

On Phthalides and 1,3-Indandiones. XXXVI. Mercuration of Arylidene-phthalides and 1,3-Indandiones by Mercury(II) Acetate

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The mercuration by mercury(II) acetate proceeds as an addition and substitution reaction in the case of benzal-phthalide, as a substitution reaction in the case of 3-(1-naphthal)phthalide and predominantly as an addition reaction in the case of 3-(2-naphthal)phthalide. 2-Brom-1,3-indandione is substituted in position 2 while 2-aryl-1,3-indandiones give some instable complexes.

This paper is a sequel of our study of the substitution reactions of arylidene-phthalides and 1,3-indandiones [1—4]. It is known that mercury(II) acetate may be used as an addition or substitution agent. We were interested to see how mercury(II) acetate would react with above phthalides since either the addition on C=C double bond or the substitution in the aromatic ring might take place with these substances. As we found in our preceding investigations [1—3], these phthalides behaved in the reaction with bromine in a different manner and so it came into question whether and to what extent this difference in the reaction ability of phthalides would also manifest itself in the reaction with mercury(II) acetate. We discovered that benzal-phthalide, 3-(1-naphthal)phthalide and 3-(2-naphthal)phthalide gave different products in the reaction with mercury(II) acetate.

Benzal-phthalide (*I*) affords in the reaction with mercury(II) acetate two products, namely the products of the substitution in benzene ring *i.e.* (4-acetoxymercuriben-zal)phthalide (*IV*) and the product of addition and substitution *i.e.* (4-acetoxy-mercuriben-zal)phthalideacetoxymercuric acetate (*V*). The ratio of both products may be influenced by varying the reaction temperature. At the temperature of about 120°C the substance *IV* is preponderately formed while at 160°C the ratio of the substance *IV* to *III* is 1 : 2. We did not succeed in isolating a product of an exclusive addition even when the reaction took place at 20°C. In this case, the substance *IV* alone arose in low yield (1.5%). By melting the substance *I* with mercury(II) acetate at 160°C and subsequently adding water to the melt, 3-(4-hydroxymercuriben-zal)phthalide (*VI*) was obtained in 70% yield.

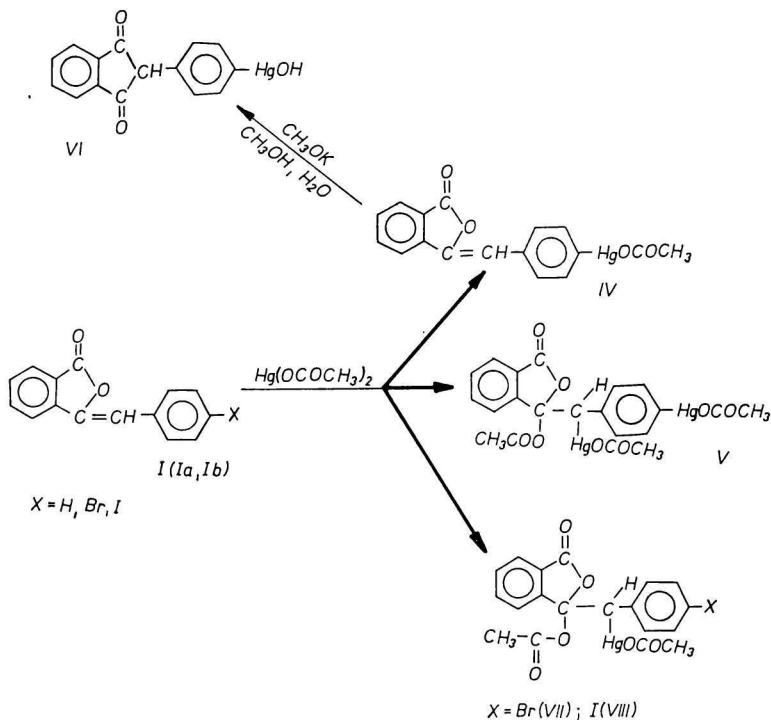
The mercuration of 3-(4-bromoben-zal)phthalide (*Ia*) and 3-(4-iodoben-zal)phthalide (*Ib*) differs from the mercuration of the substance *I*. We did obtain neither a substitution product — an analogue of the substance *IV* — nor a substitution-addition product — an analogue of the substance *V*. In both cases, the products of an addition on double bond (substance *VII* and *VIII*) were isolated in the yields of 15%. Besides the addition products *VII* and *VIII*, a substance with a lower content of mercury is formed in a greater amount (20—25%) during the reaction. We did not determine

