Diazepines. VI. The Chemistry of 3,8-Dihalo-11*H*-dibenzo[*c*,*f*][1,2]diazepin-11-ones (1a)

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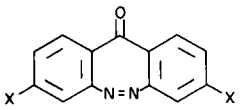
The carbonyl group in the title compounds undergoes a number of reactions typical of ketones but in general is less reactive than a typical ketone. Reaction with hydrazine leads to reduction of the 5,6-bond rather than reaction at the carbonyl group. Reduction of the carbonyl group gives rise to a rather inert carbinol. The carbonyl group appears to exert little influence on typical reactions at the 5,6-position.

In 1962 Johns and Markham (2) reported the synthesis of dibenzo[*c*,*f*][1,2]diazepin-11-one (I, X = H) from 2,2′-dinitrobenzophenone and in 1964 we reported (3) the syntheses of the 3,8-dihalo analogues (I, X = halogens) by oxidation of the corresponding diazepines (II). Johns and co-workers (2,4) have considered the possibility that I (X = H) behaves as a diazatropone but with the exception of polarographic measurements (2) the data were rather inconclusive.

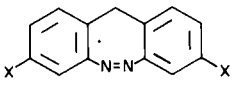
Although I (X = H) failed to react with typical ketone reagents such as 2,4-dinitrophenylhydrazine (2) it was found (5) to give compounds of the type III with sodium acetylide in liquid ammonia or with lithium acetylides in warm dioxane. The azo link of I (X = H) reacted with ketenes (5) and was reduced to the 5,6-dihydro compound (5) as is typical of the parent diazepine (II) (3). This paper represents our attempt to learn more regarding this ring system.

Using the readily available (3) dihalodiazepinones (I, X = halogens) we have further investigated the chemistry of this system. The general resistance of I (X = Cl) to reaction with normal ketone reagents is illustrated by its lack of reaction with hydroxylamine hydrochloride or with semicarbazide hydrochloride on heating in the presence of a base. Upon use of forcing conditions (refluxing in pyridine-ethanol), however, I (X = Cl) gave both an oxime and a semicarbazone in moderate to low yield.

Reaction of I (X = Cl) with hydrazine did not give rise to the expected hydrazone but rather the dihydrodiazepinone IV (X = Cl). Before settling upon structure IV for this product a number of other alternatives were also considered. As noted below, the product was not identical with the diazepinol or with the dihydrodiazepinol. Reductive ring opening had not occurred as the product was different from 2,2′-diamino-4,4′-dichlorobenzophenone (6) or its sodium borohydride reduction product. Reduction



I



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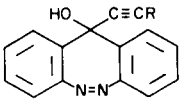

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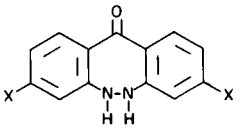
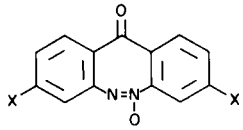
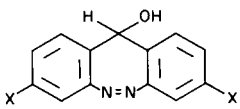


IV



V



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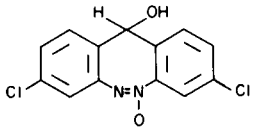

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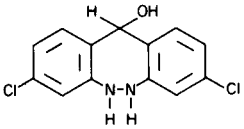
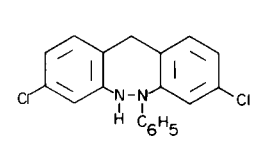
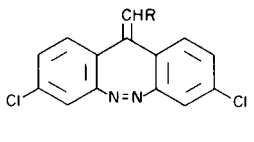


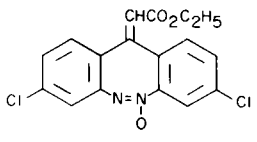
VIII



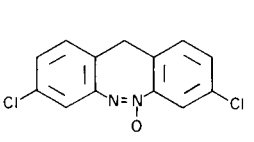
IX



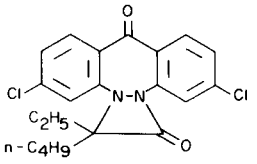
X



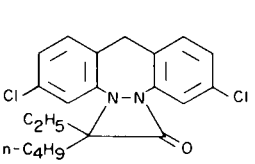
XI



XII



XIII



XIV

of IV (X = Cl) with hydrazine and Raney nickel under reflux gave 2,2′-diamino-4,4′-dichlorobenzophenone which could also be obtained from I (X = Cl) under these conditions. Oxidation of IV (X = Cl) with chromic anhydride in glacial acetic acid gave the 5-oxide (V) (3) of I. The spectral properties of IV were also consistent with the structure assigned.

