General Method for Preparation of *N*-Substituted 1-Hydroxy-2-naphthamides

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***N,N'*-dicyclohexylcarbodiimide has been used to effect the condensation of amines with 1-hydroxy-2-naphthoic acid to produce the amide in high yield under mild conditions. The yields are generally better than those obtained by alternate routes.**

N-substituted 1-hydroxy-2-naphthamides find wide use as color couplers in color photography by the oxidative condensation with *p*-aminodialkylanilines to form indoaniline dyes (*6*). They have been prepared by the reaction of 1-hydroxy-2-naphthoyl chloride with the appropriate amine or displacement of phenol from phenyl 1-hydroxy-2-naphthoate by amine (*1*, *3*). However, the variable yields in the preparation of 1-hydroxy-2-naphthoyl chloride and the necessity for elevated temperature and reduced pressure in the phenyl 1-hydroxy-2-naphthoate procedure, as well as its limitation to high boiling amines, led us to investigate a more direct route to the desired *N*-substituted amides.

N,N'-dicyclohexylcarbodiimide has been used to effect the condensation of carboxylic acids with amines to produce the amide in high yield under mild conditions (*2*, *4*, *5*). We have found that the direct action of *N,N'*-dicyclohexylcarbodiimide on a mixture of amine and 1-hydroxy-2-naphthoic acid produces the desired *N*-substituted amides in good yield. The yields are generally better than those obtained via the acid chloride route and comparable to those involving the displacement of phenol. Low-boiling amines can be used with this reaction to make amides directly from the acid. Not only is the procedure simple with minimal work-up, but it can be used with a variety of amines, as illustrated in Table I, and can be scaled up with no decrease in yield.

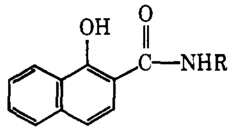
EXPERIMENTAL

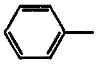
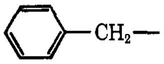
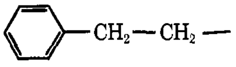
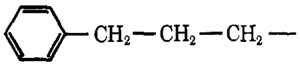
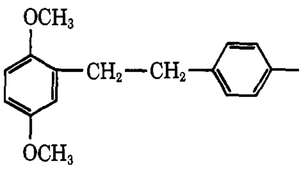
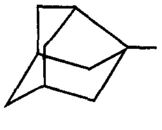
Melting points are corrected and were determined in a Thomas-Hoover melting point apparatus. Infrared spectra were recorded on a Baird Model 4-55 recording spectrophotometer as KBr pellets. Microanalysis was performed by Carol K. Fitz, Needham, Mass., and Galbraith Microanalytical Laboratories, Knoxville, Tenn.

General Procedure. *N,N'*-Dicyclohexylcarbodiimide (4.2 grams 0.02 mole) was added to a solution of 1-hydroxy-2-naphthoic acid (3.76 grams, 0.02 mole) and *n*-hexadecylamine (5.2 grams, 0.022 mole) in 25 ml of benzene. The reaction mixture was stirred at 50–65° C for 1 hr, then at ambient temperature for 3 days. *N,N'*-Dicyclohexyl urea (mp 232–3° C) was removed by filtration and the filtrate chromatographed over 65 grams of silica gel and eluated with benzene. When tlc indicated no further product in the eluate, the benzene was removed in vacuo and the product recrystallized from hexane to yield 6.3 grams (77%) of *N*-hexadecyl-1-hydroxy-2-naphthamide, mp 71–1.5° C. The infrared spectrum was consistent with the assigned structure.

Large-Scale Reaction without Column Chromatography. *N,N'*-Dicyclohexylcarbodiimide (26.8 grams, 0.13 mole) was added to a solution of 1-hydroxy-2-naphthoic acid (24.4 grams, 0.13 mole) and dodecylamine (24.0 grams, 0.13 mole) in 300 ml of benzene. The mixture was stirred and warmed to 50° C for 1/2 hr and subsequently allowed to stir at room temperature for 3 days. The urea was removed by filtration and the benzene filtrate was stirred with 100 grams of silica gel for 5 min, and then filtered. The benzene was removed in vacuo and the white solid was recrystallized

Table I. *N*-Substituted 1-Hydroxy-2-naphthamides Prepared by Carbodiimide Route[a]



R	Mp, ° C	% yield purified
n-$C_{18}H_{37}$—	82–83.5	29
n-$C_{16}H_{33}$—	71–71.5	77
n-$C_{12}H_{25}$—	66–66.5	68
n-C_8H_{17}—	66–68	70
cyclo-C_6H_{11}—	145	74
t-C_5H_{11}—	82.5–83	53
iso-C_4H_9—	102–103	79
n-C_3H_7	84–85	64
	153.5–155	51[b]
	123–123.5	71
	124–125	82
	88–89	89
	130.5–131.5	56
	167–168	38[c]

[a] Elemental analyses (C, H, N) for the new compounds reported here in agreement with theoretical values have been obtained and submitted for review. [b] Loss due to spillage. [c] Reaction run for only 1 day.