its structure. As the main portion (40–50%), the initial phthalide is recovered. Since we did not obtain any substitution product by executing the mercuration of 3-(4-X-benzal)phthalides, we suppose that the substitution in benzalphthalide is likely to take place in position 4.

3-(1-Naphthal)phthalide (*II*) reacts with mercury(II) acetate under formation of the substitution product *IX*. In the case of 3-(1-naphthal)phthalide the position 4 in naphthalene ring is very reactive so that a bis-derivative R—Hg—R comes into existence very quickly and quantitatively, R being a naphthalphthalide group. Even the use of excess of mercury(II) acetate does not result in its addition on the double bond C=C.

3-(4-Bromo-1-naphthal)phthalide and 3-(4-nitro-1-naphthal)phthalide do not react with mercury(II) acetate at 25–160°C. We assume that the mercuration of 1-naphthalphthalide takes place in position 4.

3-(2-Naphthal)phthalide (*III*) undergoes an addition reaction with mercury(II) acetate under the conditions claimed in experimental part and the substance *X* comes into existence in about 10% yield. A substance, the structure of which we did not determine with the ratio of mercury(II) acetate to the initial 2-naphthalphthalide 1 : 6 was isolated as the main reaction product.



Scheme 1

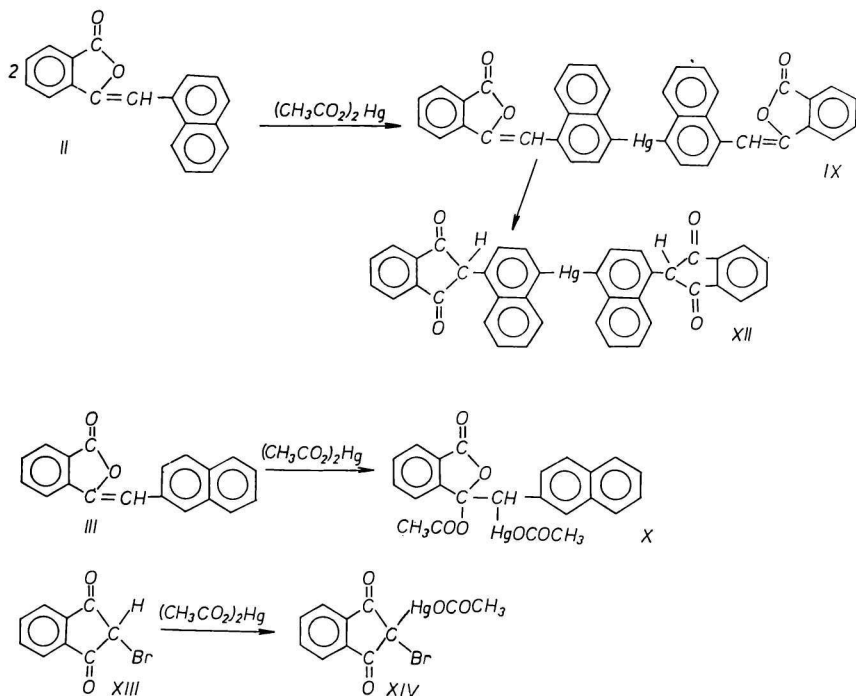
When the results of the mercuration of arylidenephthalides are compared with those of bromination [1, 2], it is to be stated that the addition reaction in the same arylidenephthalide goes easier with bromine whereas on the other hand the substi-

tution proceeds easier with mercury(II) acetate. We suppose that these differences are due to steric factors. Owing to a greater effective volume of mercury(II) acetate in comparison to bromine, the addition mercuration goes with lower yields in contrast to bromination because this double bond is screened sterically.

