# Heterocyclic Studies. 31. The Preparation of 3-Diazoacetylpyrazolines and Conversion to Diazabicyclo[3.2.0]heptenones and 1,2-Diazepinones[1]

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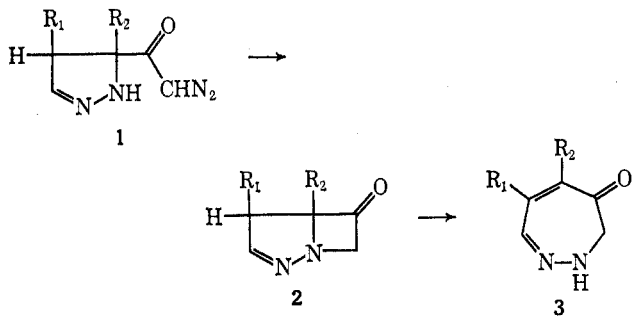
Diazoacetylpyrazolines **5**, **7**, **13**, and **15** were obtained from the corresponding isomeric $\alpha$-substituted cinnamic acids. $\alpha,\beta$-Unsaturated carboxylic–carbonic anhydrides were found superior to the acid chlorides in the preparation of these 3-diazoacetylpyrazolines. Cyclization of the 3-bromo- (**5** and **7**) and 3-ethoxycarbonyl- (**13** and **15**) pyrazolines to bicyclo[3.2.0]heptenones could not be effected. The 3-bromopyrazoline **5** with base gave 3-diazoacetyl-4-phenylpyrazole. The isomeric 3-diazoacetyl-3,4-diphenyl-1-pyrazolines **16** and **18** were converted to the 5-pyrazolines with base and thence to 1,2-diazabicyclo[3.2.0]heptenones **20** and **21**. Isomerization of **20** and **21** in acetic acid gave the diazepinone **23**. A major side reaction in the base-catalyzed isomerization of **20** and **21** was cleavage to the pyrazoline-N-acetic acids **25** and **26**. Methoxycarbonylpyrazoline (**29**) was prepared from mesaconic acid $\alpha$-methyl ester and converted to diazepinone **31**.

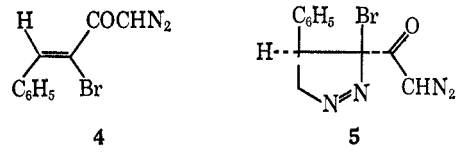
Cyclization of 3-alkyl-3-diazoacetylpyrazolines (**1**) provides an efficient and simple route to the 1,2-diazabicyclo[3.2.0]heptanone (**2**) and 1,2-diazepinone (**3**)



systems.[2,3] The utility of this reaction has led us to prepare some additional pyrazolines and examine the generality of this cyclization and subsequent isomerization to 1,2-diazepines, in particular with respect to the effect of additional functional groups and the configuration of the C-4 substituent in **2**.

The formation of 3-diazoacetylpyrazolines by reaction of $\alpha,\beta$-unsaturated acid derivatives with excess diazomethane is potentially a very general method, but for the purpose of this work, there are some restrictions. For the cyclization step, an additional 3 substituent in the pyrazoline ($R_2 \neq H$ in **1**) is required to prevent tautomerization of the initially formed 1-pyrazoline to the 2 isomer. A practical consideration is the necessity of obtaining these rather sensitive diazo ketones in crystalline form to permit isolation; a few attempts to carry reactions through to the bicyclic ketone or diazepine without purification have been unsuccessful. In view of these points, several isomeric pairs of $\alpha$-substituted cinnamic acids were selected as starting materials.

The first compounds examined were derived from the isomeric $\alpha$-bromocinnamic acids. The unsaturated diazo ketone **4** and the pyrazoline **5** were readily obtained by reaction of the acid chloride of the (*Z*) isomer[4] ("$\alpha$-bromo-*trans*-cinnamic acid") with 2 mol of and with excess diazomethane, respectively. The preparation of the acid chloride of the (*E*) isomer ("$\alpha$-bromo-*cis*-cinnamic acid") was described recently,[5] but we were unable to repeat this work, and another approach was required.



Acylation of diazomethane has almost always been accomplished with an acid chloride; the use of other reagents such as anhydrides is generally less satisfactory. Tarbell and Price reported yields of 57 and 7% for two diazomethyl ketones prepared by the use of mixed carboxylic–carbonic anhydrides.[6] Comparable results were obtained in our hands with benzoic ethylcarbonic anhydride. By using prolonged reaction time, the yield of diazoacetophenone was increased from 7 to 35%, but further improvement could not be achieved.

Although this procedure appeared marginal, it was applied to (*E*)-$\alpha$-bromocinnamic acid, and treatment of the mixed anhydride with excess diazomethane gave the diazoacetylpyrazoline **7** directly in 30% yield. Subsequent experience with other $\alpha,\beta$-unsaturated carboxylic–carbonic anhydrides as noted below has shown that these derivatives are in fact distinctly superior to the acid chloride in most cases, and we have adopted the mixed anhydride procedure as the standard method for preparing 3-diazoacetylpyrazolines. This method obviates the preparation and isolation of the acid chloride, and provides a convenient two-step procedure from acid to diazoacetylpyrazoline in overall yields at least as high as those based upon acid chloride. Another advantage of the mixed anhydrides, presumably, lies in the fact that a mole of diazomethane is not wasted in neutralizing HCl as it is when acid chlorides are used. This point was not directly observed in the present work since excess diazomethane was employed to ensure completion of the addition step, but it was noted in several cases that gas evolution ($CO_2$) began only after the reaction stood for some time. The acylation step is not dependent on pyrazoline formation,

(1) Supported by Grant GP-5219 from the National Science Foundation.

(2) J. A. Moore, W. F. Holton, and E. L. Wittle, *J. Amer. Chem. Soc.*, **84**, 390 (1962).

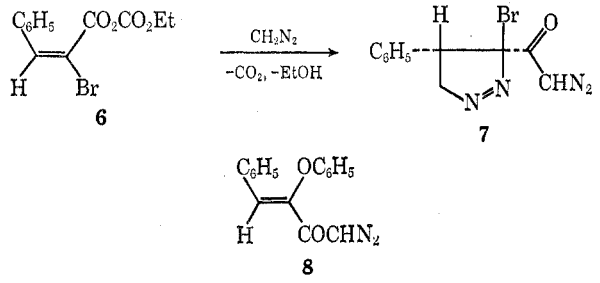
(3) J. A. Moore, F. J. Marascia, R. W. Medeiros, and R. L. Wineholt, *J. Org. Chem.*, **31**, 34 (1966).

(4) Notation of J. E. Blackwood, C. L. Gladys, K. L. Loening, A. E. Petrarca, and J. E. Rush, *J. Amer. Chem. Soc.*, **90**, 509 (1968).

(5) A. K. Plisov and I. M. Zhuravleva, *J. Org. Chem. USSR*, **1**, 1893 (1965).

(6) D. S. Tarbell and J. A. Price, *J. Org. Chem.*, **22**, 245 (1957).

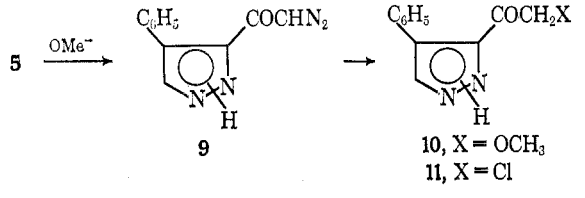
since the mixed anhydride of (*Z*)-α-phenoxycinnamic acid, in which dipolar addition of diazomethane is suppressed, gave the unsaturated diazo ketone **8** in 76% yield.