Reduction of I (X = Cl) with hydrogen and platinum oxide or with sodium sulfide also gave rise to IV (X = Cl) with some 2,2′-diamino-4,4′-dichlorobenzophenone also being obtained with the latter reagent. Phenylhydrazine but not benzoylhydrazine could replace hydrazine for the converison of I (X = Cl or Br) to IV (X = Cl or Br). Reaction of I (X = Cl or Br) with phosphorus pentasulfide in an attempt to obtain the thioketone also led to the formation of IV (X = Cl or Br).

Attempted Wolff-Kishner reduction of I (X = Cl) gave rise to 2,2′-diamino-4,4′-dichlorodiphenylmethane, a product of reduction at both the carbonyl group and the azo group.

The ketones I (X = F, Cl, and Br) were reduced with aluminum isopropoxide in isopropyl alcohol. This method is known to be specific for the reduction of carbonyl compounds to alcohols (7) and the alcohols VI (X = F, Cl, and Br) were obtained. Attempted reaction of VI (X = Cl) with ethylisocyanate, phenylisocyanate, phosphorus oxychloride, hydrogen chloride, hydrochloric acid-zinc chloride, or phosphorus tribromide gave rise to starting materials while thionyl chloride led to decomposition. This lack of reactivity can be attributed, at least in part, to hydrogen bonding since Fischer-Herschfelder-Taylor molecular models indicate that there could be strong interaction between the alcoholic proton and the azo group. Evidence for this was present in the infrared spectra which displayed hydroxyl absorption at 3300 cm^{-1}. The possibility of actual bond formation between the alcohol and the azo groups was discounted on the basis of a comparison of the ultraviolet spectra of I, II, VI, and 3,8-dichloro-5,6-dihydrodibenzo[*c*,*f*][1,2]diazepine (3). The latter compound which lacks an azo group has no maximum above 256 mμ, while the first three compounds all have maxima in the 311-322 mμ area (ϵ, 6-9 x 10^3) attributed to the azo linkage.

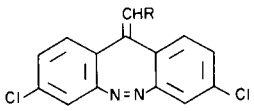
The diazepinol (VI, X = Cl) was also relatively stable to oxidation. Use of Oppenauer oxidation or of dicyclohexylcarbodiimide-dimethylsulfoxide (8) with VI (X = Cl) did not lead to any oxidation. Use of either chromic anhydride or peracetic acid, however, gave oxidation both of the hydroxyl group and of the azo linkage of VI (X = Cl) to give 3,8-dichlorodibenzo[*c*,*f*][1,2]diazepine-5-oxide-11-one (V, X = Cl) (3). This ketone (V, X = Cl) could be reduced to the corresponding alcohol VII in the same manner as I was reduced to VI.

Reduction of the diazepinol (VI, X = Cl) with hydrazine and Raney nickel gave rise to the hydrazo alcohol VIII.

The diazepinone I (X = Cl) failed to react with chlorosulfonyl isocyanate or trichloroacetylisocyanate, reagents which react at the carbonyl carbon of tropone (9). Reaction of phenylmagnesium bromide with I (X = Cl) gave a very complex mixture from which no pure products could be isolated. This is in contrast to the reaction of the parent diazepine II (X = Cl) which with phenylmagnesium bromide gave, in analogy to the reactions of simple azo compounds, IX.

It has been reported (10) that carbonyl compounds react with triethyl phosphonoacetate in the presence of sodium hydride in 1,2-dimethoxyethane to give α,β-unsaturated esters. This reaction proceeded in dioxane with I (X = Cl) and a variety of phosphonates to give compounds of the type X whose structures are based on analogy to the earlier work (10). These products are included in Table I. Reaction of IV (X = Cl) with diethyl cyanomethylphosphonate gave the same product (X, R = CN) as when I (X = Cl) was used. When triethyl-4-phosphonocrotonate was used with I (X = Cl), however, ring contraction to 3,8-dichlorobenzo[*c*]cinnoline took place (11) and no X was isolated. The cinnoline was also obtained when diethyl phosphonoacetaldehyde diethyl acetal or triethyl 2-phosphono-2-phenylacetate was used. The cinnoline was not observed when the products in Table I were obtained and the contraction was not caused by sodium hydride, by triethyl phosphite or by

