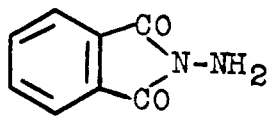
Palindromic Dihydrazones from *N*-Aminophthalimide

Michael J. Hearn,* Mary Louise Campbell, Margat Hoppe, Judith Rosenberg, and Anvita Sinha

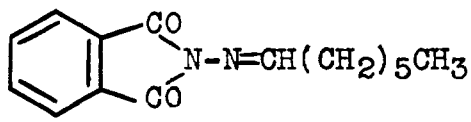
Department of Chemistry, Wellesley College, Wellesley, Massachusetts 02181

***N*-Aminophthalimide I (2 equiv) reacted directly with aliphatic dicarbonyl compounds under mild conditions to produce the linear dihydrazones III. In related reactions in the aromatic series, dihydrazones IVb–d and semicarbazone IVe were obtained from the controlled treatment of IVa with the appropriate nucleophiles. Nonetheless, IVa proved sensitive to ring cleavage with hydroxylamine, yielding hydroxamic acid VI. Characteristic infrared and ultraviolet/visible absorption bands permitted convenient monitoring of these functional group transformations.**

In view of the selectivity observed in reactions of the hydrazine synthon *N*-aminophthalimide (I) (*1–3*), it was of interest to probe further the requirements for condensation of this amino heterocyclic with dicarbonyl compounds. Although I reacts

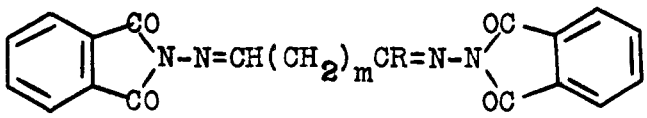


I



II

readily with simple aromatic and aliphatic aldehydes to produce in a straightforward way such Schiff bases as II, I does not yield adducts with simple ketones under identical conditions (*2*). We now report on the preparation and properties of the compounds IIIa–c and IVb–e.

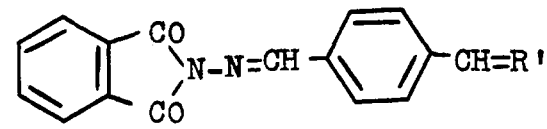


III a, m=3, R=H

b, m=0, R=H

c, m=0, R=CH_3

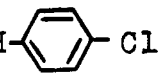
Thus treatment of glutaric dialdehyde with I in refluxing ethanol led smoothly to precipitation of the condensation product IIIa (Table I, entry 2, 72%). Materials of this structural class have been of interest as model compounds for poly(*N*,*N*-diacylhydrazones), polymers containing imide and imine functions linked by nitrogen–nitrogen bonds (*4*). In accord with earlier results (*5*), we found that I produced pyrrole V upon reaction with 2,5-hexanedione. Whereas hydrazones IVc and IVd and semicarbazone IVe were formed in uncomplicated condensations of the parent aldehyde with the respective nucleophiles, IVa nonetheless proved sensitive to ring cleavage giving hydroxamic acid VI in the presence of hydroxylamine in refluxing ethanolic pyridine. Preparative results on our new compounds are summarized in Table I, and Tables II and III include data for salient peaks in the ultraviolet, visible, and infrared absorption spectra.