**6** **7** **8**

Cyclization of the pyrazolines **5** and **7** to bicyclic ketones failed. The *cis*-phenylbromopyrazoline **5** was somewhat less reactive toward acid, as judged by nitrogen evolution and disappearance of $COCHN_2$ absorption, than the *cis*-phenylmethyl compound.[2] Under a variety of conditions with acetic, sulfuric, and other acids, any treatment which caused nitrogen evolution invariably gave intractable mixtures. Under forcing conditions, HBr was evolved; a trace of the 3-methoxyacetylpyrazole **10** was obtained from the *trans*-phenylbromopyrazoline **7** in methanolic sulfuric acid.

Treatment of **5** with base gave 3-diazoacetyl-4-phenylpyrazole (**9**) in 75% yield. Two derivatives of this diazo ketone were obtained by standard procedures; no evidence was seen in these reactions of cyclization to a bicyclo[3.2.0] system.

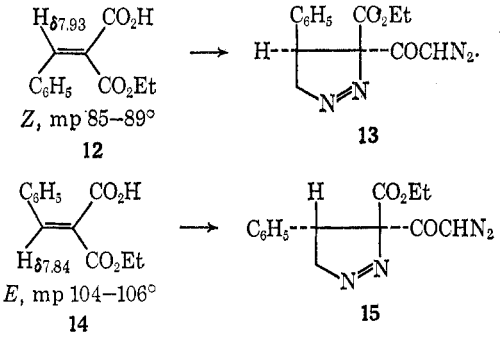


**9** **10**, X = $OCH_3$ **11**, X = Cl

The α-(ethoxycarbonyl)cinnamic acids **12** and **14** provided another potentially interesting pair of isomers for this study. These acids have been described several times,[7,8] but apparently the pure isomers have not been separated. By a modification of the standard barium salt procedure[9] used for the α-bromo acids, an acid [mp 85–89°, δ(–C**H**=C) 7.93 ppm] was obtained from the less soluble salt, and an isomer [mp 104–106°, δ (–C**H**=C) 7.84 ppm] was isolated from the soluble salt. The *Z* and *E* configurations **12** and **14** are assigned to these isomers on the basis of the barium salt solubility and vinyl proton chemical shift. In two other pairs of substituted cinnamic acids, α-bromo- and α-phenyl-, the vinyl proton signal appears 0.9–1.0 ppm further downfield in the isomer with β-H and $-CO_2H$ *cis*. A smaller difference is to be expected in the esters **12** and **14** because of the similar shielding effects of the ester and carboxylic acid groups. The difference of 0.09 ppm between **12** and **14** is of questionable significance, but assignment of the *cis*-β-H–$CO_2H$ (*Z*) configuration (**12**) to the acid with the less shielded vinyl proton is also consistent with the lower solubility of the barium salt of this acid. In the α-bromo and α-phenyl series and also unsubstituted cinnamic acids,[10] the less soluble barium salt is that with β-H and $CO_2H$ *cis*.

Diazoacetylpyrazolines **13** and **15** were obtained in high yields by the mixed anhydride procedure. The compounds were isolated without difficulty as solids which decomposed on melting at 50 and 80°, respectively. These diazo ketones are thus relatively stable in comparison with related pyrazolines bearing two electron-accepting groups such as $-CO_2R$ or –CN at C-3; examples of the latter have recently been prepared at −40° and shown to decompose rapidly at temperatures below 0°.[11]

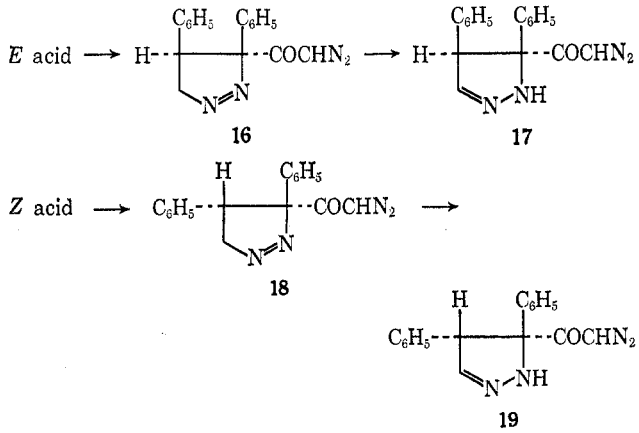
No bicyclic ketones or other products were isolated from the reactions of **13** and **15** with acid, and there was no evidence for four-ring carbonyl absorption in the ir spectra of the crude reaction mixtures. In previous cyclizations to diazabicyclo[3.2.0]heptenones, the 3-alkyl-3-diazoacetyl-1-pyrazolines have been successfully used as the substrate, although it has been shown[2,3] that isomerization to the 5-pyrazoline precedes or accompanies ring closure. The failure of the bromo- and ethoxycarbonylpyrazolines **5**, **7**, **13**, and **15** to undergo cyclization is probably due to the competition of other reactions with the acid-catalyzed tautomerization to the 5-pyrazoline isomers. With the bromo compounds the problem lies in the propensity for elimination leading to pyrazoles. In the case of the esters **13** and **15**, ring opening to a diazonium enolate and loss of nitrogen would be expected to be the major complication.[11]



*Z*, mp 85–89° **12** **13**

*E*, mp 104–106° **14** **15**

A pair of stereoisomeric bicyclic ketones was finally obtained in the α-phenylcinnamic acid series. 1-Pyrazolines **16** and **18** were readily prepared from the

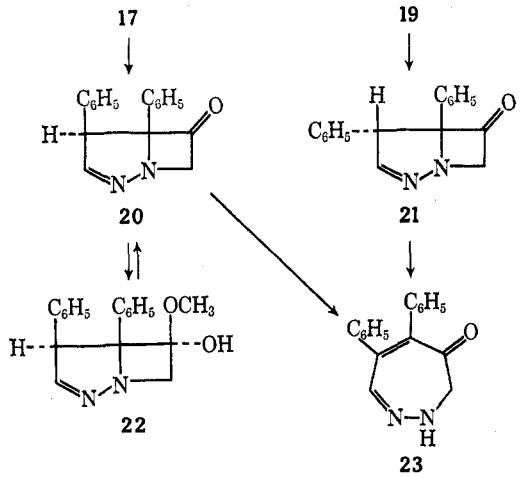


**16** **17** **18** **19**

(7) G. Reinicke, *Justus Liebigs Ann. Chem.*, **341**, 89 (1905).
(8) E. J. Corey and G. Frankel, *J. Amer. Chem. Soc.*, **75**, 1168 (1953).
(9) J. J. Sudborough and K. J. Thompson, *J. Chem. Soc.*, **83**, 673 (1903).
(10) S. A. Faseeh, *Pak. J. Sci. Res.*, 63 (1951); *Chem. Abstr.*, **47**, 11159 (1953).
(11) H. Kisch, O. E. Polansky, and P. Schuster, *Tetrahedron Lett.*, 805 (1969).

respective mixed anhydrides, and were converted to the 5-pyrazolines **17** and **19** by treatment with base. These isomerizations required carefully controlled conditions to minimize further reactions which will be described in a later paper.

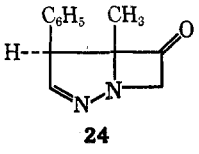
The 5-pyrazolines **17** and **19** were converted to bicyclo[3.2.0] ketones **20** and **21** with cold methanolic sulfuric acid. From the *cis*-diphenylpyrazoline, the hemiketal **22** was obtained as a major by-product; the *exo*-methoxy structure is based on the assumption of




methanol addition at the *exo* side of the carbonyl. Similar rather stable hemiketals were previously observed in the steroidal diazabicyclic ketone series.[2] Compound **22** was extremely labile and reverted rapidly in chloroform solution to the ketone **20**. No ketal was observed in the *trans*-diphenyl series, in which steric interference with the *endo*-phenyl group would be severe.

