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Oxazolines. XI. Synthesis of Functionalized Aromatic and Aliphatic Acids. A Useful Protecting Group for Carboxylic Acids against Grignard and Hydride Reagents

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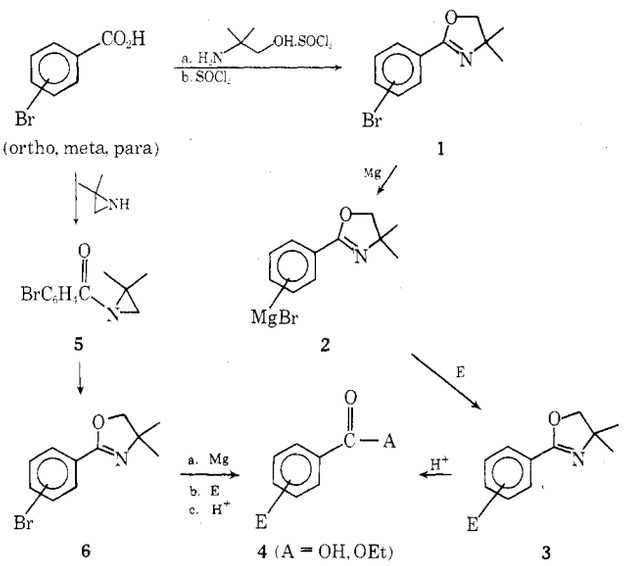
The use of an oxazoline to mask a carboxyl group is described. Since the oxazoline moiety is inert to Grignard reagents and lithium aluminum hydride, this technique serves as a novel means to elaborate or functionalize carboxylic acid derivatives. The carboxyl function may be masked either as its acid or ester derivative under generally mild conditions. A series of substituted benzoic acids, using the Grignard reagent of the *o*-, *m*-, or *p*-bromo derivatives was prepared while the carboxyl group was protected as the oxazoline. Furthermore, a series of keto-containing carboxylic acids was treated with Grignard or hydride reagents, producing hydroxy acids.

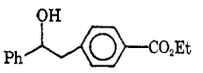
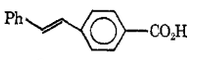
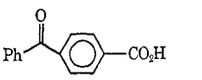
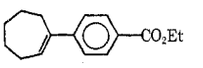
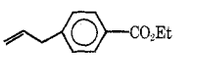
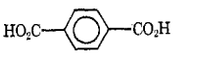
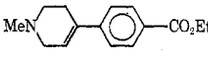
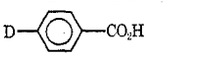
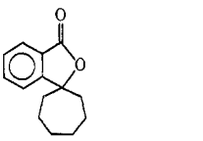
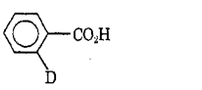
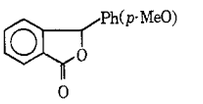
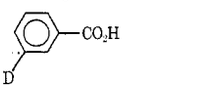
The synthetic utility of simple 2-oxazolines toward homologated acetic acids[3] and γ-butyrolactones[4] has been described in previous articles. Application of this heterocyclic system to the synthesis of functionalized aromatic and aliphatic acids is now reported. The technique is based on masking of the carboxylic group as its oxazoline derivative, which is inert to either the Grignard or lithium aluminum hydride reagent. Thus, bromo-substituted benzoic acids may be transformed into the corresponding bromophenyloxazoline **1** in high yield and then converted to its Grignard reagent **2**, with the carboxyl group safely masked as the oxazoline.[5] Addition of a wide variety of electrophiles (E) results in the substituted phenyloxazoline **3** which,



upon acidic hydrolysis or ethanolysis, releases the carboxyl group and provides the substituted benzoic acid or ester **4** (Table I). Alternatively, the isomeric oxazoline **6** may be readily prepared by treating the bromobenzoic acid with 1,1-dimethylaziridine, which furnishes the *N*-acylaziridine **5**. Rearrangement of the latter under very mild acidic conditions produces the requisite bromophenyloxazine **6**. Similar treatment of **6** with magnesium to form the Grignard followed by addition of an electrophile leads to the substituted benzoic acids or esters **4**. Since the bromobenzoic acids are very stable systems, the 4,4-dimethyloxazolines **1** were found to be more conveniently prepared and utilized. However, masking of more sensitive carboxylic acids (as described below) was performed using the dimethylaziridine method. As seen from Table I, yields and a variety of substitutions are quite satisfactory. In the case of *N*-methylpiperidone, reaction with **2** was poor (31%) under the usual conditions (15 hr, 25°, THF). This was rectified by introduction of 2.0 equiv of anhydrous magnesium bromide to the oxazoline Grignard prior to addition of the piperidone. The yield in this case rose to 82%, presumably by complexing the lone pair on the piperidone nitrogen, thus allowing the Grignard reaction to proceed normally. Of further interest is the accessibility of specifically deuterated benzoic acids *via* this technique. Simple quenching of the oxazoline Grignard in deuterium oxide leads, after hydrolysis, to benzoic acids of high deuterium content (>98%). This method should compare favorably with the recently reported technique[6] requiring sodium borodeuteride–palladium chloride reduction of bromobenzoic acids.

The purity of the magnesium employed was found to be rather critical. When "reagent" grade magnesium was used to prepare the Grignard reagent, the reactions were found to be slow and the yields were erratic. By using triply sublimed magnesium, the yields were consistently good and reproducible. Hydrolysis of the elaborated phenyloxazolines **3** was accomplished in a manner designed to produce the ethyl esters **4** (A = OEt) or the free acids **4** (A = H). By refluxing an ethanol solution of **3** containing 1.5 *N* sulfuric acid, the ethyl esters were smoothly formed, undoubtedly *via* transesterification of the initially formed open-chain amino esters. Presumably, other esters could be directly formed by utilizing the appropriate alcohol as a solvent.[3] The hydrolysis of **3** to the free carboxylic acids could be readily accomplished in either of two ways (Table I, method B or C). The choice of method usually was determined by the nature of the aryl substituent. Since it was difficult

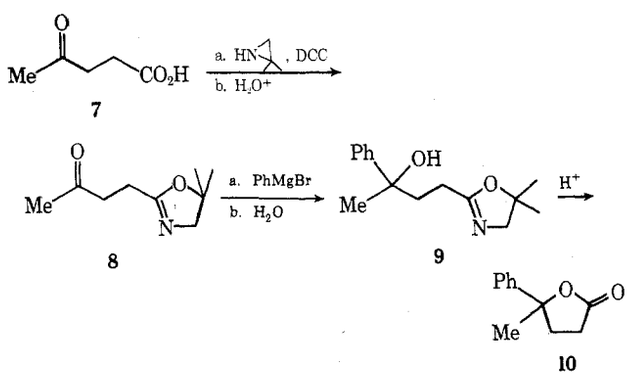
Table I
Substituted Benzoic Acids and Esters *via* Oxazoline Grignard Reagent (2)

2[a]	Electrophile	Registry no.	% 3	Hydrolysis[b] method	Acid or ester (4)[c]	Registry no.	%
p-MgBr	Styrene oxide	96-09-3	93	A		30058-62-9	81
				B		7329-77-3	94
p-MgBr	Benzonitrile	100-47-0	90	B		611-95-0	90
p-MgBr	Cycloheptanone	502-42-1	86	A		30058-58-3	92
p-MgBr	Allyl bromide	106-95-6	88[d]	A		19819-94-4	77
p-MgBr	Ethyl chloroformate	541-41-3	90	B		100-21-0	85
p-MgBr	*N*-Methylpiperidone	1445-73-4	82[d]	A		51849-82-2	27
p-MgBr	D_2O		97	C		4551-62-6	87
o-MgBr	Cycloheptanone		92	A		30058-63-0	85
o-MgBr	D_2O		97	C		51898-94-3	88
o-MgBr	*p*-Methoxybenzaldehyde	123-11-5	90	A		21615-74-7	87
m-MgBr	D_2O	7789-20-0	95	C		4551-61-5	90

