846. *The Reaction of Ethyl 2-Oxocyclopentanecarboxylate with Arylamines. Part I. The Preparation of 2,3-Dihydro-α-quinindones (2,3,4,5-Tetrahydro-4-oxo-1H-cyclopenta[c]quinolines).*

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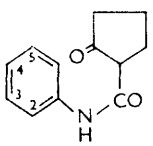
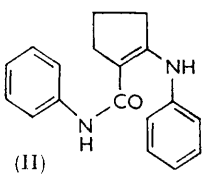
Substituted 2,3-dihydro-α-quinindones have been prepared by the cyclisation of the corresponding 2-oxocyclopentanecarboxyanilides in sulphuric acid. The required starting materials were obtained, together with the 2-anilinocyclopent-1-enecarboxyanilides, by high-temperature condensation of arylamines with ethyl 2-oxocyclopentanecarboxylate. When ethyl *p*-aminobenzoate was used, the corresponding ethyl 2-anilinocyclopent-1-enecarboxylate was also isolated.

During another investigation, it became of interest to prepare derivatives of 2,3-dihydro-α-quinindone (2,3,4,5-tetrahydro-4-oxo-1*H*-cyclopenta[*c*]quinoline) (III). The study was, therefore, undertaken of the condensation of ethyl 2-oxocyclopentanecarboxylate with arylamines at elevated temperatures, giving the anilides (I) and 2-anilinocyclopent-1-enecarboxyanilides (II), and of the cyclisation of certain of the carboxyanilides to the corresponding 2,3-dihydro-α-quinindones (III).

Dieckmann [1] obtained an anilide of type (II) from ethyl 4-methyl-2-oxocyclopentanecarboxylate at 150° and cyclised this to compound (III; R = Me) in concentrated sulphuric acid at room temperature. Blount *et al.*[2] obtained the anilide (I) from the keto-ester and aniline at the b. p. and cyclised it in sulphuric acid at 100°; by condensation at room temperature they obtained the anilino-ester (IV) which cyclised to (V) at 260° within a few minutes; Linstead and Bao-Lang Wang [3] isolated the third possible compound which may be formed in the condensation, namely, the anilino-anilide (II).


(I)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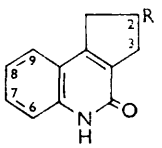
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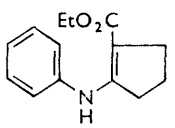
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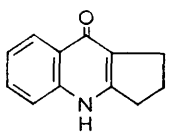
(V)

In the present investigation, anilides of types (I) and (II) were prepared in moderate yields by heating the reactants together for a few minutes at temperatures between 140° and 190°. Some of them have been cyclised to the 2,3-dihydro-α-quinindones (III) in sulphuric acid at 100°.

No parallel has been found for Sen and Basu's observation [4] of the formation of diarylureas in the condensation of ethyl 2-oxocyclohexanecarboxylate with an excess of arylamine. Condensing ethyl 2-oxocyclopentanecarboxylate with an excess of arylamine increased the yield of the anilino-anilide (II) and reduced that of the anilide (I), compared with those obtained when equimolar quantities were employed. We have been unable to cyclise the anilino-anilides under Dieckmann's conditions. We find that hydrolysis occurs

[1] Dieckmann, *Ann.*, 1901, **317**, 91.
[2] Blount, Perkin, and Plant, *J.*, 1929, 1983.
[3] Linstead and Bao-Lang Wang, *J.*, 1937, 807.
[4] Sen and Basu, *J. Indian Chem. Soc.*, 1929, **6**, 309.

TABLE 1.

Substituted 2-oxocyclopentanecarboxyanilides (I).

