie *et al* have shown that these reaction when carried out under no irradiation at low temperature proceed by way of the pyrazoline.

Formation of five membered rings through the addition of diazoalkanes to α β unsaturated esters was first observed in 1888 by Buchner (2).

The adduct from methyl diazoacetate and dimethyl fumarate is not the expected 1-pyrazoline, but instead the more stable 2-Pyrazoline-3,4-5bicarboxylate.







It is seen that both the esters give same product and this violation of cis addition is due to the tautomerisation of the initial 1-pyroazolines to 2-pyrozoline and thus loss of asymetric centre in question had occurred.

The addition of diazomethane to compounds containing carbon-carbon double bond has been found to give pyrazolines in high yield (3). In some cases unstable pyrazolines were formed which then decomposed to give either cyclopropane or C-methyl group. McGreer <u>et al</u> have suggested mechanism and conditions favouring cyclopropane or olefin formation.

The mechanism of the formation of pyrazolines has been the subject of much study and the original two stage process involving a diazonium betaine 4,5,6 (Fig. 54).

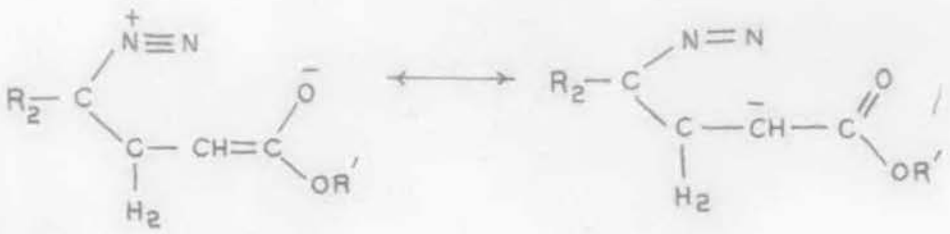


Fig - 54

This should readily lose nitrogen and should show rate enhancement with increasing solvent polarity. Many reactions, however, are known in which the pyrazoline are formed in excellent yield and for which there is no evidence of the production of cyclopropane intermediate. The addition of diphenyl diazomethane to dimethyl fumerate using a number of solvents has been investigated and it was found that there is little difference in the rate factors (8). It was thus postulated by Huisgen (7) that the addition of diazoalkanes to carbon-carbon double bonds occurs by multicentre process (Fig. 55).

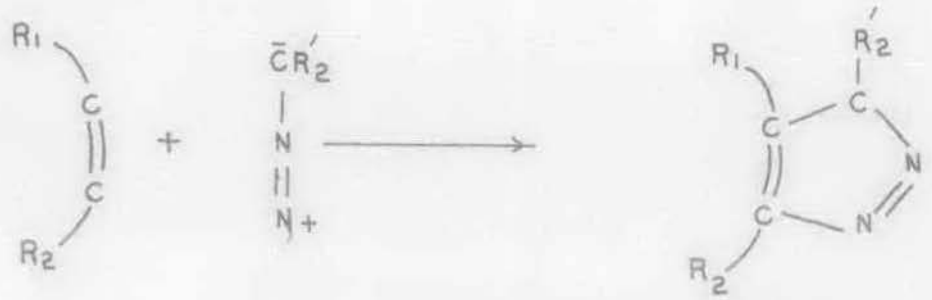
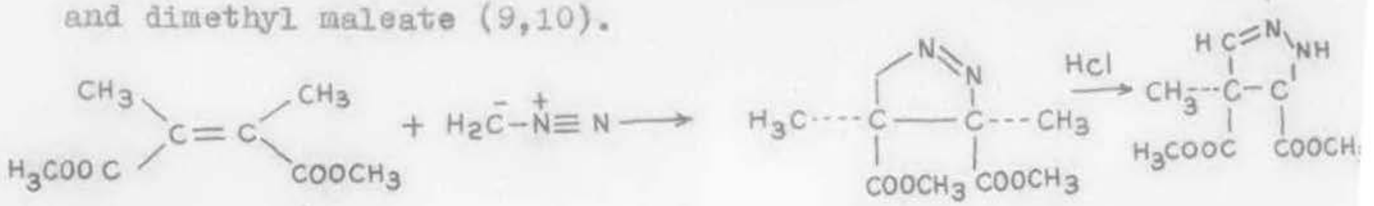
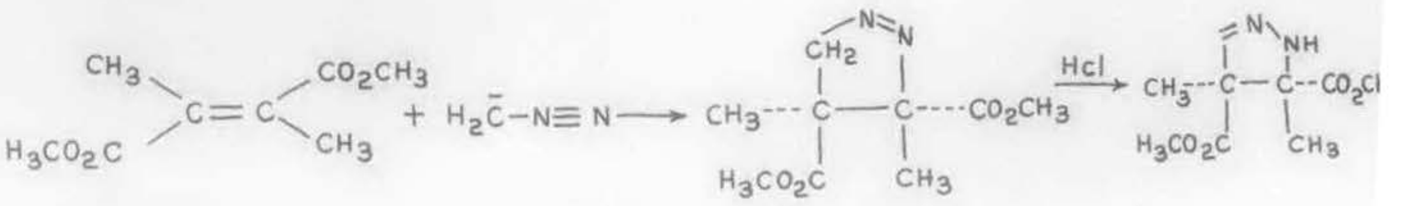


Fig - 55

This view point is supported by much evidence including the stereospecific addition of diazomethane to dimethyl fumerate and dimethyl maleate (9,10).



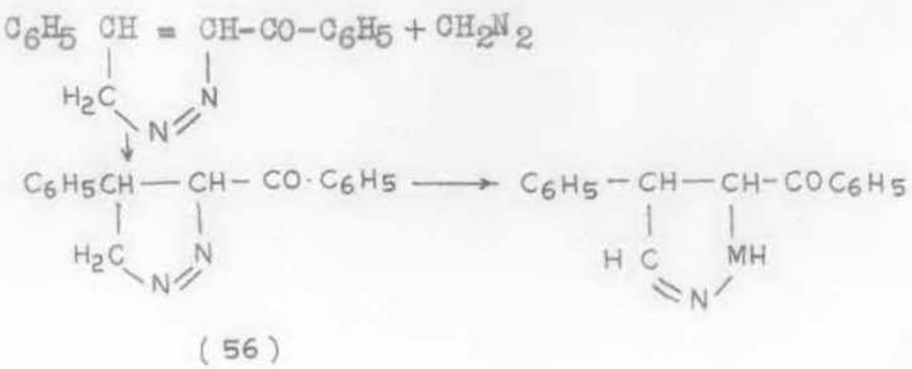


Rate studies indicate that they are electrophiles with low discriminatory ability among various alkenes. The carbene, catalyst, olefin are all involved in the transition step for addition.

Ledwith and Parry found that the reaction rates were independent of the polarity of the solvent and suggested a concerted 1,3 dipolar cyclo addition mechanism for the formation of pyrazolines from diazoalkanes and conjugated olefins.

It has also been found that both the rate of addition and the stability of pyrazoline is greatly affected by the structure of the alkane. Thus, conjugated carbonyl and nitrile groups increase both the rate of reaction and the stability of pyrazoline, and trans-alkenes are found to be more reactive than cis alkenes.

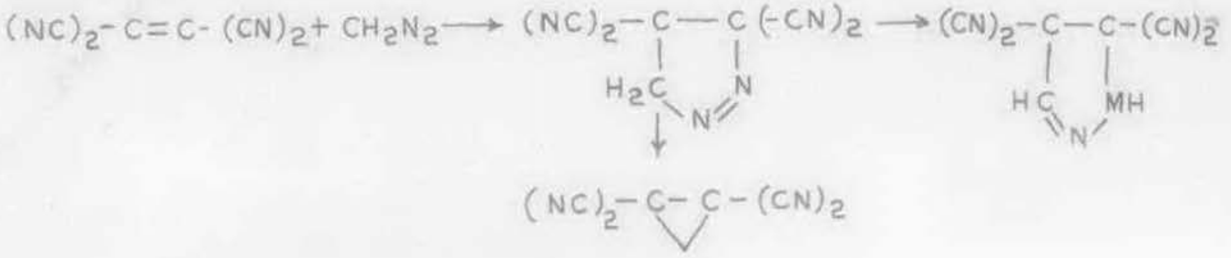
The pyrazolines formed have the structure expected from a consideration of electronic effects. The nucleophilic carbon of diazomethane becomes attached to the most electrophilic carbon of the double bond e.g. in the case of unsaturated esters and ketones, the β -carbon atom. These points are examplified by the addition of CH_2N_2 to benzal acetophenone (Fig. 56) to form 3-benzoyl-4-phenyl-1-pyrazoline which is readily transformed to the 2-pyrazoline (12 a,b).



(56)

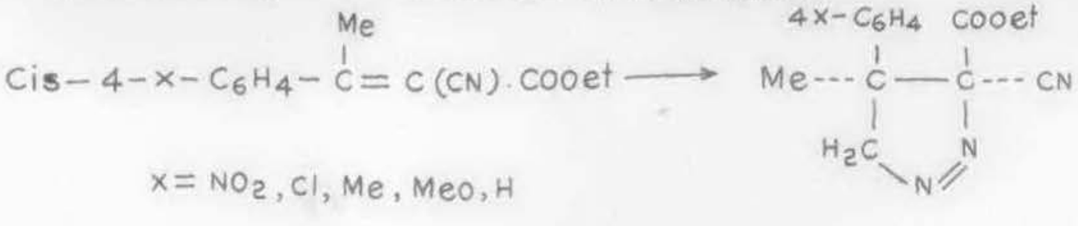
Electron releasing substituents have been found to decrease the rate of formation of the pyrazoline (13 a,b).