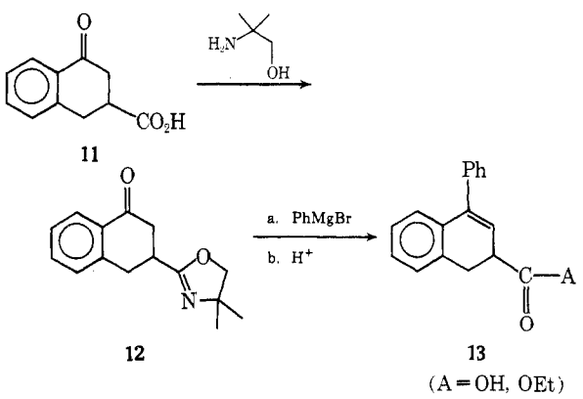
[a] Triply sublimed magnesium (Dow) used for preparing Grignard reagents. [b] Method A, heated to reflux in 1.5 *N* ethanolic sulfuric acid; method B, heated to reflux in 3 *N* hydrochloric acid (15–20 min), followed by heating in 20% methanolic sodium hydroxide; method C, heated for 1 hr in 3 *N* hydrochloric acid. See Experimental Section for complete details. [c] Comparable yields were obtained in selected cases starting from **6**. [d] One equivalent of magnesium bromide used.

to predict which would be the most efficient, a small pilot experiment was performed using both techniques.

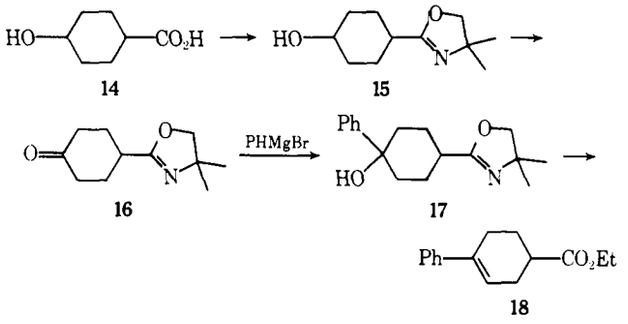
The oxazoline system was also found to be an excellent masking group for carboxylic acids if Grignard reagents are to be added to a functional group already present. For example, levulinic acid (**7**) was transformed into the oxazoline **8** (*via* rearrangement of the *N*-acylaziridine) and treated with the phenyl Grignard reagent. The carbinol **9** was produced smoothly and hydrolysis then gave γ-methyl-γ-phenylbutyrolactone (**10**). In this instance, the carboxyl



group of levulinic acid was masked using the acylaziridine method, since direct formation of the oxazoline using 2-methyl-2-aminopropanol gave only tarry products. However, the direct oxazoline formation was successfully employed for 3-carboxytetralone (**11**). The resulting oxazoline **12** could be readily converted into the carbinol using phenylmagnesium bromide. Hydrolysis gave the unsaturated acid **13** or its corresponding ester. Still a further example of this technique was demonstrated by transformation of 4-hydroxycyclohexanecarboxylic acid (**14**) to 1-phenyl-4-car-

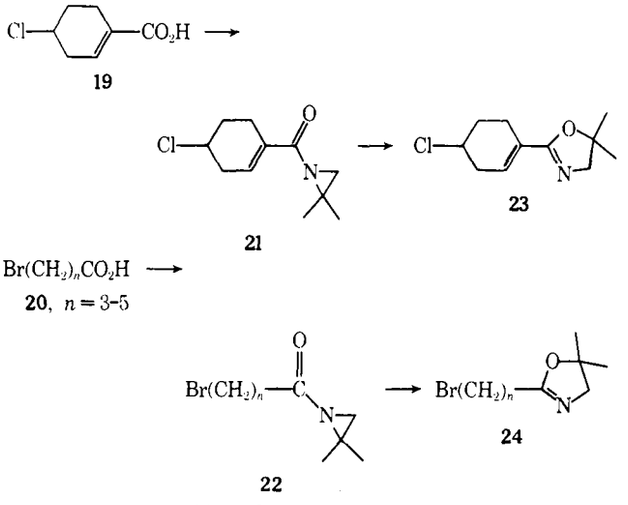


boethoxycyclohexene (18). Direct transformation of 14 to the oxazoline 15 using 2-methyl-2-aminopropanol followed by chromic acid oxidation to the keto oxazoline 16 proceeded smoothly without detrimental effect to the masking group. Grignard reaction gave the carbinol 17 which, upon ethanolysis, led to the ester 18. It therefore appears that



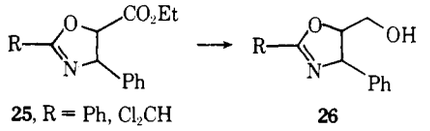
this carboxyl protecting group possesses significant synthetic value for elaborating both aliphatic and aromatic carboxylic acids.

A limitation to this method appears when Grignard reagents of bromoalkyloxazolines are to be employed. Carboxylic acids containing a halogen substituent (19, 20) could not be transformed into the haloalkyloxazolines (23, 24) owing to their instability under reaction conditions. Although the *N*-acylaziridines (21, 22) were readily prepared,

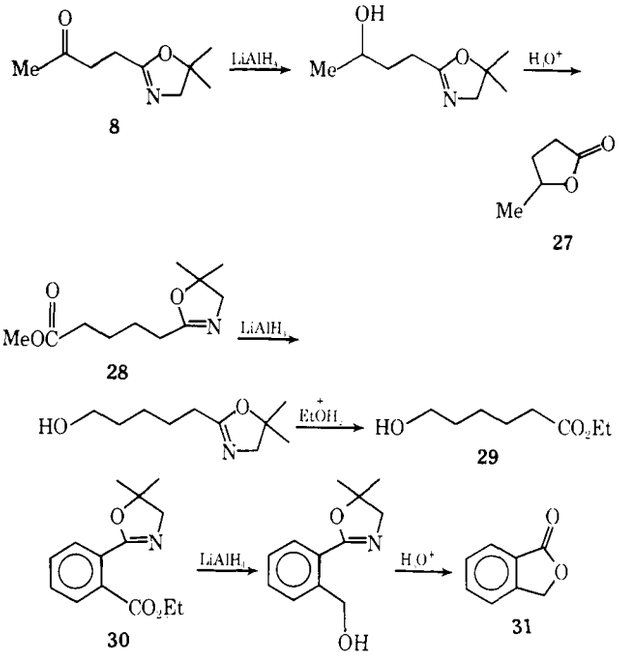


rearrangement to 23 and 24 was accompanied by elimination and polymerization reactions and the oxazolines proved to be highly sensitive materials that could not be manipulated further. This is in contrast to the haloalkyldihydro-1,3-oxazines,[7] which did respond well to Grignard formation and subsequent addition reactions.