In the case of 2-substituted 1,3-indandiones the course of mercuration is not elucidated yet. It is difficult to suppose with respect to the desactivation by carboxylic groups that the substitution mercuration occurs outside the position 2. We have selected 2-bromo-1,3-indandione (*XIII*), 2-phenyl-1,3-indandione, and 2-(4-iodophenyl)-1,3-indandione for mercuration. The reaction has been accomplished in the temperature range from 120°C to 180°C during 30–120 minutes. The substitution in the substance *XIII* takes place on the carbon atom in position 2 and 2-bromo-2-acetoxymercuri-1,3-indandione (*XIV*) arises. The mercuration of 2-phenyl-1,3-indandione and 2-(4-iodophenyl)-1,3-indandione affords a substance in which two molecules of 2-phenyl-1,3-indandione and one molecule of mercury(II) acetate are bound together.

The mercurated 2-aryl-1,3-indandiones with mercury localized in aryl can be obtained by the rearrangement of mercurated arylidenephthalides. Thus the substances *XI* and *XII* were obtained by the rearrangement of the substances *IV* and *IX* by using sodium methoxide as a catalyst (Scheme 1 and 2).

The substances prepared were tested to estimate their fungicidal, herbicidal, and antimicrobial efficacy. Although the newly prepared substances contain mercury, their effect on the fungi living as parasites on plants (*Phytophthora infestans* and



Scheme 2

Erysipho graminis) is small and varies about 20—40% of the efficacy of standard.

The herbicidal tests were accomplished with the cultures: *Avena*, *Panicum*, *Sinapis*, and *Polygonum*. The compounds investigated were not effective.

The antimicrobial testing was carried out with the cultures: *Escherichia coli*, *Salmonella typhi murium*, *Staphylococcus pyogenes aureus*, *Mycobacterium tuberculosis H₃₇*, *Candida albicans*, and some strains of the kinds *Trichophyton* and *Microsporum*. Some of the substances prepared have a bacteriostatic effect in the concentration of about 10 gamma per millilitre of substrate and also inhibit the growth of the yeast *Candida albicans* while none of the new mercury compounds had an effect on dermatophytes.

The detailed results of testing will be published at other place.

Experimental

Melting points of the substances prepared were determined on Kofler block.

(4-Acetoxymercuribenzenal)phthalide (IV)

and (4-acetoxymercuribenzenal)phthalideacetoxymercuric acetate (V)

11 g (0.05 mole) of benzalphthalide, 17 g (0.052 mole) of mercury(II) acetate, and 30 ml of acetic acid are heated in a flask with reflux at 110—120°C for two hours. After 12 hours' standing at -5—0°C a precipitate is formed. By recrystallization from acetic acid, the substance IV is obtained (m.p. 160—165°C); in the yield of about 30%. Then the filtrate is poured under stirring into 100 ml of water. A white substance V which has separated is recrystallized from dimethylformamide or dimethyl sulfoxide; the substance V (yield 55%) has m.p. 104—110°C.

For IV C₁₇H₁₂O₄Hg (480.9) calculated: 41.73% Hg; found: 41.80% Hg.

For V C₂₁H₁₈O₈Hg₂ (799.6) calculated: 50.20% Hg, found: 49.9% Hg.

(4-Hydroxymercuribenzenal)phthalide (VI)

11 g (0.05 mole) of benzalphthalide and 17 g (0.052 mole) of mercury(II) acetate are heated in a flask at 160°C for 30 minutes. Then 50 ml of water is poured under stirring into the reaction mixture which has not cooled yet. The white substance which has precipitated is recrystallized from dimethyl sulfoxide (yield 70%, m.p. 210—215°C).

For C₁₅H₁₀O₃Hg (438.6) calculated: 45.73% Hg; found: 46.00% Hg.

(4-Bromobenzenal)phthalideacetoxymercuric acetate (VII)

A mixture consisting of 1 g (0.003 mole) of (4-bromobenzenal)phthalide, 1.1 g (0.003 mole) of mercury(II) acetate and 20 ml of acetic acid is heated in a flask with reflux in silicone bath at 110—120°C for two hours. By cooling to 50°C the crude substance VII separates. Subsequently this substance is recrystallized from dimethylformamide (yield 0.9 g, i.e. 15%, m.p. 210—214°C).

