jejunum in a dilution of 1:1,000,000. It was surprising to note that the esters of glycolic acids were of the same order of activity as the esters of the corresponding acetic acids.

Experimental

Basic Esters. (a) **Hydrochlorides.**—A homogeneous solution of equimolecular quantities of the glycolic acid and the basic alkyl chloride in an appropriate volume (50 ml. per 0.03 mole) of isopropanol was refluxed for fifteen hours. After filtration the solvent was removed by evaporation at room temperature with a current of air and the oily residue became crystalline, in most cases, after being repeatedly rubbed with fresh portions of anhydrous ether. The product was recrystallized from a suitable solvent as indicated in the table.

(b) **Methobromides.**—Hydrochlorides which persisted as oils were converted to methobromides according to the procedure of Blicke and Maxwell.[6] A cold aqueous solution of the hydrochloride was made alkaline with 10% aqueous sodium carbonate and the liberated basic ester extracted with ether. After washing with water, the extract was dried over anhydrous magnesium sulfate. The magnesium sulfate was filtered off and the ether evaporated leaving an oil which was dissolved in ethanol. This solution, contained in a citrate bottle, was cooled in an ice–salt mixture and treated with four to six equivalents of methyl bromide. The bottle was stoppered and allowed to stand at room temperature for twenty-four hours after which the product was worked up in the manner described for the hydrochlorides.

(6) Blicke and Maxwell, THIS JOURNAL, **64**, 428 (1942).

Summary

Twelve alkamine esters of substituted *p*-xenylglycolic acids were prepared by the reaction of a molecular equivalent of the appropriate acid and basic alkyl chloride. The properties of these compounds are described. The anomalous data on certain of these derivatives are discussed.

All of the esters possess antispasmodic activity, although it was surprising to find that they were of the same order of activity as the esters of the corresponding acetic acids.

DETROIT, MICH. RECEIVED AUGUST 20, 1945

[CONTRIBUTION FROM THE SCIENTIFIC LABORATORIES, FREDERICK STEARNS AND COMPANY DIVISION OF STERLING DRUG, INC.]

Alkamine Esters of Substituted 1-Naphthaleneglycolic Acids[1]

BY R. F. FELDKAMP AND MAURICE L. MOORE

In view of the observations noted in the preceding article of this series,[1a] it was of interest to synthesize a series of alkamine esters of substituted 1-naphthaleneglycolic acids for pharmacological investigation in comparison with the previously prepared esters of substituted 1-naphthaleneacetic acids,[2] several of which have been reported to possess relatively high antispasmodic activity.

The substituted 1-naphthaleneglycolic acids were prepared according to the method already described by the reaction of the appropriate Grignard reagent on 1-naphthaleneglyoxylic acid.[2] Whereas a large excess (50%) of Grignard reagent was previously employed in this synthesis it was found that a small excess (10%) gave a granular solid complex and yields of 78–88%. Two of these acids have not been reported and are noted in the Experimental Part. The desired esters were prepared by the method of Horenstein and