For preparation of the 5,6-diphenyl-2,3-dihydrodiazepinone (**23**), the 1-pyrazoline **16** derived from the less expensive *Z* acid was used. Treatment of **16** with hot acetic acid gave the diazepine in 47% yield. The reaction was not so clean as that in the methylphenyl series,[3] and impurities (by tlc) began to appear before the pyrazoline had completely reacted. The diazepinone **23** had spectral properties very similar to those of the 5-methyl-6-phenyl derivative, with a considerably higher visible absorption maximum ($\epsilon_{410}$ 4400 *vs.* 2900).

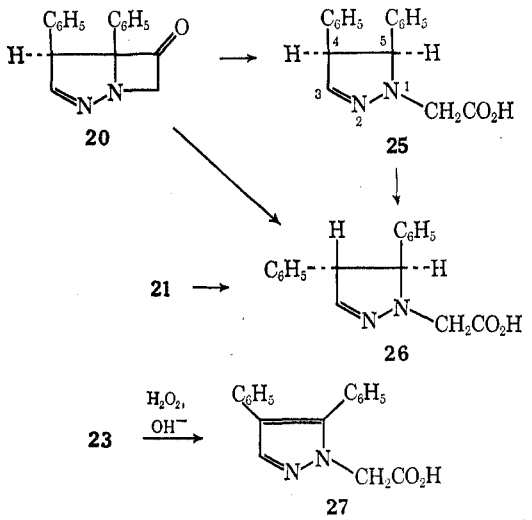
The yield of **23** from the 1-pyrazoline reflects the combined efficiency of three steps—isomerization to **17**, cyclization to **20**, and ring opening of the bicyclic ketone. The last step has been studied semiquantitatively in the methylphenyl series[3] (compound **24**); in that case the reaction is most effectively catalyzed by base and to a lesser degree by acid. To compare structural and steric effects in this ring-opening step, the rates of conversion of the two diphenylbicyclic ketones **20** and **21** and the *cis*-4-methyl-5-phenyl compound **24** to the respective diazepinones were measured spectrophotometrically in 1 *N* methanolic acetic acid at 35°. The nature of the C-4 substituent and the configuration at C-5 were found to have only a minor influence; the




| Compd | $k_1$, l. mol sec$^{-1}$ |
|---|---|
| **20** | $1.67 \times 10^{-6}$ |
| **21** | $0.80 \times 10^{-6}$ |
| **24** | $1.38 \times 10^{-6}$ |

slightly faster rates of **20** and **24** probably reflect somewhat greater eclipsing interactions in the *exo* ketones.

Comparison of the rates of the base-catalyzed reactions could not be made because of a major side reaction with the diphenyl ketones. Whereas the reaction of **24** gave a straight-line pseudo-first-order plot to 94% completion in 0.01 *N* methanolic base, the curves for **20** and **21** deviated sharply. The conversion to **23** was 15% with the *exo* isomer (**20**) and 34% with the *endo*-phenyl ketone (**21**). Treatment of **20** with methanolic base gave in low yield an acid which is assigned the *cis*-diphenylpyrazoline acetic acid structure **25**. In the nmr spectrum, H-4 and H-5 had a *cis* coupling of 10.3 Hz, and H-4 was coupled also to H-3 ($J$ = 1.3 Hz); the other peaks were consistent for **25**. In more concentrated aqueous base, both **20** and **21** gave an isomeric acid whose spectrum ($J_{4,5}$ = 13 Hz) indicated the presumably more stable *trans* acid **26**. Surprisingly, attempts to oxidize **25** with $MnO_2$, $KMnO_4$, or $H_2O_2$ to the pyrazoleacetic acid **27** were all unsuccessful. A sample of **27** was obtained in very low yield by alkaline peroxide oxidation of the diazepinone **23**.[12]



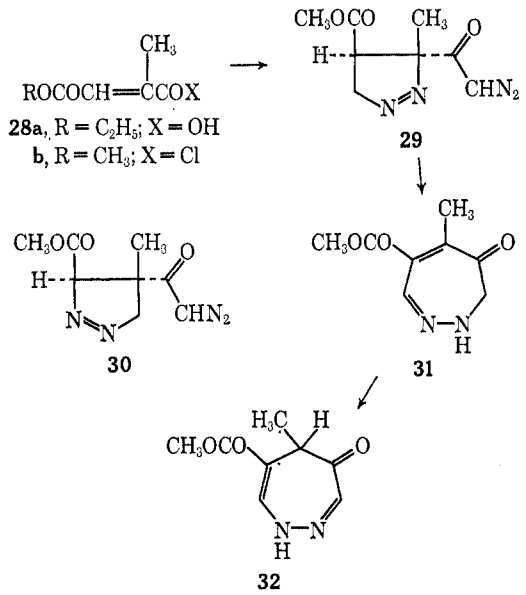

The facile cleavage of ketones **20** and **21**, in contrast to the 4-methyl ketone **24**, is easily understood in view of the stabilization of a carbanion by the phenyl substituent in **20** and **21**. The reaction apparently occurs with fairly complete retention of configuration at C-5, and isomerization of the *cis*-diphenylpyrazoline **25** presumably involves removal of H-4, which is activated by both 4-phenyl and C=N groups. In the 4-methyl ketone **24**, only the H-4 proton is activated toward base, and removal leads to diazepinone formation.

The formation of **23** represents a rather slight extension of the scope of this diazepinone synthesis, and the unsuccessful results with the bromo-, phenoxy-, and ethoxycarbonyl cinnamic acids indicate that $\alpha$-functional $\alpha,\beta$-unsaturated acids cannot be adapted, even in the relatively favorable $\beta$-phenyl case, to this sequence. A different approach thus seemed to be required for the synthesis of a functionally substituted diazepinone.

A promising candidate for this purpose was a pyrazoline derived from mesaconic acid "$\alpha$ ester" (**28**, X = OH). The half-esters of mesaconic acid have been known for many years, but some ambiguity has existed regarding the position of the ester function. Cocker

(12) J. A. Moore and C. L. Habraken, *J. Org. Chem.*, **30**, 1889 (1965).

and Fateen have shown conclusively that the monoethyl ester obtained by partial saponification is **28a**.[13] For our purposes the methyl ester was preferred because of the simpler nmr spectrum and the fact that methyl esters are, in general, more readily crystallized than ethyl esters. Assuming by analogy that the monomethyl ester chloride of Anschütz has the structure **28b** as originally formulated,[14] two pyrazolines, **29** and **30**, could arise, depending on the polarization imparted by $CO_2Me$ and $COCHN_2$ groups for cycloaddition. Of these, **30** could not cyclize to a diazabicyclo[3.2.0]-heptenone, but **29** should be a very favorable case, with a stable substituent at C-3 and a highly activated C-4 proton.




Treatment of the acid chloride **28b** with 2 mol of diazomethane gave a very unstable oil from which an unsaturated diazo ketone could not be isolated, but with excess diazomethane, a pyrazoline was obtained in 66% yield. The spectral properties did not distinguish between **29** and **30**, but on reaction with warm acetic acid the diazepinone **31** was produced (45%). The formation of **31** establishes the structure of the pyrazoline as **29**, and, incidentally, provides independent evidence for the correctness of structure **28b** (X = OH) for mesaconic acid $\alpha$-methyl ester, since neither of the pyrazolines that could be formed from the isomeric "$\beta$ ester" (**28**, R = H, X = $OCH_3$) could lead to a diazabicyclic ketone.