The addition of diazomethane to a variety of alkenes containing electron withdrawing substituents on the ∝-carbon atom has provided a convenient method for the formation of pyrazoline. Tetracyano ethylene in dry ether on treatment with CH_2N_2 in dry ether gave 3,3,4,4-tetra cyano-1-pyrazoline in 72% (14).



Certain ∝ β unsaturated acids have been shown to give the methyl pyrazoline-3-carboxylates with diazomethane (15 a,b).

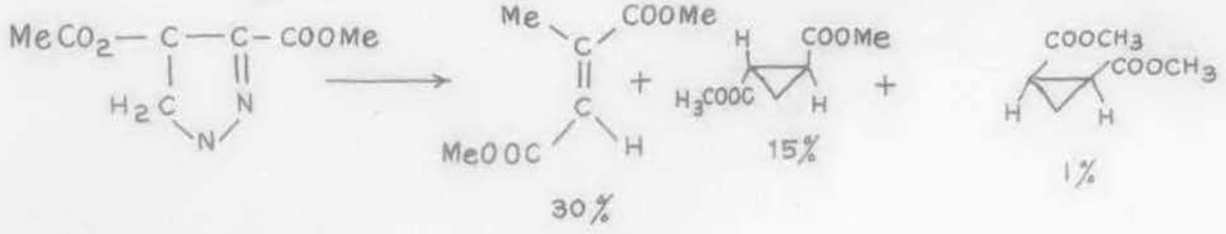
The addition of diazomethane in ether to ethyl ∝-cyano-β phenyl-4-substituted cinnamates at low temperatures proceeded in a stereo specific manner to give the corresponding cis or trans-1-pyrazolines (16). Ethyl ∝-cyano- β -phenyl-cinnamate gave an unstable pyrazoline which decomposes to 1-cyano-1-ethoxy carbonyl-2-2-diphenyl cyclopropane.



x= NO_2, Cl, Me, MeO, H

So from the above discussion it is seen that in certain cases, 1-pyrazoline, initially formed may then either lose nitrogen to give a cyclopropane or C-methyl derivatives or isomerise to a 2-pyrazoline. But these type of transformation from 1-pyrazoline involve an energy barrier.

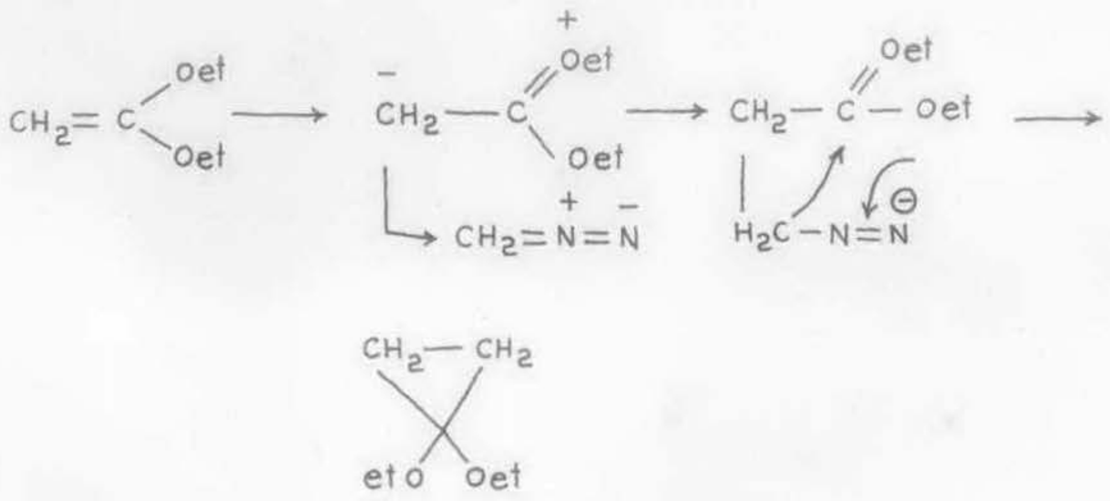
Now formation of cyclopropanes by the action of diazomethane on an alkene may occur by several routes. In some cases an unstable pyrazoline is formed which may then lose nitrogen readily, or application of heat may be necessary to remove the nitrogen to form the cyclopropane or olefin. The direct formation of cyclopropanes has also been observed, generally by the photolytic decomposition of CH_2N_2 in the presence of some metal catalyst to give a methylene radical which then adds to alkene. Amongst the earliest worker's to record the formation of cyclopropanes from pyrazoline were Von Auwers and Koeng (10 a,b).



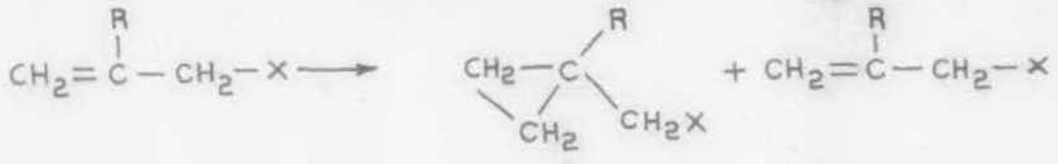
A paper by McGreer (17) confirmed the formation of both unsaturated esters and cyclopropanes and also gave evidence for the formation of both $\alpha\beta$ and $\beta\gamma$ unsaturated esters. The thermal decomposition of pyrazolines to cyclopropanes has been found to occur in a nonstereospecific manner (18). Whereas photolytic decomposition of pyrazolines occurred in stereospecific manner.

The thermal break down of 2-pyrazolines has been investigated (20 a,b,c) and it was concluded that the products produced did not depend upon their relative thermolytic stabilities but were formed by decomposition of the tautomeric 1-pyrazolines and hence depended on the relative thermodynamic stabilities of the intermediate 1-pyrazolines.

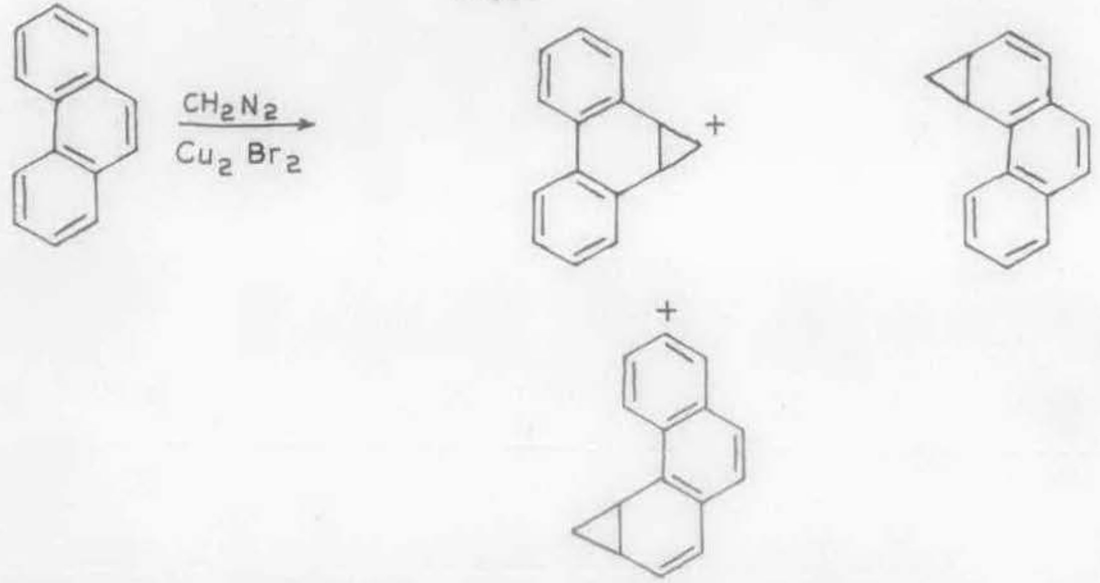
The direct addition of methylene to alkenes or aromatic compounds has been found to occur in the presence of cuprous salts as catalyst or using irradiation techniques. One of the first examples of the copper catalysed addition of diazomethane to alkenes was given by Dull and Abend (21) who found that ketone diethyl acetal and phenyl ketone diethyl acetal gave cyclopropanone diethyl acetal and phenyl cyclopropanone diethyl acetal respectively in presence of Cu_2Br_2 in 50% yield.



The formation of cyclopropanes by the addition CH_2N_2 to allyl halides has been investigated by Kirmse and his co-workers (22 a, b) and they found that two products were obtained. Cyclopropyl methyl halides and 4-halogenobutenes.



Certain heterocyclic aromatic compounds have been cyclopropanated with CH_2N_2 in the presence of Cu_2Br_2 (23). The formation of cyclopropane derivatives from certain polynuclear aromatic hydrocarbons, generally in the presence of a cuprous salt, has been investigated by numerous workers. The diazomethane adds at both the most active sites and the most active double bonds in the molecule, and also sometimes gives insertion products. Phenanthrene, for example, gave a mixture of two cyclopropane derivatives in the ratio 3:1 respectively (24 a,b) and anthracene also gave a mixture of three homologues (25). Napthalene was found to react in an analogous manner to give both cyclopropane and tropilidene derivatives, the yield of cyclopropane increasing when the reaction was carried out at low temperature. Pyrene was also found to give a cyclopropane derivatives when treated with CH_2N_2 (26).



Section-B: Aims and Objects:

With a view to explore the case of c-alkylation some of different substituted ß-phenyl methyl acrylate i.e. cinnamic esters (trans), and compare yields, products formed and study reactivity of 1,3 dipolar cyclo addition of diazomethane to unsaturated esters. The substitution of the phenyl ring was varied viz. carbomethoxy and chloro (Fig. 57).

