When guinacetophenone was condensed with an equimolar amount of benzaldehyde in the presence of aqueous alkali, 6-hvdroxvflavanone (II) was again found to be the chief product.<sup>13</sup> But a paper chromatographic study of the reaction (which was complete in three to four days at room temperature) revealed the presence of 2',5'-dihydroxychalcone (III) and the new by-product, 6-hydroxy-3-benzylideneflavanone (IV). With the 1:1 gram ratio of aldehyde to acetophenone suggested by Vyas and Shah<sup>14</sup> IV was often the chief crystallizable product. In fact, we propose that the yellow material, m.p. 215°, designated by them as the chalcone III was the by-product IV.<sup>15</sup> We obtained red-orange crystals, m.p.  $173^{\circ}$ , in less than a 10%vield which was shown to be the chalcone by the absorption spectrum and by conversion to II.<sup>16</sup> The structure of the by-product IV was confirmed by its synthesis from II and benzaldehyde in both acidic and basic media.

The ultraviolet and infrared absorption spectra of IV reveals its hybrid character, since they resemble both those of chalcones and flavanones. A Fisher-Hirschfelder model shows that the  $\alpha,\beta$ unsaturated ketonic group is held rigidly in IV (unlike the situation of free rotation in chalcones) by the superimposed  $\gamma$ -pyrone ring and that steric hindrance between the two "B" phenyl rings prevents planarity of the carbonyl and ethylenic linkages. As a result, IV is lighter in color than III and has the carbonyl band at 1670 cm.<sup>-1</sup> in the infrared, resembling that of II not of III.

#### Experimental<sup>17</sup>

General Conditions of Reaction.—Quinacetophenone (1-3-g. samples) and benzaldehyde were dissolved in 95% alcohol (7-60 ml.) and cooled. Simultaneously the mixture was flushed with nitrogen and 40% aqueous potassium hydroxide (7-30 ml.) was added slowly. The flask was tightly stoppered and allowed to stand 3-4 days at room temperature or in the refrigerator; paper chromatography was used to determine the disappearance of quinacetophenone. The ruby-red reaction mixture was then acidified and the resulting precipitate washed free of benzoic acid with saturated bicarbonate.

**6-Hydroxyflavanone** (II) was obtained as the main product (32.5%) when a mole to mole ratio of benzaldehyde to quinacetophenone was employed and concentrated hydrochloric acid was used to precipitate the yellow product. After repeated recrystallizations from 95% alcohol, the last traces of yellow color (due to III) were removed from this material by passing it through a column packed with a washed<sup>18</sup>

mixture of nylon<sup>19</sup> powder and Celite<sup>20, 21</sup> (2:1). When the 30% methanolic eluate<sup>22</sup> was allowed to stand several days in the refrigerator, pure white crystals of II separated.

2',5'-Dihydroxychalcone (III) could be isolated in 4–9% yields from a similar reaction mixture if the acidification was done with 6 N hydrochloric acid and the yellow-orange precipitate was extracted with methanol. On evaporation of the methanol crude chalcone was deposited; this was obtained as orange-red crystals after repeated recrystallization from benzene. When III was refluxed with dilute alcoholic hydrochloric acid for 10 hr., it was converted into II.

6-Hydroxy-3-benzylideneflavanone (IV) was obtained as the main product (28-37%) when equal weights of quinacetophenone and benzaldehyde were used (a 1:1.3 molar ratio). A larger excess of benzaldehvde (up to 7 moles) increased the yields, a 50% yield being isolated after recrystal-lization from methanol. The same compound was obtained in a 70% yield by substituting 6-hydroxyflavanone (II) for quinacetophenone in the standard procedure with excess benzaldehyde and running the reaction for 1 day. The same compound was also isolated in 29% yield when an alcoholic solution of 0.184 g. of 6-hydroxyflavanone and 0.6 g. of benzaldehyde was saturated with hydrogen chloride and allowed to stand for 4 days at room temperature. Mixed melting points proved the identity of the three samples of IV. The yellow methyl ether of this compound was prepared by means of dimethyl sulfate and anhydrous potassium carbonate in anhydrous acetone. When IV was refluxed for 10 days with dilute alcoholic hydrochloric acid, no color change occurred and the melting point of the product was little changed. Paper chromatography showed a second spot appearing.