The methoxycarbonyldiazepinone **31** was an orange solid, appreciably soluble in water. The spectral properties were consistent with those of **23** and the 5-methyl-6-phenyl derivative. The compound was not stable to storage at room temperature, and no crystalline derivatives have been obtained. Attempted hydrolysis of the ester group with aqueous carbonate followed by neutralization gave an orange solution from which nothing was extracted with chloroform. In DMSO solution containing sodium methoxide, the nmr spectrum of **31** was transformed completely to a spectrum corresponding to that expected for the 1,5-dihydro isomer **32**. The equilibrium **31** $\rightleftarrows$ **32** appears to lie much further to the right than in the corresponding 4-methyl-5-phenyldiazepinones.[15]

In summary, these studies have shown that the formation of 2,3-dihydrodiazepinones by the sequence **1** → **2** → **3** is of some generality, and certain limitations on the possible structural variations have been delineated. The configuration of substituents in the pyrazoline and bicyclic ketone seems to be of little importance in the overall process. It seems reasonable to expect that 5,6-diaryldiazepinones analogous to **23** could be obtained in some variety. A number of transformations of the 5-methyl-6-phenyldiazepinone proceed in preparatively useful fields to give pyridines, pyridazines, pyrroles, and furans with substitution patterns that are rather difficultly accessible by more conventional routes.[16] On the occasion of a need for diaryl counterparts of these compounds, syntheses based on rearrangements of **23** or variants thereof may be quite convenient. The practical difficulties arising from the instability and solubility properties of **31** and, presumably, other nonarylated derivatives would appear to preclude most synthetic applications.

## Experimental Section[17]

**(*Z*)-α-Bromocinnamoyl chloride,**[18] bp 104° (0.5 mm), nmr δ 8.65 (s, 1), was prepared in 92% yield from the *Z* acid and thionyl chloride.

**(*Z*)-3-Bromo-1-diazo-4-phenyl-3-buten-2-one (4).**—A solution of 3.9 g (16 mmol) of the above acid chloride in 25 ml of ether was added dropwise to a solution of 38 mmol of diazomethane in 120 ml of ether. After standing 2 hr at 0°, the solution was concentrated and a total of 2.0 g (50%) of diazo ketone **4**, mp 69–71°, was obtained in two crops. Recrystallization from ether–pentane gave yellow needles: mp 71–72°; $\nu_{KBr}$ 2080 ($COCHN_2$), 1630 $cm^{-1}$ (CO); δ ($CDCl_3$) 6.25 (s, 1), 7.35 (m, 3), 7.8 (m, 2), 8.10 ppm (s, 1).

*Anal.* Calcd for $C_{10}H_7BrN_2O$: C, 47.84; H, 2.81; N, 11.16. Found: C, 47.58; H, 2.83; N, 10.87.

**3*r*-Bromo-3-diazoacetyl-4*c*-phenyl-1-pyrazoline (5).**—A solution of 3 g (0.012 mol) of (*Z*)-α-bromocinnamoyl chloride in ether was added to 0.05 mol of diazomethane. After standing at 0° for 2 days, some insoluble material was removed and the solution was evaporated with the temperature not above 0°. Methanol was added to the residue and the solution was chilled in Dry Ice. The yellow solid which separated was collected, washed with cold methanol, and dried to give 1.6 g of pyrazoline **5**, mp 45°. Recrystallization from methanol gave pale yellow crystals: mp 46–48°; $\nu_{KBr}$ 2090, 1635 $cm^{-1}$; δ ($CDCl_3$) 3.95 (center line of symmetrical three-line multiplet; X part of ABX), 4.67, 5.00 [eight lines, calculated centers of gravity of AB part of ABX, $J_{AB}$ = |18.2|, $J_{AX}$ = 7.4, $J_{BX}$ = 8.2 Hz], 6.3 (s, 1, $CHN_2$), 7.3 ppm (s, 5, $C_6H_5$). Because of the low melting point, the compound could not be dried completely for analysis.

*Anal.* Calcd for $C_{11}H_9BrN_4O$: C, 45.07; H, 3.09; N, 19.11. Found (dried 24 hr at 25° over $P_2O_5$): C, 44.47; H, 2.86; N, 18.44.

Treatment of the unsaturated diazo ketone **4** with diazomethane at 0° for 12 hr gave a mixture of equal amounts of **4** and pyrazoline **5** (by nmr analysis); these compounds were not separated by tlc (chloroform–MeOH, 23:2).

**Attempted Preparation of (*E*)-α-Bromocinnamoyl Chloride.**[5]—A solution of 6.8 g of the *E* acid and 10 g of oxalyl chloride in 10 ml of ether was refluxed for 24 hr. After evaporation, 2 g of the unreacted *E* acid was recovered; distillation at 88° (0.7 mm) [*cf.* ref 5; reaction time 30 min at 50°, distillation at 100–101° (2 mm)] gave 1 g of acid chloride which by nmr was a 1:1 mixture of *E* and *Z* isomers. With thionyl chloride at 40–50°, the acid was recovered unchanged; at 60–70°, crude solids were

(13) W. Cocker and A. K. Fateen, *J. Chem. Soc.*, 2630 (1951).
(14) R. Anschutz, *Justus Liebigs Ann. Chem.*, **353**, 139 (1907).
(15) M. G. Pleiss and J. A. Moore, *J. Amer. Chem. Soc.*, **90**, 1369 (1968).
(16) J. A. Moore, *Trans. N. Y. Acad. Sci.*, **27**, 591 (1965).
(17) General procedures are given in paper 22 of this series: J. A. Moore, R. W. Medeiros, and R. L. Williams, *J. Org. Chem.*, **31**, 52 (1966).
(18) H. Staudinger and E. Otto, *Chem. Ber.*, **44**, 1634 (1911).

obtained which gave nmr spectra consistent with the $C_6H_5$-CHCl-CHBrCO system.

**3*r*-Bromo-3-diazoacetyl-4*t*-phenyl-1-pyrazoline (7).**—The mixed anhydride (6) of (*E*)-α-bromocinnamic acid[9] was prepared from 2.27 g (0.01 mol) of the *E* acid, 1.08 g of ethyl chloroformate, and 1.03 g of triethylamine in dry ether. After filtration of triethylamine hydrochloride, the ethereal solution was concentrated and was added to an ethereal solution of diazomethane (0.04 mol) at 0°. Gas evolution was observed immediately after addition. The mixture was kept in a refrigerator for 2 days. After removing some precipitate by filtration, the ethereal solution was concentrated under reduced pressure at 0° bath temperature. The yellow crystalline residue was collected, washed with cold methanol, and dried to give 0.9 g (31%) of crude pyrazoline, mp 90° dec. Recrystallization from methanol gave pale yellow crystals: mp 90° dec; $\nu_{KBr}$ 2110, 1630 cm$^{-1}$; δ ($CDCl_3$) 7.4–6.7 (m, 5, aromatic H), 6.22 (s, 1, $COCHN_2$), $\delta_A$ 5.17, $\delta_B$ 4.78, $\delta_X$ 3.90 ppm ($J_{AB}$ = |17.7|, $J_{AX}$ = 6.3, $J_{BX}$ = 1.5 Hz).

*Anal.* Calcd for $C_{11}H_9BrN_4O$: C, 45.07; H, 3.09; N, 19.11. Found: C, 44.49; H, 2.93; N, 18.45.