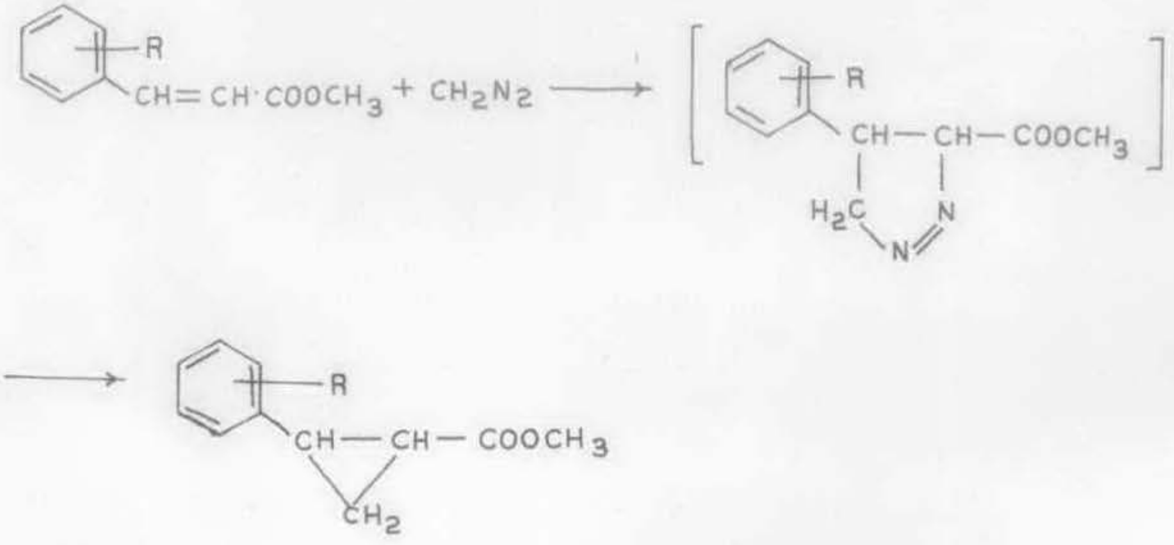


Fig- 57

Our observation in these reactions is that in all the cases 2-pyrazoline was isolated instead of 1-pyrazoline or C-methyl or cyclopropane derivatives. Probably intially formed 1-pyrazoline was easily isomerised to stable 2-pyrazoline (Fig. 58).

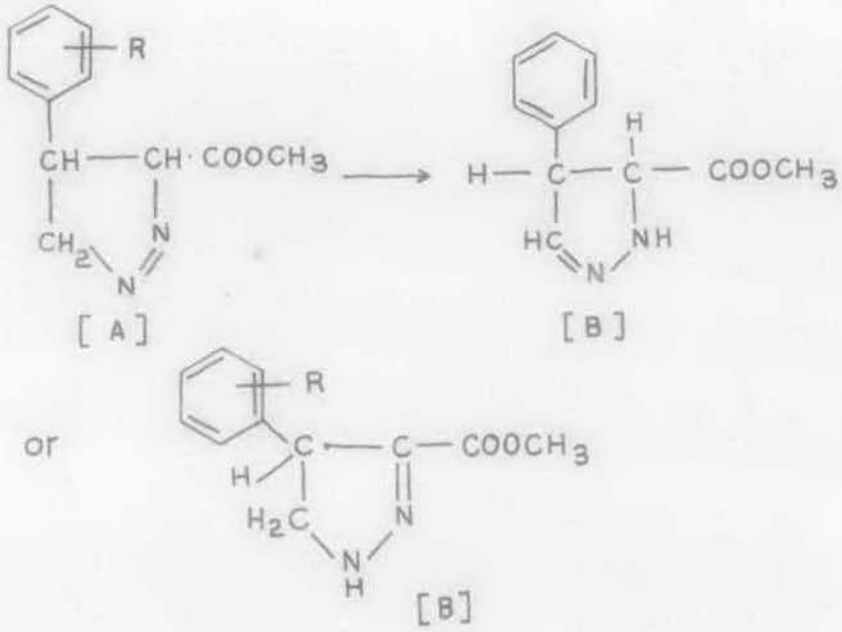


Fig- 58

These 2-pyrazoline were heated to reflux for a long time in xylene in order to eliminate nitrogen from the 2-pyrazoline and obtain cyclopropane derivatives. But in all cases 2-pyrazoline was recovered and so elimination of nitrogen was not facile. No trace of cyclopropane isolated in our subsequent work up. So the 2-pyrazolines prepared from trans o-substituted cinnamic ester (by electron with drawing groups) are highly stable at the boiling point of xylene and no tautomerism occurs at this temperature between A and B of the Fig. 58.

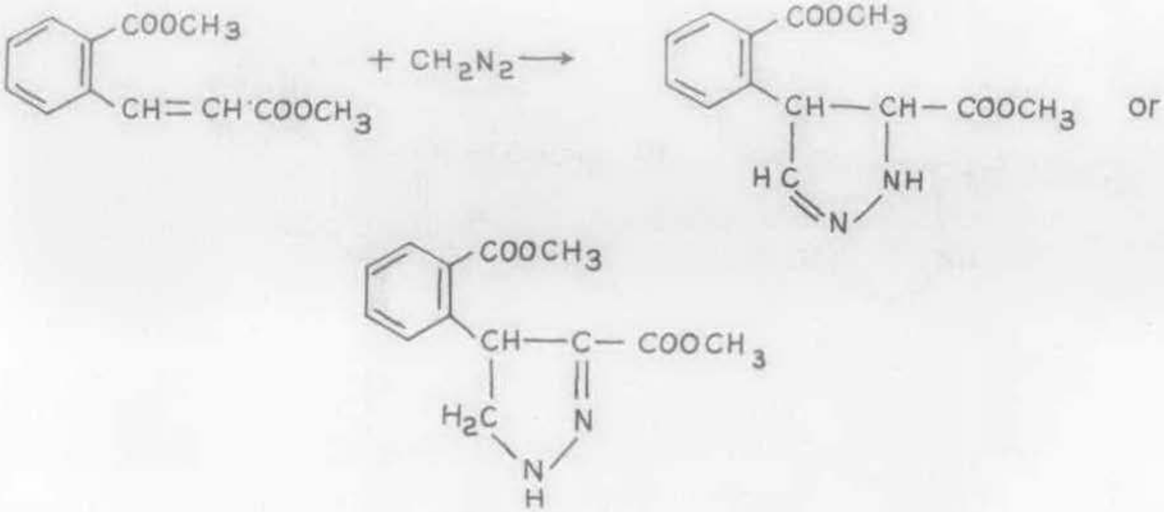
As 2-pyrazoline thus formed from the trans-substituted cinnamic esters (o or p-substitution by electron withdrawing group) is highly stable, so cyclopropane derivatives of these esters could not be synthesised with diazomethane without any catalyst.

Section-C: Results and Discussions

Reaction of diazomethane with dimethyl esters of o-carboxy cinnamic acid.

The reaction product of diazomethane and dimethyl ester of o-carboxy cinnamic acid was chromatographed and purified by repeated crystallisations. The structure of these product was confirmed to be 3-carbomethoxy-4-(o-carbomethoxy) phenyl-2-pyrazoline by elemental analysis, I.R., Mass and N.M.R.

I.R. band at 3400 cm^{-1} indicated for secondary NH group, M/e = 262.

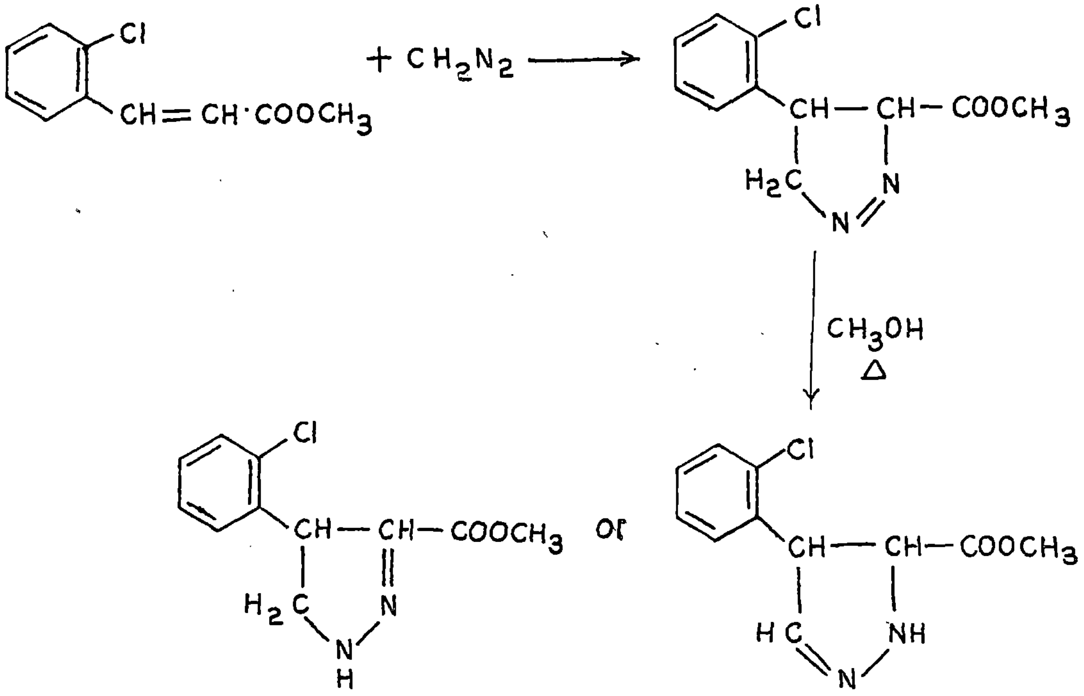


Reaction of diazomethane with o-chloro methyl cinnamate.

The crude reaction product of these two reactants was subjected to U.V, absorption and it was seen that it absorbed max 318 (Fig.). But as soon as it was crystallised from methanol, it UV max shifted to 280 nm. This indicated that there occurred a quick tautomerism in presence of methanol.