No.	Subst. in aryl ring	Form	Solvent for crystn.*	M. p.	Yield (%)	Found (%) C	H	N	Formula	Required (%) C	H	N
1	2-Me	Needles	Pet(a)	89°	60	71·8	6·9	6·45	$C_{13}H_{15}NO_2$	71·9	6·9	6·45
2	3-Me	Needles	Pet(a)	99·5	57	71·7	6·9	6·5				
3	4-Me	Needles	MeOH–Pet(a)	131·5—132	65	71·9	7·2	6·7				
4	2,4-Me_2	Needles	EtOH–H_2O	109	45	72·8	7·3	6·2	$C_{14}H_{17}NO_2$	72·7	7·4	6·1
5	2,5-Me_2	Needles	EtOH–H_2O	131	47	72·8	7·5	6·3				
6	(α-Naphthalide)	Needles	$COMe_2$–Pet(a)	102·5—103·5	54	75·8	5·8	5·7	$C_{16}H_{15}NO_2$	75·9	5·9	5·5
7	4-Phenyl-	Plates	C_6H_6–Pet(a)	145	28	77·7	6·2	4·9	$C_{18}H_{17}NO_2$	77·5	6·1	5·0
8	(Cyclohexylamide)	Needles	Pet(a)	113—113·5	64	69·0	9·0	6·7	$C_{12}H_{19}NO_2$	68·9	9·1	6·7
9	2-Cl	Needles	Pet(a)	50	38	60·2	5·2	5·9	$C_{12}H_{12}ClNO_2$	60·6	5·05	5·9
10	3-Cl	Needles	Pet(b)	100	42	60·3	5·1	5·8				
11	4-Cl	Plates	Pet(b)	119	47	60·8	4·9	5·8				
12	2,4-Cl_2	Needles	EtOH–Pet(b)	159—159·5	21	52·9	4·0	5·3	$C_{12}H_{11}Cl_2NO_2$	53·0	4·05	5·15
13	4-Br	Needles	EtOH–Pet(a)	133—134	47	50·7	4·3	4·8	$C_{12}H_{12}BrNO_2$	50·8	4·2	4·9
14	4-MeO	Needles	EtOH	139	15	67·3	6·3	6·0	$C_{13}H_{15}NO_3$	66·9	6·4	6·0
15	4-HO	Needles	C_6H_6–Pet(b)	125	65	65·9	5·8	6·5	$C_{12}H_{13}NO_3$	65·8	5·9	6·4
16	4-CO_2Et	Prisms	EtOH	149—150	23	65·5	6·3	5·0	$C_{15}H_{17}NO_4$	65·5	6·2	5·1
17	4-CO_2H	Needles	EtOH	295	85	63·45	5·4	5·6	$C_{13}H_{13}NO_4$	63·2	5·3	5·7
18	4-NO_2	Plates †	$COMe_2$–Pet(a)	155—156	55	58·3	4·8	11·2	$C_{12}H_{12}N_2O_4$	58·1	4·8	11·3
19	2-Me-5-NO_2	Plates †	$COMe_2$–Pet(a)	150—150·5	70	59·6	5·4	10·7	$C_{13}H_{14}N_2O_4$	59·5	5·4	10·7

* Pet(a) = light petroleum (b. p. 60—80°). Pet(b) = light petroleum (b. p. 80—100°). † Yellow.

TABLE 2.

Substituted 2-anilinocyclopent-1-enecarboxyanilides (II).