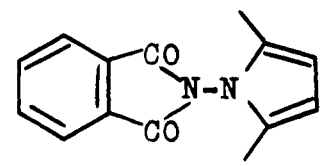
IV a, R'=O

b, R'=N-Phth

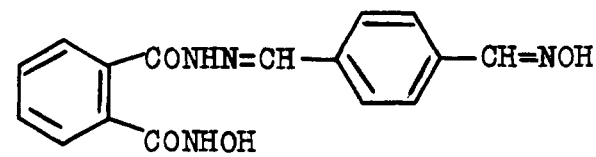
c, R'=N-NHC_6H_5

d, R'=N-NH-  Cl

e, R'=N-$NHCONH_2$



V



VI

Experimental Section

Satisfactory elemental analyses were obtained for all new compounds and were submitted for review. Elemental analyses were performed by Galbraith Laboratories, Knoxville, TN, and Multichem Laboratories, Lowell, MA. Melting points were taken in open capillary tubes using a Mel-Temp apparatus and are uncorrected. Infrared spectra were recorded on a Perkin-Elmer 1310 spectrophotometer as Nujol mulls. Ultraviolet/visible spectra were obtained on a GCA-McPherson 707 Vis/UV/NIR instrument. *N*-Aminophthalimide was used as received from Fluka A.-G. or readily prepared by using the convenient method of Drew and Hatt (*6*). Reagent grade solvents were purchased from Baker. Carbonyl compounds from Aldrich Chemical Co. were used without further purification. With the exception of II, the materials described below were highly insoluble in common organic solvents. Ultraviolet/visible spectra were in

0021-9568/86/1731-0255$01.50/0

Table I. Preparative Results

entry	compd	% yield	mp, °C
1	II	25	195
2	IIIa	72	250
3	IIIb	45	>300
4	IIIc	45	280
5	IVa	100	320–323
6	IVb	74	>300
7	IVc	67	189
8	IVd	82	220
9	IVe	82	>300
10	VI	22	>300

Table II. Ultraviolet and Visible Absorption Maxima

entry	compd	absorption maxima, nm
1	IIIa	299
2	IIIb	229, 308
3	IIIc	246, 264
4	IVa	221, 315
5	IVb[a]	336
6	IVc	253, 298, 398, 803
7	IVd	254, 289, 395, 801
8	IVe	228, 330, 745
9	VI	256, 261, 264, 303

[a] Ultraviolet data for IVb from ref 4. Spectra were recorded in 95% ethanol.

Table III. Infrared Absorption Maxima

entry	compd	absorption maxima, cm^{-1}
1	IIIb[a]	1790, 1725, 1315
2	IVa[b]	1765, 1720, 1685
3	IVb	1780, 1728, 1318
4	IVd	3285, 1770, 1714, 1315
5	IVe	3480, 1773, 1722, 1312
6	VI	3170, 3120, 1652, 1600

[a] Significant maxima for IIIa and IIIc were within 10 cm^{-1} of those for IIIb. Similarly, maxima for IVc were within 6 cm^{-1} of those for IVd. [b] Infrared data for IVa from ref 2.

each case recorded on saturated solutions.

***N*-Heptylidenaminophthalimide (*II*).** Compound I (1.00 g, 6.17 mmol) was suspended in 95% ethanol (25 mL) and heated to the boil. Heptanal (1.00 mL, 7.44 mmol) was added through the condenser in several small portions, and the reaction mixture was refluxed for 3 h, and then evaporated to dryness on a watchglass in air, to produce a slightly waxy solid, which could be recrystallized from sparing amounts of 95% ethanol (25%): IR 1780, 1730, 1310 cm^{-1}.

Glutaraldehyde N-Aminophthalimide Dihydrazone (IIIa). Compound I (0.819 g, 5.06 mmol) and glutaraldehyde (25% aqueous solution, density 1.05 g/mL, 0.76 mL, 1.99 mmol) were mixed with absolute ethanol (25 mL) and refluxed for 2.5 h. During the reflux period, the reaction mixture changed from a clear dark yellow solution to an off-white suspension. The mixture was allowed to cool, and the resulting solid was recovered by filtration (72%, see Tables I–III).

Glyoxal N-Aminophthalimide Dihydrazone (IIIb). *N*-Aminophthalimide (0.702 g, 4.33 mmol) was combined with glyoxal (40% aqueous solution, 1.565 g, 10.8 mmol) and absolute ethanol (25 mL) and refluxed for 2.5 h, during which time the mixture went from a dark yellow solution to an off-white suspension. The pale peach microcrystalline product was collected by filtration of the cooled reaction mixture (45%).

Pyruvaldehyde N-Aminophthalimide Dihydrazone (IIIc). *N*-Aminophthalimide (0.806 g, 4.97 mmol) and pyruvaldehyde (40% aqueous solution, 2 mL) were refluxed for 2.5 h in absolute ethanol (25 mL) and the product (45%) isolated by gravity filtration of the cooled reaction mixture.