The structure of this product was confirmed to be 3-carbomethoxy-4-(o-chloro) phenyl-2-pyrazoline by means of elemental analysis, I.R. and mass spectta.

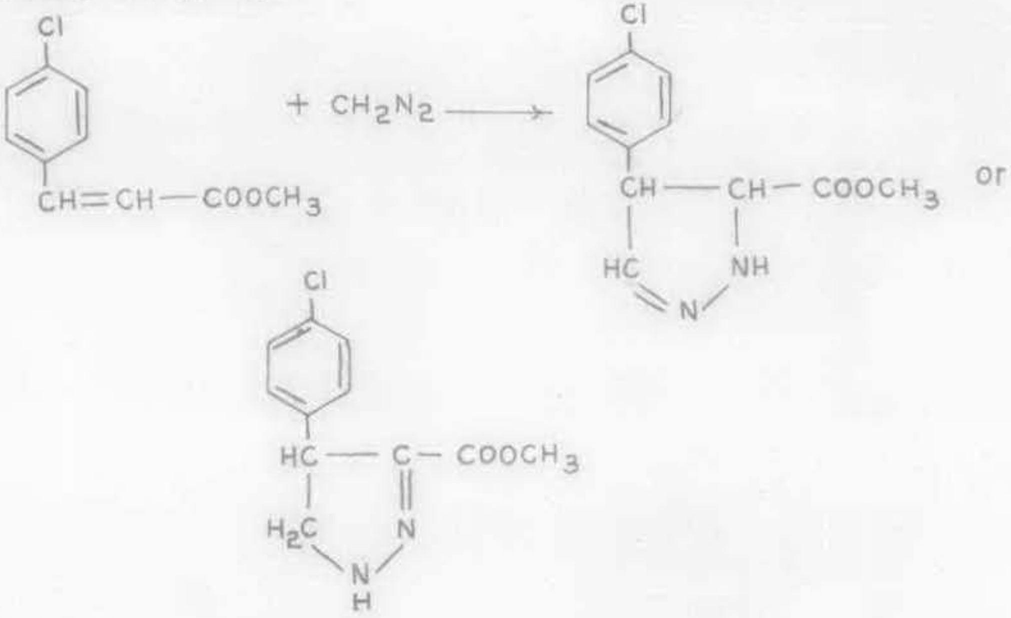
I.R. peak at 3400 cm^{-1} indicated for secondary NH group. M/e = 240.



Reaction of diazomethane with p-chloro methyl cinnamate.

The structure of the reaction product of these two substrates was also confirmed to be 3-carbomethoxy-4-(p-chloro) phenyl-2-pyrazoline by means of elemental analysis, I.R.

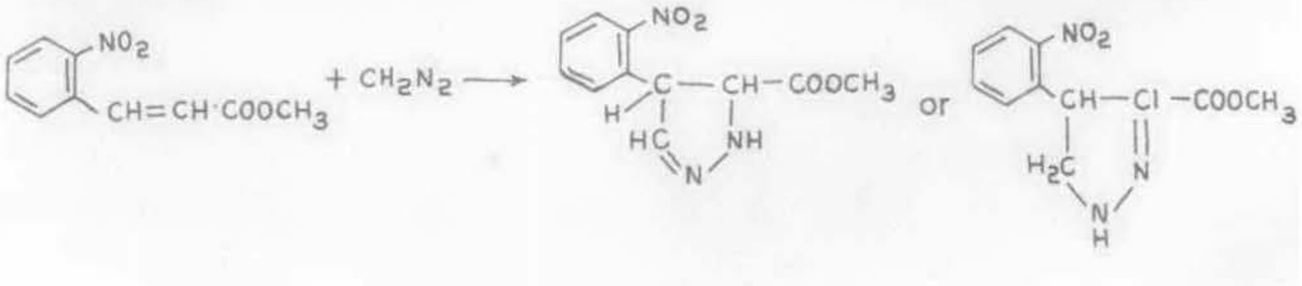
I.R. peak at 3400 cm^{-1} indicated the presence of secondary NH group.



Reaction of diazomethane with o-nitro methyl cinnamate.

The structure of the reaction product of these two substrates confirmed to be 3-carbomethoxy-4-(o-nitro) phenyl-2-pyrazoline by means of elemental analysis, I.R.

I.R. peak at 3400 cm^{-1} indicated the presence of NH group.



Reaction of diazomethane with mesityl oxide.

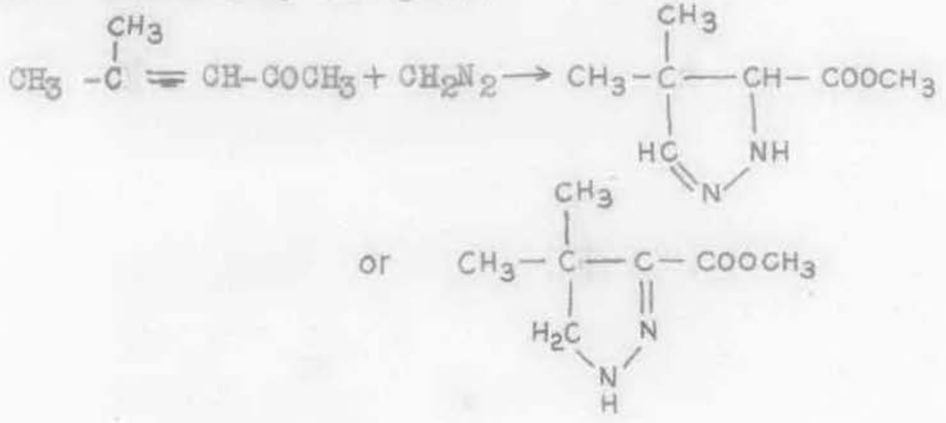
The crude reaction product of these two substrates showed U.V. max at 318 nm. But after purification by distillation, U.V. absorption max at 282 nm indicating the presence of $-N = C.COOCH_3$ group.

It's structure was confirmed to be 3-acetyl-4-methyl 2-pyrazoline by means of elemental analysis, I.R. G.L.C.

U.V. max at 282 nm.

I.R. peak at 3400 cm^{-1} (broad) indicated the presence of secondary NH group.

G.L.C showed only one peak.

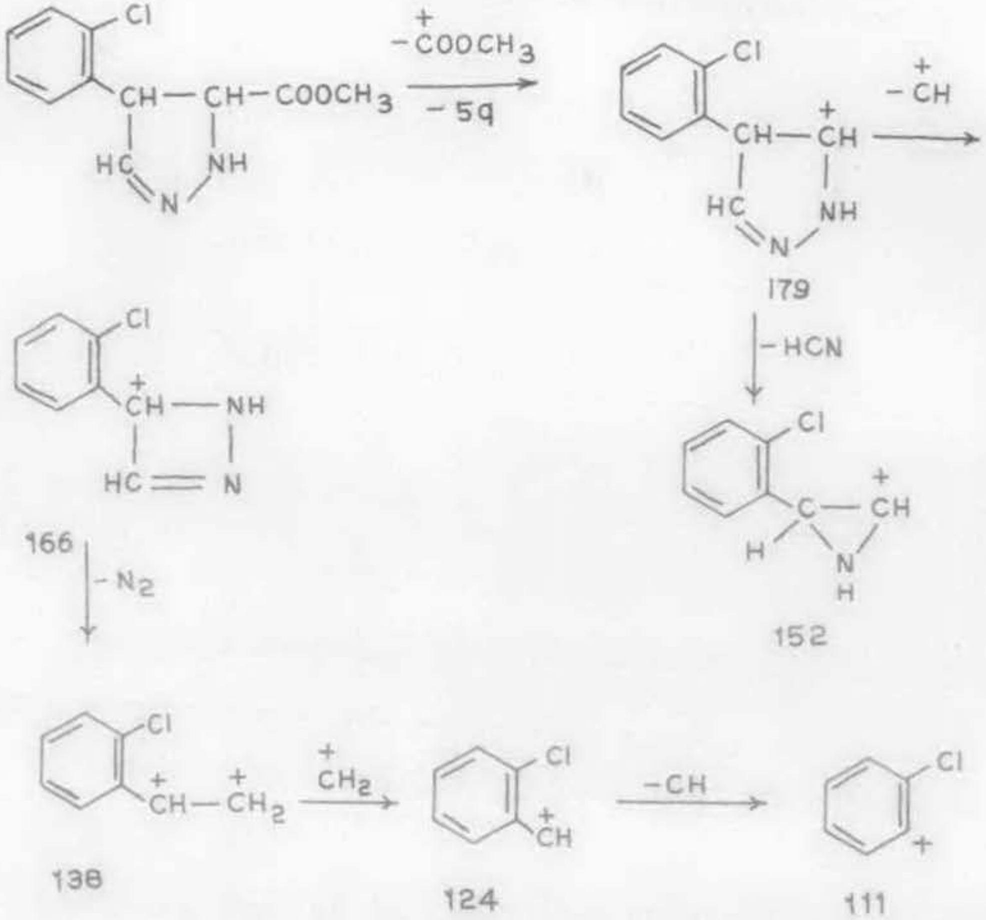


Mass spectrum of 2-pyrazoline.

Peaks of mass spectrum of 3-carbomethoxy-4-(o-chloro) phenyl-2-pyrazoline are as follow.

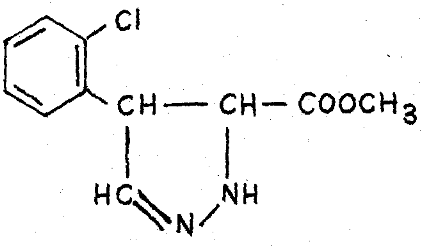
238, 179, 166, 152, 138, 124, 111, 72, 59, 44, 28.

So the decomposition had occurred in the following path.