TABLE I



R	Yield	M.p.	Analyses Calcd. C	H	N	Found C	H	N
$CO_2C_2H_5$	29	113-115 (a)	58.81	3.48	8.06	57.93	3.79	7.94
CN	b	210-212 (a)	60.02	2.35	14.00	60.01	2.58	13.93
COC_6H_5	10	70-74 (b)	66.50	3.19	7.39	66.52	3.32	7.36
$CON(C_2H_5)_2$	34	109-112	60.97	4.58		60.73	4.57	

(a) Recrystallized from ethanol. (b) Recrystallized from hexane.

sodium hydride-triethyl phosphite.

We had previously noted (3) that use of an excess of chromic anhydride in the preparation of I (X = Cl) led to the formation of V (X = Cl). Compounds of the type V (X = Cl or Br) can also be prepared by oxidation of the ketone (I) with peroxyacetic acid. In order to observe the effect, if any, of the *N*-oxide grouping on the reactions of the carbonyl group, several reactions analogous to those carried out with I, were attempted with V.

The reactivity of V (X = Cl) toward carbonyl reagents was approximately the same as that of I. Thus, V (X = Cl) reluctantly gave an oxime and semicarbazone and failed to give a 2,4-dinitrophenylhydrazone. With hydrazine, V (X = Cl) reacted in an analogous manner to I and was reduced to IV (X = Cl). In this case the hydrazine reduced the azoxy group to the hydrazo compound. The diazepinone-*N*-oxide V (X = Cl) reacted with triethyl phosphonoacetate in the same manner as I to give XI.

The reduction of V (X = Cl) to the corresponding diazepinol-*N*-oxide has been noted above. Reduction of V (X = Cl) with phosphorus tribromide gave I (X = Cl). Prior to this a variety of methods were tried to deoxygenate XII to II (X = Cl). In addition to those previously reported (3) we have found that the use of triethylphosphite, sulfur dioxide, or phosphorus trichloride, did not give the desired reduction. Treatment of XII with phosphorus tribromide in benzene, however, gave II (X = Cl) in a very clean reaction. Attempts to form the 5,6-dioxide by further oxidation of XII gave only recovered XII and 2,2′-dinitro-4,4′-dichlorodiphenylmethane, an oxidative cleavage product.

In addition to oxidation to the 5-oxide, the chemistry of the 5,6-position of I resembles the chemistry of the 5,6-position of II in other respects. Thus both I (X = Cl) and II (X = Cl) were converted to the lcatams XIII and XIV, respectively, by reaction with *n*-butyl ethyl ketene. A similar type reaction had previously been reported (5) with I (X = H). Both I (X = Cl) and II (X = Cl) gave unstable perchlorate salts on treatment with perchloric acid. Attempts to recrystallize these salts led to the isolation of unprotonated I and II.

EXPERIMENTAL (12)

3,8-Dichlorodibenzo[*c*,*f*][1,2]diazepin-11-one Oxime.

A mixture of 0.2 g. of I (X = Cl) (3), 1 g. of hydroxylamine hydrochloride, 20 ml. of pyridine, and 20 ml. of ethanol were refluxed for 3.5 hours and poured into water. Upon cooling 0.13 g. (65%) of the oxime, m.p. 263-265°, were obtained. Recrystallization from methylene chloride did not effect the melting point.

Anal. Calcd. for $C_{13}H_7Cl_2N_3O$: C, 53.45; H, 2.42; Cl, 24.28. Found: C, 53.19; H, 2.52; Cl, 24.30.

3,8-Dichlorodibenzo[*c*,*f*][1,2]diazepin-11-one Semicarbazone.

A mixture of 0.5 g. of I (X = Cl) (3), 0.37 g. of semicarbazide hydrochloride, 16 ml. of pyridine, and 30 ml. of absolute ethanol was refluxed for 6.5 hours and poured into water. The solid obtained was chromatographed on alumina to give (benzene) starting ketone and semicarbazone (chloroform). Recrystallization of the semicarbazone from ethanol gave 0.1 g. (20%) of product, m.p. 248-249°.

