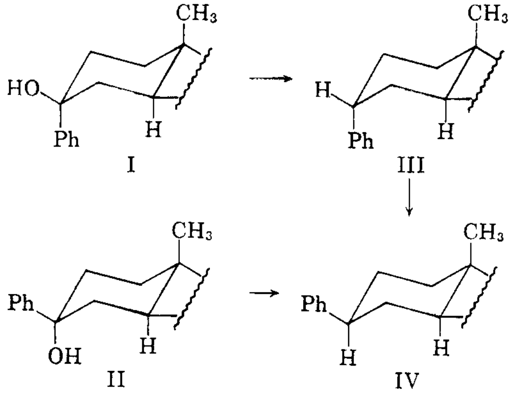
spectively.[5] However, when I was stirred with Raney nickel at room temperature, pure 3α-phenylcholestane (III) was obtained.[4] The proton magnetic resonance spectrum of III exhibits absorptions at 6.95τ and 2.80τ for the C-3 proton and phenyl protons, respectively. Under refluxing ethanol hydrogenolysis conditions, III was gradually converted to IV. Hydrogenolysis of II proceeded slowly at room temperature (as compared with I) to give IV. Under comparable conditions, I was converted to III with < 5% of IV. By modifying the catalyst through the addition of small amounts of sodium methoxide, the rate of equilibration was apparently reduced relative to the rate of hydrogenolysis, and higher temperatures could be employed to further demonstrate the stereospecificity of the hydrogenolysis which now proceeded at a convenient rate. Using this procedure, I was hydrogenolyzed to a mixture of 85% of III and 15% of IV in refluxing ethanol–Raney nickel. Likewise, II was converted to pure IV.[4]



Experimental

3α-Phenylcholestan-3β-ol (I) and 3β-phenylcholestan-3α-ol (II) were prepared as described previously[2] and melted at 109.5–110° and 164–165°, respectively; reported,[2] m.p. 100–103° and 163–165°, respectively.

Hydrogenolysis at 78°.—A mixture of 50 mg. of I, 2 g. of W-2[6] Raney nickel and 4 ml. of ethanol was refluxed for 20 min. The ethanol solution then was decanted into a mixture of 10 ml. of pentane and 10 ml. of water. The catalyst was washed twice with 10-ml. portions of pentane and the washings were added to the water–pentane mixture. The pentane layer was washed with water and the pentane then evaporated. Infrared analysis of the residue (37 mg.) gave approximately 85% of IV and 15% of III.[4] After one recrystallization from acetone, pure 3β-phenylcholestane (IV), m.p. 113–114.5°, was obtained; infrared spectrum (CS_2), 13.16 (s) μ and 14.25 (s) μ; reported,[2] m.p. 113–114°. The hydrogenolysis of II as described above led to 42 mg. of pure IV.[4]

Hydrogenolysis at Room Temperature.—A mixture of 100 mg. of I, 3 g. of Raney nickel, and 10 ml. of ethanol was stirred for 10 min. at room temperature. The reaction mixture was processed as previously described to give 84 mg. of pure 3α-phenylcholestane (III), m.p. 82–85°.[4] Several recrystallizations from acetone raised the melting point to 86.5–88.5°; infrared spectrum (CS_2), 13.51 (m) μ, 13.77 (m) μ, and 14.25 (s) μ.

Anal. Calcd. for $C_{33}H_{52}$: C, 88.32; H, 11.68. Found: C, 88.51, H, 11.48.

A mixture of 40 mg. of III, 4 ml. of ethanol, and 3 g. of Raney nickel was refluxed for 15 min. The crude product of this reaction analyzed for 35% of III and 65% of IV (infrared).

A mixture of 30 mg. of II, 4 ml. of ethanol, and 3 g. of Raney nickel was stirred for 2 hr. The infrared spectrum of the crude hydrogenolysis product showed about a 50% conversion of II to IV and no detectable amount of III.[4] A comparable treatment of I led to III contaminated with < 5% of IV.

Hydrogenolysis at 78° with Added Sodium Methoxide.—Treatment of 50 mg. of I with 2 g. of Raney Nickel and 10 mg. of sodium methoxide in 4 ml. of ethanol at reflux for 7 min. led to the isolation of 36 mg. of a mixture of 85% of III and 15% of IV (by infrared analysis).

The treatment of 50 mg. of II in the same manner as above led to 37 mg. of pure IV.