**(*Z*)-1-Diazo-3-phenoxy-4-phenyl-3-buten-2-one (8).**—(*Z*)-α-Phenoxycinnamic acid,[19] mp 180°, 7.2 g (0.03 mol), was converted to the anhydride with 3.25 g of EtOCOCl and 3.1 g of $Et_3N$ as described above, and the filtered ethereal solution of anhydride was added to a solution of 0.08 mol of diazomethane. After the solution had stood at 25° for 1 day and some amorphous solid was removed, the solution was evaporated to give 6.0 g of yellow solid, mp 100°. Recrystallization from methanol gave **8** as yellow crystals: mp 102–103°; $\nu_{KBr}$ 2100, 1640, 1580 cm$^{-1}$; δ ($CDCl_3$) 7.7–6.8 (m, 11, aromatic **H** + vinyl **H**), 5.6 ppm (s, 1, $COCHN_2$).

*Anal.* Calcd for $C_{16}H_{12}N_2O_2$: C, 72.71; H, 4.58; N, 10.60. Found: C, 72.51; H, 4.53; N, 10.46.

No pyrazoline was obtained after further treatment of **8** with 2 equiv of diazomethane for 2 days at 25°.

**3-Diazoacetyl-4-phenylpyrazole (9).**—To a solution of 1.47 g (0.005 mol) of 3*r*-bromo-3-diazoacetyl-4*c*-phenyl-1-pyrazoline (**5**) in 10 ml of dry methanol was added a solution of 0.36 g (2 equiv) of sodium methoxide in 10 ml of dry methanol at 0°, and the reaction mixture was left standing at 0°. After 30 min, the mixture was poured into ice water and the aqueous solution was neutralized with acetic acid (pH 6). The yellow crystalline material which separated was extracted with methylene chloride and the organic layer was washed with water, dried, and evaporated to give 0.55 g (76%) of crude pyrazole, mp 150° dec. Recrystallization from methanol and water gave fine needles of **9**: mp 153° dec; $\nu_{KBr}$ 3050, 2080, 1590 cm$^{-1}$; δ (DMSO-$d_5$) 6.5 (s, 1), 7.2–7.8 (m, 5), 8.02 (s, 1), 13.5 ppm (s, 1).

*Anal.* Calcd for $C_{11}H_8N_4O$: C, 62.25; H, 3.80; N, 26.40. Found: C, 62.09; H, 3.81; N, 26.16.

**3-Methoxyacetyl-4-phenylpyrazole (10).**—The diazo ketone **9**, 212 mg, was dissolved in 10 ml of methanol and to the solution was added 0.02 ml of concentrated sulfuric acid at 0°. Gas evolution took place immediately. After the solution had stood at 25° for 30 min, white crystals appeared which were collected; concentration of the filtrate gave additional product; the total yield was 210 mg (97%), mp 200°. Recrystallization from methanol gave needles of **10**: mp 205° with preliminary coloration; $\nu_{KBr}$ 3000, 1690 cm$^{-1}$; δ (DMSO-$d_6$) 8.04 (s, 1, **H**-5), 7.7–7.2 (m, 5, aromatic **H**), 4.74 (s, 2, $COCH_2OCH_3$), 3.4 ppm (s, 3, $OCH_3$).

*Anal.* Calcd for $C_{12}H_{12}N_2O_2$: C, 66.65; H, 5.59; N, 12.96. Found: C, 66.83; H, 5.51; N, 13.02.

**3-Chloroacetyl-4-phenylpyrazole (11).**—A solution of 424 mg of **9** in 5 ml of tetrahydrofuran mixed with a solution of 400 mg of 12 *N* HCl in 5 ml of THF at 0°. Gas evolution began at 0° and became vigorous as the solution was warmed; after standing at 25° for 30 min, the solution was concentrated *in vacuo*. Addition of water to the residue gave white crystals which were collected on a filter and dried to give 433 mg (96%) of solid, mp 185° (darkening). Recrystallization from methanol gave **11**: mp 185° (darkening); $\nu_{KBr}$ 3070, 1690 cm$^{-1}$; δ (DMSO-$d_6$) 8.1 (s, 1, **H**-5), 7.6–7.2 (m, 5, aromatic **H**), 5.05 ppm (s, 2, $COCH_2Cl$).

*Anal.* Calcd for $C_{11}H_9ClN_2O$: C, 59.88; H, 4.11; N, 12.70. Found: C, 60.00; H, 3.84; N, 12.55.

(19) Prepared according to "Beilstein's Handbuch," 4th ed, Vol. 10, p 303, lit. mp 179°.

Treatment of **11** with methanolic NaOH overnight at 30° gave the methoxyacetylpyrazole **10**.

**Separation of (*E*)- and (*Z*)-α-(Ethoxycarbonyl)cinnamic Acids.**—A mixture of (*E*)- and (*Z*)-α-ethoxycarbonylcinnamic acids (benzylidene malonic acid monoethyl esters) was prepared from ethyl potassium malonate, benzaldehyde, and acetic acid.[7] The mixture contained *Z* and *E* acids in a 63:37 ratio (by nmr).

The mixture, 13 g, was suspended in 300 ml of water, and a total of 5 ml of concentrated aqueous $NH_4OH$ was added in small portions until a clear solution was obtained. Solid $BaCl_2$ was added to the solution until saturation. After the solution was stirred for 3 hr, the white precipitate was collected and washed with saturated aqueous $BaCl_2$. This barium salt was decomposed with 2 *N* HCl and the oily acid was extracted with ether. The ethereal solution was washed with water, dried, and evaporated to a colorless residue which crystallized on cooling. It was washed with pentane and dried to give 6 g of the crude *Z* acid (α-ethoxycarbonyl-*trans*-cinnamic acid, **12**): mp *ca.* 85°; δ ($CDCl_3$), 10.8 (s, 1, COOH), 7.93 (s, 1, CH=C), 7.44 (s, 5), 4.37 (q, *J* = 7 Hz, 2, $CH_2$), 1.26 (ppm (t, *J* = 7 Hz, 3, $CH_3$). After several recrystallizations from benzene and pentane, the melting point became 85–89°.

The filtrate from the barium salt of the *Z* acid was acidified and the oily material which separated was extracted with ether. After drying and evaporation, 3 g of solid, mp 80–90°, was obtained. Nmr indicated a mixture of 90% *E* and 10% *Z* acid. After several recrystallizations from benzene and pentane, almost pure *E* acid **14**, mp 104–106°, was obtained: δ ($CDCl_3$) 10.67 (s, 1, COOH), 7.84 (s, 1, CH=C), 7.4 (m, 5), 4.32 (q, *J* = 7 Hz, 2), 1.32 ppm (t, *J* = 7 Hz, 3).

**Ethyl 3-Diazoacetyl-4*c*-phenyl-1-pyrazoline-3*r*-carboxylate (13).**—The mixed anhydride of (*Z*)-α-ethoxycarbonylcinnamic acid and ethyl hydrogen carbonate was prepared from 4.4 g (0.02 mol) of the *Z* acid **12**, as described for **6**. After concentrating the ethereal solution, it was added to an ethereal solution of 0.05 mol of diazomethane at 0°. The reaction mixture was allowed to warm to room temperature overnight. After removal of some insoluble material by filtration, the reaction mixture was concentrated *in.vacuo* to give a thick yellow oil, which was stored in a Dry Ice box for 5 days. Small amounts of ether and pentane were then added and the oil was rubbed with a spatula. Crystallization occurred and 4.5 g (79%) of crude pyrazoline, mp 48°, was obtained. Recrystallization from ether–pentane gave **13**: mp 50–53° dec; $\nu_{KBr}$ 2100, 1740, 1635 cm$^{-1}$; δ ($CDCl_3$) 7.2 (m, 5, aromatic **H**), 6.05 (s, 1, $COCHN_2$), 5.0–4.1 (m, 3, ring **H**), 3.75 (q, *J* = 7 Hz, 2, $CH_2$), 0.80 ppm (t, *J* = 7 Hz), 3, $CH_3$).