No.	Subst. in both aryl rings	Form	Solvent for crystn.*	M. p.	Yield (%)	Found (%) C	H	N	Formula	Required (%) C	H	N
1	2-Me	Needles	Pet(b)	145°	24	78·2	7·4	9·1	$C_{20}H_{22}N_2O$	78·4	7·2	9·2
2	3-Me	Needles	EtOH–H_2O	148·5—149	21	78·4	7·4	9·1				
3	4-Me	Plates	EtOH–H_2O	140	15	78·0	7·2	9·2				
4	2,4-Me_2	Needles	MeOH–Pet(a)	189	25	78·7	7·8	8·4	$C_{22}H_{26}N_2O$	79·0	7·8	8·4
5	2,5-Me_2	Needles	EtOH	141—142	25	78·9	7·8	8·4				
6	(α-Naphthalide)	Plates †	EtOH	166—167	16	82·3	5·8	7·3	$C_{26}H_{22}N_2O$	82·5	5·8	7·4
7	4-Ph	Plates †	C_6H_6	237·5	30	83·7	6·1	6·2	$C_{30}H_{26}N_2O$	83·8	6·05	6·5
9	2-Cl	Needles	EtOH	153	27	62·3	4·5	8·2	$C_{18}H_{16}Cl_2N_2O$	62·2	4·6	8·1
10	3-Cl	Needles	EtOH–H_2O	141·5	20	62·3	4·4	8·0				
11	4-Cl	Cubes †	EtOH–Pet(b)	175	22	62·0	4·3	7·9				
12	2,4-Cl_2	Needles	C_6H_6	194	32	51·6	3·6	6·5	$C_{18}H_{14}Cl_4N_2O$	51·9	3·4	6·7
13	4-Br	Needles	EtOH–H_2O	184—185	15	49·3	3·6	6·3	$C_{18}H_{16}Br_2N_2O$	49·5	3·7	6·4
14*a*	2-MeO	Needles †	EtOH	162	30	70·6	6·4	8·0	$C_{20}H_{22}N_2O_3$	71·0	6·5	8·3
14	4-MeO	Plates	EtOH–H_2O	134—134·5	20	70·6	6·7	8·3				
16	4-CO_2Et	Needles	EtOH–Pet(b)	163—164	18	68·1	6·1	6·8	$C_{24}H_{26}N_2O_5$	68·2	6·15	6·65
18*a*	2-NO_2	Needles ‡	EtOH	213—214	15	58·8	4·3	15·2	$C_{18}H_{16}N_4O_5$	58·7	4·35	15·2
18	4-NO_2	Needles ‡	—	265 (decomp.)	10	58·5	4·4	15·0				
19	2-Me-5-NO_2	Needles ¶	C_6H_6	256	12	60·6	5·2	13·8	$C_{20}H_{20}N_4O_5$	60·6	5·05	14·1

* Pet(a) = Light petroleum (b. p. 60—80°). Pet(b) = Light petroleum (b. p. 80—100°). † Yellow. ‡ Red. ¶ Orange.

to give the anilide (I), which may then be cyclised by subsequent short heating at 100°. Attempts to cyclise the anilino-anilides at 100° without prior protracted storage in sulphuric acid in the cold led to complete hydrolysis and formation of cyclopentanone.

The Experimental section describes the preparation of compounds of types (I), (II), and (III); that of compounds (IV) and their cyclisation is deferred.

Experimental

Yields are based on the consumption of ethyl 2-oxocyclopentanecarboxylate.

2-Oxocyclopentanecarboxyanilide.—Ethyl 2-oxocyclopentanecarboxylate,[5] b. p. 108—109°/13 mm., n_D^{20} 1·44765, (0·05 mole) and aniline (0·05 mole) were mixed, heated at 189° for 5 min. after evolution of ethanol commenced, and then cooled to room temperature. The solid product was stirred under 0·1N-sodium hydroxide (50 ml.) at room temperature for 30 min., and the insoluble anilino-anilide filtered off. Neutralisation of the filtrate with acetic acid precipitated the anilide (I). It crystallised from methanol–light petroleum (b. p. 40—60°) as needles (62%), m. p. 103° (Found: C, 70·8; H, 6·2; N, 6·9. Calc. for $C_{12}H_{13}NO_2$: C, 70·9; H, 6·4; N, 6·9%). The alkali-insoluble product was washed thoroughly with dilute acid and water, and crystallised from aqueous alcohol. 2-Anilinocyclopent-1-enecarboxyanilide formed prisms (10%), m. p. 128—129° (Found: C, 77·5; H, 6·5; N, 10·0. Calc. for $C_{18}H_{18}N_2O$: C, 77·7; H, 6·5; N, 10·1%). Linstead and Bao-Lang Wang [3] give m. p. 103·5—104°, and 128—130° for these two compounds. Blount, Perkin, and Plant [2] give m. p. 104° for the anilide (I).