The use of the oxazoline moiety as a protecting group for carboxylic acids against lithium aluminum hydride was also evaluated. This was based upon earlier observations[8] that ester-containing oxazolines 25 could be reduced to the carbinols 26. However, the synthetic potential of this trans-

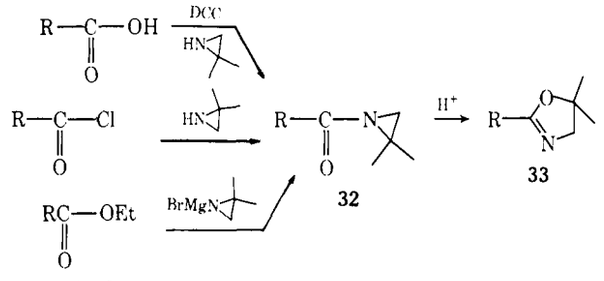


formation does not appear to have been further explored. Several examples depicting the protecting group ability of oxazolines were examined and the results are given below. Thus, levulinic acid was transformed into lactone 27, ester oxazoline 28 from the half-ester of adipic acid was transformed into hydroxy ester 29, and phthalide 31 was pre-

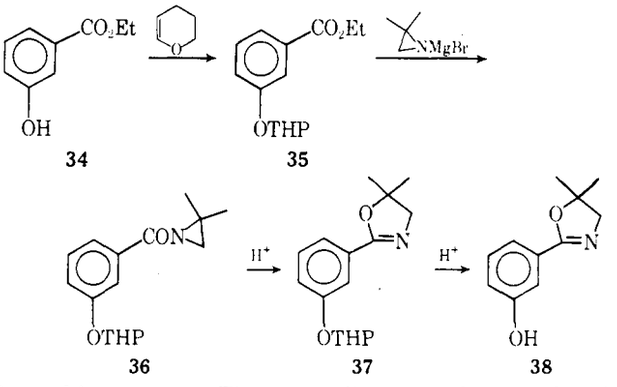


pared from oxazoline 30. All of the above proceeded without event and the carboxyl group was deblocked in the manner already described.

Masking of the carboxyl group initially required the preparation of the *N*-acylaziridine 32. This was performed using the acid, acid chloride, or ester. The latter was ac-



complished using the magnesium halide salt of 2,2-dimethylaziridine. In order to demonstrate that carboxyl masking could be carried out on polyfunctional compounds, ethyl *m*-hydroxybenzoate (34) was successfully transformed into 2-(*m*-hydroxyphenyl)oxazoline (38) *via* the sequence depicted. Two significant points are evident



from this sequence. First, oxazolines may be introduced into a molecule containing a hydroxyl group, since the tetrahydropyranyl masking group is stable to the acylaziridine–oxazoline rearrangement (36 to 37). Second, the tetrahydropyranyl ether may be cleaved under conditions which do not effect the oxazoline (37 to 38).

In general, rearrangement of acylaziridines 32 was found

to proceed smoothly in ether or dichloromethane (depending upon solubility) with 0.2–0.5 mol % of sulfuric acid, toluenesulfonic acid, pyridinium tosylate, triethylammonium tosylate, or potassium bisulfate for 12–15 hr at room temperature. This is considerably milder than the previous conditions reported for acylaziridine–oxazoline rearrangements.[9]

It is obvious that the rearrangement occurs under essentially neutral conditions, since the acid catalyst is neutralized by the basic oxazoline after only a few per cent of the reaction has taken place. In fact, the protonated oxazoline is probably the source of the required proton necessary for rearrangement. This was substantiated by successfully employing a small quantity of the oxazoline sulfate or tosylate as the catalyst.

It is of interest that the rearrangement was not general acid catalyzed, since hydrogen chloride, pyridinium chloride, or triethylamine hydrochloride failed to bring about reaction. Thus, the acid counterion was critical to the rearrangement, perhaps by virtue of its solvation properties. It was also found that the *N*-acylaziridine **32** need not be isolated en route to the oxazoline **33.** For example, *p*-bromobenzoyl chloride was treated with 2,2-dimethylaziridine in ether containing 1.0 equiv of triethylamine. After formation of the *N*-acylaziridine **5,** the triethylamine hydrochloride was removed by filtration and a drop of concentrated sulfuric acid was added. Continued stirring of the ethereal solution gave the bromophenyloxazoline in 85% yield.

Experimental Section[10]

2,2-Dimethylaziridine. A modification of the reported procedure was used[11] which did not involve destruction of the reaction vessel and gave product that was found to be stable for 10 months at ambient temperature. The reported preparation claims that the aziridine polymerizes within 10 hr at room temperature.

To a mixture of 100 g (1.12 mol) of 2-amino-2-methylpropanol and 200 ml of water was added a cold (0–5°) mixture of 110 g of concentrated sulfuric acid and 200 ml of water. The mixture was heated so that water distilled off and until the temperature of the pot residue reached 115°. The water was then completely removed under aspirator pressure (10–15 mm) while heating continued and this resulted in the solidification of the pot residue. After cooling, a solution of 100 g (2.5 mol) of sodium hydroxide in 200 ml of water was slowly added and then allowed to stand overnight to allow trituration of the solid mass. Distillation of the alkaline slurry was performed at atmospheric pressure until the distillation temperature reached 101°. The distillate was repeatedly saturated with potassium hydroxide pellets until two layers appeared. The aziridine (top layer) was removed, dried in potassium hydroxide, and distilled from potassium hydroxide to give 35 g (44%), bp 72°.

2-(4-Bromophenyl)-4,4-dimethyl-2-oxazoline 1 (*p*-Br). 4-Bromobenzoic acid (50 g, 0.25 mol) was added to 90.0 g (0.75 mol) of thionyl chloride and the mixture was stirred at 25° for 24 hr. The excess thionyl chloride was distilled and the remaining dark oil was distilled (123°, 20 mm) to yield 48.8 g (90%) of the acid chloride. The 48.8 g (0.22 mol) of acid chloride was dissolved in 100 ml of methylene chloride and added in a dropwise manner to a magnetically stirred solution of 39.2 g (0.44 mol) of 2-amino-2-methyl-1-propanol in 100 ml of methylene chloride at 0°. The mixture was stirred at 25° for 2 hr. The white precipitate was filtered and washed with water and the solid remaining combined with that obtained by concentrating, cooling, and filtering the methylene chloride solution to give a total yield of 62.0 g (100%) of *N*-(2,2-dimethyl-3-hydroxypropyl)-*p*-bromobenzamide.

To cyclize the amide, thionyl chloride (35.8 g, 0.30 mol) was added dropwise with stirring to 25.0 g (0.092 mol) of the benzamide. When the vigorous reaction had subsided, the yellow solution was poured into 150 ml of dry ether and 26.8 g (100%) of white crystals separated out with swirling and were filtered. The hydrochloride salt was neutralized with cold 20% sodium hydroxide and extracted with ether. The ether was dried (K_2CO_3) and evaporated to yield a pale yellow oil which solidified on cooling, giving 18.0 g (77%) of oxazoline. A portion was recrystallized from hexane to give white spires: mp 37–38°; ir (film) 1650 cm^{-1}; nmr ($CDCl_3$) δ 7.60 (d, 2), 7.70 (d, 2), 4.01 (s, 2), 1.32 (s, 6).

Anal. Calcd for $C_{11}H_{12}NOBr$: C, 51.98; H, 4.77; N, 5.51. Found: C, 52.01; H, 4.68; N, 5.47.

2-(2-Bromophenyl)-4,4-dimethyl-2-oxazoline 1 (*o*-Br) was prepared in the same manner using *o*-bromobenzoic acid: mp 33–35.5°; 90%; bp 63° (0.2 mm); colorless oil (hydrochloride mp 108–110°); ir (film) 1650 cm^{-1}; nmr ($CDCl_3$) δ 7.66 (m, 2), 7.27 (m, 2), 4.05 (s, 2), 1.37 (s, 6).

Anal. Calcd for $C_{11}H_{12}NOBr$: C, 51.98; H, 4.77; N, 5.51. Found: C, 51.87; H, 4.74; N, 5.59.