TABLE I

ALKAMINE ESTERS OF SUBSTITUTED 1-NAPHTHALENEGLYCOLIC ACIDS, 1-$C_{10}H_7CR'OHCOOR \cdot HCl$

No.	R	R′	Yield, %	M. p., °C.	Formula	Analyses, %[a] Nitrogen Calcd.	Nitrogen Found	Chlorine Calcd.	Chlorine Found	Antispasmodic activity[b] av. max. effective diln. on isolated rabbit jejunum: Acetylcholine	Barium chloride
1	$-CH_2CH_2N(C_2H_5)_2$	CH_3	87	139–141	$C_{19}H_{28}O_3NCl$	3.98	3.95	10.07	10.25	2M[c]	500T[d]
2	$-CH_2CH_2N(C_2H_5)_2$	C_2H_5	90	147–148	$C_{20}H_{30}O_3NCl$	3.83	3.84	9.69	9.82	500T–1M	200–500T
3	$-CH_2CH_2N(C_2H_5)_2$	C_3H_7	95	153–155	$C_{21}H_{32}O_3NCl$	3.69	3.83	9.33	9.55	500T–1M	250–500T
4	$-CH_2CH_2N(C_2H_5)_2$	C_4H_9	82	133–135	$C_{22}H_{32}O_3NCl$	3.56	3.58	9.00	9.35	500T–1M	250–500T
5	$-CH_2CH_2CH_2N(C_2H_5)_2$	CH_3	74	134–135	$C_{21}H_{32}O_3NBr$[e]	3.30	3.49	18.83	18.73	200–500T	100–200T
6	$-CH_2CH_2CH_2N(C_2H_5)_2$	C_2H_5	89	138–140	$C_{21}H_{32}O_3NCl$	3.69	3.78	9.33	9.33	250–500T	250–500T
7	$-CH_2CH_2CH_2N(C_2H_5)_2$	C_3H_7	83	153–154	$C_{22}H_{34}O_3NCl$	3.56	3.52	9.00	9.00	250–500T	100–200T
8	$-CH_2CH_2CH_2N(C_2H_5)_2$	C_4H_9	77	123–125	$C_{23}H_{36}O_3NCl$	3.43	3.46	8.69	8.58	100–200T	200T
9	$-CH_2CH_2CH_2N(C_2H_5)_2$	C_6H_5	93	163–165	$C_{25}H_{30}O_3NCl$	3.27	3.24	8.29	8.33	500T–1M	200–500T
10	$-CH_2CH_2NC_5H_{10}$[f]	CH_3	74	148–149	$C_{21}H_{30}O_3NBr$[e]	3.32	3.31	18.92	18.69	500T–1M	250–500T,
11	$-CH_2CH_2NC_5H_{10}$[f]	C_2H_5	50	164–166	$C_{22}H_{32}O_3NCl$	3.71	3.63	9.38	9.38	200–500T	100–200T,
12	$-CH_2CH_2NC_5H_{10}$[f]	C_3H_7	81	143–145	$C_{23}H_{34}O_3NCl$	3.57	3.77	9.05	8.85	100–200T,	100T
13	$-CH_2CH_2NC_5H_{10}$[f]	C_4H_9	89	128–130	$C_{24}H_{36}O_3NCl$	3.45	3.52	8.74	8.32	100–200T	100–200T,

[a] We are indebted to Mary Jane Eastwood and Elizabeth B. Macks for the analytical data on these compounds. [b] The figures recorded represent preliminary results only but they are sufficiently accurate to permit a relative comparison of the compounds. [c] 1:2,000,000. [d] 1:500,000. [e] Methobromides. [f] NC_5H_{10} = Piperidino. Compounds 1, 2, 3, 4, 5, 6, 10 and 11 were recrystallized from isopropanol and isopropyl ether, compounds 7, 8, 9 and 12 from isopropanol and ethyl ether, and compound 13 from isopropanol.

(1) Prepared for the 1945 meeting-in-print of the Division of Medicinal Chemistry, A. C. S.

(1a) See THIS JOURNAL, **67**, 1897 (1945).

(2) Blicke and Feldkamp, *ibid.*, **66**, 1087 (1944).

Pählicke,[3] as described in the previous article, and are summarized in Table I.

We are indebted to Dr. A. M. Lands and Miss V. L. Nash, of the Pharmacological Laboratories, for a preliminary report on the antispasmodic activity of these compounds as included in Table I. In general, the spasmolytic activity is about the same as for the corresponding esters in the 1-naphthaleneacetic acid series. One compound, β-diethylaminoethyl methyl-1-naphthaleneglycolate, was active against acetylcholine on the isolated rabbit jejunum in a dilution greater than 1:1,000,000. As in the case of the *p*-xenyl series, it was surprising to find that the esters of glycolic acids were of the same order of activity as the esters of the corresponding acetic acids.

Experimental[4]

Methyl-1-naphthaleneglycolic Acid (I).—Methylmagnesium bromide was prepared from 15.8 g. (0.65 mole) of magnesium, 61.7 g. (0.65 mole) of methyl bromide and 300 ml. of anhydrous ether. The Grignard solution was slowly added to a cold, well-stirred solution of 60 g. (0.3 mole) of 1-naphthaleneglyoxylic acid. Throughout the addition the complex remained well suspended and, when the addition was complete, it was collected on a filter and washed thoroughly with anhydrous ether. The dry complex was slowly added to 1 liter of 3% sulfuric acid with thorough stirring and cooling. The crystals that separated were filtered off and washed with water. The yield was 55.6 g. (85.6%); m. p. 147–148° after recrystallization from water. The product gives orange to green colors with concentrated sulfuric acid.

