temperature, the mixture was filtered and the filtrate was distilled to give 2.8 grams (67% yield) of 3-methoxy-1,1,3-trimethyl-spiro[4,4]nonan-2-one, bp 80° at 0.5 mm; nmr (CCl_4) τ 6.8 (3 H), 7.95 (1 H), 8.10 (1 H), 8.4 (8 H), 8.8 (3 H), 8.95 (3 H) and 9.05 (3 H); ir bands at 2950 and 1725 cm^{-1}.

Elemental analyses (C and H), in agreement with the theoretical values have been obtained and submitted for review.

Alkylation of 2-Hydroxy-spiro[4,4]non-1-ene-3-one. (a) A solution of 1.5 grams (0.01 mole) of 2-hydroxy-spiro[4,4]non-1-ene-3-one (*6*) and 20 ml of glyme was added slowly to a stirred suspension of 10 ml of glyme and 0.42 gram (0.01 mole) of 57% sodium hydride. After stirring for 1 hr, 1.4 grams (0.01 mole) of methyl iodide was added and, after an additional 0.5-hr stirring period, the mixture was poured into 20 ml of 3*N* hydrochloric acid and worked up in the usual manner. Distillation of the residue gave 1.8 grams (88% yield) of 2-methoxy-spiro[4,4]non-1-ene-3-one, bp 120° at 0.25 mm; nmr (CCl_4) τ 3.85 (1 H), 6.3 (3 H), 7.8 (2 H) and 8.3 (broad, 8 H).

Elemental analyses (C and H) in agreement with the theoretical values have been obtained and submitted for review. (b) A solution of 1.5 grams (0.01 mole) of 2-hydroxy-spiro[4,4]non-1-ene-3-one (*3*) and 20 ml of glyme was added slowly to a stirred suspension of 10 ml of glyme and 1.68 grams (0.04 mole) of 57% sodium hydride. The mixture was stirred for 1 hr and 5.2 grams (0.04 mole) of methyl iodide was then added slowly. After it was stirred for 2 hr, the mixture was poured into 30 ml of 3*N* hydrochloric acid and was worked up in the usual way. The residue was distilled to give 1 gram (60% yield) of 4,4-dimethyl-2-methoxy-spiro[4,4]non-1-ene-3-one, bp 100–102° at 0.25 mm. It solidified and was recrystallized from Skellysolve B, mp 59°; nmr (CCl_4) τ 3.85 (1 H), 6.3 (3 H), 8.2 (broad, 8 H) and 9.0 (6 H); ir bands at 2950, 1750, and 1620 cm^{-1}.

Elemental analyses (C and H) in agreement with the theoretical values have been obtained and submitted for review.

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N,N-Dialkyl Carbamates of Diols

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The condensation of *N,N*-diethyl and *N,N*-dimethyl carbamyl chloride with alcohols is readily accomplished by reaction of the sodium alkoxide with the dialkyl carbamyl chloride. The physical constants are given for 26 new dialkyl carbamates which were tested for activity against Sarcoma 180.

Carbamates have been prepared from carbamyl chlorides and alcohols in the presence of pyridine (*1–4*, *6*) or potassium hydroxide (*7*), but neither of these techniques was satisfactory for the diols under study. Conversion of these diols to their sodium salts by treatment with sodium hydride in dry dioxane and reaction of this salt with the carbamyl chloride proved to be a satisfactory procedure, and the 26 new *N,N*-diethyl and *N,N*-dimethylcarbamates listed in Table I were prepared by this technique.

A typical preparation was performed as follows: Six grams (0.051 mole) of 3-methylpentane-1,5-diol in 50 ml of anhydrous dioxane was added dropwise to a nitrogen-swept stirred suspension of 6.54 grams (0.14 mole) of 53% oil-dispersed sodium hydride in 50 ml of dry dioxane. This mixture was refluxed for 6 hours. Then 15.05 grams (0.14 mole) of dimethyl carbamyl chloride was added dropwise with stirring. This produced a vigorous reaction, so the addition was made slowly, about 1 to 2 hours, while reflux was maintained. After addition of the carbamyl chloride, reflux was continued for 15 hours. The reaction mixture was allowed to cool to room temperature and filtered. The filtrate was stripped of dioxane and the crude product distilled to give 8.2 grams (63% theoretical) of colorless liquid, boiling at 120°/0.15 mm, n_D^{28} = 1.4555. The physical data for this compound, 3-methyl-1,5-pentamethylene-bis(*N,N*-dimethyl carbamate), are given in Table II.