2-(3-Bromophenyl)-4,4-dimethyl-2-oxazoline 1 (*m*-Br) was prepared in the same manner using *m*-bromobenzoic acid: 84%; bp 105–108° (0.05 mm); ir (film) 1653 cm^{-1}; nmr (CCl_4) δ 8.2–7.1 (m, 4), 4.05 (s, 2), 1.33 (s, 6).

Anal. Found: C, 51.88; H, 4.68; N, 5.63.

2-(4-Bromophenyl)-5,5-dimethyl-2-oxazoline 6 (*p*-Br). To a solution of 7.1 g (10 mmol) of 2,2-dimethylaziridine and 12.1 g (12 mmol) of dry triethylamine in 100 ml of benzene, cooled to 10° was added dropwise 21.9 g (10 mmol) of *p*-bromobenzoyl chloride in 100 ml of benzene. The reaction mixture was stirred at room temperature (15 hr) and the salts were removed by filtration. Evaporation of the solvent gave 23.0 g (91%) of the *N*-acylaziridine which was sufficiently pure for subsequent use. Pure material (mp 35–37°) was obtained by chromatography on Woelm Grade I neutral alumina: ir (film) 1660 cm^{-1}; nmr (neat, 38–40°) δ 7.30–7.80 (m, 4), 2.10 (s, 2), 1.00 (s, 6).

A solution of the above in dichloromethane (16.0 g in 350 ml) was treated with 0.1 ml of concentrated sulfuric acid and stirred at room temperature for 15 hr. After addition of 1.0 g of sodium bicarbonate, the solution was filtered and concentrated to give an oil which was distilled, bp 103° (0.3 mm), and crystallized on cooling: mp 59–61°; yield 11.0 g (70%); ir (KBr) 1630 cm^{-1}; nmr ($CDCl_3$) δ 7.40–7.90 (m, 4), 3.80 (s, 2), 1.50 (s, 6).

Anal. Calcd for $C_{11}H_{12}NOBr$: C, 51.98; H, 4.77; N, 5.51. Found: C, 52.16; H, 4.92; N, 5.62.

Formation of Grignard Reagent from 2-(Bromophenyl)-4,4-dimethyl-2-oxazoline 2 (*o*-, *m*-, or *p*-Br). A solution of 5.0 g (20 mmol) of the bromophenyloxazolines **1** in 60 ml of dry tetrahydrofuran was added dropwise to 0.61 g (25 mg-atoms) of triply sublimed magnesium. The reaction became immediately exothermic and the rate of addition was adjusted to maintain gentle reflux. (A crystal of iodine may be introduced to initiate reaction.) After stirring for 2 hr to ensure complete reaction, the Grignard reagent was used for the following reactions.

General Procedure for Products in Table I. All reactions were carried out under a nitrogen atmosphere.

Reaction of 2 (*p*-Br) with Styrene Oxide. 1-Phenyl-2-(4-carboethoxyphenyl)ethanol. To the Grignard reagent, formed above, was added 1.25 equiv of styrene oxide diluted with 10 volumes of tetrahydrofuran and the solution was heated to reflux for 4 hr. Aqueous quenching of the **7** solution resulted in a two-phase system. The organic layer was removed and the aqueous layer was extracted several times with ether, combined with the organic layer, dried (K_2CO_3), and concentrated to give crystalline material. Recrystallization from ether–petroleum ether gave 7.5 g (90%): mp 105–107°; *m/e* 295; ir (Nujol) 1640, 3300 cm^{-1}; nmr (CCl_4) δ 7.70 (d, 2), 7.05 (m, 7), 4.70 (t, 1), 4.00 (s, 2), 2.85 (d, 2), 1.22 (s, 6). The oxazoline carbinol (295 mg) was heated to reflux in 40 ml of ethanol containing 3.6 ml of concentrated sulfuric acid for 8 hr and the ethanol was removed (~60–70%) by evaporation. The residue **7** was poured into saturated salt solution and the mixture was extracted with ether. The ethereal solution was washed with 10% bicarbonate solution, dried (K_2CO_3), and concentrated. Purification was accomplished by elution through alumina using chloroform–ethanol (10:1). Recrystallization from ether–hexane also gave crystalline material; mp 53–55°; 81%; ir (Nujol) 1710, 3460 cm^{-1}; nmr ($CDCl_3$) δ 8.00 (d, 2), 7.30 (m, 7), 4.91 (t, 1), 4.35 (q, 2), 3.00 (m, 3), 1.35 (t, 3); *m/e* 270.

4-Carboxystyrene. The oxazoline carbinol (2.0 g) was heated in 3 *N* hydrochloric acid for 20 min and the solid amino ester hydrochloride was removed and added to 50 ml of 20% methanolic sodium hydroxide (using 50% aqueous sodium hydroxide). The solution was heated to reflux for 30 min and concentrated to 20–25 ml, cooled in an ice bath, and acidified with 9 *N* hydrochloric acid. The product was collected and recrystallized from chloroform: mp 260–262° (90%); *m/e* 224; λ_{max} (EtOH) 320 nm.[12]

Reaction of 1 (*p*-Br) with Benzonitrile. 4-Benzoylbenzoic acid. The Grignard reagent **2** (*p*-MgBr, 39 mmol) in 60 ml of tetrahydrofuran at reflux was treated with 4.12 g (40 mmol) of benzonitrile and heating was continued for 8 hr. After cooling, the mixture was quenched with 150 ml of 10% ammonia and extracted

with 150 ml of ether and then 150 ml of chloroform. Drying (K_2CO_3) and concentration gave 11.3 g of a viscous red oil which was passed through alumina (ether–chloroform, 1:1): ir (film) 1650 cm^{-1} (broad); nmr ($CDCl_3$) δ 7.05–8.00 (m, 9), 4.10 (d, 2), 1.40 (s, 6). The *p*-benzoylphenyloxazoline (3.4 g) was hydrolyzed in 3 *N* hydrochloric acid followed by sodium hydroxide as above, to give 2.7 g (92%) of carboxylic acid, mp 196–198°, *m/e* 226.[13]

Reaction of 1 (*p*-Br) with Cycloheptanone. Ethyl 4-Cycloheptenylbenzoate. A solution of cycloheptanone (2.36 g, 21 mmol) in 20 ml of tetrahydrofuran was added to the Grignard reagent **2** (*p*-MgBr, 19.5 mmol) in 30 ml of tetrahydrofuran at room temperature. After stirring at room temperature for 8 hr, and heating to reflux for 2 hr, the solution was quenched with 20 ml of 20% ammonia. Work-up in the usual manner and passage through alumina (petroleum ether) gave the carbinol (86%), mp 106–108° (petroleum ether), *m/e* 289. Cleavage of the oxazoline carbinol (141 mg) in 10 ml of ethanol containing 0.75 ml of concentrated sulfuric acid was accomplished by heating for 16 hr. The ester was isolated as described earlier. Chromatography of the crude ester (alumina using ether) gave pure material: ir (film) 1710 cm^{-1}; nmr ($CDCl_3$) δ 8.16 (d, 2), 7.52 (d, 2), 6.33 (t, 1).

Anal. Calcd for $C_{16}H_{20}O_2$: C, 78.65; H, 8.25. Found: C, 78.68; H, 8.29.

