Thermal [2 + 3] cycloaddition of *N*-trichloroacetyldiphenylcyclopropenimine to 3-aroylaziridines and 3-carbomethoxyaziridines

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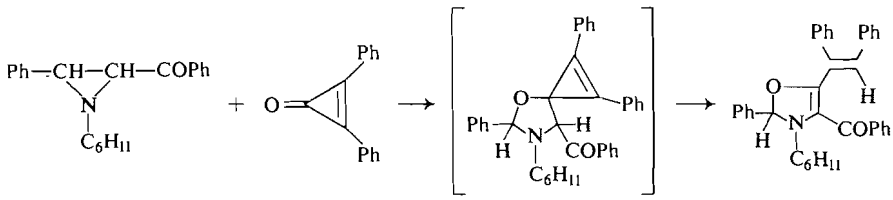
Received October 20, 1969

N-Trichloroacetyldiphenylcyclopropenimine reacted with either *cis*- or *trans*-3-benzoyl-1-cyclohexyl-2-*m*-nitrophenylaziridine in a [2 + 3] cycloaddition to the C=N bond of the imine to form (*a*) 5-benzoyl-2-*m*-nitrophenyl-4-(spirodiphenylcyclopropene)-3-(trichloroacetylhydrate)-imidazolidine and (*b*) 1-cyclohexyl-4-(*cis*-1,2-diphenylvinyl)-3-dichloroacetyl-2-*m*-nitrophenylimidazoline. Similar reactions with other 3-aroylaziridines gave analogous imidazolidines and imidazolines. Isolation of an unhydrated imidazolidine of type (*a*) in the corresponding addition with 3-carbomethoxy-1-cyclohexyl-2-phenylaziridine gave direct spectroscopic proof for the cyclopropene moiety in these adducts. The orientation of the 1,3 dipolar additions was confirmed by a reaction using a specifically 3-deuterated aziridine.

The isolation of these adducts of type (*a*) strongly supports the previously suggested intermediacy of an oxazolidine in the analogous addition of 3-aroylaziridines to diphenylcyclopropenone.

Canadian Journal of Chemistry, **48**, 1682 (1970)

Diphenylcyclopropenone reacts with 3-aroylaziridines to form 4-aroyl-4-oxazolines (1). This reaction is most plausibly interpreted as proceeding by an initial [2+3] cycloaddition of an azomethine ylide (derived from the thermal cleavage of the aziridine (2–6)) to the carbonyl group of the diphenylcyclopropenone, followed by rearrangement (eq. [1]). Although [2+3] cycloaddition of bicyclic aziridines to the carbonyl group of *p*-nitrobenzaldehyde has been reported (7) and addition of activated aromatic aldehydes to 3-aroylaziridines gives 4-aroyloxazolidines **3** in good yield (8) (eq. [2]), more direct evidence for the intermediacy of the oxazolidine species **1** was lacking. The preparation of iminocyclopropenes was recently reported by Paquette *et al.* (9, 10). We have shown that the C=N double bond of imines and sulfonylimines reacts readily with aroylaziridines to form imidazolidines (11). When the C=N bond of the imine is activated by an electron-withdrawing group in the latter reaction, the product is obtained quantitatively with only one orientation of addition (eq. [3]). Therefore the *N*-trichloroacetyldiphenylcyclopropenimine was reacted with an equimolar quantity of 1-cyclohexyl-3-*p*-nitrobenzoyl-2-phenylaziridine in refluxing acetonitrile for 24 h (eq. [4]). Chromatographic separation afforded two crystalline products to which structures **5** and **6** have been assigned in 50 and 6% yields respectively. Compound **5** analyzed for $C_{38}H_{34}N_3O_5Cl_3$, corresponding to a 1:1 addition product plus a molecule of H_2O. By comparison with product **6** and other products in this series it is evident that the water molecule has added to the trichloro-

[1] 

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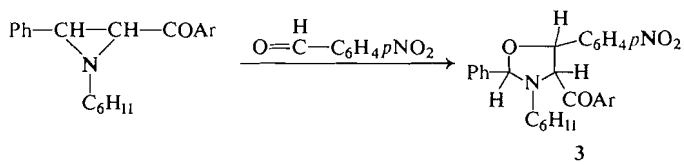
[2] 