Peaks at 44 indicating elimination of CO_2 from the compound and strong peak at 28 indicates that the compound contains two nitrogen atoms attached to each other.

These fragmentation patterns can well be explained if the structure of the compound is written as follow whose molecular wt. is found to be 238.



Mass spectrum peaks of 3-carbomethoxy-4-(o-carbomethoxy) phenyl 2-pyrazolene are as follow.

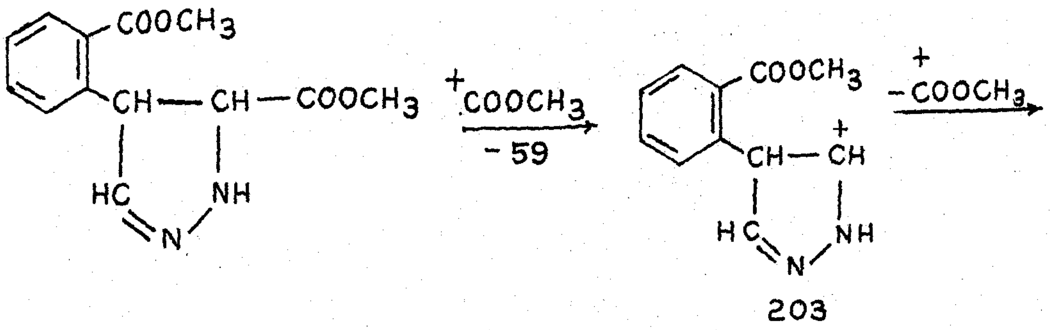
262(M^+), 203, 144, 131, 116, 103, 89, 76, 59,

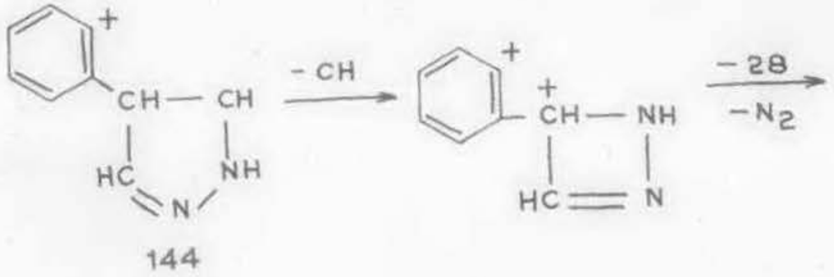
44 and 28.

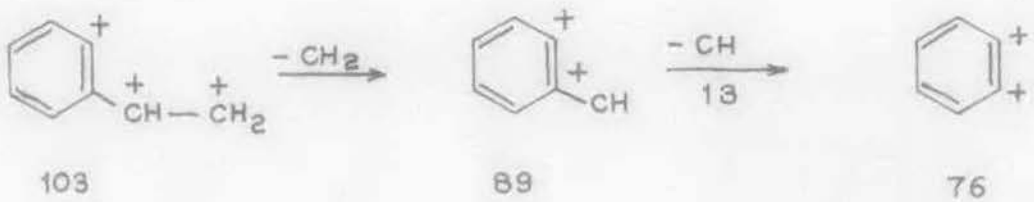
Strong peak at 28 indicated that the compound contains two nitrogen atoms attacked to each other.

Peak at 44 indicates the elimination of CO_2 from its ether function.

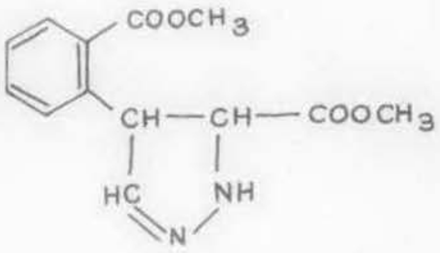
Other fragmentation of the product can be explained by the following way.







So on the basis of the mass fragmentations, the structure of this compound whose molecular wt. is 262 may be written as follows.



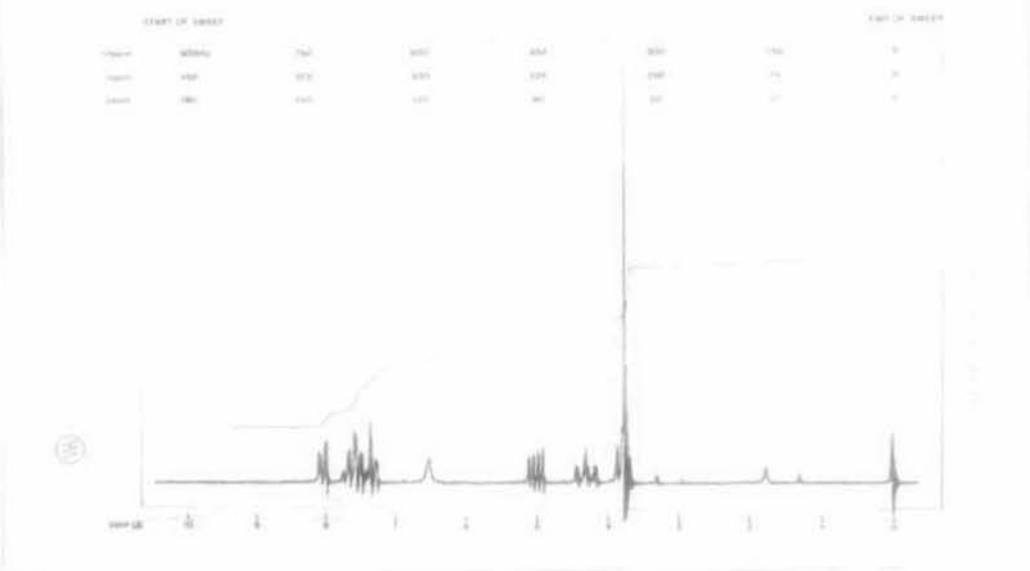


Fig. P.16 N.M.R. spectrum of 3-carbomethoxy-4-(o-nitro) phenyl-2-pyrazoline.

N.M.R. spectrum of 2-pyrazoline.

In the previous discussion about the structure of 2-pyrazoline, we had discussed I.R., U.V. and mass spectrum to explain the structure of 2-pyrazoline. Now with the help of N.M.R., we would like to confirm the structure of the reaction product of trans o-nitromethyl cinnamate and diazomethane.

It is reported (27) that proton signals for 4, 4.5, 5 tetramethyl-2-pyrazoline cis-3-carboxylate are as follows.

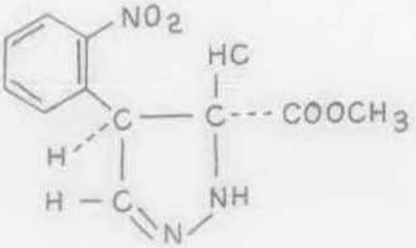
δ 8.93 and 8.92 (12H), δ 6.78 (3H of carbomethoxy) and δ 4.2 broad (1H, NH). It is also reported in this paper also that all the 2-pyrazoline, there is a broad peak at δ 4.2 to δ 4.5. Soit can be concluded that the characteristic peak of 2-pyrazoline is due to NH hydrogen.

N.M.R. signals of the reaction product of trans o-nitro methyl cinnamate and diazomethane in $CDCl_3$ are as follows. Fig.

δ 7.3 to 8.1 (phenyl proton), δ 3.8 (CH_3 of carbomethoxy group), δ 5.2 broad (1H of NH), δ 6.5 (olefinic proton of $CH = N$)

and δ 4.15 to δ 4.45 quasi triplet (for H_a and H_b).

These results satisfy the structure given below for the reaction product.



Section-C: Experimental

Melting points and boiling points are uncorrected. Dry solvents were used where necessary. I.R. spectra were recorded in a Beckmann IR-20 Spectrophotometer. Mass spectrum were taken in a mass spectrophotometer in C.D.R.I., Lucknow. N.M.R. spectrum was determined on a VA-90 MHz N.M.R. Spectrophotometer using chloroform-d solution containing tetramethyl silane as internal reference.

1. Reaction of diazomethane with dimethyl ester of o-carboxy Cinnamic acid:

A mixture of 200 ml of ethereal solution of 1.47 gm of diazomethane (dried over potassium hydroxide pellets for 6 hrs.) and 50 ml ethereal solution of 2.2 gm of dimethyl ester of o-carboxy cinnamic acid was kept for 18 days in a dark and