Anal. Calcd. for $C_{14}H_9Cl_2N_5O \cdot H_2O$: C, 47.74; H, 3.14; N, 19.88; Cl, 20.13. Found: C, 47.80; H, 3.16; N, 19.90; Cl, 19.99.

Reaction of 3,8-Dichlorodibenzo[*c,f*][1,2]diazepin-11-one (I, X = Cl) with Hydrazine.

A mixture of 0.5 g. of I (X = Cl), 0.13 g. of 95% hydrazine, 0.5 ml. of glacial acetic acid, and 200 ml. of ethanol was refluxed for 14 hours and partially concentrated *in vacuo*. Cooling gave 0.19 g. (40%) of IV (X = Cl), m.p. 242-244°. Recrystallization from ethanol raised the melting point to 245-246°; IR (potassium bromide), 3300, 3100, 1650 cm^{-1}; mass spectra (13), 278, 280, 282 (M), 263, 265, 267 (M-NH), 249, 251, 253 (M-N_2H), 243, 245 (M-Cl).

Anal. Calcd. for $C_{13}H_8Cl_2N_2O$: C, 55.93; H, 2.88; N, 10.03; Cl, 25.40. Found: C, 55.74; H, 3.14; N, 10.12; Cl, 25.28.

2,2′-Diamino-4,4′-dichlorodiphenylcarbinol.

To 0.7 g. of 2,2′-diamino-4,4′-dichlorobenzophenone (6) in 35 ml. of methanol was added with cooling 0.7 g. of sodium borohydride. The mixture was stirred at room temperature for 2 hours, filtered, and the filtrate treated with 50% sulfuric acid. The mixture was made basic (50% sodium hydroxide) and extracted with ether. The washed (water) and dried (magnesium sulfate) ether extract was concentrated and the residue was subjected to dry column chromatography with ethanol on alumina to give 0.11 g. (19%) of the carbinol, m.p. 123-128° from hexane-chloroform.

Anal. Calcd. for $C_{13}H_{12}Cl_2N_2O$: C, 55.14; H, 4.27; N, 9.89. Found: C, 55.05; H, 4.33; N, 9.85.

Reaction of 3,8-Dichloro-5,6-dihydrodibenzo[*c,f*][1,2]diazepin-11-one (IV, X = Cl) with Hydrazine and Raney Nickel.

To 0.1 g. of IV (X = Cl) and 1.25 ml. of 95% hydrazine in 35 ml. of warm ether was added *ca.* 0.12 g. of Raney nickel and the mixture was refluxed for 4 hours. Filtration and evaporation gave 0.08 g. (88%) of 2,2′-diamino-4,4′-dichlorobenzophenone identical in all respects with an authentic sample (6).

Reaction of 3,8-Dichlorodibenzo[*c,f*][1,2]diazepin-11-one (I, X = Cl) with Hydrazine and Raney Nickel.

A mixture of 0.2 g. of I (X = Cl), 2.5 ml. of 95% hydrazine, 70 ml. of warm ether, and *ca.* 0.25 g. of Raney nickel treated as described in the above experiment gave 0.09 g. (45%) of 2,2′-diamino-4,4′-dichlorobenzophenone.

Oxidation of 3,8-Dichloro-5,6-dihydrodibenzo[*c,f*][1,2]diazepin-11-one (IV, X = Cl) with Chromic Anhydride.

A solution of 0.18 g. of IV (X = Cl) in 15 ml. of glacial acetic acid was heated to reflux and 0.36 g. of chromic anhydride was added. The mixture was refluxed for 15 minutes, cooled and filtered to give 0.12 g. (66%) of V (X = Cl) identical in all respects with an authentic sample (3).

Hydrogenation of 3,8-Dichlorodibenzo[*c,f*][1,2]diazepin-11-one. (I, X = Cl).

A slurry of 0.3 g. of I (X = Cl) in 50 ml. of ethanol was hydrogenated in the presence of 30 mg. of platinum oxide. After filtration the residue was washed with chloroform and tetrahydrofuran and the combined organic solutions were evaporated to give 0.28 g. (93%) of IV (X = Cl) identical with that reported above.

Reaction of 3,8-Dichlorodibenzo[*c,f*][1,2]diazepin-11-one (I, X = Cl) with Sodium Sulfide.