Reaction of 1 (*p*-Br) with Allyl Bromide. Ethyl 4-Allylbenzoate. A solution of *p*-bromophenyloxazoline (11.20 g, 44 mmol) in 50 ml of tetrahydrofuran was treated with 4.15 g of ethylene dibromide. This solution was added to 2.34 g of magnesium in 40 ml of tetrahydrofuran. After addition was complete, another 4.15 g of ethylene dibromide was added and the reaction mixture was stirred at room temperature for 2 hr. Allyl bromide (21.4 g) was introduced neat and the mixture was heated at reflux overnight. Work-up in the general manner gave 8.4 g (88%) of a viscous yellow oil which was solvolyzed in acidic ethanol to the ester: 4.0 g (77%); bp 80–85° (0.075 mm); ir (film) 1720 cm^{-1}; nmr ($CDCl_3$) δ 8.22 (d, 2), 7.39 (d, 2), 6.50–5.78 (m, 1), 5.40–4.85 (m, 2), 4.49 (q, 2), 3.46 (d, 2), 1.37 (t, 3).

Anal. Calcd for $C_{12}H_{14}O_2$: C, 75.76; H, 7.42. Found: C, 75.60; H, 7.38.

Reaction of 1 (*p*-Br) with Ethyl Chloroformate. Terephthalic Acid. The Grignard reagent **2** (*p*-MgBr) prepared in the General Procedure was treated all at once with 6.6 g (60 mmol) of ethyl chloroformate at 0°. The reaction mixture was then heated to reflux for 12 hr and quenched with 10% ammonia. Work-up gave 7.6 g of a viscous oil which was purified by alumina chromatography (neutral) using ether-petroleum ether (1:1): oil; ir (film) 1740, 1650 cm^{-1}; nmr ($CDCl_3$) δ 7.97 (d, 2), 7.34 (d, 2), 4.20 (q, 2), 4.10 (s, 2), 1.40 (s, 6), 1.25 (t, 3). Hydrolysis was performed on 3.8 g using 20 ml of 3 *N* hydrochloric acid. The gummy material was removed, placed in 20 ml of methanolic sodium hydroxide, and refluxed for 3 hr. Evaporation of the solvent and acidification with 3 *N* hydrochloric acid gave 2.8 g (85%) of colorless crystals: mp 300° (sublimes); ir (Nujol) 1685 cm^{-1}; nmr (D_2SO_4) δ 8.28 (s, 4).

Reaction of 1 (*p*-Br) with *N*-Methyl-4-piperidone. 4-(Carboethoxyphenyl)-1-methyl-1,2,5,6-tetrahydropyridine. A solution of 5.00 g (20 mmol) of **1** (*p*-Br) and 7.52 g (40 mmol) of ethylene dibromide in 40 ml of tetrahydrofuran was added dropwise to 1.44 g (60 mg-atoms) of magnesium in 60 ml of tetrahydrofuran. The reaction was moderated with an ice bath. To the resulting Grignard reagent–magnesium bromide was added 2.50 g (22 mmol) of *N*-methyl-4-piperidone in 20 ml of tetrahydrofuran and the mixture was heated to reflux for 16 hr. The reaction mixture was quenched with 10% ammonia solution (150 ml) and 100 ml of ether. The layers were separated and the aqueous layer was extracted with ether, combined, dried ($MgSO_4$), and concentrated to yield 5.80 g of an oil. The oil was repeatedly washed with cold petroleum ether and dried to give 4.7 g (82%) of oxazoline adduct: ir (film) 1650, 3350 cm^{-1}; nmr ($CDCl_3$) δ 7.88 (d, 2), 7.35 (d, 2), 4.12 (s, 2), 2.00–3.00 (m, 8), 2.16 (s, 3), 1.40 (s, 6). This product was heated for 16 hr in 50 ml of ethanol containing 4 ml of concentrated sulfuric acid and after usual work-up gave 3.3 g of viscous dark oil. Purification was performed by passage through alumina (neutral) using ether and then chloroform. The product was an unstable oil (27%): ir (film) 1710 cm^{-1}; nmr ($CDCl_3$) δ 8.00 (d, 2), 7.32 (d, 2), 5.00 (t, 1), 4.25 (q, 2), 2.18 (br s, 3), 1.0–2.5 (m, 6), 1.35 (t, 3); *m/e* 231.

Reaction of 1 (*o*-Br) with Cycloheptanone. Benzospirolactone. The Grignard reagent **1** (*o*-Br) as prepared in the General Procedure was treated with 2.35 g (21 mmol) of cycloheptanone and the reaction mixture was stirred for 16 hr at room temperature and heated to reflux for 1 hr. After cooling, the mixture was quenched with 100 ml of 20% aqueous ammonia. Work-up gave 5.40 (98%) of a pale yellow solid which was recrystallized from petroleum ether to give 5.23 g (95%) of colorless crystals: mp 95–97°; ir (Nujol) 1670, 3100 cm^{-1}; nmr ($CDCl_3$) δ 7.20–7.90 (m, 4), 3.50 (s, 2), 3.20 (s, 1, OH), 1.55–2.20 (m, 12), 1.40 (s, 6); *m/e* 275. Cleavage to the lactone was accomplished using 2.0 g of the oxazoline in 50 ml of ethanol containing 4.0 ml of concentrated sulfuric acid and heating to reflux for 16 hr. Evaporation of the solvent followed by addition of 200 ml of ether gave a solution which was washed twice with 100-ml portions of saturated salt solution. Drying ($MgSO_4$) and concentration of the ethereal solution gave 1.5 g (95%) of the spiro lactone as a viscous oil which solidified in storage. Recrystallization from ether–petroleum ether gave pure material: mp 85–87; ir (Nujol) 1755 cm^{-1}; nmr (CCl_4) δ 7.30–7.89 (m, 4), 1.60–2.20 (m, 12); *m/e* 216.

Anal. Calcd for $C_{14}H_{16}O_2$: C, 77.75; H, 7.46. Found: C, 77.40; H, 7.70.

Reaction of 1 (*o*-Br) with *p*-Methoxybenzaldehyde. Grignard reagent **2** (*o*-MgBr) was treated with an equimolar amount (21 mmol) of *p*-methoxybenzaldehyde as described in the previous experiment. Work-up gave 6.0 g (95%) of the oxazoline as an oil: ir (film) 1645, 3250 cm^{-1}; nmr (CCl_4) δ 6.60–8.00 (m, 8), 3.95 (s, 2), 3.86 (s, 1, OH), 3.65 (s, 3), 1.40 (s, 6). Conversion to the lactone (2.0 g) was accomplished by heating (16 hr) in ethanolic sulfuric acid as previously described: yield 1.6 g (98%); mp 110–112° (petroleum ether); ir (Nujol) 1750 cm^{-1}; nmr (CCl_4) δ 6.70–8.10 (m, 8), 6.40 (s, 1), 3.29 (s, 3); *m/e* 240.

Anal. Calcd for $C_{15}H_{12}O_3$: C, 74.99; H, 5.03. Found: C, 74.99; H, 5.16.

Reaction of 1 (*o*-, *m*-, *p*-Br) with Deuterium Oxide. *o*-, *m*-, and *p*-Deuteriobenzoic Acid. The Grignard reagents **2** from *o*-, *m*-, and *p*-bromophenyloxazoline were each treated with deuterium oxide and worked up using aqueous ammonia (10%) as above. The corresponding deuteriophenyloxazolines were each hydrolyzed in 3 *N* hydrochloric acid (reflux, 1 hr), cooled, extracted with ether, concentrated, and recrystallized.

***o*-Deuteriobenzoic acid:** 88% yield; mp 121°; nmr (CCl_4) δ 13.0 (s, 1), 8.15 (m, 1), 7.55 (m, 3); % D >98% (mass spectrum and nmr).

***m*-Deuteriobenzoic acid:** 90% yield; mp 121°; nmr (CCl_4) δ 12.9 (s, 1), 8.2 (m, 2), 7.5 (m, 2); % D >98% (mass spectrum and nmr).