Anal. Calcd. for $C_{13}H_{12}O_3$: C, 72.20; H, 5.59. Found: C, 71.82; H, 5.88.

Ethyl-1-naphthaleneglycolic Acid (II).—This compound was obtained in the manner described above from 92.6 g. (0.85 mole) of ethyl bromide, 23.2 g. (0.85 mole) of magnesium in 500 ml. of ether and 80 g. (0.4 mole) of 1-naphthaleneglyoxylic acid. The yield was 72.8 g. (78.5%); m. p. 117–118°, after recrystallization from benzene.

Anal. Calcd. for $C_{14}H_{14}O_3$: C, 73.03; H, 6.13. Found: C, 72.60; H, 6.00.

(3) Horenstein and Pählicke, *Ber.*, **71**, 1654 (1938).

(4) All melting points reported are uncorrected.

Summary

Thirteen alkamine esters of substituted 1-naphthaleneglycolic acids were prepared by the reaction of a molecular equivalent of the appropriate acid and basic alkyl chloride. The properties of these compounds are described.

All of the esters possess antispasmodic activity although it was surprising to find that they were of the same order of activity as the esters of the corresponding acetic acids.

DETROIT, MICHIGAN RECEIVED AUGUST 20, 1945

[CONTRIBUTION FROM THE LABORATORY OF PHYSIOLOGICAL CHEMISTRY, THE OHIO STATE UNIVERSITY]

The Fatty Acids of Corn Oil

FREDRIC J. BAUR, JR.,[1,2] AND J. B. BROWN

Corn oil is a semi-drying oil noted for its high content of linoleic acid. Its principal commercial value lies in its use as a salad oil and shortening. Additional industrial uses are as a lard substitute, in the manufacture of soft soaps, and as a paint material when used along with drying oils. In the research laboratory, corn oil is a valuable source of linoleic acid which can be isolated from the mixed acids of the oil by the debromination[3] and the low temperature crystallization procedures.[4]

Comparatively few investigations have been conducted on the fatty acids of this oil. Prior to its analysis by Baughman and Jamieson[5] in 1931, the results reported were not quantitative and were very contradictory. The following acids had been noted: palmitic, stearic, arachidic, oleic, linoleic and hypogaeic. Hehner and Mitchell[6] in 1896 reported the absence of stearic acid. Evidence for the presence of traces of linolenic acid was presented by Frankel and Brown.[4a]

Other than Baughman and Jamieson's analysis, the only complete investigation of the oil by modern methods is that of Longenecker in 1939.[7] These results along with those reported in the present investigation are summarized in Table I.

TABLE I

ANALYSES OF CORN OIL FATTY ACIDS

Acid	Baughman and Jamieson, wt. %	Longenecker, mole %	Our results, wt. %
Myristic	..	1.7	0.1
Palmitic	7.8	11.0	8.1
Stearic	3.6	2.9	2.5
Arachidic	0.4	..	..
Lignoceric	0.2	..	..
Hexadecenoic	..	1.6	1.2
Oleic	46.3	48.8	30.1
Linoleic	41.7	34.0	56.3
Above C_{18}	..	..	1.7

Baughman and Jamieson used the lead salt ether procedure to separate the saturated and unsaturated acids of corn oil. They based their calculations on iodine and saponification numbers and on the bromine derivatives of the unsaturated acids. Longenecker used a modified Twitchell method to separate the acids and distilled the

(1) Submitted in partial fulfillment of the requirements for the Ph.D. degree, the Graduate School.

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(3) (a) Rollett, *Z. physiol. Chem.*, **62**, 410 (1909); (b) Frankel and Brown, THIS JOURNAL, **65**, 415 (1943).

(4) (a) Frankel and Brown, *ibid.*, **63**, 1483 (1941); (b) Frankel, Stoneburner and Brown, *ibid.*, **65**, 259 (1943).

(5) Baughman and Jamieson, *ibid.*, **43**, 2696 (1921).

(6) Hehner and Mitchell, *Analyst*, **21**, 328 (1896).

(7) Longenecker, *J. Biol. Chem.*, **129**, 13 (1939).