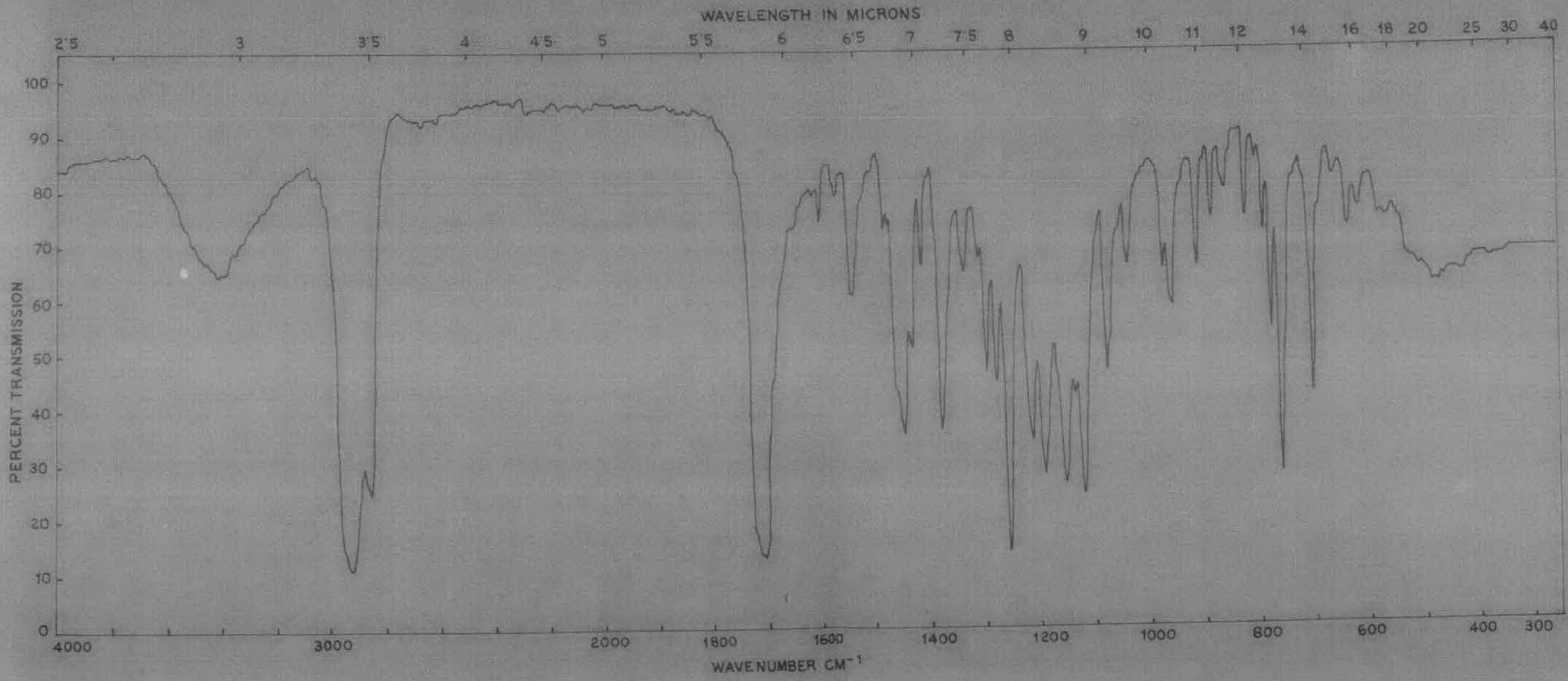


Fig- 48. 3- Carbomethoxy-4- (o- carbomethoxy) phenyl-2- pyrazoline.

cool place. When the colour of the diazomethane was no longer found to be present; ether was removed completely at reduce pressure. An oily liquid remained in the flask.

U.V. of this oily liquid showed peak at λmax 314 nm and also positive test for nitrogen. Attempted crystallisation from dry methanol did not succeed.

It was then chromatographed over alumina and the fraction eluted with 60% benzene and 40% pet-ether solvent mixture crystallised from dry methanol. This, after several recrystallisation from dry methanol gave colourless crystals m.p. 191°. Yield-1.2 gm

I.R. shows peak at 3400 cm^{-1} for secondary NH grouping. Fig. 48.

Analysis found: C, 58.5%; H, 5.35%

Calculated for $C_{13}H_{14}O_2N_2$: C, 59.53%; H, 5.59%.

Mother liquor was further concentrated, but no crystals could be separated.

The alumina column was washed down with ether, which on evaporation did not afford any solid product. A semi solid product separated. which was identified as the ester starting material.

Mass spectrum Fig. P.19.

2. Reaction of diazomethane with methyl ester of o-chloro cinnamic acid.

A mixture of 200 ml of ethereal solution of diazomethane (1.2 gm) and 50 ml ethereal solution of 1.96 gm of the ester

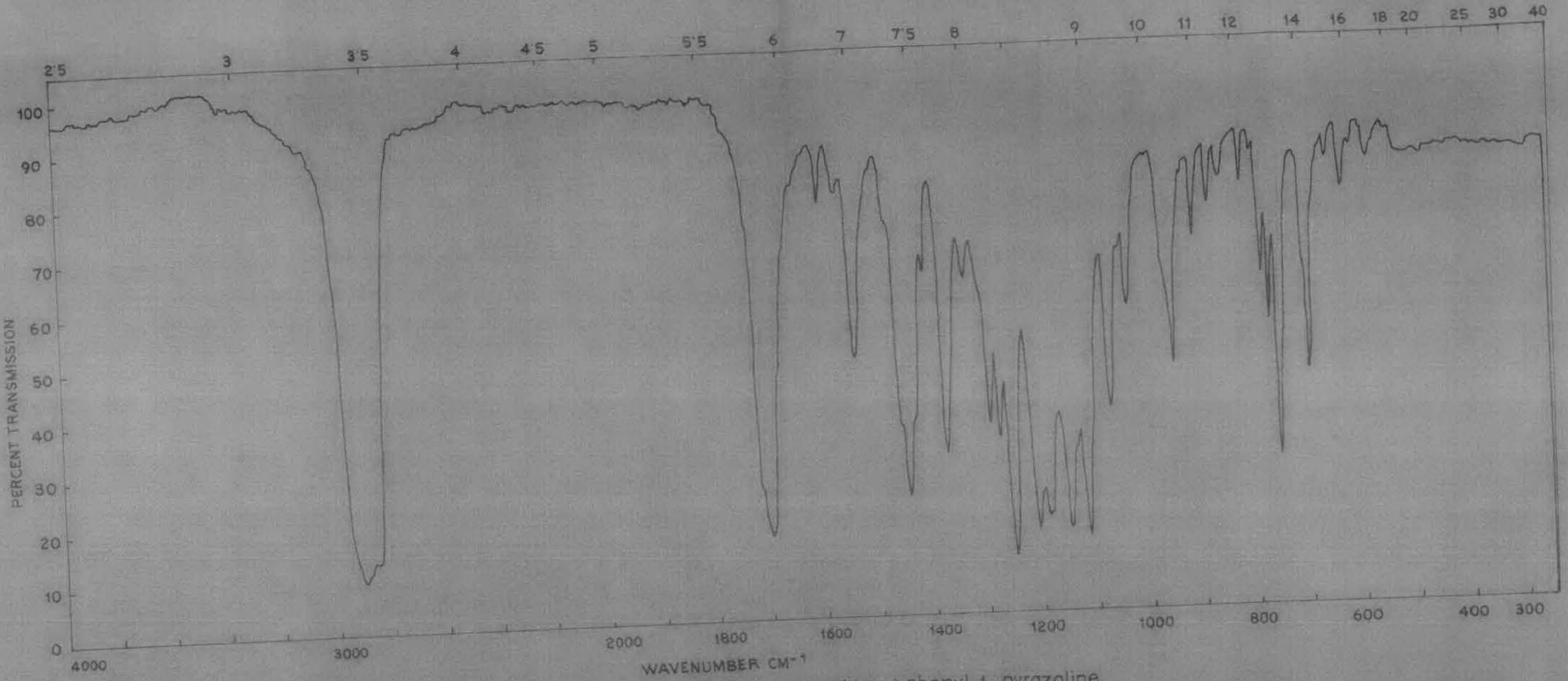
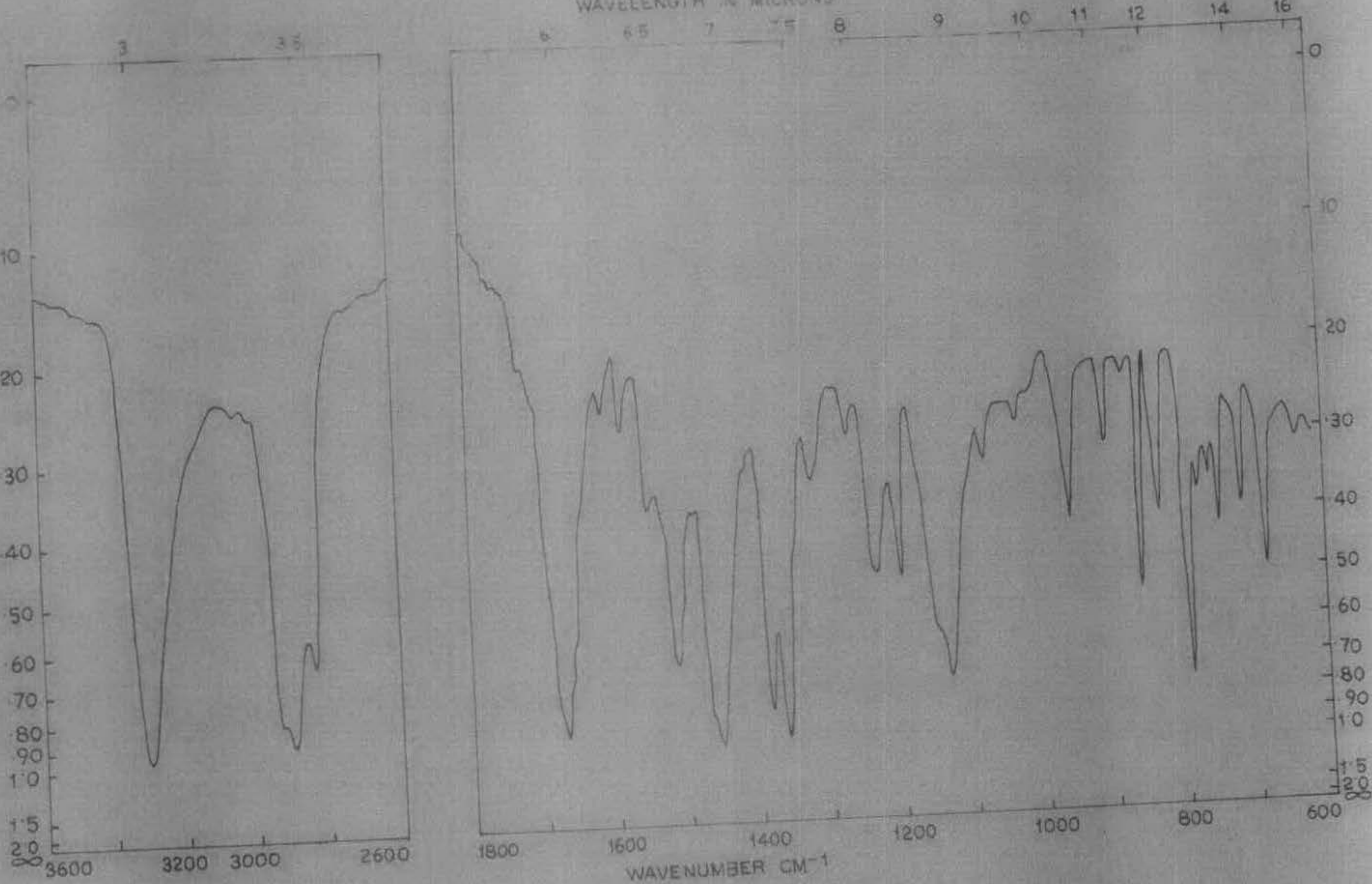


Fig- 49. 3- Carbomethoxy-4-(0- Chloro) phenyl-1- pyrazoline



3- Carbomethoxy-4-(o-nitro) phenyl-2-pyrazoline.