Synthesis of 3-Substituted 3-Phenylphthalides[1]

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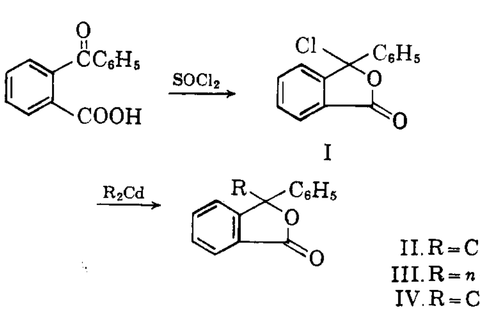
In connection with other work, we have found that the pseudo chloride of *o*-benzoylbenzoic acid, 3-chloro-3-phenylphthalide (I), reacts with organocadmium reagents to give 3-substituted 3-phenylphthalides in excellent yields (equation 1). The reaction is effected by the technique recommended by Cason[2] for preparation of ketones from acid chlorides.



II. R = CH_3
III. R = $n-C_4H_9$
IV. R = C_6H_5

Three examples of the reaction were effected. Treatment of I with dimethylcadmium, prepared from methylmagnesium bromide, gave 3-methyl-3-phenylphthalide (II) in 88% yield, based on *o*-benzoylbenzoic acid. Similarly, di-*n*-butylcadmium

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(5) The proton magnetic resonance spectra were determined by Dr. W. B. Schwabacher.

(6) R. Mozingo, *Org. Syntheses*, Vol. III, John Wiley & Sons, Inc., New York, 181 (1955). The Raney nickel used in this work was freshly prepared and of the same batch.

(1) Supported by the Army Research Office (Durham).

(2) J. Cason, *Chem. Rev.*, **40**, 15 (1947).

gave III in 80% yield, and diphenylcadmium gave IV in 70% yield. The melting points of known phthalides II and IV agreed with published values. The infrared spectra of II, III, and IV showed an intense single carbonyl band near 5.65 μ, as expected for α,β-unsaturated lactones. Other features of the spectra strongly supported the assignment of these structures.

Among the numerous phthalide syntheses that have been reported are several that are adaptable to synthesis of phthalides which bear unlike substituents in the 3-position. Certain alkylations of 3-sodio-3-phenylphthalide afford such compounds in good yields.[3] Ethyl o-benzoylbenzoate affords II (among other products) on treatment with methylmagnesium iodide.[4] Friedel-Crafts reaction of I with aromatic compounds affords 3,3-diarylphthalides.[5,6]

However, in cases for which the required organocadmium reagent is available, the present method appears to be equal or superior in yield and convenience to the above methods for synthesis of 3,3-disubstituted phthalides in which at least one substituent is aromatic.

Experimental[7]

3-Methyl-3-phenylphthalide (II).—By the procedure of Koelsch,[8] 56.5 g. (0.25 mole) of o-benzoylbenzoic acid was stirred with 100 g. of thionyl chloride overnight at room temperature. Excess thionyl chloride was distilled under reduced pressure on a steam bath, and three 100-ml. portions of dry benzene were added and in turn distilled, leaving 3-chloro-3-phenylphthalide (I) as a tan oil.

Methylmagnesium bromide was prepared from 47.5 g. (0.50 mole) of methyl bromide. To the ether solution of this reagent was cautiously added 40.8 g. (0.25 mole) of powdered, anhydrous cadmium chloride. The resulting mixture was stirred at reflux for 1 hr., when Gilman's test[9] of a sample indicated the absence of Grignard reagent. Ether was then distilled out of the reaction vessel, and dry benzene was added periodically to replace the solvent being removed. This process was continued until the b.p. of the solvent had reached 80°. The resulting benzene solution of dimethylcadmium was cooled to 5° on an ice bath and rapidly stirred as a solution of the 3-chloro-3-phenylphthalide in 100 ml. of dry benzene was added. The resulting reaction mixture was then stirred at reflux for 2 hr. and allowed to stand overnight. To this mixture was then added 100 ml. of water, followed by 125 ml. of 6 N hydrochloric acid. The organic layer was separated and washed in turn with 3 N sodium hydroxide and with three portions of water. The organic layer was dried over magnesium sulfate, and the solvent was removed, leaving 55.7 g. (99%) of II, m.p. 72–76°. Recrystallization of this material from a mixture of ligroin (b.p. 100–102°) and absolute ethanol gave 50.2 g. (88%) of II, in two crops of m.p. 77–78° and 73–75°, reported m.p. 76.8–78.0°.[10] The infrared spectrum of this material had a single, strong band in the carbonyl region at 5.65 μ, reported 5.65 μ.[10]

3-n-Butyl-3-phenylphthalide (III).—The above procedure was employed, using 50 g. (0.21 mole) of o-benzoylbenzoic acid, 34.8 g. (0.28 mole) of n-butyl bromide, and 27.5 g. (0.15 mole) of cadmium chloride. Distillation of the crude product (48 g.) gave 43.1 g. (80%) of III, b.p. 152–155° at 0.2 mm. The infrared spectrum had a strong band at 5.66 μ.