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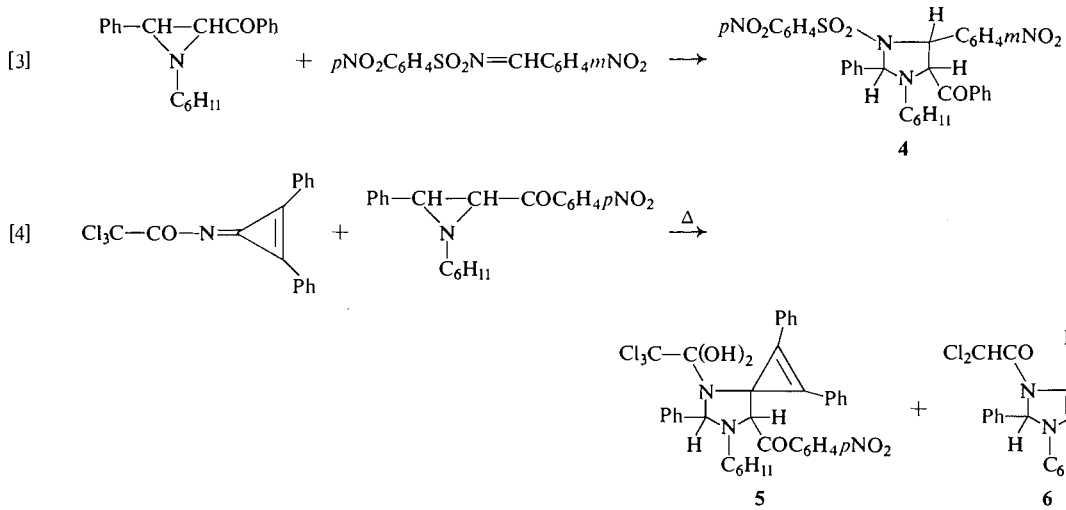
[1] NRCC Postdoctoral Fellow, 1967–1969.



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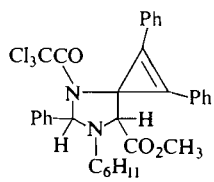
5 6

acetyl carbonyl group. The infrared (i.r.) spectrum showed one sharp OH band at 3360 cm^{-1} (unaffected by dilution and therefore assigned to an *intra*molecular hydrogen bond) and a broad OH band at 3440 cm^{-1} (diminished by dilution and therefore assigned to *inter*molecular hydrogen bonding) (12). These assignments were supported by the nuclear magnetic resonance (n.m.r.) spectrum which showed two (1H) singlets at δ 5.8 and 8.5 both exchangeable with deuterium oxide and assigned to *inter*- and *intra*molecularly bonded OH protons respectively. The n.m.r. spectrum also showed two non-exchangeable singlets at δ 4.2 and 5.9 due to the 5- and 2-imidazolidine protons respectively (vide infra).

The imidazolidine **7** was prepared by the reaction of *N*-trichloroacetyldiphenylcyclopropenimine with 3 - carbomethoxy - 1 - cyclohexyl - 2-phenylaziridine in anhydrous acetonitrile. The product analyzed for $C_{33}H_{31}N_2O_3Cl$; i.e. a 1:1 adduct without hydration of the trichloroacetyl



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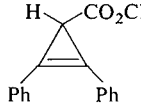
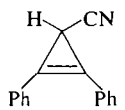
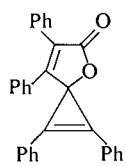
carbonyl. The compound showed a normal cyclopropene ultraviolet (u.v.) absorption spectrum with maxima at 292 mμ (ε, 8790) and 222 mμ (ε, 14 870). The i.r. spectrum confirmed that no hydration of the amide carbonyl had taken place and showed a band at 1735 cm^{-1} due to the saturated ester carbonyl and at 1725 cm^{-1} due to the free amide carbonyl (13). The n.m.r. spectrum of **7** showed two singlets at δ 5.47 and 4.95 assigned to the 2- and 5-imidazolidine protons respectively.

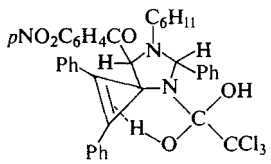
The u.v. spectra of **5** and the similar compounds **8** and **10** in this series unlike **7** show two principal maxima in the range (267–260) mμ and at 225 mμ (sh). The u.v. spectra of some related cyclopropenes illustrated in Table 1 show two major absorptions in the region 306–297 and 228–223 mμ with additional shoulder bands.