(19) Polypenco Nylon Powder, The Polymer Corp., Reading, Pa.

- (20) Johns Manville.
- (21) R. Neu, Nature, 182, 660 (1958).
- (22) III eluates only with 75% methanol.

# Diels-Alder Reaction. Experiments with 2,6-Distyryl-γ-pyrone and 2-Styrylchromones

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 $\gamma$ -Pyrones differ from *p*-quinones to which they bear structural resemblance as the former do not function as dienophiles in the Diels-Alder reaction. This may be attributed to the important contribution of structures I and Ia to the actual state of the molecule.<sup>1,2</sup>



The use of 2,6-distyryl- $\gamma$ -pyrone as a diene component in the Diels-Alder reaction seems not to have been investigated so far. In the present in-

<sup>(13)</sup> A. Robertson, V. Venkateswarlu, and W. B. Whalley, J. Chem. Soc., 3137 (1954).

<sup>(14)</sup> G. N. Vyas and N. M. Shah, J. Indian Chem. Soc., 26, 273 (1949).

<sup>(15)</sup> The methyl ether of IV melts relatively close to that reported by Vyas and Shah<sup>14</sup> for their chalcone.

<sup>(16)</sup> Vyas and Shah<sup>14</sup> report no such reaction for their supposed chalcone although the reaction was reported for all other chalcones in their paper.

<sup>(17)</sup> Melting points are uncorrected.

<sup>(18)</sup> Washed with benzene, ether, ethyl acetate, acetone, methanol, and hot water (R. Birzgalis, M.A. thesis, Wellesley College, 1960, p. 43).

<sup>(1)</sup> K. Alder in "Newer Methods of Preparative Organic Chemistry," New York, 1948, p. 501.

<sup>(2)</sup> B. Eistert, "Tautomerie und Mesomerie," F. Enke, Stutgart, 1938, p. 56 ff.

vestigation it is found that the adducts (IVa, IVb, IVc) have been formed by the interaction of 2,6distyryl- $\gamma$ -pyrone (II) as diene component and *trans*-diaroylethylenes (IIIa, IIIb, IIIc) as dienophiles in boiling anisole. The reaction has been extended to 2-styrylchromone (IX), 2-styrylkhellin (XIa), and 2-styrlvisnagin (XIb).

(A). Experiments with 2,6-Distyryl- $\gamma$ -pyrone.— Chromone derivatives (IVa, IVb, IVc) are easily formed when 2,6-distyryl- $\gamma$ -pyrone (II) is allowed to react with trans-diaroyl-ethylenes (IIIa, IIIb, IIIc) in boiling anisole. The analyses of the adducts obtained by the action of dibenzoylethylene and di-p-toluylethylene on 2,6-distyryl- $\gamma$ -pyrones are in fair agreement with both structures in which one or two molecules of the dienophile may be added to the distyryl compound. However, molecular weight determinations (cryoscopic method) indicated that only one molecule of the dienophile has been added to the distyryl compound, and hence the adducts are probably 2-styrylchromone derivatives. The structure assigned to these adducts is supported by a study of their absorption spectra.



The maxima at 315 m $\mu$  (Table I) appear to be due to the chromophore C<sub>6</sub>H<sub>5</sub>CH=CHCH=CHC=O (A), since the same band was observed in the absorption spectrum of cinnamylidene acetone (VI). The maxima at 248, 258 and 258 m $\mu$ , respectively (see Fig. 1), appear to be due to the aroyl group (B) since acetophenone absorbs at  $\lambda_{max}$  244 m $\mu$  ( $\epsilon_{max}$ 15,850).<sup>3</sup> The fact that the molecular extinction coefficient of these adducts at the short wave length region is double that for acetophenone is good evidence for the presence of two such groups in the molecule.

		IAB.	LE 14		
Formula of the compound	$\lambda_{\max}$	€max	$\lambda_{min}$	€min	Figure
IVa	315	34,953	275	16,020	I, IVa
	248	32,040			-,
$\mathbf{IVb}$	315	35,904	280	22,032	I, IVb
	258	29,884	<b>240</b>	18,768	,
IVc	315	34,480	280	21,346	I, IVc
	258	32,429	240	23,809	
VI	315	35,787	250	1,812	I, VI
4 The m		onto mono	a a mai a d		- n-1-1-1

Turn Te

"The measurements were carried out with a Perkin-Elmer Spectrocord Model 4000A, in absolute ethanol.