In general, the yields of biscarbamate are only fair, apparently because the reaction is complicated by formation of considerable amounts of monocarbamate, which often makes the separation of products difficult. The infrared spectra given in Table II are generally consistent with the carbonyl absorption frequency of 1687 ± 4 cm^{-1} observed previously (*5*) for such compounds. However, there are exceptions caused by effects of the structure of the compounds. Also, in some cases, shoulders or doubling of the carbonyl peaks are observed, but these are often obscured by the overlap produced by the two carbonyl groups of the molecule.

3-Methyl-2-pentene-1,5-diol was synthesized by the lithium aluminum hydride reduction of *cis-trans*-ethylmethyl-β-methylglutaconate in 51% yield; bp 98/0.2 mm; n_D^{25} = 1.4785.

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Table I. Nitrogen Analyses of the *N,N*-Dialkyl Carbamates of Diols

Diol	Molecular Formula	Elemental Analysis[a] N Calcd.	Found
	Bis(*N,N*-dimethylcarbamates)		
3-Methyl-2-pentene-1,5-diol	$C_{12}H_{22}N_2O_4$	10.85	10.65
3-Methylpentane-1,5-diol	$C_{12}H_{24}N_2O_4$	10.76	10.68
cis-2-Butene-1,4-diol	$C_{10}H_{18}N_2O_4$	12.17	12.01
Butane-1,4-diol	$C_{10}H_{20}N_2O_4$	12.06	11.89
Propane-1,3-diol	$C_9H_{18}N_2O_4$	12.84	12.59
2-Butyne-1,4-diol	$C_{10}H_{16}N_2O_4$	12.27	12.17
2,2-Dimethylpentane-1,5-diol	$C_{13}H_{26}N_2O_4$	10.21	10.21
trans-2,2,4,4-Tetramethylcyclobutane-1,3-diol	$C_{14}H_{26}N_2O_4$	9.78	9.66
cis-2,2,4,4-Tetramethylcyclobutane-1,3-diol	$C_{14}H_{26}N_2O_4$	9.78	9.53
Cyclopentane-1,1-dimethanol	$C_{13}H_{24}N_2O_4$	10.29	10.48
trans-Cyclohexane-1,4-dimethanol	$C_{14}H_{26}N_2O_4$	9.78	10.03
Norcamphane-2,2-dimethanol	$C_{15}H_{26}N_2O_4$	9.39	9.41
Norcamphane-2,5-(or 6)-diol	$C_{13}H_{22}N_2O_4$	10.36	9.48
	N,N-dimethylcarbamates		
Norcamphane-2,5-(or 6)-diol	$C_{10}H_{17}NO_3$	7.03	7.33
	Bis(*N,N*-diethylcarbamates)		
3-Methyl-2-pentene-1,5-diol	$C_{16}H_{30}N_2O_4$	8.91	8.76
3-Methylpentane-1,5-diol	$C_{16}H_{32}N_2O_4$	8.85	8.76
cis-2-Butene-1,4-diol	$C_{14}H_{26}N_2O_4$	9.78	9.51
Butane-1,4-diol	$C_{14}H_{28}N_2O_4$	9.71	9.47
2-Butyne-1,4-diol	$C_{14}H_{24}N_2O_4$	9.85	9.56
2,2-Dimethylpentane-1,5-diol	$C_{17}H_{34}N_2O_4$	8.48	8.42
trans-2,2,4,4-Tetramethylcyclobutane-1,3-diol	$C_{18}H_{34}N_2O_4$	8.18	8.51
cis-2,2,4,4-Tetramethylcyclobutane-1,3-diol	$C_{18}H_{34}N_2O_4$	8.18	8.41
Cyclopentane-1,1-dimethanol	$C_{17}H_{32}N_2O_4$	8.53	8.53
Norcamphane-2,2-dimethanol	$C_{19}H_{34}N_2O_4$	7.90	8.13
trans-Cyclohexane-1,4-dimethanol	$C_{18}H_{34}N_2O_4$	8.18	7.51
	N,N-diethylcarbamates		
cis-2-Butene-1,4-diol	$C_9H_{17}NO_3$	7.48	7.62

[a] Nitrogen analyses performed by Micro-Tech Laboratories, Skokie, Ill.