***p*-Deuteriobenzoic acid:** 87% yield; mp 121°; nmr (CCl_4) δ 11.6 (s, 1), 8.2 (d, 2), 7.5 (d, 2); % D >98% (mass spectrum and nmr).

γ-Methyl-γ-phenylbutyrolactone (10). To a solution of 11.6 g (0.10 mol) of distilled levulinic acid (**7**) in 100 ml of dichloromethane cooled to 5° was added portionwise 20.0 g (97 mmol) of dicyclohexylcarbodiimide (DCC). A white slurry was formed before all of the DCC was added (10 min).To this was added 8.0 g (11 mmol) of 2,2-dimethylaziridine (exothermic). The mixture was stirred at room temperature for 16 hr and filtered and evaporation of volatiles gave 18.0 g of crude *N*-acylaziridine. The latter was triturated with 150 ml of hexane and filtered and the filtrate was evaporated to dryness to give 16.0 g (95%) of 1-(γ-ketopentoyl)-2,2-dimethylaziridine.

The analytical sample was prepared by molecular distillation: ir (film) 1720, 1680 cm^{-1}; nmr ($CDCl_3$) δ 2.40–2.90 (m, 4), 2.20 (s, 5), 1.30 (s, 6).

Anal. Calcd for $C_9H_{15}NO_2$: C, 63.86; H, 8.95; N, 8.28. Found: C, 63.58; H, 8.79; N, 8.13.

To a solution of 10.0 g of the above *N*-acylaziridine in 100 ml of ether was added 2 drops of concentrated sulfuric acid and stirring was performed at room temperature for 16 hr. The reddish reaction mixture was washed with 5% sodium bicarbonate (K_2CO_3). Filtration and evaporation of solvent gave 8.0 g (80%) of 2-(γ-ketobutyl)-5,5-dimethyl-Δ^2-oxazoline (**8**) as an oil: ir (film) 1720, 1665 cm^{-1}; nmr ($CDCl_3$) δ 3.50 (t, 2), 2.40–2.90 (m, 4), 2.20 (s, 3), 1.40 (s, 6).

To 0.73 g (0.03 g-atom) of magnesium in 10 ml of ether was added dropwise 4.7 g (30 mmol) of bromobenzene in 50 ml of ether. After completion of the exotherm, the reaction mixture was stirred at room temperature for an additional 30 min. To the resulting phenylmagnesium bromide was added dropwise 5.0 g (30 mmol) of **8** in 20 ml of ether. The resulting slurry was stirred at room temperature for 30 min and then poured into ice–water. The ethereal extracts were dried (K_2CO_3), filtered, and evaporated to give 4.0 g (55%) of 2-(γ-hydroxy-γ-phenylbutyl)-5,5-dimethyl-Δ^2-oxazoline (**9**), mp 84–88°. The analytical sample was prepared by two recrystallizations from hexane: mp 92–93°; ir (KBr) 3225, 1655 cm^{-1}; nmr ($CDCl_3$) δ 7.20–7.60 (m, 5), 4.70–5.20 (br s, 2, OH), 3.50 (s, 2), 2.20 (s, 4), 1.60 (s, 3), 1.40 (s, 6).

Anal. Calcd for $C_{15}H_{21}NO_2$: C, 72.98; H, 8.57; N, 5.66. Found: C, 73.07; H, 8.41; N, 5.73.

To 0.342 g of **9** was added 15 ml of 3 *N* HCl. After 30 min at reflux, the reaction mixture was cooled and extracted with ether and the ethereal extracts were dried ($MgSO_4$). Evaporation of solvent gave 0.211 g (87%) of γ-methyl-γ-phenylbutyrolactone (**10**):[14] ir (film) 1770–1780 cm^{-1}; nmr ($CDCl_3$) δ 7.35 (m, 5), 2.45 (m, 4), 1.70 (s, 3).

3-Carboxy-1-phenyl-3,4-dihydronaphthalene (13, A = OH). 3-Carboxy-1-tetralone (**11**, 20.0 g, 10.6 mmol) was mixed with 2-amino-2-methyl-1-propanol (9.40 g, 10.6 mmol), and the mixture was heated (Nujol bath) with stirring at 190–200° until 2 equiv of water had been distilled into hexane. The dark residue was distilled (170°, 0.10 mm) to yield 14.6 g (57%) of a viscous oil **12**, which solidified upon standing (mp 95–96°): ir (Nujol) 1655, 1680 cm^{-1}; nmr (CCl_4) δ 7.95 (d, 1), 7.30 (q, 3), 3.90 (s, 2), 2.70–3.20 (m, 5), 1.20 (d, 6). A phenylmagnesium bromide–magnesium bromide mixture in 100 ml of tetrahydrofuran was prepared from bromobenzene (6.29 g, 40 mmol), ethylene bromide (4.22 g, 20 mmol), and magnesium turnings (1.45 g). To the stirred solution of Grignard reagent was added 4.70 g (19.3 mmol) of **12** in 40 ml of tetrahydrofuran over a 30-min period. The mixture was stirred for 12 hr, refluxed for 1 hr, and then cooled in an ice bath and decomposed with 50 ml of cold, dilute ammonia solution. The organic layer was decanted and the aqueous layer was extracted with ether. The combined extracts were dried ($MgSO_4$) and evaporated to yield a viscous oil [3-(4,4-dimethyl-Δ^2-oxazolino)-1-hydroxy-1-phenyltetralin] which solidified upon standing. The material was recrystallized from ether–petroleum ether to yield 6.00 g (96%) of white crystals: mp 148–149°, ir (Nujol) 3200, 1655, 715, 770 cm^{-1}; nmr ($CDCl_3$) δ 7.26 (d, 9), 3.90 (s, 2), 2.45–3.20 (m, 5), 1.24 (s, 3), 0.90 (s, 3).

The *oxazoline carbinol from above* (1.00 g, 3.1 mmol) was dissolved in 40 ml of 3 *N* hydrochloric acid and refluxed for 15 min. The solution was cooled and the resulting solid precipitate was dissolved in chloroform, dried ($MgSO_4$), and evaporated to yield 0.70 g (91%) of a viscous oil **13** which solidified upon standing. The solid was recrystallized from ether: mp 158–161°; ir (Nujol) 1690 cm^{-1}; nmr ($CDCl_3$) δ 7.00–7.50 (m, 9), 6.16 (d, 1), 2.90–3.67 (m, 3).

Anal. Calcd for $C_{17}H_{14}O_2$: C, 81.58; H, 5.64. Found: C, 81.39; H, 5.59.

Ethyl 1-Phenyl-3,4-dihydronaphthalene-1-carboxylate (13, A = OEt). 3-(4,4-Dimethyl-Δ^2-oxazolino)-1-hydroxy-1-phenyltetralin (1.00 g, 3.1 mmol) obtained in the previous experiment was dissolved in 50 ml of ethanolic sulfuric acid (prepared from 95% ethanol and 3.9 ml of acid) and refluxed for 12 hr. The solution was cooled and poured into 200 ml of ether. The ether solution was washed with 50 ml of saturated sodium carbonate solution, dried ($MgSO_4$), and evaporated to yield **13** (A = OEt) as an oil. The oil eluted from a Woelm Grade I neutral alumina column with chloroform to yield 0.72 g (8) of a viscous oil: ir (film) 1730 cm^{-1}; nmr ($CDCl_3$) δ 6.90–7.50 (m, 9), 6.12 (d, 1), 4.11 (q, 2), 2.89–3.50 (m, 3), 1.20 (t, 3).