TABLE 1

Ultraviolet spectra of some cyclopropene derivatives

Compound	Solvent	λ_{max}	ε	Reference
	C_2H_5OH	323 306 232 224	26 400 33 900 19 500 21 900	14
	C_2H_5OH	318 303 295 287 231 223	29 400 38 400 28 700 26 800 20 200 22 100	15
	C_2H_5OH	313 297 284 sh 228 222	28 600 39 300 35 200 38 400 37 300	16

N-Trichloroacetyldiphenylcyclopropenimine shows a principal absorption maximum at 278–286 mμ in isooctane and at 288 mμ in acetonitrile (9) compared with the principal maximum in diphenylcyclopropenone at 297 mμ in acetonitrile (16). Therefore we anticipated a principal maximum in **5** around 290–285 mμ as observed in **7**. The observed lower value of 267–260 mμ of the principal absorption in **5** and **9** may possibly be associated with the effects of *intra*molecular hydrogen bonding of the type shown in structure **5** (17–19). Precedents exist in



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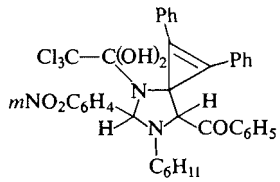
the literature of *intra*molecular hydrogen bonds between hydroxyl groups and π-electrons as bases from (*i*) olefins (20) (*ii*) acetylenes (21*a*), and (*iii*) aromatic sextets (21). While the observed lack of hydration of the chloroacetyl group in **6** and similar structures would tend to support this proposal, its tentative nature must be emphasized.

Reaction of *N*-trichloroacetyldiphenylcyclopropenimine separately with stereoisomerically pure *cis*- and *trans*-3-benzoyl-1-cyclohexyl-2-*m*-nitrophenylaziridine afforded the identical imidazolidine **8** and imidazoline **9**. Similar lack of stereospecificity with respect to the aziridine was observed in the addition of *cis*- and *trans*-2-aryl-3-aroylaziridines (with *N*-alkyl substituents) to imines and sulfonylimines to form imidazolidines



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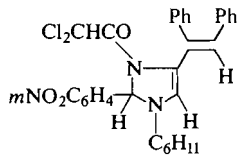

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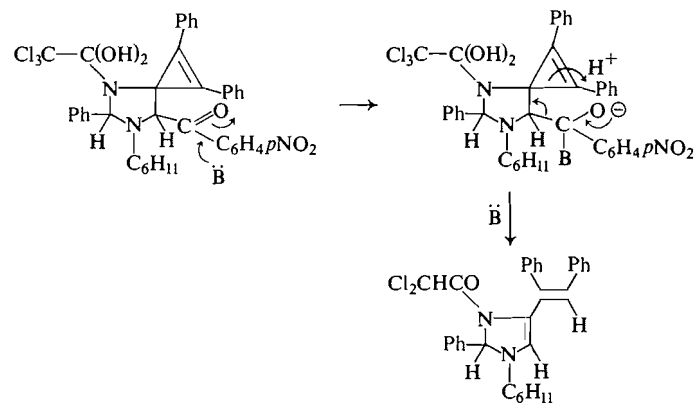
(11) and to aryl aldehydes and chloral to form oxazolidines (8). This may be attributed to equilibration of the *cis*- and *trans*-azomethine ylide intermediates (22) (derived from the thermal conrotatory ring opening of the *trans*- and *cis*-aziridines respectively (5)) prior to addition leading to 1,3-dipolar addition exclusively via the more stable *trans*-azomethine ylide (22).

The u.v. spectrum of compound **6**, $C_{31}H_{30}Cl_2N_2O$, shows a band at 280 mμ (ε, 17 450) typical of *cis*-stilbene absorption and at 238 mμ (ε, 35 800). The n.m.r. spectrum showed the 2-imidazoline proton at δ 5.55 and the side-chain vinyl proton at the characteristic position of δ 7.95 (23). The i.r. confirms that the side-chain aroyl group has been removed.