It is of interest to note that only one molecule of the *trans*-diaroylethylene is added to the 2,6-dicoeffectent.)

🕹 (Molecular extinction

\$ 3.60

4.20

4.0

3.90

3.80

3.70

3.50

3.49





styryl- $\gamma$ -pyrone, even when excess of the former is used and the duration of heating is prolonged. This may be due to a weakening of the diene character of the 1:1 adduct by the cross conjugation as shown in V.



When N-phenylmaleimide (VII) is allowed to react with 2,6-distyryl- $\gamma$ -pyrone (II) in boiling xylene, one molecule of the former is added to give VIII (cf., A. Mustafa and M. A. Ibrahim).<sup>4</sup>



<sup>(3)</sup> Gillman and Stern, "An Introduction to Electronic Absorption Spectroscopy in Organic Chemistry," Edward Arnold, Ltd., London, 1955, p. 126,

<sup>(4)</sup> A. Mustafa and M. A. Ibrahim, J. Org. Chem., 21, 849 (1956).

		Mol. wt. 571 8		ıyl-2-sty-		[ 5	10.39	
	Found	<sup>7</sup> ound CI	3.36		;	Found H	4.0	4.8
	=	ь 5.9 4.4	4.8	IIIA °		C J	67.8	77.77
	> ] t ]	. w. C 34 82.7 73.8		chromone.		G	10.86	•
		U Mo 56 11.7	•	.l-2-styryl	-		4.0	4.7
	Caled	4 : : 1 :	86 2.99	yl-7-pheny		C	68	77.97
		82.97 5.0 73.4 4.	78.62 4.3	hlorodibenzo <u>,</u>		Formula	3 <sub>37</sub> H <sub>26</sub> O <sub>7</sub> Cl <sub>2</sub>	36H26O6
	Formula	C30H2204 C37H2504Cl2	C <sub>31</sub> H <sub>23</sub> O <sub>4</sub> N	/dro-5,6-die	V.M.	g.	0.21 C	0.26 C
ABLE II	Yield,	$\begin{array}{c} 0.25\\ 0.24\end{array}$	0.26	,7-Tetrah) BLE III		M.p.	$230^{\circ}$	$246^{\circ}$
TA Time of	M.p., Solvent of cryst. °C.	bold + benzene 266 zene + pet. ether 248 $b. p. 60-80^{\circ}$	tone 292	chromone. <sup>b</sup> IVc—4a,5,6. T₄		Solvent of cryst.	Benzene + pet. ether $(b.p. 60-80^{\circ})$	$\underline{Alcohol}$ + benzene
	me of ating, hr.	25 Alco 80 Ben (b	l0 Acei	1-2-styrylc boximide.	Volume of	anisole	25 ml.	35 ml.
	T he	, 50 ml.	, 30 ml.	luyl-7-pheny yl)-5,6-dicau	Time of heating	hr.	30	30
	ŭ	g. Anisole 5. Anisole	Xylene	-5,6-di-p-tol me (N-phen		Dienophile	Ic, 0.6 g.	Ia, 0.42 g.
	Dienophile	111b, 1.76 IIIc, 2.34 <sub>£</sub>	VII, 1.1 g.	.Tetrahydrc ydrochromc		l but	7 g. II.	; 
	Styryl compound	ьі ці — —	0.5 g.		Styry	compor	XIa, 0.	XIb, 1 £
	Ad- duct	$IVb^{a}$ $IVe^{b}$	VIIIc	a IVE ryl-4a,5	Ad-	duct	XIIa <sup>a</sup>	$XIIb^b$

11.0	- <i>Н</i> с-ох
4.8 3.65	thoxy-5-0
77.77 68.9	zoyl-4-me
	-6,7-diben
$\frac{4.7}{3.85}$	etrahydro e.
77.97 69.34	5a,6,7,8-T b)xanthen
Ca6H26O6 Ca6H24O6Cl2	hene. <sup>b</sup> XIIb
$\begin{array}{c} 0.26 \\ 0.25 \end{array}$	3,2-b)xant -5-0x0-5H
246° 258°	enylfuro() I-methoxy
Alcohol + benzene Benzene + pet. ether $(b.p. 60-80^{\circ})$	-dimethoxy-5-oxo-5 <i>H</i> -8-ph ,7- <i>p</i> , <i>p</i> '-dichlorodibenzoyl-4
35 ml. 25 ml.	enzoyl-4,11. etrahydro-6,
30 35	chlorodib a,6,7,8-Te
IIIa, 0.42 g. IIIc, 0.5 g.	hydro-6,7- <i>p</i> , <i>p</i> '-di
XIb, 1 g. XIb, 0.58 g.	a-5a,6,7,8-Tetra Ifuro(3,2-b)xanth
XIIb <sup>b</sup> XIIe <sup>c</sup>	<sup>a</sup> XII 8-pheny