The *compounds* in Tables 1 and 2 were prepared similarly from the substituted anilines. The following notes apply:

Table 1. No. 8, the only isolable product from the reaction of cyclohexylamine. No. 15, the only isolable product from the reaction of *p*-aminophenol. No. 17, prepared by the protracted standing of no. 16 in cold 0·1N-sodium hydroxide.

Table 2. No. 14a, the only pure product isolated from the reaction of *o*-anisidine. No. 16, fractional crystallisation of the alkali-insoluble residue also gave *ethyl* 2-p-*ethoxycarbonylanilino-cyclopent*-1-*enecarboxylate*, needles [from light petroleum (b. p. 60—80°)], m. p. 67° (Found: C, 67·3; H, 6·85; N, 4·6. $C_{17}H_{21}NO_4$ requires C, 67·3; H, 6·9; N, 4·6%), in 20% yield. No. 18a, the only isolable product from the reaction of *o*-nitroaniline. No. 18, obtained as red needles by exhaustive extraction of the alkali-insoluble residue with boiling ethanol.

No pure products were isolated on reaction of 2-aminobiphenyl or of 3-ethoxycarbonylamino-4-methylaniline with ethyl 2-oxocyclopentanecarboxylate.

2,3-Dihydro-α-quinindone.—2-Oxocyclopentanecarboxyanilide (5 g.) was slowly added with cooling to concentrated sulphuric acid (20 ml.). When dissolution was complete, the mixture was heated on the steam bath for 15 min., then cooled and poured into water (500 ml.) the product (85%) being precipitated. 2,3-Dihydro-α-quinindone formed needles (from aqueous acetic acid), m. p. 272° (Found: C, 77·5; H, 5·7; N, 7·6. Calc. for $C_{12}H_{11}NO$: C, 77·7; H, 6·0; N, 7·6%). Blount, Perkin, and Plant [2] give m. p. 256°.

The *compounds* in Table 3 were prepared similarly. All crystallised from aqueous acetic acid. They are soluble also in pyridine and nitrobenzene but sparingly soluble in other solvents.

Table 3.

Substitued 2,3-dihydro-α-quinindones (III; R = H).

			Yield	Found (%)				Required (%)		
Subst.	Form	M. p.	(%)	C	H	N	Formula	C	H	N
6-Me	Plates	265°	80	78·8	6·5	7·2	$C_{13}H_{13}NO$	78·4	6·5	7·0
7(or 9)-Me	Needles	243—244 *	87	78·6	6·5	7·1				
8-Me	Plates	309—310	90	78·4	6·25	7·4				
6,8-Me_2	Needles	292	75	78·9	7·2	6·7	$C_{14}H_{15}NO$	78·9	7·0	6·6
6,9-Me_2	Laths	272·5 *	80	78·9	7·2	6·5				
Benzo[*h*]	Powder	338—339 *	65	81·9	5·2	6·3	$C_{16}H_{13}NO$	81·7	5·5	6·0
6-Cl	Needles	222—223	70	65·7	4·5	6·4	$C_{12}H_{10}ClNO$	65·6	4·6	6·4
7(or 9)-Cl	Needles	292—293 *	75	65·7	4·6	6·3				
8-Cl	Needles	306 *	75	65·4	4·6	6·3				
8-Br	Needles	313—314 *	80	54·6	3·7	5·1	$C_{12}H_{10}BrNO$	54·5	3·8	5·3

* With decomp.

[5] Dobson, Ferns, and Perkin, *J.*, 1909, **95**, 2015.

Attempts to cyclise the nitro-, methoxy-, hydroxy-, phenyl, ethoxycarbonyl, carboxy-, and cyclohexyl derivatives of 2-oxocyclopentanecarboxyanilide with sulphuric acid proved unsuccessful.

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