Compound **6** may arise from base-catalyzed elimination of the aroyl group of **5** either during the reaction or during the work up procedure as shown in Scheme 1. The reaction is analogous to the deacylation involved in the last step of the Knorr pyrrole synthesis (24) (eq. [5]), and also the observed dehydrogenative elimination of an aroyl group from a 2-iminothiazolidine by the action of quinones in acetic acid (25), which resembles decarboxylative dehydrogenation (26) (eq. [6]).

In support of Scheme 1, in similar reactions



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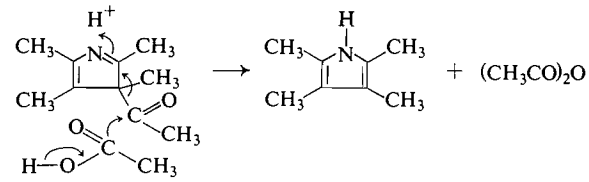
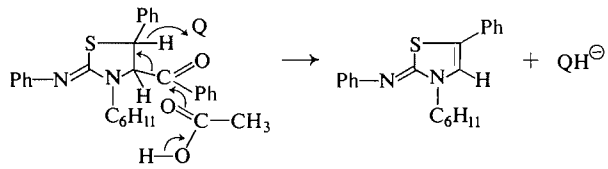
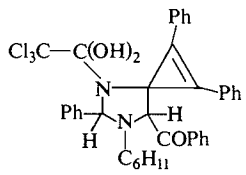
SCHEME 1

[5] 

[6] 

between *N*-trichloroacetyldiphenylcyclopropenimine and 3-benzoyl-1-cyclohexyl-2-phenylaziridine, the products were **10**, a new imidazolidine analogous to **5**, and **11**, the imidazoline which was identical in all respects to the second product **6** obtained in the first reaction. Compound **10** just like **5** also showed hydration of the trichloroacetyl carbonyl and *intra*molecular hydrogen



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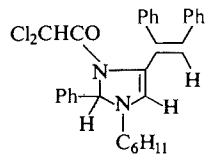


11 ≡ 6

bonding. In a similar reaction of 1-cyclohexyl-2-phenyl-3-*p*-toluoylaziridine and *N*-trichloroacetyldiphenylcyclopropenimine, compound **6** was the only product isolated, confirming that in all these reactions the 5-aroyl group of the intermediate imidazolidine has been removed.

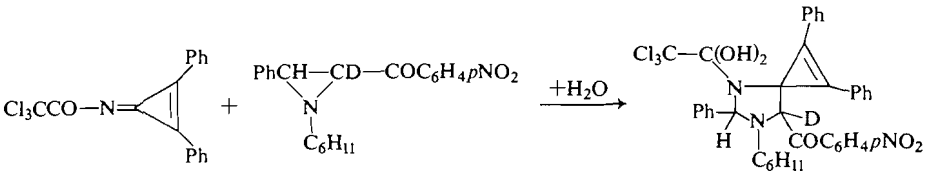
When the 2-aryl substituent on the aziridine ring is not common, then the imidazoline obtained is different from **6**, as in the case of **9** above, as expected. While this interpretation appears plausible, the exact conditions for the above conversion of **5** to **6** have not as yet been established.

The orientation of the thermal [2+3] cycloaddition of sulfonylimines to 3-aroylaziridines to produce 24 imidazolidines with structures like **4** was always in the direction indicated (11). It is reasonable therefore to assume a similar orientation in the addition of the iminocyclopropene to the 3-aroylaziridines to form **5** and **10** and their elimination product **6**. The 2-imidazolidine proton in **4** appears in the n.m.r. at δ 5.8, so the two singlets in the n.m.r. of **5** observed at δ 5.82 and 4.18 were tentatively assigned to the 2- and 5-imidazolidine protons respectively. The above assumption was justified and the line positions confirmed by reaction of the specifically 3-deuterated aziridine **12** (11) with the iminocyclopropene to form **13** (eq. [7]). Examination of the n.m.r. spectrum of **13** after deuterium oxide exchange showed singlets at δ 5.82 (1H) and 4.18 (0.5H). The reduction in the integral of the latter proton due to partial deuteration confirmed the line position assignments proposed above.

In conclusion, it may be stated that the observed [2+3] cycloaddition of 3-substituted aziridines (via the azomethine ylide) to the C=N bond of iminocyclopropenes and isolation of the resulting imidazolidine lends credence to the previously suggested intermediacy of an oxazolidine in the analogous addition of 3-aroylaziridines to diphenylcyclopropenone.