Notes



# Experimental

.COAr

The method of Boon, et al.,<sup>8</sup> for the preparation of 2,6distyryl- $\gamma$ -pyrone has been modified and a better yield was obtained.

Preparation of 2,6-Distyryl- $\gamma$ -pyrone.—To the cooled solution of 2,6-dimethylpyrone<sup>9</sup> [purified by recrystallization from benzene-petroleum ether (b.p 60-80°)] 1 g. (0.008 mole) in 15 ml. of absolute ethyl alcohol, and benzaldehyde (freshly distilled in a stream of dry carbon dioxide) 1.7 g.

(5) O. M. Aly, W. I. Awad, and A. M. Islam, J. Org. Chem., 23, 1623 (1958).

(6) M. Cesaris, Gazz. Chim. Ital., 42, 11, 453.

(7) A. Schönberg, A. Mustafa, and G. Aziz, J. Am, Chem. Soc., 76, 4576 (1954).

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(9) Arndt, et al., Ber., 69, 2373 (1936).

(B). Experiments with 2-Styrylchromones.--

Although the adducts contain ketonic groups,

they fail to condense with ketonic reagents, e.g.

The use of 2-styrylchromones as diene components has already been investigated.<sup>4,7</sup> In the present work 2-styrylchromone (IX) is allowed to react with p, p-dichlorodibenzoylethylene (IIIc) in boiling anisole leading to the formation of xanthene derivative (X).



dichlorodibenzoylethylene (IIIc) to give the adduct (XIIa), while 2-styrylvisnagin (XIb) reacts with both dibenzoylethylene and p,p-dichlorodibenzoyl-

hydroxylamine, phenylhydrazine, and 2,4-dinitrophenylhydrazine. Compounds having ketonic groups and behaving similarly have been reported in the literature.<sup>5,6</sup>

(0.016 mole) was added a cooled solution of 0.43 g. of sodium in 15 ml. of absolute ethyl alcohol. The mixture was kept overnight (at temperature not above 20°). Orange crystals of 2,6-distyryl- $\gamma$ -pyrone 0.75 g. (0.0025 mole) m.p. 166°, separated. After crystallization from ethyl alcohol, yellow flakes, m.p. 168°, no depression on admixture with an authentic sample,<sup>8</sup> were obtained.

Anal. Calcd. for  $C_{21}H_{16}O_2$ : C, 84.0; H, 5.33. Found, C, 83.5; H, 5.6.

The trans-diaroylethylenes were prepared according to the method of Conant and Lutz.<sup>10</sup>

(A). Experiments with 2,6-Distyryl- $\gamma$ -pyrone. (i). Action of trans-Dibenzoylethylene on 2,6-Distyryl- $\gamma$ -pyrone.— A mixture of 2,6-distyryl- $\gamma$ -pyrone, 1 g. (0.0033 mole), and trans-dibenzoylethylene, 1.55 g. (0.0066 mole), in anisole, 50 ml., was refluxed for 25 hr. Anisole was distilled in vacuum. The oily residue was dissolved in the least amount of chloroform and petroleum ether (b.p. 60-80°) was added dropwise till a slight turbidity appeared, kept overnight, whereby colorless crystals 0.25 g. (0.0004 mole) of 4a,5,6,7-tetrahydro-5,6-dibenzoyl-7-phenyl-2-styrylchromone (IVa) m.p. 238° separated. After recrystallization from a mixture of alcohol and benzene, colorless crystals, m.p. 242°, were obtained.

Ânal. Caled. for  $C_{37}H_{28}O_4$ : C, 82.83; H, 5.22. mol. wt. 536. Found: C, 82.3; H, 5.4. mol. wt. 532.