A mixture of 0.3 g. of I (X = Cl), 1.4 g. of sodium sulfide (nonahydrate), and 10 ml. of ethanol was refluxed for 3.25 hours, cooled, poured into water, and filtered to give 0.28 g. (93%) of crude IV (X = Cl) which after recrystallization was identical with an authentic sample.

Reaction of 3,8-Dichlorodibenzo[*c,f*][1,2]diazepin-11-one (I, X = Cl) with Phenylhydrazine.

A mixture of 0.5 g. of I (X = Cl), 0.40 g. of phenylhydrazine, 0.5 ml. of glacial acetic acid, and 200 ml. of ethanol was refluxed 14 hours and concentrated *in vacuo* to a small volume. Filtration of the cooled mixture gave 0.44 g. (88%) of IV (X = Cl) identical with the samples above.

Reaction of 3,8-Dibromodibenzo[*c,f*][1,2]diazepin-11-one (I, X = Br) with Phenylhydrazine.

A mixture of 0.2 g. of I (X = Br), 4 ml. of phenylhydrazine, and 40 ml. of ethanol was refluxed for 21 hours and cooled to give, after recrystallization from ethanol-water, 0.1 g. (50%) of IV (X = Br), m.p. 241-243°. IR (potassium bromide), 3300, 3100, 1635 cm^{-1}.

Anal. Calcd. for $C_{13}H_8Br_2N_2O$: C, 42.42; H, 2.19; N, 7.61. Found: C, 42.84; H, 2.30; N, 7.64.

Reaction of 3,8-Dichlorodibenzo[*c,f*][1,2]diazepin-11-one (I, X = Cl) with Phosphorus Pentasulfide.

A mixture of 0.5 g. of I (X = Cl), 0.8 g. of phosphorus pentasulfide, and 40 ml. of pyridine was refluxed for 4 hours, poured into water, filtered, and recrystallized from ethanol to give 0.18 g. (35%) of IV (X = Cl) identical with that obtained above.

Reaction of 3,8-Dibromodibenzo[*c,f*][1,2]diazepin-11-one (I, X = Br) with Phosphorus Pentasulfide.

In a similar manner I (X = Br) and phosphorus pentasulfide in pyridine gave a 50% yield of IV (X = Br).

Wolff-Kishner Reduction of 3,8-Dichlorodibenzo[*c,f*][1,2]diazepin-11-one (I, X = Cl).

A mixture of 0.5 g. of I (X = Cl), 35 ml. of diethylene glycol, 5 ml. of 95% hydrazine, and 2 g. of potassium hydroxide was refluxed for 1 hour. The solution was then distilled until the pot temperature reached 170-190° and the mixture was heated for an additional 4.25 hours. The solution was poured into water, filtered, and the solid obtained was subjected to dry column chromatography on alumina with chloroform to give 0.23 g. (47%) of 2,2′-diamino-4,4′-dichlorodiphenylmethane, m.p. 130-133°, identical with an authentic sample.

3,8-Dichlorodibenzo[*c,f*][1,2]diazepin-11-ol (VI, X = Cl).

A mixture of 0.8 g. of I (X = Cl), 1 g. of aluminum isopropoxide, and 20 ml. of anhydrous isopropyl alcohol was heated at reflux and allowed to distill slowly until the distillate gave a negative test with 2,4-dinitrophenylhydrazine. The mixture was cooled and 30 ml. of 5% hydrochloric acid was added. After standing 0.85 g. (100%) of VI (X = Cl), m.p. 176-178°, was obtained. After recrystallization from ethanol-water the melting point was 180-181°.

Anal. Calcd. for $C_{13}H_8Cl_2N_2O$: C, 55.93; H, 2.89; N, 10.03. Found: C, 55.67; H, 3.13; N, 9.76.

3,8-Difluorodibenzo[*c,f*][1,2]diazepin-11-ol (VI, X = F).

In a similar manner I (X = F) (3) gave a 42% yield of VI (X = F), m.p. 152-154° from ethanol-water.

Anal. Calcd. for $C_{13}H_8F_2N_2O$: C, 63.41; H, 3.27; N, 11.37. Found: C, 63.14; H, 3.37; N, 11.24.

3,8-Dibromodibenzo[*c,f*][1,2]diazepin-11-ol (VI, X = Br).

In a similar manner I (X = Br) (3) gave a 66% yield of VI (X = Br), m.p. 178-180° from ethanol-water.