Experimental

Melting points were determined on a Fisher–Johns apparatus and are uncorrected. The i.r. spectra were recorded on a Perkin–Elmer model 421 spectrophotometer, and only the principal, sharply defined peaks are reported. The n.m.r. spectra were recorded on Varian A-60 and A-100 analytical spectrometers. The spectra were measured on approximately 10–15% (w/v) solutions in $CDCl_3$, with tetramethylsilane as a standard. Line positions are reported in parts per million (p.p.m.) from the reference. Absorption spectra were recorded in "spectro"-grade solvents on a Beckman DB recording spectrophotometer. Mass spectra were determined on an Associated Electrical Industries MS-9 double-focusing high resolution mass spectrometer. The ionization energy, in general, was 70 eV. Peak measurements were made by comparison with perfluorotributylamine at a resolving power of 15000. Kieselgel DF-5 (Camag, Switzerland) and Eastman Kodak precoated sheets were used for thin-layer chromatography (t.l.c.) Microanalyses were carried out by Dr. C. Daesslé, Organic Microanalysis Ltd., Montreal, Quebec and by Mrs. D. Mahlow of this department.

[7] 

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Synthesis of Aziridines

The 3-aroylaziridines and 3-carbomethoxyaziridine required in this work were prepared by the Gabriel synthesis employing standard procedures described by Cromwell and Caughlan (27).

N-Trichloroacetyldiphenylcyclopropenimine

N-Trichloroacetyldiphenylcyclopropenimine was prepared in 70% yield by the method of Paquette and Horton (10) and had a m.p. 171°–174° (lit. (10) m.p. 169–171°).

Reaction between 3-Benzoyl-1-cyclohexyl-2-phenylaziridine and N-Trichloroacetyldiphenylcyclopropenimine

A solution of 3.06 g (0.01 mole) of 3-benzoyl-1-cyclohexyl-2-phenylaziridine (28) and 3.4 g (0.01 mole) of *N*-trichloroacetyldiphenylcyclopropenimine in 50 ml of acetonitrile was heated under reflux for 24 h. The solvents were removed from the resulting dark red solution *in vacuo* leaving a deep red oil. Chromatography of this oil on alumina (BDH) with benzene gave as the first fraction (*a*) 5-benzoyl-1-cyclohexyl-2-phenyl-4-(spirodiphenylcyclopropene)-3-(*N*-trichloroacetylhydrate)-imidazolidine, 0.551 g (10% yield as a white solid m.p. 153–155° (from hexane)).

Anal. Calcd. for $C_{38}H_{35}Cl_3N_2O_3$: C, 67.70; H, 5.25; N, 4.15. Found: C, 67.80; H, 5.30; N, 4.10.

Mol. Wt. Calcd. (mass spectrum) for $C_{38}H_{35}{}^{35}Cl_3N_2O_3$, 672.1715. Found 672.1710.

The i.r. spectrum: ν_{max} ($CHCl_3$), 3450 (broad, *inter*molecularly bonded (OH), 3370 (sharp, *intra*molecularly bonded OH), 1720 cm^{-1} (C=O). The n.m.r. spectrum: δ_{TMS} ($CDCl_3$): 0.7–1.3, and 3.8 (11H, multiplet, cyclohexyl protons); 4.2 (1H, singlet, 5-imidazolidine proton); 5.9 (1H, singlet, 2-imidazolidine proton); 8.5 and 5.8 (1H each, singlets, exchangeable with deuterium oxide, *intra*- and *inter*molecularly bonded OH protons respectively), 7.2–8.0 (20H, multiplet, aromatic protons). Absorption spectrum (CH_3OH): λ_{max} 260 mμ (sh) (ε, 12 620), 225 mμ (ε, 19 700).

(*b*) Further elution of the column with chloroform gave 0.283 g (5% yield) of a dark red solid, which was purified by recrystallization from ethyl acetate/hexane to give white crystals m.p. 252–253° of 1-cyclohexyl-4-(*cis*-1,2-diphenylvinyl)-3-*N*-dichloroacetyl-2-phenyl-imidazoline.