Anal. Calcd. for $C_{18}H_{18}O_2$: C, 81.17; H, 6.81. Found: C, 81.04; H, 7.14.

3,3-Diphenylphthalide (IV).—The procedure used for preparation of II was employed, using 56.5 g. (0.25 mole) of o-benzoylbenzoic acid, 47 g. (0.35 mole) of bromobenzene, and 34.8 g. (0.19 mole) of cadmium chloride. The partly crystalline product (77 g.) was recrystallized from a mixture of petroleum "hexane" and absolute ethanol, giving 58.0 g. (70%) of IV, m.p. 112–114°, reported m.p. 114°,[11] 115°,[12] 117.5–118.5°.[13] A sample recrystallized twice more from these solvents (94% recovery) had m.p. 116–116.5°. The infrared spectrum had a strong band at 5.65 μ.

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[3] C. R. Hauser, M. T. Tetenbaum, and D. S. Hoffenberg, *J. Org. Chem.*, **23**, 861 (1958).

[4] E. Bergmann, *ibid.*, **4**, 1 (1939).

[5] C. Friedel and J.-M. Crafts, *Compt. rend.*, **84**, 1450 (1877).

[6] M. Copisarow, *J. Chem. Soc.*, **111**, 10 (1917).

[7] Melting points were taken using a Laboratory Devices "Mel-temp" block and are corrected. Infrared spectra were recorded using a Perkin-Elmer 21 spectrophotometer. Analysis was performed by Dr. Ing. Schoeller, Kronach, West Germany.

[8] C. F. Koelsch, *J. Org. Chem.*, **25**, 642 (1960).

[9] H. W. Gilman and F. Schulze, *J. Am. Chem. Soc.*, **47**, 2002 (1925).

[10] M. S. Newman, *J. Org. Chem.*, **27**, 323 (1962).

[11] N. Maxim and A. Andreescu, *Bull. soc. chim. France*, [5], **5**, 54 (1938).

[12] J. M. Wilson, *J. Chem. Soc.*, 2297 (1951).

[13] H. Gilman, W. J. Meikle, and J. W. Morton, *J. Am. Chem. Soc.*, **74**, 6282 (1952).

A Novel Reaction of Carbodiimides

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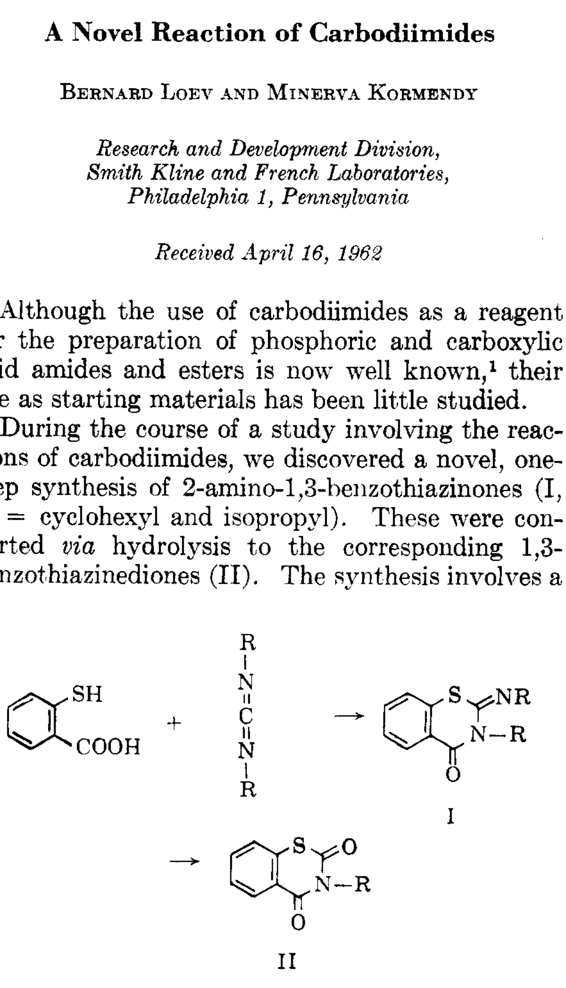
Although the use of carbodiimides as a reagent for the preparation of phosphoric and carboxylic acid amides and esters is now well known,[1] their use as starting materials has been little studied.

During the course of a study involving the reactions of carbodiimides, we discovered a novel, one-step synthesis of 2-amino-1,3-benzothiazinones (I, R = cyclohexyl and isopropyl). These were converted *via* hydrolysis to the corresponding 1,3-benzothiazinediones (II). The synthesis involves a



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[1] See for example, H. G. Khorana, *Chem. Rev.*, **53**, 145 (1953); E. Schmidt and R. Schnegg, U.S. Patent 2,686,180 (1954).