Anal. Calcd. for $C_{13}H_8Br_2N_2O$: C, 42.42; H, 2.19; N, 7.61; Br, 43.42. Found: C, 42.41; H, 2.28; N, 7.52; Br, 43.50.

Oxidation of 3,8-Dichlorodibenzo[*c,f*][1,2]diazepin-11-ol (VI, X = Cl).

A mixture of 0.05 g. of VI (X = Cl) and 0.1 g. of chromic anhydride in 5 ml. of glacial acetic acid was refluxed for 30 minutes, cooled, and filtered to give 0.03 g. (60%) of V (X = Cl) identical with an authentic sample (3). Treatment of 0.15 g. of VI (X = Cl) with 15 ml. of glacial acetic acid and 10 ml. of 50% hydrogen peroxide for 8 hours gave 50% yield of V (X = Cl).

3,8-Dichlorodibenzo[*c,f*][1,2]diazepin-5-oxide-11-ol (VII).

A mixture of 0.1 g. of V (X = Cl) and 0.2 g. of aluminum isopropoxide in 20 ml. of anhydrous isopropyl alcohol was treated as described for the preparation of VI to give 0.09 g. (90%) of VII, m.p. 189-196° from ethanol-water.

Anal. Calcd. for $C_{13}H_8Cl_2N_2O_2$: C, 52.90; H, 2.73; N, 9.49; Cl, 24.03. Found: C, 53.08; H, 2.70; N, 9.61; Cl, 23.91.

Reduction of 3,8-dichlorodibenzo[*c,f*][1,2]diazepin-11-ol (VI, X = Cl).

A mixture of 0.2 g. of VI (X = Cl) and 2.5 ml. of 95% hydrazine was dissolved in 50 ml. of warm ether and *ca.* 0.25 g. of Raney nickel was added. The solution was warmed on a steam bath for 5 minutes, filtered, and evaporated *in vacuo* to give 0.1 g. (50%) of VIII, m.p. 148° from benzene. IR (potassium bromide), 3300, 3325, and 3450 cm^{-1}.

Anal. Calcd. for $C_{13}H_{10}Cl_2N_2O$: C, 55.54; H, 3.58; N, 9.96; Cl, 25.22. Found: C, 55.58; H, 3.66; N, 9.90; Cl, 25.18.

5-Phenyl-3,8-dichloro-5,6-dihydro-11*H*-dibenzo[*c,f*][1,2]diazepine (IX).

A solution of 0.5 g. of II (X = Cl) in 50 ml. of tetrahydrofuran was added dropwise to a refluxing solution of phenylmagnesium bromide freshly prepared from 2.8 g. of bromobenzene and 0.4 g. of magnesium in 50 ml. of tetrahydrofuran. The solution was refluxed for 6 hours, cooled, and 100 ml. of 5% hydrochloric acid and a small amount of ether was added. The organic phase was washed, dried, and evaporated to give, after recrystallization from ethanol, 0.2 g. (33%) of IX, m.p. 170-173°.

Anal. Calcd. for $C_{19}H_{14}Cl_2N_2$: C, 66.87; H, 4.14; N, 8.21; Cl, 20.78. Found: C, 66.73; H, 4.20; N, 8.06; Cl, 20.78.

Preparation of Compounds in Table I.

The following is a typical experiment. A solution of 0.43 g. of diethyl cyanomethylphosphonate in 5 ml. of anhydrous dioxane was added at 20° to 0.50 g. of 30% sodium hydride-oil in 10 ml. of dioxane. The mixture was stirred for 2 hours and 0.5 g. of I (X = Cl) in 45 ml. of dioxane was added dropwise at 20°. The mixture was stirred for 4 hours at room temperature and poured onto ice water. Filtration (in some cases chloroform extraction was used) gave 0.54 g. (100%) of X (R = CN), m.p. 210-212° from ethanol. IR (potassium bromide), 2225 cm^{-1}. The remaining compounds of this type are shown in Table I.

When the diethyl cyanomethylphosphonate was replaced by triethyl phosphonocrotonate, diethyl phosphonoacetaldehyde diethyl acetal, or triethyl 2-phosphono-2-phenylacetate in the above experiment 3,8-dichlorobenzo[*c*]cinnoline (11) was obtained in 25, 27, and 90% yields, respectively.