Anal. Calcd. for $C_{31}H_{30}Cl_2N_2O$: C, 71.95; H, 5.84; N, 5.41. Found: C, 71.99; H, 5.43; N, 5.28.

The i.r. spectrum ν_{max} ($CHCl_3$) 1625 cm^{-1} (amide). The n.m.r. spectrum δ_{TMS} ($CDCl_3$): 1.8–2.0 (10H, multiplet, cyclohexyl protons), 4.0 (1H, multiplet, C*H*—N—); 5.65 (1H, singlet, 2-imidazoline proton), 7.0–7.8 (16H, aromatic and vinyl protons); 8.05 (1H, singlet, *cis*-1,2-diphenylvinyl proton). Absorption spectrum (CH_3OH): λ_{max} 320 mμ (ε, 9250); 280 mμ (ε, 17 450), and 238 mμ (ε, 35 800).

Reaction between 1-Cyclohexyl-3-p-nitrobenzoyl-2-phenylaziridine and N-Trichloroacetyldiphenylcyclopropenimine

A solution of 3.50 g (0.01 mole) of 1-cyclohexyl-3-*p*-nitrophenyl-2-phenylaziridine (25) and 3.49 g (0.01 mole) of *N*-trichloroacetyldiphenylcyclopropenimine in 50 ml of acetonitrile was heated under reflux for 24 h. The dark red solution obtained was evaporated to dryness to give a viscous red oil. Column chromatography of this oil on BDH alumina using benzene as eluant gave

(*a*) 3.6 g (50% yield) of 1-cyclohexyl-5-*p*-nitrobenzoyl-2-phenyl-4-(spirodiphenylcyclopropene)-3-(trichloroacetylhydrate)-imidazolidine, as a pale yellow solid. Recrystallization of this product from benzene/hexane gave white crystals, m.p. 177–180°.

Anal. Calcd. for $C_{38}H_{34}Cl_3N_3O_5$: C, 63.5; H, 4.75; N, 5.85. Found: C, 63.9; H, 5.05; N, 5.65.

Mol. Wt. Calcd. (mass spectrum) for $C_{38}H_{34}{}^{35}Cl_3N_3O_5$: 717.1564. Found, 717.1550.

The i.r. spectrum ν_{max} ($CHCl_3$), 3440 (broad, *inter*molecularly bonded OH); 3360 (sharp, *intra*molecularly bonded OH); 1710 (aroyl C=O), 1500, 1345 cm^{-1} (aromatic NO_2). The n.m.r. spectrum: δ_{TMS} ($CDCl_3$): 0.8–1.6 (10H, multiplet, cyclohexyl protons); 4.0 (1H, multiplet, C*H*N—); 4.2 (1H, singlet, 5-imidazolidine proton); 5.82 (1H, singlet, 2-imidazolidine proton); 8.45 and 5.7 (1H each, singlets, exchangeable with D_2O *intra*- and *inter*molecularly bonded OH respectively); 7.2–8.2 (19H, multiplet, aromatic protons). Absorption spectrum (CH_3OH): λ_{max} 265 mμ (ε, 18 600); 225 mμ (sh) (ε, 19 620).

(*b*) Further elution of the column with chloroform gave 0.339 g (6% yield) of a white solid, m.p. 248–250° of 1-cyclohexyl-4-(*cis*-1,2-diphenylvinyl)-3-*N*-dichloroacetyl-2-phenylimidazoline which had a superimposable i.r. spectrum and was otherwise identical with the compound similarly obtained in the previous reaction with 3-benzoyl-1-cyclohexyl-2-phenylaziridine described above.

Reaction between 1-Cyclohexyl-2-phenyl-3-p-toluoylaziridine and N-Trichloroacetyldiphenylcyclopropenimine

A solution of 3.505 g (0.01 mole) of *N*-trichloroacetyldiphenylcyclopropenimine and 3.19 g (0.01 mole) of 1-cyclohexyl-2-phenyl-3-*p*-toluoylaziridine (28) in 50 ml of acetonitrile was heated under reflux for 24 h. The dark red solution obtained was evaporated to dryness and the residual red oil subjected to chromatography on BDH alumina. Elution of the column with benzene gave a yellow oil which resisted all attempts at crystallization. Elution of the column with chloroform gave a red oil which solidified on trituration with hexane, 1.345 g (24% yield). Recrystallization from ethyl acetate gave 1-cyclohexyl-4-(*cis*-1,2-diphenylvinyl)-3-*N*-dichloroacetyl-2-phenylimidazoline, m.p. 252–253°.