For C₁₉H₁₅O₆BrHg (619.84) calculated: 32.66% Hg; found: 32.37% Hg.

After 12 hours' standing of the filtrate at 0°C, the starting substance is recovered (45%). By diluting the filtrate, a substance with a less content of mercury separates.

(4-Iodobenzenal)phthalidoxymercuric acetate (VIII)

The preparation is analogous to the procedure described and used for the substance VII. The substance VIII is recrystallized from dimethylformamide (yield 17%, m.p. 229—234°C).

For C₁₉H₁₅O₆IHg (742.0) calculated: 30.10% Hg; found: 29.98% Hg.

β -Naphthalphthalideacetoxymercuric acetate (X)

A mixture of 1 g (0.003 mole) of β -naphthalphthalide (III) and 1.4 g (0.003 mole) of mercury acetate is heated in 40 ml of acetic acid at 110–120°C for four hours. By cooling to 50°C, a crude product (X) separates. This product is recrystallized from dimethylformamide (yield 0.6 g, 10%), m.p. 230°C.

For $C_{23}H_{18}O_6Hg$ (590.93) calculated: 33.80% Hg; found: 33.90% Hg.

Bis[4-(phthalidylidenemethyl)-1-naphthyl]mercury (IX)

1.5 g (0.006 mole) of 3-(1-naphthal)phthalide (II), 2 g (0.007 mole) of mercury(II) acetate and 40 ml of acetic acid are heated in a flask with reflux by means of a silicone bath for 30 minutes. Then the solution is filtered and poured into 100 ml of water. The bright yellow substance (IX) which has precipitated is recrystallized from acetic acid or acetone (yield 85–90%, m.p. 96–98°C).

For $C_{38}H_{22}O_4Hg$ (734.16) calculated: 26.99% Hg; found: 26.61% Hg.

2-Acetoxymercuri-2-bromo-1,3-indandione (XIV)

0.003 mole of 2-bromo-1,3-indandione is heated with 0.003 mole of mercury(II) acetate in 25 ml of acetic acid at 120°C for 45 minutes. A brown-red solution comes into existence. After cooling, the reaction mixture is poured into 50 ml of water and the separated yellow substance is filtered and recrystallized from acetic acid (yield 90%, m.p. 146–149°C under decomposition).

For $C_{11}H_7O_4BrHg$ (483.6) calculated: 41.48% Hg; found: 40.98% Hg.

2-(4-Hydroxymercuriphenyl)-1,3-indandione (XI)

0.003 mole of the substance IV is added in parts into 200 ml of 1% methanolic solution of sodium methoxide. This mixture is then heated under reflux for 30 minutes and filtered. Subsequently 150 ml of methanol are distilled off, 100 ml of water are added to the residue and the solution is acidified with 20 ml of acetic acid. After one hour's standing the precipitated substance is sucked and purified from dimethyl sulfoxide. The substance obtained decomposes over 220°C without melting.

For $C_{15}H_{10}O_3Hg$ (438.6) calculated: 45.73% Hg; found: 45.45% Hg.

Bis[4-(1,3-indandione-2-yl)-1-naphthyl]mercury (XII)

1 g (0.0013 mole) of the substance X is dissolved in 100 ml of 0.4% methanolic solution of sodium methoxide. The reaction mixture which turns red is heated under reflux for 45 minutes. After cooling the reaction mixture is filtered and acidified to pH 4–6. An orange substance is then formed (yield 65%, m.p. 165–170°C).

For $C_{38}H_{22}O_3Hg$ (743.16) calculated: 26.99% Hg; found: 26.58% Hg.

References

1. Furdík M., Hrnčiar P., *Chem. Zvesti* **14**, 44 (1960).
2. Furdík M., Hrnčiar P., *Chem. Zvesti* **12**, 464 (1958).
3. Hrnčiar P., Úlehla J., *Chem. Zvesti* **23**, 59 (1969).
4. Hrnčiar P., Krasnec Ľ., Jr., *Acta Facult. Rer. Natur. Univ. Comenianae (Chimia)*, in press.

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