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Abstract

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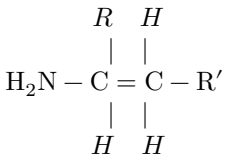
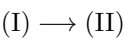
UNSYMMETRICAL THREE-CARBON CONDENSATIONS WITH INDANDIONE-1,3

In a number of papers ([1–3]) we have shown that, when arylideneindandiones interact with ammonium acetate, complex heterocyclic compounds—dibenzoylenepyridines—are formed. There are data in the literature indicating that arylideneindandiones ([4,5]) and arylideneindanones ([6]) also react with aliphatic amino compounds of the type



with the formation of derivatives of 4-azafluorenones-9 or 4-azafluorenes. This is convenient for obtaining 1-aryl-4-azafluorenones. 1-Alkyl-4-azafluorenones cannot be synthesized by this method, since 2-alkylideneindandiones are not formed. The aim of the present work was to synthesize 2-carboxy-4-azafluorenones from indandione derivatives. This is possible only when there is no aryl group in position 1, since the carboxyl group tends to cyclize with the latter. Thus, for example, on saponification of (I), only 2,3(CO), 4,5(CO)-dibenzoylenepyridine (II) was obtained ([4]).



Avoidance of cyclization by obtaining 4-azafluorenones without an aryl group was not achieved by the authors mentioned. In the present work we have shown that derivatives of 4-azafluorenones without an aryl group are readily obtained by an unsymmetrical three-carbon condensation of indandione, paraform, and an unsaturated amino compound.

There are as yet few data in the literature on such reactions. G. Hellmann and co-workers ([7,8]) carried out reactions of unsymmetrical condensation with certain β-dicarbonyl compounds, for example dibenzoylmethane, malonic ester, and cyclohexanediones. Errera ([9]) converted a compound obtained from indandione and ethoxymethyleneacetoacetic ester into 3-methyl-4-azafluorenone-9

under the action of ammonia. We have extended this interesting reaction to indandione. It proved that, in the condensation of indandione (III), paraform, and β-aminocrotonic ester (IV), 2-carbethoxy-3-methyl-1,4-dihydro-4-azafluorenone-9 (V) is formed:

$$(\mathrm{III}) + \mathrm{OCH_2} + (\mathrm{IV}) \longrightarrow (\mathrm{V}) \longrightarrow \overset{\mathrm{H_2CrO_4}}{\longrightarrow} (\mathrm{VI}) \overset{\mathrm{NaOH}}{\longrightarrow} (\mathrm{VII})$$

The condensation reaction mentioned above was carried out by us in a neutral medium (toluene), since an acidic medium leads to resinification, while basic catalysts cannot be used because indandione is unstable toward them. V is readily oxidized by chromic acid to 2-carbethoxy-3-methyl-4-azafluorenone (VI), and the latter is saponified by alkali to acid VII.

It turned out that 3-amino-5,5-dimethylcyclohexen-2-one-1 can also be introduced into the condensation reaction:

$$\mathrm{III} + \mathrm{OCH_2} + (\mathrm{VIII}) \longrightarrow (\mathrm{IX}) \overset{\mathrm{H_2CrO_4}}{\longrightarrow} (\mathrm{X})$$

The IX formed is readily oxidized by chromic acid to X. With regard to the reaction mechanism, it seemed probable to us that the unsymmetrical condensation proceeds through a whole series of intermediate, highly reactive compounds. It is possible that in the course of the reaction oxymethylindandione is first formed; this subsequently, after elimination of water, reacts with the amino compound with subsequent cyclization:

$$\mathrm{III}+\mathrm{OCH_2} \longrightarrow \left[\begin{array}{c}\text{oxymethylindandione intermediate}\\ (\mathrm{CH_2OH})\end{array}\right] \xrightarrow{-\mathrm{H_2O}} \left[\begin{array}{c}\text{methyleneindandione intermediate}\\ (\mathrm{CH_2})\end{array}\right] + \mathrm{H_2}$$

$$\longrightarrow \left[\begin{array}{c}\text{indandione–aminomethylene intermediate}\\ \mathrm{CH_2{-}C(=C){-}R,\ X}\end{array}\right] \longrightarrow \text{cyclized 4-azafluorenone derivative}$$

It is not excluded that, in parallel with the asymmetric condensation products, symmetric products are also formed, which we have not yet isolated.