Anal. Calcd. for $C_{31}H_{30}Cl_2N_2O$: N, 5.41. Found: N, 5.28.

This material was identical in all respects to that obtained in the previous experiments described above.

Reaction of 1-Cyclohexyl-3-deutero-2-phenyl-3-p-nitrobenzoylaziridine and N-Trichloroacetyldiphenylcyclopropenimine

The reaction of 1.17 g (0.0033 mole) of 1-cyclohexyl-3-deutero-2-phenyl-3-*p*-nitrobenzoylaziridine (11) (60% deuterium incorporation at position 3 by n.m.r.) and 1.17 g (0.0033 mole) *N*-trichloroacetyldiphenylcyclopropenimine was carried out in exactly the manner described for the protium compound above affording 0.749 g (31% yield) of 1-cyclohexyl-5-deutero-5-*p*-nitrobenzoyl-2-phenyl-4(spirodiphenylcyclopropene)-3-(trichloroacetylhydrate)-imidazolidine which recrystallized from hexane as a white solid m.p. 177–180°. Examination of the n.m.r. spectrum showed the position and extent of deuterium incorporation. The product was identical in all other respects to the protium analogue described above.

The n.m.r. spectrum δ_{TMS} ($CDCl_3$): 0.8–1.6 (10H, multiplet, cyclohexyl protons); 4.0 (1H, multiplet, C*H*N—); 4.2 (0.54 H, singlet, 5-imidazolidine proton); 8.45 and 5.7 (1H each, singlets, exchangeable with D_2O *intra-* and *inter*molecularly bonded OH respectively, 7.2–8.2 (19H, multiplet, aromatic protons).

Reaction of 3-Carbomethoxy-1-cyclohexyl-2-phenylaziridine and N-Trichloroacetyldiphenylcyclopropenimine

A solution of 1.33 g (0.00514 mole) of 3-carbomethoxy-1-cyclohexyl-2-phenylaziridine (25) and 1.80 g (0.00514 mole) of *N*-trichloroacetyldiphenylcyclopropenimine in 50 ml of anhydrous acetonitrile was heated under reflux for 16 h. The solvents were removed *in vacuo* (< 40°) and the residual brown oil subjected to chromatography on 100 g of BDH alumina in hexane. Elution with hexane afforded 1.35 g of a yellow oil which upon dissolution in 5 ml of heptane and chilling gave 5-carbomethoxy-1-cyclohexyl-4-(spirodiphenylcyclopropene)-2-phenyl-3-trichloroacetylimidazolidine 0.363 g (44% yield based on unrecovered aziridine), m.p. 179–181° (from heptane).

Anal. Calcd. for $C_{33}H_{31}Cl_3N_2O_3$: C, 64.98; H, 5.12; N, 4.59; Cl, 17.44. Found: C, 65.01; H, 5.34; N, 4.51; Cl, 18.08.

Mol. Wt. Calcd. (mass spectrum) for $C_{33}H_{31}N_2O_3{}^{35}Cl_3$: 608.1402. Found: 608.1399.

The i.r. spectrum: ν_{max} ($CHCl_3$) 1738 (ester C=O); 1725 cm^{-1} (amide C=O (13)), no OH bonds in the region 3400 cm^{-1}. The n.m.r. spectrum: δ_{TMS} ($CDCl_3$): 0.33–2.67 (11H, multiplet cyclohexyl protons), 3.77 (3H, singlet, $COOCH_3$), 4.95–5.46 (1H each, singlets, 5- and 2-imidazolidine protons respectively), 6.68–8.0 (15H, multiplet, aromatic protons). Absorption spectrum (CH_3OH) λ_{max} 292 mμ (ε, 8790), 222 mμ (sh) (ε, 14 870).

Evaporation of the solvents from the filtrate of this fraction gave unreacted 3-carbomethoxy-1-cyclohexyl-2-phenylaziridine (0.98 g) identified by the n.m.r. spectrum.