Fig- 50.

was kept at a dark and cool place for 18 days when no yellow colour of diazomethane was found to be present. Ether was removed at reduced pressure. The oily residue was crystallised from methanol when pale yellow coloured solid separated. This on recrystallisation from dry methanol gave colourless compound m.p. 165°C. Yield. 2 gm.

Analysis found: C, 55.21%; H, 4.63%
Calculated for $C_{11}H_{11}O_2N_2Cl$: C, 55.37%; H, 4.84%
I.R. (neat) - Fig. 49.
Mass spectrum Fig. P15

Mother liquor was further concentrated, but no solid product could be separated.

3. <u>Reaction of diazomethane with o-nitro methyl cinnamate</u>.

A mixture of 200 ml of ethereal solution of diazomethane (1.28 gm) and 50 ml of ether solution of 1.8 gms of o-nitro methyl cinnamate was kept in a dark and cool place for 20 days when the colour of the diazomethane was no longer present, ether was removed at room temperature under suction. The semi-solid product was crystallised from pet-ether and further recrystallisation afforded a solid product. m.p. 162°C. Yield 1.2 gm.

Analysis found:* C, 53.8%; H, 4.3%
Calculated for $C_{11}H_{11}O_4N_3$: C, 53.06%; H, 4.45%
C, 53·06 %; H, 4·45 %
I.R. (neat - Fig. 50
N.M.R. Fig. P.16.

* Ref. No. CHY/SP/RSSC/2241 of 19.5.1979
by CDRI, Lucknow, India.

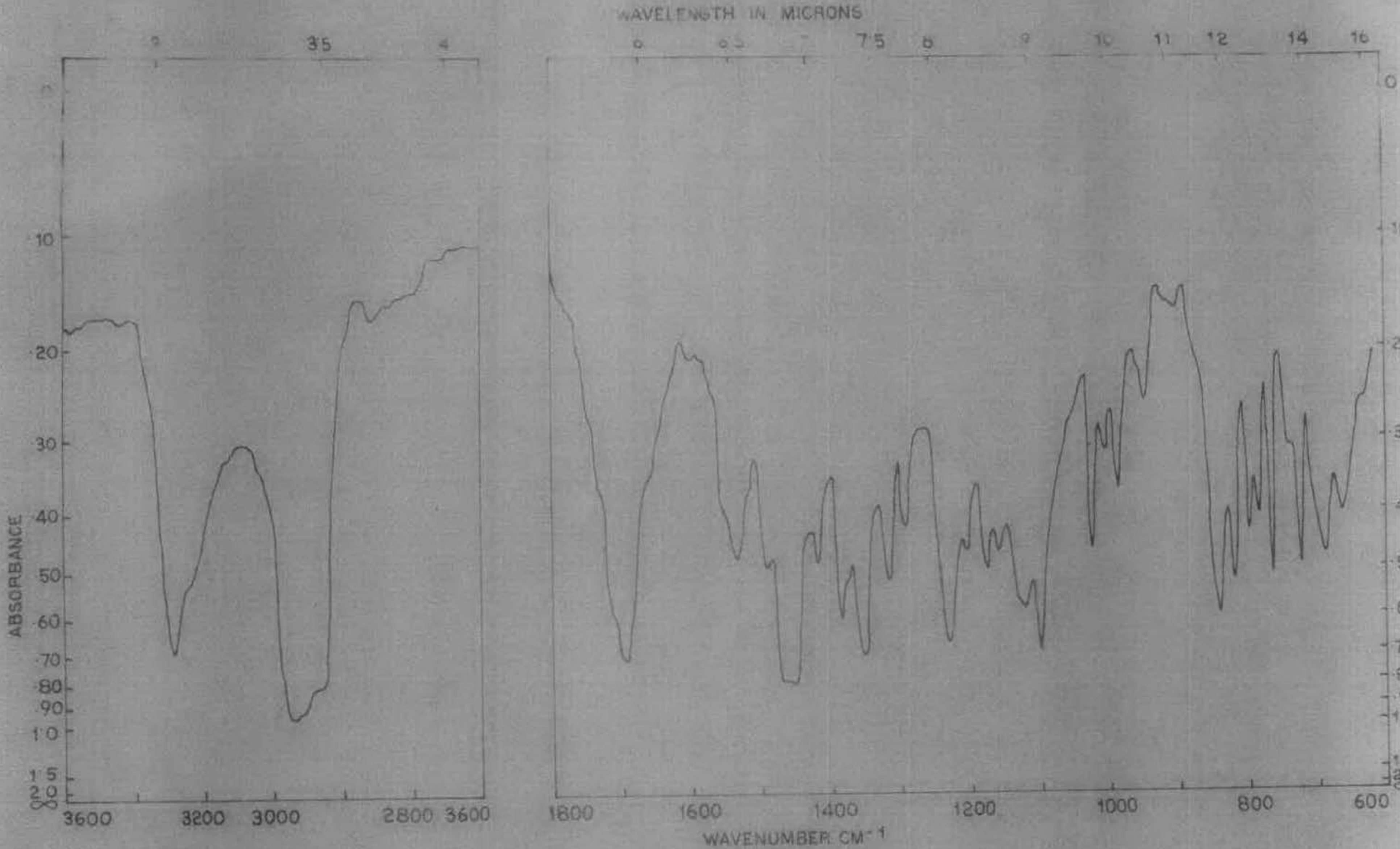


Fig- 51. 3- Carbomethoxy - 4- (P- chloro) phenyl- 2- pyrazoline.

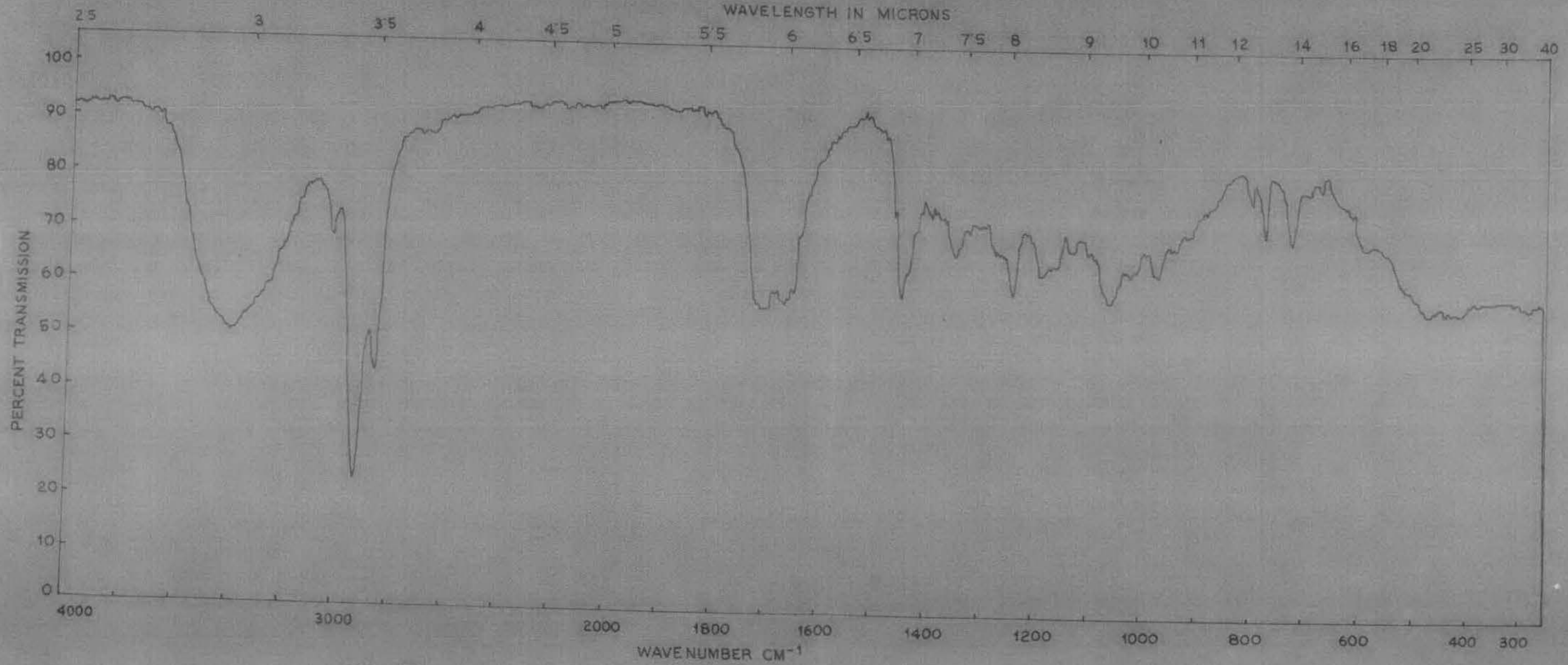


Fig- 52 3- acetyl- 4- methyl- 2- pyrazoline .