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from hexane to yield 29.9 grams (65%) of *N*-dodecyl-1-hydroxy-2-naphthamide, mp 66–7° C.

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Synthesis of Adamantyl Alkyl Ketones

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A series of adamantyl-1 alkyl ketones was prepared by alkylation of ethyl adamantyl-1-carbonylacetate followed by hydrolysis and decarboxylation. Infrared, nuclear magnetic resonance, and mass spectra were measured, which revealed that the influence of the adamantyl group on ir and nmr spectral properties of the rest of the molecule is just the same as that of *t*-butyl group.

A series of adamantyl alkyl ketones reported here was synthesized as intermediates in the preparation of surface active agents for the purpose of studying the surface activity of the adamantyl group. In a homologous series of adamantyl-1 alkyl ketones, only the first two members are known: adamantyl methyl ketone, prepared by Stetter and Rauscher (*9*) by decarboxylation of adamantyl-1-carbonylacetic acid, as well as by Hala and Landa (*3*) by reaction of adamantanecarboxylic acid with acetic acid over thorium oxide catalyst at elevated temperature; and adamantyl-1 ethyl ketone, synthesized by Lauria et al. (*5*) by the reaction of adamantylcarbonyl chloride with diethylcadmium. However, neither of the last two methods seems satisfactory for the preparation of higher homologs of the series. In fact, we observed that the reaction of di-*n*-decylcadmium with adamantylcarbonyl chloride by the method of Lauria et al. (*5*) gave *n*-eicosane as a major product (21% yield), only a 2.6% yield of adamantyl-1 *n*-decyl ketone (isolated as 2,4-dinitrophenylhydrazone) having been obtained.

Our method of preparation consists in alkylation of ethyl adamantyl-1-carbonylacetate with an appropriate alkyl halide, followed by hydrolysis and decarboxylation. Ethyl adamantyl-1-carbonylacetate can be alkylated in the usual manner with an alkyl halide in the presence of sodium ethoxide, while hydrolysis of the resultant β-ketoesters is best effected by alkaline, rather than acid, hydrolysis by use of potassium hydroxide in 95% ethanol at room temperature. Use of boiling diluted sulfuric acid, even in the presence of some acetic acid, resulted in an incomplete hydrolysis, probably owing to small solubility of the β-ketoesters, and this is especially so for ones with higher alkyl group. Potassium salts of alkylated β-ketoacids thus obtained are easily decarboxylated on acidification with heating to give the desired adamantyl-1 alkyl ketones, which are listed, together with 2,4-dinitrophenylhydrazone, in Table I.

The first two members of the series [mp's: Me, 53–54°C (*9*), 54°C (*3*); Et, 30–32°C] and those with an alkyl group of the carbon number greater than 11 are solid, while those with *n*-propyl through *n*-nonyl are liquid at room temperature.

Some characteristic features are found in the ir, nmr, and mass spectra of these ketones. In the infrared spectra, the carbonyl stretching frequency has a constant value of 1700 cm^{-1}, and three absorption bands around 1100 cm^{-1} (absorptions due to skeletal vibration of C—CO—C) assume the values 1070–1080 cm^{-1}, 1045–1055 cm^{-1}, and 1020–1030 cm^{-1}, irrespective of the size and structure of the alkyl groups.

The nmr spectrum of every ketone, with the exception of those for the methyl and the ethyl ketones, consists of five signals: the signal due to the protons of the alkyl methylene group adjacent to the carbonyl group (7.58 τ, triplet, $J = 7$ Hz), that due to the terminal methyl protons (9.11 τ), that due to the protons on the rest of the alkyl carbon atom(s) (8.4–8.9 τ), that due to $H\gamma$'s (*2*) (protons on the tertiary carbon atoms of the adamantane ring, 7.99 τ, broad singlet), and that due to $H\beta$'s and $H\delta$'s (*2*) (protons on the secondary carbon atoms of the adamantane ring, 8.22 τ, doublet, $J = 2$ Hz). Here again, these chemical shifts values are all the same throughout the series, irrespective of the size and shape of the alkyl groups. In addition to this, these spectral characteristics of the alkylcarbonyl moiety of the ketone molecule are not altered very much by changing the adamantane ring into a tertiary alkyl group. For example, *n*-butyl *t*-butyl ketone (*1*, *12*) is found to have a similar ir carbonyl stretching frequency (1710 cm^{-1}) and nmr signals (—$COCH_2$—: 7.58 τ, *t*, $J = 7$ Hz; —$COCH_2CH_2CH_2$—: 8.4–8.9 τ, complex m; —CH_3: 9.12 τ, *t*, $J = 7$ Hz). Thus it is clear that the spectral properties of these adamantyl alkyl ketones are just as expected, and the adamantyl group does not exert any unusual influence on the spectral properties of the rest of the molecule.

In the mass spectra of the series of the ketones, the adamantyl cation (Ad^+, m/e 135) appears always as the base peak (relative intensity, 100). The parent peaks appear in relatively low intensities (0.2–8.2), and other important peaks appearing commonly throughout the series are those of adamantylcarbonyl

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