Anal. Calcd for $C_{19}H_{18}O_2$: C, 81.99; H, 6.52. Found: C, 81.85; H, 6.73.

4-Carboethoxy-1-phenylcyclohexene (18). A mixture of 4-hydroxycyclohexanecarboxylic acid (**14** 5.0 g, 35 mmol) and 2-amino-2-methyl-1-propanol (3.12 g, 35 mmol) was heated with stirring in an oil bath and the volatiles distilling between 112 and 275° were collected into a receiver containing 50 ml of ether. The water was separated from the ethereal solution in the distillate, and after drying (K_2CO_3) and concentration gave 4.4 g (64%) of a pale yellow oil. The latter was dissolved in cold 3 *N* hydrochloric acid and extracted with ether, and evaporation produced 0.3 g of the lactone derived from the starting acid. The aqueous solution was neutralized with cold 4 sodium hydroxide and extracted twice with ether. After drying (K_2CO_3) and concentration, there remained 4.3 g (63%) of oxazoline **15:** ir (film) 1660, 3320 cm^{-1}; nmr ($CDCl_3$) δ 3.90 (s, 2), 3.45 (m, 2), 1.4–2.3 (m, 9) , 1.2 (s, 6). The product **15** was oxidized to **16** without further purification as follows. A mixture containing 2.2 g (10.5 mmol) of **15** and 5.0 g of chromic anhydride in 50 ml of pyridine was stirred at room temperature for 18 hr, poured into 100 ml of water, and extracted with ether. The extracts were dried ($MgSO_4$) and concentrated to give 1.5 g (72%) of **16:** ir (film) 1660, 1710 cm^{-1}; nmr (CCl_4) δ 3.90 (s, 2), 1.90–2.90 (m, 9), 1.20 (s, 6).

Reaction of **16** with phenylmagnesium bromide was performed in exactly the same manner as described for **13.** Yield of **17** was 77%: mp 146–148°; the product showed a single spot on tlc (ether), R_f 0.40; ir (Nujol) 1650, 770, 710 cm^{-1}; nmr ($CDCl_3$) δ 7.25–7.70 (m, 5), 4.00 (s, 2), 2.14–2.50 (m, 2), 1.80–2.14 (m, 8); *m/e* 285.

A solution of **17** (612 mg) in 50 ml of ethanol containing 7.5 g of concentrated sulfuric acid was heated to reflux for 16 hr. The mixture was cooled and poured into 200 ml of ether. The ethereal solution was shaken with saturated salt solution and dried ($MgSO_4$). Concentration left 0.43 g (78%) of **18** as an oil. Purification was accomplished by passage through neutral alumina (ether): *m/e* 230; ir (film) 1730 cm^{-1}; nmr ($CDCl_3$) δ 7.33 (m, 5); 6.12 (br s, 1), 4.15 (q, 2), 2.05–2.85 (m, 7), 1.22 (t, 3).

Anal. Calcd for $C_{15}H_{18}O_2$: C, 78.23; H, 7.88. Found: C, 78.09; H, 7.99.

Ethyl 6-Hydroxyhexanoate (29). To 16.0 g (10 mmol) of adipic acid monoethyl ester in 100 ml of dichloromethane cooled to 5° was added 20.0 g (97 mmol) of DCC followed by 8.0 g (11 mmol) of 2,2-dimethylaziridine. The resulting slurry was stirred at 5° for 15 min and then at ambient temperature for 16 hr. Filtration of urea and evaporation of volatiles gave 23 g of residue. This residue was triturated with 300 ml of hexane and filtered and the filtrate was evaporated to dryness to give 18.0 g (84%) of ester acylaziridine. The analytical sample was prepared by molecular distillation at 50° (0.3 mm): ir (film) 1740, 1685 cm^{-1}; nmr ($CDCl_3$) δ 3.75 (s, 3), 2.30–2.60 (m, 4), 2.20 (s, 2), 1.60–1.90 (m, 4), 1.40 (s, 6).

Anal. Calcd for $C_{11}H_{19}NO_3$: C, 61.93; H, 9.00; N, 6.57. Found: C, 61.68; H, 9.07; N, 6.31.

Ester oxazoline **28** was prepared in 80% yield by stirring 10.7 g of the acylaziridine at ambient temperature (16 hr) in 75 ml of ether containing 2 drops of concentrated sulfuric acid. The analytical sample was prepared by molecular distillation at 50° (0.3 mm): ir (film) 1740, 1665 cm^{-1}; nmr ($CDCl_3$) δ 3.75 (s, 3), 3.60 (t, 2), 2.30–2.60 (m, 4), 1.60–1.90 (m, 4), 1.35 (s, 6).

Anal. Calcd for $C_{11}H_{19}NO_3$: C, 61.93; H, 9.00; N, 6.57. Found: C, 62.22; H,9.26; N, 6.47.

The hydroxypentyloxazoline was prepared in 75% yield by slow addition (25°) of 10.7 g (50 mmol) of **28** to 2.1 g of lithium aluminum hydride in 100 ml of ether. The mixture was stirred at room temperature for 2 hr and hydrolyzed with ice–water and the ethereal extracts were dried ($MgSO_4$). Filtration and evaporation *in vacuo* gave hydroxypentyloxazoline, which was purified by distillation: bp 60° (0.3 mm); ir (film) 3300–3400, 1660 cm^{-1}; nmr δ 4.40–4.80 (br s, 2), 3.50–3.80 (m, 4), 2.10–2.40 (m, 2), 1.42–1.80 (m, 6), 1.40 (s, 6).

Anal. Calcd for $C_{10}H_{19}NO_2$: C, 64.81; H, 10.36; N, 7.56. Found: C, 65.06; H, 10.64; N, 7.28.

Hydrolysis of the above oxazoline (7.0 g, 38 mmol) was performed by refluxing in 210 ml of 8% ethanolic sulfuric acid for 16 hr. After evaporation to 40 ml of residue, 200 ml of ether was added and neutralized with 10% sodium bicarbonate solution. The ethereal extracts were washed twice with water and the organic layer was dried ($MgSO_4$). Filtration and evaporation gave 4.0 g (82%) of ethyl 6-hydroxyhexanoate (**29**).[15]

Distillation at 60° (0.3 mm) gave pure samples (vpc), ir (film) 3300–3400, 1735 cm^{-1}.

Phthalide 31. A mixture of 10.1 g (10 mmol) of triethylamine, 7.1 g (10 mmol) of 2,2-dimethylaziridine, and 19.8 g (10 mmol) of 2-carboethoxybenzoyl chloride[16] in 200 ml of benzene was stirred for 1.0 hr at 5°. After work-up, there was obtained 21.0 g (90%) of the ester aroylaziridine, mp 52–54°. The analytical sample was prepared by recrystallization from petroleum ether: mp 53–54°; ir (KBr) 1730, 1660 cm^{-1}; nmr ($CDCl_3$) δ 7.35–7.85 (m, 4), 3.90 (s, 3), 2.30 (s, 2), 1.35 (s, 6).

Anal. Calcd for $C_{14}H_{17}NO_3$: C, 66.94; H, 6.48; N, 6.00. Found: C, 66.66; H, 6.54; N, 5.90.

Rearrangement to **30** was performed from 4.0 g of the aziridine in 75 ml of dichloromethane (in ether no rearrangement takes place) and 2 drops of concentrated sulfuric acid after stirring at ambient temperature for 16 hr. There was obtained, after distillation, 2.88 g (72%) of ester oxazoline **30:** bp 128° (1.3 mm); ir (film) 1730, 1650 cm^{-1}; nmr ($CDCl_3$) δ 7.40–7.80 (m, 4), 3.90 (s, 3), 3.80 (s, 2), 1.40 (s, 6).