*Anal.* Calcd for $C_{14}H_{14}N_4O_3$: C, 58.73; H, 4.93; N, 19.57. Found: C, 58.65; H, 4.96; N, 18.85, 18.82.

**Ethyl 3-Diazoacetyl-4*t*-phenyl-1-pyrazoline-3*r*-carboxylate (15).**—By the procedure described above, 2.2 g of the *E* acid **14** was converted to the pyrazoline **15**. The crude solid, obtained in 94% yield, was recrystallized from ether: mp 85–87° dec; $\nu_{KBr}$ 2110, 1740, 1625 cm$^{-1}$; δ ($CDCl_3$) 7.4–6.8 (m, 5, aromatic **H**), 5.8 (s, 1, $COCHN_2$), 5.54–4.0 (m, 5, ring H + $CH_2CH_3$), 1.3 ppm (t, *J* = 7 Hz, 3, $CH_3$).

*Anal.* Calcd for $C_{14}H_{14}N_4O_3$: C, 58.73; H, 4.93; N, 19.57. Found: C, 58.68; H, 4.94; N, 19.12.

**3-Diazoacetyl-3,4-*cis*-diphenyl-1-pyrazoline (16).**—The mixed anhydride of (*E*)-α-phenylcinnamic acid [$\delta_{\beta\text{-H}}$ ($CDCl_3$) 8.08 ppm] and ethyl chloroformate was prepared from 2.24 g (0.01 mol) of the acid, 1.09 g (0.01 mol) of ethyl chloroformate, and 1.03 g (0.0102 mol) of triethylamine in dry ether. After removal of $Et_3NHCl$, the ethereal solution of the mixed anhydride was concentrated and added to an ethereal solution of 0.04 mol of diazomethane. Gas evolution was observed after 2–3 hr. The reaction mixture was left standing at room temperature for one day, filtered, and concentrated to give a yellow oil which was crystallized by addition of methanol and chilling to −50°. The yellow solid was collected, washed with pentane, and dried to give 2.2 g (76%) of crude 1-pyrazoline, mp 60°. Recrystallization from ether–pentane gave pale yellow crystals of **16**: mp 62–64°; $\nu_{KBr}$ 2100, 1640 cm$^{-1}$; δ ($CDCl_3$) 7.2–6.5, (m, 10, aromatic **H**), 5.67 (s, 1, $COCHN_2$), 5.0–4.25 ppm (m, 3, did not fit simple ABX pattern).

*Anal.* Calcd for $C_{17}H_{14}N_4O$: C, 70.33; H, 4.86; N, 19.30. Found: C, 70.25; H, 4.84; N, 18.88.

**3-Diazoacetyl-3,4-*trans*-diphenyl-1-pyrazoline (18).**—(*Z*)-α-Phenylcinnamic acid, mp 135–138°, $\delta_{\beta\text{-H}}$ ($CDCl_3$) 7.20 ppm, was prepared by photolysis of the *E* isomer and separated by differ-

ential acidification.[20,21] The mixed anhydride was prepared from 22.4 (0.1 mol) of acid and converted to the pyrazoline with 0.4 mol of diazomethane as described for **16**. Pale yellow crystals separated from the dilute ethereal solution after two days. A total of 23.5 g of **18** (81%), mp 150° dec, was obtained (recrystallization from methanol raised the melting point to 157° dec): $\nu_{KBr}$ 2100, 1630 cm$^{-1}$; $\delta$ ($CDCl_3$) 7.7–6.9 (m, 10, aromatic **H**), 6.00 (s, 1, $COCHN_2$), 5.3–4.2 (AB part of ABX, $\delta_A$ 5.05, $\delta_B$ 4.45, $J_{AB}$ = |17.0|, $J_{AX}$ = 7.5, $J_{BX}$ = 2.5 Hz, 2, C-5 $CH_2$), 3.8–3.6 ppm (X part of ABX, $\delta_1$ 3.73, 1, **H**-4).

*Anal.* Calcd for $C_{17}H_{14}N_4O$: C, 70.33; H, 4.86; N, 19.30. Found: C, 70.14; H, 4.73; N, 18.75.

**3-Diazoacetyl-3,4-*cis*-diphenyl-5-pyrazoline (17).**—To a solution of 5.80 g of 1-pyrazoline **16** in 100 ml of methanol was added 1.0 ml of 1 *N* KOH (in methanol) at 0°. The reaction mixture was left standing at 0° for 4 hr. Dry Ice was then added and the solution was concentrated under reduced pressure to give off-white crystals which were collected and washed with a mixture of ether and pentane. A second crop was obtained from the mother liquor; after recrystallization from ether–pentane, it was combined with the first crop to give a total of 3.85 g (65.5%) of **17**, mp 125–127° dec. The analytical sample was recrystallized from ether and *n*-pentane: mp 125–127° dec; $\nu_{KBr}$ 3240, 2100, 1630 cm$^{-1}$; $\delta$ ($CDCl_3$) *ca.* 7 (m, 10, aromatic H), 6.9 (d, $J$ = 1.7 Hz, 1, 5 H), 6.4 (s, 1, NH), 5.33 (s, 1, $COCHN_2$), 5.18 ppm (d, $J$ = 1.7 Hz, 1, 4 H).

*Anal.* Calcd for $C_{17}H_{14}N_4O$: C, 70.33; H, 4.86; N, 19.30. Found: C, 70.18; H, 4.96; N, 19.13.

**3-Diazoacetyl-3,4-*trans*-diphenyl-5-pyrazoline (19).**—To a solution of 580 mg of the 1-pyrazoline **18** in 10 ml of THF and 10 ml of methanol was added 0.2 ml of 1 *N* KOH. The mixture was left standing at room temperature for 4 hr; tlc showed that some **18** remained and that a second product, slower moving than **22**, was also being formed. After neutralization of the reaction mixture, it was concentrated to give a yellow crystalline residue. Recrystallization from methanol gave 255 mg (44%) of 5-pyrazoline (5% impurity by nmr), mp 130° dec. Recrystallization from methanol gave pure **19**: mp 133° dec; $\nu_{KBr}$ 3230, 2100, 1625 cm$^{-1}$; $\delta$ ($CDCl_3$) 7.7–7.0 (m, 10, aromatic H), 6.83 [d, $J$ = 1.5 Hz, 1, H-5], 6.67 (s, 1, NH), 5.33 (s, 1, $COCHN_2$), 4.73 ppm (d, $J$ = 1.5 Hz, 1, H-4).

*Anal.* Calcd for $C_{17}H_{14}N_4O$: C, 70.33; H, 4.86; N, 19.30. Found: C, 70.19; H, 4.83; N, 19.00.

**4-*endo*-5-Diphenyl-1,2-diazabicyclo[3.2.0]-2-hepten-6-one (21).**—A solution of 1.16 g of the *trans*-$\Delta^5$-pyrazoline **19** in 30 ml of methanol was treated with a solution of 300 mg (1.5 equiv) of concentrated sulfuric acid in 5 ml of methanol at room temperature. After 20 min, the reaction mixture was poured into ice water and the aqueous mixture was neutralized with $NaHCO_2$ and extracted with ether. After washing and drying, the ether was evaporated to give a yellow residue, which was extracted with boiling hexane. Concentration of the hexane solution gave white crystals of **21**: mp 80–81° ((recrystallization from hexane did not change the melting point); $\nu_{KBr}$ 1800 cm$^{-1}$; $\delta$ ($CDCl_3$) 7.5–7.0 (m, 11, aromatic H + **H**-3, AB of C-7 $CH_2$, $\delta_A$ 4.70, dd, $J_{3-7A}$ = 1.2 Hz, $\delta_B$ 4.42, dd, $J_{3-7B}$ = 1.0 Hz, $J_{AB}$ = |16| Hz), 4.32 ppm (d, $J$ = 1.0, 1, H-4).