Experimental Part

2-Carbethoxy-3-methyl-1,4-dihydro-4-azafluorenone-9 (V). 5.8 g of β-aminocrotonic acid ester, 6.6 g of indandione, and 1.5 g of paraform in 70 ml of toluene are boiled for 20 min with vigorous stirring.

mixing in a flask with a Dean-Stark trap. From the dark-brown solution 20 ml of toluene are distilled off. After cooling, 3.65 g (30%) of a reddish-brown

substance are filtered off. The material on the filter is washed with ether. M.p. 253° (from glacial acetic acid or dioxane). It dissolves in ethanol; with alcoholic alkali it gives a blue solution, and with conc. sulfuric acid—a light-green one.

Found, %: N 5.24. $C_{16}H_{15}O_3N$. Calculated, %: N 5.20.

2-Carboethoxy-3-methyl-4-aza-fluorenone-9 (VI).
2 g of V are dissolved in 100 ml of acetic acid, and 1 g of chromic anhydride dissolved in water is added. Instantaneous oxidation occurs at room temperature. After dilution of the filtrate with water, 1.5 g (76%) of a light-orange substance precipitates. M.p. 125–126° (from acetic acid). It dissolves in ethanol, dioxane, and benzene.

Found, %: N 5.46; $C_{16}H_{13}O_3N$. Calculated, %: N 5.24.

2-Carboxy-3-methyl-4-azafluorenone-9 (VII).
1.5 g of VI and 20 ml of a normal solution of sodium hydroxide are heated until complete dissolution (15 min.). Acid VII is precipitated with hydrochloric acid (1:1). The orange substance is difficult to filter. M.p. 290° (from butyl cellosolve or nitrobenzene). It dissolves very poorly in organic solvents.

Found, %: N 5.77; $C_{14}H_9O_3N$. Calculated, %: N 5.86.

Sodium salt—VII. VII is neutralized with the calculated amount of sodium bicarbonate. The solution is evaporated in vacuo. A light-brown salt is obtained, very readily soluble in water and sparingly in alcohol.

Found, %: N 4.92; $C_{14}H_8O_3NNa$. Calculated, %: N 5.36.

2,3(CO)-Benzoylene-5-keto-7,7-dimethyl-1,4,5,6,7,8-hexahydroquinoline (IX).
2 g (0.0137 mole) of indandione, 1.92 g (0.0137 mole) of VIII, and 0.4 g of paraform are suspended in 20 ml of toluene. The mixture is boiled for 20 min. in a flask with a Dean–Stark trap (for separation of water). The dark-brown solution is left for 2 days. The precipitated 2.6 g (70%) of a reddish-violet substance are washed with ether. M.p. 244–245° (from acetic acid). It dissolves in ethanol and methanol, very poorly in benzene, better in dioxane. With alcoholic alkali it gives a dark-blue color, and with conc. sulfuric acid a green color.

Found, %: N 5.03; $C_{18}H_{17}O_2N$. Calculated, %: N 5.00.

2,3(CO)-Benzoylene-5-keto-7,7-dimethyl-5,6,7,8-tetrahydroquinoline (X).
IX is oxidized with chromic acid analogously to V. A yellow substance, m.p. 154° (from acetone or acetic acid + water), readily soluble in ethanol, dichloroethane, and benzene.

Found, %: N 4.88; $C_{18}H_{15}O_2N$. Calculated, %: N 5.05.

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Note: Figure translations are in progress. See original paper for figures.