Table II. Data on *N,N*-Dialkyl Carbamates of Diols

Diol	BP, °C., Mm Hg[a]	n_D or MP, °C.[b]	Yield,[c] %	Infrared Carbonyl Absorption Bands, Cm^{-1}[d]
		Bis(*N,N*-dimethyl carbamates)		
3-Methyl-2-pentene-1,5-diol	130–132 (0.13)	1.4714^{25}	57	1689
3-Methylpentane-1,5-diol	120 (0.15)	1.4555^{28}	64	1675
cis-2-Butene-1,4-diol	125–128 (0.05)	1.4700^{27} (mp 32)	36	1695
Butane-1,4-diol	120–122 (0.10)	1.4530^{29}	20[e]	1689
Propane-1,3-diol	85 (0.05)	1.4570^{27}	7	1689
2-Butyne-1,4-diol	...	59–61	26	1707
2,2-Dimethylpentane-1,5-diol	129 (0.10)	1.4570^{25}	29	1689
trans-2,2,4,4-Tetramethylcyclobutane-1,3-diol[f]	...	138–140	14	1707[g] and 1695
cis-2,2,4,4-Tetramethylcyclobutane-1,3-diol[f]	...	70–72	15	1707 and 1695
Cyclopentane-1,1-dimethanol	...	60–61	20	1683
trans-Cyclohexane-1,4-dimethanol	135 (0.17)-sublimes	115–117	3	1683
Norcamphane-2,2-dimethanol	...	106	24	1683
Norcamphane-2,5-(or 6)-diol	131–134 (0.24)	1.4830^{25}	19	1689
		N,N-dimethyl carbamates		
Norcamphane-2,5-(or 6)-diol	127–130 (0.07)	1.4852^{25}	4	1689
		Bis(*N,N*-diethyl carbamates)		
3-Methyl-2-pentene-1,5-diol	114 (0.10)	1.4671^{25}	32	1686 and 1675[g]
3-Methylpentane-1,5-diol	134 (0.05)	1.4555^{27}	46	1671
cis-2-Butene-1,4-diol	121–124 (0.10)	1.4622^{28}	69	1686
Butane-1,4-diol	126–130 (0.14)	1.4535^{25}	38[e]	1689
2-Butyne-1,4-diol	142 (0.05)	1.4709^{25}	5	1700[g] and 1689
2,2-Dimethylpentane-1,5-diol	130 (0.05)	1.4542^{28}	19	1683
trans-2,2,4,4-Tetramethylcyclobutane-1,3-diol[f]	...	84	15	1689 and 1670[g]
cis-2,2,4,4-Tetramethylcyclobutane-1,3-diol[f]	...	43–44	18	1683 and 1670[g]
Cyclopentane-1,1-dimethanol	134 (0.20)	1.4660^{25}	28	1678
Norcamphane-2,2-dimethanol	151 (0.15)	1.4770^{25}	57	1675
trans-Cyclohexane-1,4-dimethanol	145 (0.10)	1.4695^{25}	8	1670
		N,N-diethyl carbamates		
cis-2-Butene-1,4-diol	99–101 (0.20)	1.4663^{25}	27	1684

The elemental analyses for nitrogen of the compounds listed have been submitted for review and are in agreement with the theoretical values.

[a] Boiling points are uncorrected. [b] Melting points taken on a Thomas-Hoover capillary melting point apparatus and are uncorrected. [c] Yield based on the starting diol unless indicated otherwise. [d] Infrared spectra determined with a Baird Associates, Inc., Double-Beam Recording Infrared Spectrophotometer *via* solution technique with 0.1-mm NaCl cells and spectral-grade chloroform. [e] Yield based upon the starting *cis*-2-butene-1,4-bis(dialkyl carbamate). [f] Prepared from a cis-trans mixture of the diol, followed by separation of the product *via* fractional recrystallization. Nuclear magnetic spectrum is compatible with the assigned structure. [g] Shoulders.