*Anal.* Calcd for $C_{17}H_{14}N_2O$: C, 77.84; H, 5.38; N, 10.68. Found: C, 77.83; H, 5.45; N, 10.78.

**4-*exo*-4,5-Diphenyl-1,2-diazabicyclo[3.2.0]-2-hepten-6-one (20) and 6-*exo*-Methoxy-4-*exo*-4,5-diphenyl-1,2-diazabicyclo[3.2.0]-2-hepten-6-*endo*-ol (22).**—The 5-pyrazoline **17** (3.85 g, 0.013 mol) was dissolved in 70 ml of methanol and to the solution was added a solution of 1 g (1.5 equiv) of concentrated $H_2SO_4$ in methanol at room temperature. After the addition, the reaction mixture was stirred at 0° for 10 min and then poured into ice water. After extraction with $CH_2Cl_2$, the organic layer was washed with dilute $NaHCO_3$ solution and water, dried, and evaporated to dryness. The yellow residue was extracted several times with boiling hexane. The white crystals which remained undissolved were collected and dried to give 730 mg of hemiketal **22**, mp ~125°.

The hexane solution was evaporated to dryness and the residue was slowly recrystallized from hexane to give 2.2 g (65%) of off-white crystals of ketone **20**: mp 108–110°; $\nu_{KBr}$ 1790 cm$^{-1}$; $\delta$ ($CDCl_3$) 7.5–6.7 (m, 11, 2 $C_6H_5$ + **H**-3), 4.86 ppm (d, $J$ = 1.6 Hz, 1, **H**-4, AB of C-7 $CH_2$, $\delta_A$ 4.83, dd, $J_{3-7A}$ = 1.4 Hz, $\delta_B$ 4.32, d, $J_{AB}$ = |16| Hz).

*Anal.* Calcd for $C_{17}H_{14}N_2O$: C, 77.84; H, 5.38; N, 10.68. Found: C, 77.93; H, 5.32; N, 10.68.

The ir spectrum of the hexane-insoluble solid (**22**) contained a very small peak at 1790 cm$^{-1}$ due to **20** and a broad band around 3000 cm$^{-1}$. This material was dissolved in methanol at room temperature and cooled in a Dry Ice box after addition of a small amount of hexane. The white crystals thus obtained had a very small absorption at 1790 cm$^{-1}$; mp 125°; $\delta$ (DMSO-$d_6$) ~6.9 (m, 11, 2 $C_6H_5$ + **H**-3), 5.17 (d, $J$ = 2 Hz, 1, **H**-4, AB of C-7 $CH_2$, $\delta_A$ 3.87, $\delta_B$ 3.43, $J_{AB}$ = |11| Hz), 2.97 ppm (s, 3, $OCH_3$).

The nmr spectrum in DMSO-$d_6$ gradually changed on standing at room temperature. After 2 days, the presence of **20** and methanol was quite clear and after 4 days, 30% of the methoxy protons were present as methanol. (In $CDCl_3$, this change was complete in a few hours.)

*Anal.* Calcd for $C_{18}H_{18}N_2O_2$: C, 73.45; H, 6.16; N, 9.52. Found: C, 73.78; H, 6.18; N, 9.46.

**2,3-Dihydro-5,6-diphenyl-1,2-diazepin-4-one (23).**—The $\Delta^1$-pyrazoline **16** (17.4 g, 0.06 mol) was dissolved in 100 ml of acetic acid, and the solution was heated at 90° for 5.5 hr. Tlc showed that some starting material remained at this point and some slower-moving products were being formed. Acetic acid was removed by distillation at reduced pressure. Addition of methanol to the residue gave dark orange crystals which were collected, washed with methanol, and dried to give 6.5 g (47%) of crude **23**, mp 195–198° dec. The diazepinone was recrystallized from ethanol: mp 195–198° dec; $\nu_{KBr}$ 3200, 1630 cm$^{-1}$; $\delta$ (DMSO-$d_6$) ~7.1 (m, 12, 2 $C_6H_5$, **H**-7 and **NH**), 3.92 ppm (s, 2, $CH_2$).

*Anal.* Calcd for $C_{17}H_{14}N_2O$: C, 77.84; H, 5.38; N, 10.68. Found: C, 77.92; H, 5.41; N, 10.59.

**2-Acetyl-2,3-dihydro-5,6-diphenyl-1,2-diazepin-4-one** was prepared by treatment of **23** with acetic anhydride and pyridine for 3 hr at 26°. After pouring the solution into ice water, the product was collected and recrystallized from chloroform–hexane as light orange crystals: mp 158–160°; $\nu_{KBr}$ 1700, 1670 cm$^{-1}$; $\delta$ ($CDCl_3$) 7.48 (s, 1, **H**-7), 7.15 (m, 10), 4.8 (s, 2), 2.45 ppm (s, 3).

*Anal.* Calcd for $C_{19}H_{16}N_2O_2$: C, 74.98; H, 5.30; N, 9.21. Found: C, 74.89; H, 5.35; N, 8.95.

**Isomerization Rates of Bicyclic Ketones.**—Samples of the ketones **20**, **21**, and **24** (0.05 mmol) were accurately weighed and added ($t$ = 0) to 25.0 ml of 1 *N* methanolic acetic acid which had been standing in a bath at 35 ± 0.5°. At appropriate intervals (30, 60, 120 min), the absorbance of the solution at the long-wavelength maximum of the diazepinone (410 mμ for **23**; 401 mμ for the 5-methyldiazepine) was measured on a Cary 14 spectrophotometer. Plots of $\log A_\infty/(A_\infty - A)$ *vs.* time gave straight lines; values of $k$ were obtained by a least-squares calculations.

***cis*-4,5-Diphenyl-2-pyrazoline-1-acetic Acid (25).**—A solution of 380 mg of the 4-*exo*-diphenyl bicyclic ketone **20** in 10 ml of methanol was treated with 3 ml of 1 *N* methanolic KOH. On standing at 25° the solution became yellow; after 2 hr, ice water was added and the mixture was extracted with $CH_2Cl_2$ to remove **23**. The colorless aqueous solution was acifiied and extracted with ether. After washing and drying, the ether layer was evaporated to a crystalline residue. Recrystallization from ether–pentane gave 70 mg (17%) of the *cis*-pyrazoline **25**: mp 150–153° dec (recrystallization from chloroform–pentane gave crystals with the same melting point); $\nu_{KBr}$ 1730 cm$^{-1}$; $\delta$ ($CDCl_3$) 9.48 (s, 1, $CO_2H$), 7.4–6.7 (m, 11, 2 $C_6H_5$ + **H**-3), 4.87 (d, $J_{4-5}$ = 10.3 Hz, 1, **H**-5), 4.33 ppm (dd, $J_{4-5}$ = 10.3 Hz, $J_{3-4}$ = 1.5 Hz, 1, **H**-4, AB of $CH_2CO_2H$, $\delta_A$ 4.10, d, $\delta_B$ 3.62, d, $J_{AB}$ = |17| Hz).

*Anal.* Calcd for $C_{17}H_{16}N_2O_2$: C, 72.84; H, 5.74; N, 9.99. Found: C, 72.52; H, 5.78; N, 9.86.