(ii). The above experiment was repeated using 2,6distyryl- $\gamma$ -pyrone, 1 g. (0.0033 mole), and *trans*-dibenzoylethylene, 3.1 g. (0.0132 mole), and heating was continued for 35 hr. A 0.3-g. sample (0.00055 mole) of the adduct (IVa), m.p. 242°, no depression on admixture with an authentic sample, was obtained.

(iii). Attempted Condensation with Hydroxylamine.— To 0.3 g. (0.0057 mole) of IVa in 200 ml. of ethyl alcohol, a mixture of 0.78 g. (0.00114 mole) of hydroxylamine hydrochloride, and sodium acetate, 1.2 g. (0.0114 mole), was added. The mixture was refluxed for 3 hr., cooled, and the precipitate which formed filtered, washed with water, dried, and crystallized from a mixture of alcohol and benzene, whereby, colorless crystals of IVa, no depression on admixture with an authentic sample, were obtained.

(iv). Attempted Condensation with Other Ketonic Reagents.—When repeating experiment iii using phenyl-hydrazine hydrochloride and sodium acetate or 2,4-dinitrophenylhydrazine, IVa was recovered unchanged. Table II shows the experimental details of other Diels-Alder reactions with 2,6-distyryl- $\gamma$ -pyrone.

(B). Experiments with 2-Styrylchromone (IX), 2-Styrylkhellin (XIa), and 2-Styrylvisnagin (XIb). Action of p,p-Dichlorodibenzoylethylene (IIIc) on 2-styrylchromone.— A mixture of 2-styrylchromone,<sup>11</sup> 1 g. (0.004 mole), and trans-p,p'-dichlorodibenzoylethylene, 1.22 g. (0.004 mole), dissolved in 40 ml. of anisole was heated for 30 hr. Anisole was distilled in vacuum, the oily residue crystallized from benzene-petroleum ether (60-80°), whereby, 0.05 g. (0.0004 mole) of 2-styrylchromone (IX), m.p. and mixed m.p. with an authentic sample 131°, separated. On concentrating the mother liquor, almost colorless crystals 0.15 g. (0.00027 mole) of 1,2,3,9a-tetrahydro-1,2-p,p'-dichlorodibenzoyl-9-oxo-3-phenyl-xanthene (X), m.p. 212°, separated, which after recrystallization from a mixture of alcohol-benzene, gave colorless crystals, m.p. 215°.

Anal. Calcd. for C<sub>33</sub>H<sub>22</sub>O<sub>4</sub>Cl<sub>2</sub>: C, 71.6; H, 3.99; Cl, 12.87. Found: C, 71.1; H, 4.1; Cl, 12.4.

Table III shows the experimental details of other Diels-Alder reactions with 2-styrylfurochromones. For the preparation of 2-styrylkhellin, and 2-styrylvisnagin see Schönberg, Mustafa, and Aziz.<sup>7</sup> Acknowledgment.—The author wishes to express his full gratitude to Professor Dr. F. G. Baddar, Chemistry Department, Faculty of Science, A'in Shams University, for carrying out the ultraviolet measurements and for his valuable criticism.

## 3-Aminoxy-D-alanine

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In the course of our work on cycloserine (I), we became interested in the preparation of its hydrolysis product,  $\beta$ -aminoxy-D-alanine (III). This amino acid is related structurally to another aminoxy amino acid, canaline,<sup>1</sup> which was obtained from the interesting guanidinoxy amino acid, canavanine.<sup>2</sup> In 1957, Nyberg and Christensen,<sup>3</sup> in their paper describing the synthesis of both DL-canaline and DL-canavanine, reported an unsuccessful attempt to synthesize  $\beta$ -aminoxy-DL-alanine. They concluded that the aminoxy group was rapidly degraded to a hydroxyl group in hot acid. Under the conditions which we used, the aminoxy group remained intact.

This note describes the preparation of  $\beta$ -aminoxyp-alanine (III) by two routes. The methanolysis of I giving the ester II has been described by



Kuehl, et al.,<sup>4</sup> and is analogous to reactions used in the synthesis<sup>5</sup> of I. The hydrolysis of the ester II in 6 N hydrochloric acid at 90° gave III in 68%yield. Direct hydrolysis of cycloserine using 6 N hydrochloric acid at 60° gave III in 41% yield. The conditions (time, temperature, and acid concentrations) used in both hydrolyses were approxi-

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