3,8-Dibromodibenzo[*c,f*][1,2]diazepin-11-one-5-oxide (V, X = Br).

To a solution of 0.1 g. of I (X = Br) in 15 ml. of glacial acetic acid was added 15 ml. of 30% hydrogen peroxide. The solution was refluxed for 5 hours with extra hydrogen peroxide being added periodically. The mixture was filtered to give 0.06 g. (60%) of V (X = Br), m.p. 266-269° from benzene. IR (potassium bromide), 1675 cm^{-1}.

Anal. Calcd. for $C_{13}H_6Br_2N_2O_2$: C, 40.87; H, 1.58; N, 7.33; Br, 41.84; Found: C, 40.68; H, 1.68; N, 7.27; Br, 41.72.

The corresponding dichloro compound V (X = Cl) (3) was also prepared by this procedure.

3,8-Dichlorodibenzo[*c,f*][1,2]diazepin-11-one-5-oxide Oxime.

Using the procedure described above for the preparation of the oxime of I (X = Cl), 0.1 g. of V (X = Cl) gave 0.08 g. (80%) of an oxime, m.p. 272-275° from ethanol-water.

Anal. Calcd. for $C_{13}H_7Cl_2N_3O_2$: C, 50.67; H, 2.29; N, 13.64; Cl, 23.02. Found: C, 50.71; H, 2.37; N, 13.54; Cl, 23.00.

3,8-Dichlorodibenzo[*c,f*][1,2]diazepin-11-one-4-oxide Semicarbazone.

Using the procedure described above for the preparation of the semicarbazone of I (X = Cl), 0.4 g. of V (X = Cl) gave a small quantity of unreacted ketone-*N*-oxide and 0.12 g. (26%) of semicarbazone, m.p. 233-235°.

Anal. Calcd. for $C_{14}H_9Cl_2N_5O_2$: C, 48.02; H, 2.59; N, 20.00. Found: C, 48.17; H, 2.70; N, 20.32.

Reaction of 3,8-Dichlorodibenzo[*c,f*][1,2]diazepin-11-one-5-oxide (VI, X = Cl) with Hydrazine.

Using the procedure described above for the reaction of I (X = Cl) with hydrazine, V (X = Cl) gave a 68% yield of IV identical with that obtained above.

Reaction of 3,8-Dichlorodibenzo[*c,f*][1,2]diazepin-11-one-5-oxide (V, X = Cl) with Triethyl Phosphonoacetate.

Using the procedure described above for the preparation of the compounds in Table I, V (X = Cl) and triethyl phosphonoacetate gave a 58% yield of XI, m.p. 145-155° from ethanol. IR (potassium bromide), 1725 cm^{-1}.

Anal. Calcd. for $C_{17}H_{12}Cl_2N_2O_3$: C, 56.22; H, 3.33; N, 7.71; Cl, 19.52. Found: C, 56.40; H, 3.48; N, 7.78; Cl, 19.48.

Reaction of 3,8-Dichlorodibenzo[*c,f*][1,2]diazepin-11-one-5-oxide (V, X = Cl) with Phosphorus Tribromide.

To a slurry of 0.5 g. of V (X = Cl) in 20 ml. of anhydrous benzene was added 1.38 g. of phosphorus tribromide in 15 ml. of benzene and the mixture was refluxed for 5 hours. The mixture was stirred with water and made alkaline with 5% sodium hydroxide. The benzene phase was separated and the aqueous phase washed with chloroform. The combined benzene and chloroform solution was washed with water, dried over magnesium sulfate and concentrated to give 0.29 g. (61%) of I (X = Cl) (3) identical with an authentic sample.

In a similar manner XII gave a 34% yield of II (X = Cl).

Reaction of 3,8-Dichloro-11*H*-dibenzo[*c,f*][1,2]diazepin-5-oxide (XII) with Hydrogen Peroxide.

A mixture of 0.7 g. of XII, 70 ml. of glacial acetic acid, and 35 ml. of 50% hydrogen peroxide was refluxed for 11.5 hours, with 21 ml. of additional hydrogen peroxide being added after 30 minutes. The mixture was cooled and filtered to give a solid which was chromatographed on alumina to give two components.

The first component (0.13 g.) was identical with the starting material (XII). The second component (0.13 g.) was 2,2′-dinitro-4,4′-dichlorodiphenylmethane, m.p. 120-123° (reported (3) m.p. 120-121°).