***trans*-4,5-Diphenyl-2-pyrazoline-1-acetic Acid (26).**—Compound **20** (200 mg) was added to 5 ml of 30% aqueous KOH solution. The solid dissolved and then some insoluble solid separated which redissolved on addition of water. After 4 hr the colorless solution was neutralized with HCl and extracted with $CH_2Cl_2$. Evaporation of the dried organic layer gave 140 mg (66%) of white crystalline solid, mp 153–155°. Recrystallization from ether gave pure **26**: mp 153–155°; $\delta$ ($CDCl_3$) 11.2 (s, 1, $CO_2H$), 7.3 (s, 10, 2 $C_6H_5$), 6.8 (s, 1, **H**-3), 4.48 (d, $J_{4,5}$ = 13 Hz, 1, **H**-5), 4.15 (d, $J_{4,5}$ = 13 Hz, 1, **H**-4), 4.06, 3.65 ppm (AB, $J$ = |17| Hz, 2, $-CH_2-$).

(20) R. Stoermer and G. Voht, *Justus Liebigs Ann. Chem.*, **409**, 36 (1915), report mp 137–138°.

(21) Samples of comparable purity were also obtained from Frinton Chemical Co.

*Anal.* Calcd for $C_{17}H_{16}N_2O_2$: C, 72.84; H, 5.74; N, 9.99. Found: C, 73.15; H, 5.76; N, 9.88.

A mixture of **25** and **26** was dissolved in 30% aqueous KOH for 1 hr. After isolation, the nmr showed the presence of only **26**.

Reaction of 4-*endo*-phenyl ketone **21** in aqueous base gave **26**, mp 153–155°, ir and nmr identical with those of **26** prepared from **20**.

**4,5-Diphenylpyrazole-1-acetic Acid (27).**—To a solution of 520 mg of diazepinone **23** in 20 ml of methanol was added 4 ml of 30% hydrogen peroxide; part of the starting material precipitated. After stirring for 2 days, the reaction mixture was added to water and the suspension was extracted with chloroform. The aqueous layer was treated with 2 *N* HCl until turbid and extracted with chloroform. The chloroform layers were washed, dried, and evaporated to a syrup. Addition of ether and pentane caused white solid, mp 70–160°, to separate. Recrystallization from chloroform–pentane gave 40 mg of **27** (7%): mp 170–171°; $\nu_{KBr}$ 1725 cm$^{-1}$; $\delta$ ($CDCl_3$) 12.5 (s, 1, $CO_2H$), 7.87 (s, 1, **H**-3), 7.5–7.1 (m, 10, 2 $C_6H_5$), 4.75 ppm (s, 2, $CH_2CO_2H$).

*Anal.* Calcd for $C_{17}H_{14}N_2O_2$: C, 73.36; H, 5.07; N, 10.07. Found: C, 73.38; H, 5.01; N, 10.04.

**Methyl 3-Diazoacetyl-3*c*-methyl-1-pyrazoline-4*r*-carboxylate (29).**—A solution of 26 g (0.16 mol) of acid chloride **28b**,[14] bp 66–68° (5 mm), in 120 ml of ether was added to a solution of 0.75 mol of diazomethane in ether. After standing at 0° for 4 days, the yellow solution was filtered and concentrated at reduced pressure to an oil. Addition of a few milliliters of ethanol and scratching caused crystallization; a total of 22 g of lemon yellow crystals of **29**, mp 73–74°, was obtained in several crops. Recrystallization from ethanol gave crystals: mp 75–76°; $\nu_{KBr}$ 2070, 1710, 1620; $\delta$ ($CDCl_3$) 5.82 (s, 1, $CHN_2$), 4.91–3.2 (m, 3, apparent ABC pattern of **H**-4 and **H**-5), 3.71 (s, 3, $OCH_3$), 1.50 ppm (s, 3, $CH_3$).

*Anal.* Calcd for $C_8H_{10}N_4O_3$: C, 45.71; H, 4.80; N, 26.66. Found: C, 45.80; H, 4.71; N, 26.45.

**6-Methoxycarbonyl-5-methyl-2,3-dihydro-4H-1,2-diazepin-4-one (31).**—A solution of 20 g of pyrazoline **29** in 100 ml of acetic acid was warmed at 75–80° for 4.5 hr; tlc showed that some starting material remained and that additional products were beginning to accumulate at this point. The solution was evaporated *in vacuo*, and reevaporated after addition of benzene until the acetic acid odor had disappeared. The red syrup was seeded with crystalline sample obtained from chromatography of a previous preparation; 2.1 g of thick orange prisms of **31**, mp 92–96°, was obtained. The remaining material was absorbed on a column of silicic acid and eluted with chloroform to give an additional 5.8 g of **31** (total 45%) and 2.6 g of unreacted **29**. Recrystallization of **31** from ether gave bright orange prisms: mp 95–96°; $\nu_{KBr}$ 3300, 1730, 1640 cm$^{-1}$; $\lambda_{max}^{MeOH}$ 222 ($\epsilon$ 9700), 260 (infl 3100), 322 (3000), 406 m$\mu$ (2450); $\delta$ ($CDCl_3$) 7–7.4 (br, 1, **NH**), 3.93 (s, 3, $OCH_3$), 3.78 (m, 2, $-CH_2-$, → singlet in $D_2O$), 2.12 ppm (s, 3, 5-$CH_3$).

*Anal.* Calcd for $C_8H_{10}N_2O_3$: C, 52.74; H, 5.53; N, 15.38. Found: C, 52.40; H, 5.56; N, 15.08.

On standing, the diazepine darkened and became gummy; such samples were most easily purified by sublimation.

For conversion to the 1,5-dihydro isomer **32** a solution of 91 mg (0.5 mmol) of **31** in 2 ml of dimethyl sulfoxide was treated with 0.05 mequiv of sodium methoxide (0.02 ml of 2.6 *N* in methanol). One portion of this solution was stored at 30° and the other at 62°. After 67 hr, the nmr spectrum of the 30° solution showed 65 ± 10% of the 1,5 isomer [doublets due to H-3 and H-7 at 7.36 and 7.66 ppm *vs.* DMSO ($\delta$ 2.62), singlet due to H-7 in the 2,3-dihydro isomer at 7.01 ppm]. The spectrum of the 62° solution showed no peak at 7.01 ppm.

The 30° solution was then warmed to 2 days at 60° and the combined DMSO solutions were poured into 25 ml of water. The mixture was extracted with $CH_2Cl_2$ and the extract was washed, dried, and evaporated to 80 mg of dark oil. Chromatography on silicic acid gave a yellow oil which did not crystallize: $\delta$ ($CDCl_3$) 7.7 (d, $J \sim 1$ Hz, 1), 7.60 (d, $J - 1$ Hz, 1 ), 4.0 (m, 1, **H**-5), 3.8 (s, 3, $OCH_3$), 1.0 ppm (d, $J = 7.5$ Hz, 3).

**Registry No.**—**4**, 24302-26-9; **5**, 24302-27-0; **7**, 24302-28-1; **8**, 24302-09-8; **9**, 24301-62-0; **10**, 24301-63-1; **11**, 24301-64-2; **12**, 24302-10-1; **13**, 24302-11-2; **14**, 24302-12-3; **15**, 24302-13-4; **16**, 24302-14-5; **17**, 24302-15-6; **18**, 24302-16-7; **19**, 24302-17-8; **20**, 24302-18-9; **21**, 24302-19-0; **22**, 24301-65-3; **23**, 24301-66-4; **25**, 24302-20-3; **26**, 24302-21-4; **27**, 24301-67-5; **29**, 24302-22-5; **31**, 24301-68-6; 2-acetyl-2,3-dihydro-5,6-diphenyl-1,2-diazepin-4-one, 24301-69-7.