4. Reaction of diazomethane with trans-p-Chloro methyl cinnamate.

A mixture of 200 ml of ethereal solution of diazomethane (1.2 gm) and 50 ml ethereal solution of 1 gm ester was kept in a dry and cool place at room temperature for 18 days. When the colour of diazomethane was no longer present, ether was removed at room temperature under suction. A semi-solid residue remained was crystallised several times from pet-ether (60-80°) m.p. 110°C. Yield - 700 mg.

Analysis found: C, 55.1%; H, 4.57%

Calculated for $C_{11}H_{11}O_2N_2Cl$: C, 55.37%; H, 4.84%

I.R. Fig. 51

5. Reaction of diazomethane with mesityl oxide.

A mixture 200 ml of ethereal solution of diazomethane (5 gm) and 50 ml ether solution of 3 gm of mesityl oxide was kept in a dark and cool place for 15 days. When the colour of the diazomethane was no longer present, ether was removed at room temperature under suction. The liquid residue was distilled at 88°C/7 mm. Yield-1.3 gm. This compound was found to contain nitrogen.

Analysis found: C, 64.11%; H, 9.13%

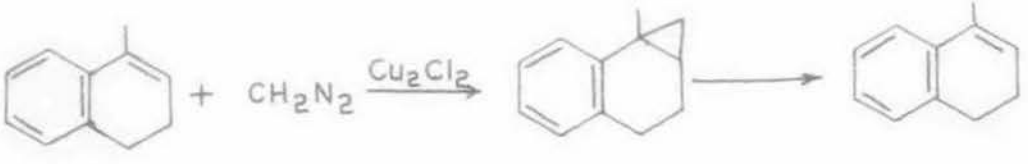
Calculated for $C_6H_{10}ON_2$: C, 64.27%; H, 8.98%

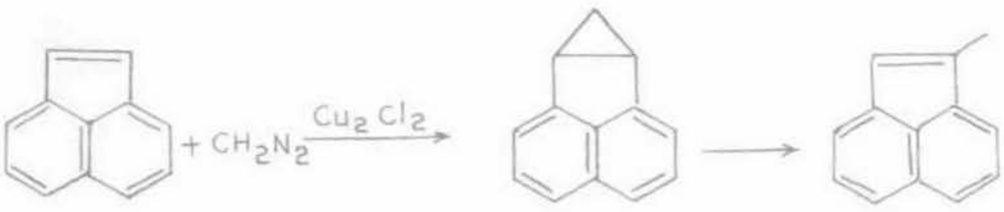
I.R. (neat) Fig. 52

CHAPTER - II

Section-A : Aim and object of the decomposition of diazomethane with metal catalyst.

It is reported that diazomethane adds to double bonds forming cyclopropane derivative in presence of copper. Our aim was to prepare cyclopropane derivatives of αmethyl, 3,4 dihydro napthalene and acenaphthene and thereby to see the insight of the state of $:CH_2$ addition and its subsequent fate. Keto carbene addition to double bond in presence of copper catalyst was described as being effected via the singlet state. But methylene addition to double bond in absence of any catalyst was shown to be non stereo specific. So to find out any stereo specificity or not of methylene addition to double bond in presence of copper catalyst and to draw a relationship as to the state of methylene and that of the ketocarbene was our main objective. To prepare C-methyl derivative of α-methyl 3,4 dihydro napthalene and acenapthene was our main goal in this route.





Section-B : Results and Discussions.

Addition of diazomethane to some other olefins in presence of cuprous salts active copper powder was attempted. It is interesting to note in these connection that in the cases studied, addition to the olefins did not take place.

In a reaction of α-methyl 3,4-dihydro naphthalene, with diazomethane in presence of anhydrous cuprous chloride we isolated a solid product of m.p. 110-12°C. In a similar reaction with acenaphthene we isolated the same solid product of m.p. 110-12°C. Decomposition of an ethereal solution of diazomethane in presence of Cu_2Cl_2 or active copper furnished the same solid product of m.p. 110-12°C. The same product also was isolated when the catalyst is anhydrous copper sulphate.

Some properties of this compound:

1. This compound decomposed slowly at room temperature and within 10 days it decomposed completely.
2. It contained nitrogen.
3. It was found to be highly basic in character.
4. When treated with KOH, it evolved NH_3 gas.
5. It could not be hydrogenated in presence palladised charcoal.
6. Heat and light decomposed the oxygenated dimer giving off nitrous fumes.
7. Pyrolysis of the compound in presence of reactive olefin did not give products that are obtained with diazomethane.

As it is decomposed very quickly, the elemental analysis of this compound could not be determined. Its molecular weights was determined by Beckmann freezing point depression method and molecular wt. was found to be 90.4.

Inspection of the I.R. spectra, it is seen that it contains a hydrogen bonded primary amine group. I.R. peak at 1780 cm^{-1} indicating that it may contain an amide function.

Inspection of the I.R. spectrum and molecular weight determination, it is suggested that the compound may be a polymer of diazomethane (a) or a formamide derivative (b). We could not give exact structure of this product still now.

Section-C: Experimental

(a) Decomposition of diazomethane in presence of copper sulphate.

In a one Lt. R.B. flask which was placed in a ice bath was taken 500 ml of ethereal solution of diazomethane prepared from 20 gms of nitrosomethylurea and which was dried on KOH pellets for 4 hours. In 500 mg anhydrous copper sulphate was added in one lot and the flask was fitted with calcium chloride guard tube. Immediate evolution of gas was observed. After two to three hours when ethereal solution became colourless the solvent was removed at room temperature using a water pump. When almost all the solvent was removed, the colourless solid was

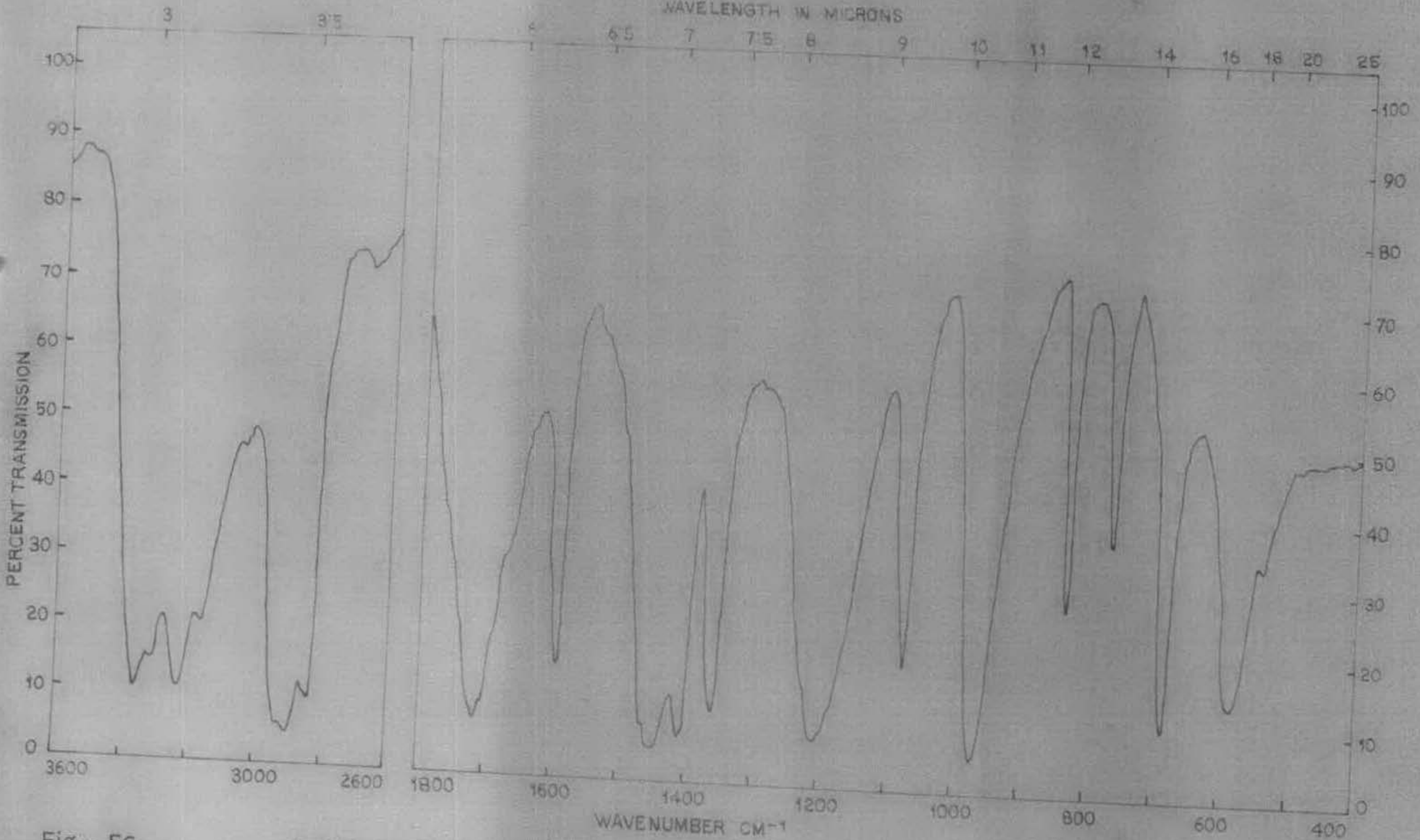


Fig - 56. Solid product obtained from diazomethane.

crystallised several times from dry benzene Yield-3.5 gm. m.p. 112°c.

(b) Molecular wt. determination by Beckmann freezing point depression method was found to be 90.4 .

1. Probable molecular formula could not be assigned

2. Deoxygenation/Degassed Experiments.

(c) Analysis found N, 20%.

(d) I.R. Fig. 56.

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