Terephthalaldehyde N-Aminophthalimide Dihydrazone (IVb). Terephthalylidenaminophthalimide (*2*) (IVa, 0.278 g, 1.00 mmol) and *N*-aminophthalimide (0.165 g, 1.00 mmol) were refluxed together for 3.25 h in 95% ethanol (20 mL) and the product (IVb) isolated by gravity filtration from the cooled reaction mixture (74%).

Phenylhydrazonoterephthalylidenaminophthalimide (IVc). Compound IVa (0.278 g, 1.00 mmol) was suspended in 95% ethanol (30 mL) and heated to boiling on a water bath. Standard phenylhydrazine reagent (*7*) (10 mL) was added and occasioned the immediate formation of a bright yellow precipitate. After reheating to the boil, the mixture was cooled to room temperature, gravity filtered, and dried overnight. Washing the crystalline material with hot 95% ethanol (7 mL) gave the analytical sample (67%).

***p*-Chlorophenylhydrazonoterephthalylidenaminophthalimide (IVd).** *p*-Chlorophenylhydrazine (1.00 g), sodium acetate (1.50 g), and compound IVa (0.271 g) were combined with water (10 mL) and 95% ethanol (8 mL) and brought to the boil on the water bath, with occasional addition of ethanol to replace evaporated solvent. After 10 min, the mixture was cooled and gravity filtered, and the mustard colored solid thus obtained was dried overnight. The solid was washed with hot ethanol (8 mL) and dried to give bright yellow IVd (82%).

Semicarbazonoterephthalylidenaminophthalimide (IVe). Terephthalylidenaminophthalimide (0.20 g) was suspended in 95% ethanol, to which was then added pyridine (2 mL) and semicarbazide hydrochloride (2.7 mmol). The mixture was warmed on the steam bath for 15 min, and the product (IVe, 82%) was isolated by gravity filtration and washed with 95% ethanol.

***N*-Hydroxylphthalamic Acid *p*-(Formylbenzylidene)-hydrazide *p*-Oxime (VI).** Compound IVa (0.25 g) and hydroxylamine hydrochloride (0.25 g) were treated with pyridine (2 mL) and 95% ethanol (2.5 mL) and the mixture was refluxed for 2 h. The cooled mixture was allowed to evaporate on a watchglass and the white microcrystalline solid thus obtained was washed with hot 95% ethanol to give the analytical sample (22%).

Registry No. 2, 32386-99-5; I, 1875-48-5; II, 100334-24-5; IIIa, 100334-25-6; IIIb, 100334-26-7; IIIc, 100334-27-8; IVb, 89444-40-6; IVc, 100334-28-9; IVd, 100334-29-0; IVe, 100334-30-3; VI, 100334-31-4; $PhNHNH_2$, 100-63-0; *p*-$ClC_6H_4NHNH_2$, 1073-69-4; heptanol, 111-71-7; glutaraldehyde, 111-30-8; glyoxal, 107-22-2; pyruvaldehyde, 78-98-8.

Literature Cited

(1) Hearn, M. J.; Prisch, S. B. *Org. Prep. Proced. Int.* **1981**, *13*, 421.
(2) Hearn, M. J.; Lucero, E. L. *J. Heterocycl. Chem.* **1982**, *19*, 1537.
(3) Hearn, M. J.; Lucas, L. E. *J. Heterocycl. Chem.* **1984**, *21*, 615.
(4) Troy, R. C.; Stevens, M. P. *J. Polym. Sci.: Polym. Lett. Ed.* **1984**, *22*, 113.
(5) Epton, R. *Chem. Ind. (London)* **1965**, 425.
(6) Drew, H.; Hatt, H. *J. Chem. Soc.* **1937**, 16.
(7) Vogel, A. I. "Practical Organic Chemistry"; Wiley: New York, 1956; pp 706, 711.

Received for review August 29, 1985. Accepted October 24, 1985. This work was supported by grants from the American Philosophical Society, the Dreyfus Foundation, and the Merck Foundation.