Reaction of 3,8-Dichlorodibenzo[*c,f*][1,2]diazepin-11-one (I, X = Cl) with *n*-Butyl Ethyl Ketene.

To 1 g. of I (X = Cl) in 140 ml. of anhydrous toluene at 35-40° was added dropwise with stirring 3.4 g. of 20% *n*-butyl ethyl ketene in toluene (14). The mixture was stirred at 35-40° for 15 minutes and at 50-60° for 1.5 hours. Filtration gave 0.26 g. of starting material (I) and evaporation gave an oil which was chromatographed on alumina using benzene to give 0.28 g. (30%) of XIII, m.p. 93-94°. IR (potassium bromide), 1788 and 1638 cm^{-1}.

Anal. Calcd. for $C_{21}H_{20}Cl_2N_2O_2$: C, 62.54; H, 5.00; N, 6.95; Cl, 17.58. Found: C, 62.65; H, 5.12; N, 6.92; Cl, 17.66.

Reaction of 3,8-Dichloro-11*H*-dibenzo[*c,f*][1,2]diazepine (II, X = Cl) with *n*-Butyl Ethyl Ketene.

In a similar manner 1 g. of II (X = Cl) gave 0.52 g. (37%) of XIV, m.p. 87-89°; IR (potassium bromide), 1780 cm^{-1}.

Anal. Calcd. for $C_{21}H_{22}Cl_2N_2O$: C, 64.78; H, 5.70; N, 7.20. Found: C, 64.88; H, 5.77; N, 7.16.

Perchlorate of 3,8-Dichlorodibenzo[*c,f*][1,2]diazepin-11-one (I, X = Cl).

To 0.07 g. of pure I (X = Cl) in 25 ml. of benzene was added several drops of 70% perchloric acid. The precipitate was filtered and dried *in vacuo* at 80° for 13 hours to give 0.05 g. (55%) of salt, m.p. 239-240°, IR (potassium bromide), 2000 and 1680 cm^{-1}.

Anal. Calcd. for $C_{13}H_7Cl_3N_2O_5$: Cl, 28.17. Found: Cl, 27.58.

When placed in water this salt gave I.

Perchlorate of 3,8-Dichloro-11*H*-dibenzo[*c,f*][1,2]diazepine (II, X = Cl).

In a similar manner 0.1 g. of pure II (X = Cl) gave 0.11 g. (84%) of salt, m.p. 213-215°, IR (potassium bromide), 2000 cm^{-1}.

Anal. Calcd. for $C_{13}H_9Cl_3N_2O_4$: Cl, 29.26. Found: Cl, 28.78.

When placed in water this salt gave II.

REFERENCES

(1a) Part V: G. Rosen and F. D. Popp, *J. Heterocyclic Chem.*, 6, 9 (1969). Supported in part by a grant (GM-11006) from the National Institutes of Health. Portions of this material were presented at the First International Congress of Heterocyclic Chemistry, Albuquerque, N.M., June 1967. (b) U.S.P.H.S. Predoctoral Fellow.

(2) R. B. Johns and K. R. Markham, *J. Chem. Soc.*, 3712 (1962).

(3) A. Catala and F. D. Popp, *J. Heterocyclic Chem.*, 1, 178 (1964).

(4) R. S. Amiet and R. B. Johns, *Aust. J. Chem.*, **20**, 723 (1967).

(5) W. Ried and S. Piesch, *Chem. Ber.*, 99, 233 (1966).

(6) R. T. Parfitt, *J. Chem. Soc.*, C, 87 (1966).

(7) A. Wilds, *Org. Reactions* 2, 179 (1960).

(8) L. Paquette and L. Wise, *J. Am. Chem. Soc.*, 89, 6659 (1967).

(9) L. A. Paquette and N. Horton, *Tetrahedron Letters*, 2289 (1968).

(10) W. Wadsworth and W. Emmons, *J. Am. Chem. Soc.*, 83, 1733 (1961).

(11) R. J. Dubois and F. D. Popp, *Chem. Commun.*, 675 (1968).

(12) Analyses by Spang Microanalytical Laboratory, Ann Arbor, Mich. and by Galbraith Laboratories, Knoxville, Tenn. Melting points are corrected and are taken in capillaries.

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