To 1.0 g of lithium aluminum hydride in 50 ml of ether was added 2.88 g (12 mmol) of ester oxazoline **30.** After stirring for 4 hr at room temperature and hydrolysis with ice–water, 2.38 g (95%) of crude hydroxymethyloxazoline was obtained, ir (film) 3300, 1640 cm^{-1}. This was used in the next step without further purification.

Hydrolysis to phthalide **31** was effected by refluxing 2.05 g of the hydroxymethyloxazoline in 150 ml of 3 *N* hydrochloric acid for 16 hr. Extraction with chloroform and evaporation gave 0.65 g

(50%) of phthalide: mp 71–72° (after recrystallization from water) (lit.[17] mp 73°); ir (KBr) 1750 cm^{-1}; nmr ($CDCl_3$) δ 7.20–8.00 (m, 4), 5.40 (s, 2).

γ-Methylbutyrolactone (27). The keto oxazoline **8** (0.85 g, 5.0 mmol) in 10 ml of ether was added to lithium aluminum hydride (95 mg, 2.5 mmol) in 30 ml of ether (foaming results) and the mixture was stirred at room temperature for 1.5 hr. Ice–water was added dropwise and the mixture was filtered and evaporated to give 0.63 g of the oxazoline carbinol (80%), ir (film) 3350, 1660 cm^{-1}. Hydrolysis to the lactone was performed using 30 ml of 5% ethanolic sulfuric acid and heating to reflux for 15 hr. The ethanol was removed by fractional distillation and the residue was taken up in ether, washed with saturated brine, and dried ($MgSO_4$) to give 0.51 g of lactone **27.** This material was identical with that prepared using propylene oxide and the lithio oxazoline.[4]

Formation of Oxazolines 33 (R = Ph) without Isolation of Intermediate Acylaziridine 32. To 5.1 g (50 mmol) of triethylamine and 3.6 g (50 mmol) of 2,2-dimethylaziridine in 300 ml of anhydrous ether at 0° was added 7.0 g of benzoyl chloride. The resulting white slurry was stirred for 30 min and the triethylamine hydrochloride was removed by filtration. The filtrate was cooled to 0°, 0.2 ml of concentrated sulfuric acid was added, and the solution was stirred overnight at room temperature. The ethereal solution was extracted with cold (0–10°) 10% hydrochloric acid and the aqueous layer was neutralized with bicarbonate. The aqueous solution was extracted with ether, dried, and concentrated to give 7.3 g (85%) of 2-phenyl-5,5-dimethyl-2-oxazoline (**33,** R = Ph): mp 36–37°; ir (film) 1645 cm^{-1}; nmr ($CDCl_3$) δ 7.90–8.10 (m, 2), 7.30–7.60 (m, 3), 3.80 (s, 2), 1.45 (s, 6).

Anal. Calcd for $C_{11}H_{13}NO$: C, 75.38; H, 7.49; N, 8.00. Found: C, 75.48; H, 7.48; N, 8.04.

Conversion of Ethyl *m*-Hydroxybenzoate (34) to Oxazoline 38. A mixture of **34** (8.3 g, 50 mmol) and dihydropyran (5.0 g, 60 mmol) was stirred for 15 min at room temperature and the excess dihydropyran was removed *in vacuo.* The residue was distilled (from three or four sodium hydroxide pellets) to give 11.3 g (90%) of **35,** bp 133° (0.8 mm), ir (film) 1720 cm^{-1}.

Anal. Calcd for $C_{14}H_{18}O_4$: C, 67.17; H, 7.26. Found: C, 66.89; H, 7.25.

A solution of **35** (4.7 g, 19 mmol) in 20 ml of ether was treated with the magnesium bromide salt of 2,2-dimethylaziridine (prepared from 25 mmol of ethylmagnesium bromide and 25 mmol of 2,2-dimethylaziridine in 70 ml of ether) and stirred at room temperature for 5 hr. The mixture was quenched in cold water, and the ethereal layer was dried and concentrated to give the crude acylaziridine **36.** This was dissolved in 100 ml of dichloromethane containing 0.6 g of triethylammonium tosylate and the solution was stirred overnight. After addition of 1.0 g of sodium carbonate, the solvent was removed and the residue was taken up in ether, washed with water, dried, and concentrated to give 4.0 g of **36.** If the ethereal solution was shaken with cold 1 hydrochloric acid, and the aqueous solution neutralized, there was obtained 2.0 g of **38:** mp 132–133° (hexane–benzene); ir (KBr) 3200–3400, 1650 cm^{-1}; nmr ($CDCl_3$) δ 7.10–7.60 (m, 5), 3.95 (s, 2), 1.50 (s, 6).

Anal. Calcd for $C_{11}H_{13}NO_2$: C, 69.08; H, 6.86; N, 7.33. Found: C, 69.36; H, 6.77; N, 7.42.

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Registry No.—**1** (*p*-Br), 32664-14-5; **1** (*o*-Br), 32664-13-4; **1** (*o*-Br) HCl, 51849-83-3; **1** (*m*-Br), 51849-84-4; **6** (*p*-Br), 51849-85-5; **7,** 123-76-2; **8,** 38285-58-4; **9,** 51849-86-6; **10,** 21303-80-0; **11,** 6566-40-1; **12,** 29947-04-4; **13** (A = OH), 17560-23-5; **13** (A = OEt), 51849-87-7; **14,** 17419-81-7; **15,** 51849-88-8; **16,** 51849-89-9; **17,** 51849-90-2; **18,** 29947-07-7; **28,** 38285-59-5; **29,** 5299-60-5; **30,** 51849-91-3; **31,** 87-41-2; **33** (R = Ph), 33561-48-7; **34,** 7781-98-8; **35,** 51849-92-4; **36,** 51849-93-5; **38,** 51849-94-6; 2,2-dimethylaziridine, 2658-24-4; 2-amino-2-methylpropanol, 124-68-5; 4-bromobenzoic acid, 586-76-5; *N*-(2,2-dimethyl-3-hydroxypropyl)-*p*-bromobenzamide, 52306-15-7; *o*-bromobenzoic acid, 88-65-3; *m*-bromobenzoic acid, 585-76-2; *p*-bromobenzoyl chloride, 586-75-4; *N*-(*p*-bromobenzoyl)-2,2-dimethylaziridine, 32158-85-3; 2-[γ-hydroxy-γ-(*p*-bromophenyl)butyl]-5,5-dimethyl-Δ-oxazoline, 51849-96-8; 2-(*p*-benzoylphenyl)-4,4-dimethyl-Δ^2-oxazoline, 51849-97-9; oxazoline carbinol (mp 106–108°), 51849-98-0; oxazoline adduct (ir 1650, 3350 cm^{-1}), 51849-99-1; oxazoline carbinol (mp 95–97°), 51850-00-1; oxazoline adduct (ir 1645, 3250 cm^{-1}), 51933-46-1; 1-(γ-ketopentoyl)-2,2-dimethylaziridine, 38278-95-4; 3-(4,4-dimethyl-Δ^2-oxazolino)-1-hydroxy-1-phenyltetralin, 29947-05-5; adipic acid monomethyl ester, 627-91-8; 1-(5-carbomethoxypentoyl)-2,2-dimethylaziridine, 38285-55-1; 2-(5-hydroxypentyl)-5,5-dimethyl-Δ^2-oxazoline, 51850-02-3; 2-carboethoxybenzoyl chloride, 22103-82-8; 1-(2-carboethoxybenzoyl)-2,2-dimethylaziridine, 51850-03-4; benzoyl chloride, 98-88-4.

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