Anal. Calcd. for $C_6H_{12}O_2$: C, 62.04; H, 10.41. Found: C, 62.17; H, 10.62.

The carbamates tested gave negative results in the Sarcoma 180 tests.

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Synthesis in Indole Series

Chloromethylation and Chlorosulfonation of 1-Acetyl-5-bromoindoline

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Chloromethylation and chlorosulfonation of 1-acetyl-5-bromoindoline yielded 1-acetyl-5-bromo-7-chloromethyl- and 7-chlorosulfonyl indolines, which were transformed to the corresponding indole derivatives. Percent yields, melting points, and infrared data are given for the reported compounds.

In a recent paper (*4*), we described the preparation of the 5-, 6-, and 7-carboxy- and cyanoindolines and indoles. The present communication describes the preparation of 7-substituted indolines and indoles, mainly the chloromethyl and chlorosulfonyl derivatives.

The easily available 1-acetyl-5-bromoindoline (*2*) gave with dichlorodimethyl ether, 1-acetyl-5-bromo-7-chloromethylindoline. This product tended to polymerize and was immediately treated with aniline to give the 7-anilinomethyl compound. The structure of the 1-acetyl-5-bromo-7-chloromethylindoline was proved by its transformation to 7-methylindole.

Also, chlorosulfonic acid replaced 1-acetyl-5-bromoindoline at the 7-position. The product, 5-bromo-7-chlorosulfonylindoline, was deacetylated with concentrated hydrochloric acid and then treated either with ammonium carbonate or diethylamine, yielding the sulfonamide and the *N,N*-diethylsulfonamide, respectively. The latter was dehydrogenated with chloranil to form the corresponding indole.

5-Sulfonamides derived from indoline and indole had been prepared before by Terent'ev and co-workers (*6*), but no analogs substituted in the 7-position have been known.

EXPERIMENTAL

1-Acetyl-5-bromo-7-chloromethylindoline. 1-Acetyl-5-bromoindoline (5 grams) was stirred into a cooled solution of dichlorodimethyl ether (8 ml) (*1*), in concentrated sulfuric acid (50 ml). The temperature was then raised to 10° C and the stirring continued for 2 hr. The crude product was poured onto ice, and the solid phase filtered off. It was then recrystallized from ethanol yielding 4.2 grams (70%) of material of mp 169–170° C. ν_{max}^{KBr} 1675 cm^{-1}.

1-Acetyl-5-bromo-7-anilinomethylindoline. A mixture of 1-acetyl-5-bromo-7-chloromethylindoline (3 grams), aniline (5 ml), and a saturated solution of sodium carbonate (50 ml) was heated on the water bath for 2 hr. After it was cooled, the mixture was extracted with benzene (50 ml); most of the benzene was removed under reduced pressure. Then hexane was added. The product was obtained in 70% yield (2.45 grams); mp 151–153°.

1-Acetyl-5-bromo-7-diethylaminomethylindoline. This compound was prepared similarly to the previous one, using diethylamine. It melted at 133–135°. ν_{max}^{KBr} 1660 cm^{-1} (C=O).

1-Acetyl-7-methylindoline. 1-Acetyl-5-bromo-7-chloromethylindoline (3 grams) in 100 ml of absolute ethanol was dehalogenated by treating it with hydrogen at 3.5 atm in the presence of 2 grams of Pd/C (10%). After 30 min, the catalyst was filtered off and the filtrate concentrated under reduced pressure. The residue was recrystallized from methanol, mp 98–100°. Yield, 1.35 g (75%).

7-Methylindole. 1-Acetyl-7-methylindoline (1.2 grams) and concentrated hydrochloric acid (10 ml) were refluxed for 30 min. The cooled mixture was neutralized with solid sodium carbonate, and the oily product extracted with xylene and dried over magnesium sulfate. To the filtered solution, chloranil (1 gram) was added and the mixture refluxed for 3 hr and filtered. The filtrate was concentrated under reduced pressure. Recrystallization of the residue from benzene-hexane yielded crystals (200 mg) of 7-methylindole of mp 79–81°. The product was further purified by preparative thin-layer chromatography on silica gel G plates (7-methylindole serving as a reference) and

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