Reaction between cis- and trans-3-Benzoyl-1-cyclohexyl-2-m-nitrophenylaziridines and N-Trichloroacetyldiphenylcyclopropenimine

A solution of 1.70 g (0.005 mole) of *N*-trichloroacetyldiphenylcyclopropenimine and 1.70 g (0.005 mole) of *trans*-3-benzoyl-1-cyclohexyl-2-*m*-nitrophenylaziridine in 25 ml of acetonitrile was heated under reflux for 21 h. The dark red solution obtained was concentrated *in vacuo* and the residual oil subjected to chromatography on 110 g of BDH alumina. Elution of the column with benzene gave

(*a*) 1.85 g (54.5 yield) of 1-cyclohexyl-5-benzoyl-2-*m*-nitrophenyl-4-(spirodiphenylcyclopropene)-3-(trichloroacetylhydrate)-imidazolidine, as a tan solid m.p. 90–92° from ethyl acetate – hexane.

Anal. Calcd. for $C_{38}H_{34}Cl_3N_3O_5$: C, 63.5; H, 4.75; N, 5.85. Found: C, 63.28; H, 4.77; N, 5.72.

Mol. Wt. Calcd. (mass spectrum) for $C_{38}H_{32}{}^{35}Cl_3N_3O_4$: 699.1459. Found: 699.1443.

The i.r. spectrum ν_{max} ($CHCl_3$), 3440 (broad, *inter*molecularly bonded OH); 3360 (sharp, *intra*molecularly bonded OH), 1710 (aroyl C=O), 1530, 1352 cm^{-1} (aromatic NO_2). The n.m.r. spectrum: δ_{TMS} ($CDCl_3$): 0.64–2.22 (11H, multiplet, cyclohexyl protons), 4.2 (1H, singlet, 5-imidazoline proton); 5.85 (1H, singlet, 2-imidazoline proton); 8.47 and 5.68 (1H each, singlet, exchangeable with D_2O *intra* and *inter*molecularly bonded OH respectively); 6.7–8.4 (19H, multiplet, aromatic protons). Absorption spectrum (CH_3CN): λ_{max} 262 mμ (sh) (ε, 20 300), 248 mμ (ε, 22 200).

(*b*) Further elution of the column with chloroform gave 0.183 g (5.4% yield) of a tan solid, m.p. 243–247° of 1-cyclohexyl-4-(*cis*-1,2-diphenylvinyl)-3-dichloroacetyl-3-*m*-nitrophenylimidazoline.

Anal. Calcd. for $C_{31}H_{29}Cl_2N_3O_3$: C, 66.20; H, 5.19; N, 7.47; Cl, 12.60. Found: C, 66.28; H, 4.68; N, 7.40; Cl, 12.55.

The i.r. spectrum ν_{max} (Nujol) 1625 cm^{-1} (amide). The n.m.r. spectrum δ_{TMS} [$(CD_3)_2SO$]: 0.7–2.4 (10H, multiplet, cyclohexyl protons), 3.5–4.0 (1H, multiplet, C*H*—N—); 5.64 (1H, singlet, 2-imidazoline proton); 6.8–8.8 (14H, multiplet aromatic protons). Absorption spectrum ($CHCl_3$): λ_{max} 312 mμ (ε, 9130) 352 mμ (ε, 9600).

A similar reaction between 1.70 g (0.005 mole) of *N*-trichloroacetyldiphenylcyclopropenimine and 1.70 g (0.005 mole) of *cis*-3-benzoyl-1-cyclohexyl-2-*m*-nitrophenylaziridine in 25 ml of acetonitrile, refluxed for 21 h gave after chromatographic separation on alumina 1.78 g (52.3% yield) of the identical 1-cyclohexyl-5-benzoyl-2-*m*-nitrophenyl-4-(spirodiphenylcyclopropene)-3-(trichloroacetylhydrate)-imidazolidine m.p. 91° and as the second component 1-cyclohexyl-4-(*cis*-1,2-diphenylvinyl)-3-dichloroacetyl-2-*m*-nitrophenylimidazoline 0.403 g (11.8% yield) m.p. 245–248°. Both compounds were identical in all respects to those obtained in the reaction with the *trans* aziridine.

This research was supported by a National Research Council of Canada grant to J. W. Lown. We thank Mr. R. Swindlehurst and Dr. A. Hogg for the n.m.r. and mass spectra, respectively.

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