TABLE I

ALCOHOLS $RCH(CHOHR')CH_2NMe_2$ AND SALTS $[RCH(CHOHR')CH_2NMe_2R'']Cl$ FROM KETONES $RCHCOR'$

R	R′	R″	Conversion of ketone to alcohol, %		B.p. of base,		$n^{25}D$ of base	Conversion of alcohol to salt, %	Empirical formula	Neut. equiv.		Nitrogen, %		Chlorine, %	
			NaBH₄	LiAlH₄	°C.	Mm.				Calcd.	Found	Calcd.	Found	Calcd.	Found
Hexyl	Methyl			45	112	2			$C_{12}H_{27}NO$	201	206				
		Hydrogen						93	$C_{12}H_{28}NOCl$			5.89	5.65	14.92	15.60
		Methyl						35	$C_{13}H_{30}NOCl$			5.56	5.38	14.09	13.95
		Benzyl[a]						86	$C_{19}H_{34}NOCl$			4.27	4.15	10.82	10.50
Octyl	Methyl		36	45	120	0.7	1.4457		$C_{14}H_{31}NO$	229	236				
		Hydrogen						77	$C_{14}H_{32}NOCl$			5.27	5.10	13.34	13.20
		Methyl						55	$C_{15}H_{34}NOCl$			5.00	4.59	12.67	12.32
		Benzyl						54	$C_{21}H_{38}NOCl$			3.93	3.92	9.97	10.25
Decyl	Methyl			51	147	.9	1.4510		$C_{16}H_{35}NO$	257	255				
		Hydrogen						71	$C_{16}H_{36}NOCl$			4.77	4.70	12.07	12.20
		Methyl						78	$C_{17}H_{38}NOCl$			4.55	4.30	11.52	11.95
		Benzyl						63	$C_{23}H_{42}NOCl$			3.65	3.66	9.24	9.25
Tetradecyl	Methyl		45	41	165	.4	1.4532		$C_{20}H_{43}NO$	313	315				
		Hydrogen						67	$C_{20}H_{44}NOCl$			4.00	3.96	10.13	10.08
		Methyl						47	$C_{21}H_{46}NOCl$			3.85	3.88	9.74	9.95
		Benzyl						81	$C_{27}H_{50}NOCl$			3.18	3.02	8.06	7.72
Hexyl	Heptyl			68[c]	130	.3	1.4502		$C_{18}H_{39}NO$	286	295				
		Hydrogen						69	$C_{18}H_{40}NOCl$			4.35	4.00	11.04	11.58
		Benzyl						90	$C_{25}H_{47}NOCl$			3.40	3.60	8.61	8.72
Octyl	Nonyl		34		160	.2	1.4542		$C_{22}H_{47}NO$	341	360				
		Hydrogen						91	$C_{22}H_{48}NOCl$			3.71	3.48	9.38	9.82
		Benzyl[b]						86	$C_{29}H_{54}NOCl$			2.93	2.94	7.58	7.48
Decyl	Undecyl		46[c]		190–195	.2	1.4564		$C_{26}H_{55}NO$	398	485				
		Benzyl						58	$C_{33}H_{62}NOCl$			2.68	2.68	6.78	6.54

[a] M.p. 135–138°. [b] M.p. 117–120°. [c] Crude.

ml. of water and careful hydrolysis with 200 ml. of concentrated hydrochloric acid, the mixture was clarified by addition of ethanol, and extracted with Skellysolve F to remove non-basic material. After removal of ethanol, the residue was made alkaline and extracted with Skellysolve F. The extract was washed, dried, and fractionally distilled to give the crude base in 45% conversion. Pure material was obtained by a second fractionation, b.p. 165–170° at 4 mm. Infrared examination of the forerun revealed the presence of small amounts of unsaturated alcohol, probably the reduction product of the unsaturated ketone arising by deamination of the Mannich base.

A portion of the base obtained from methyl undecyl ketone was reduced at 200° and 2000 pounds pressure with Raney nickel catalyst. The product, which was shown by infrared examination to contain about 5% ketone, was reduced further with sodium in ethanol. Distillation gave a liquid, b.p. 100° at 0.2 mm., $n^{25}D$ 1.4446. Infrared examination showed this to be a secondary alcohol, differing from 3-tetradecanol ($n^{25}D$ 1.4428) in its much stronger methyl band at 7.3 μ.

Anal. (Galbraith Laboratories, Knoxville, Tenn.). Calcd. for $C_{14}H_{30}O$: C, 78.50; H, 14.02. Found: C, 78.57; H, 14.05.

Salts of the amino alcohols were made by three methods depending upon the halide used: (a) the base was mixed with an equivalent of benzyl chloride, and warmed for several days in an ethyl acetate–methanol mixture; (b) the base was heated for several hours at 125° in a bomb with excess methyl chloride in methanol; (c) hydrogen chloride was passed into a solution of the base in Skellysolve F. The products, or alcoholic solutions thereof, were freed of starting materials by several washings with Skellysolve F, affording analytically pure products. In general, these were hygroscopic solids, possessing no definite decomposition or melting points.

The salts of bases derived from symmetrical ketones were soluble in Skellysolve F, especially in the presence of even small amounts of polar solvents. Purification was achieved by trituration of the dry solid with Skellysolve F.

Acknowledgment.—We thank Mr. L. D. Metcalfe for the nitrogen analyses, Mr. R. A. Reck and co-workers for the ketones, Mr. A. E. Brake for the infrared analyses, and Drs. H. J. Harwood and E. Rapkin for helpful discussions.

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The Synthesis of Certain Ketones and Carbinols Containing Perfluoroalkyl Groups[1]

BY THOMAS F. MCGRATH[2] AND ROBERT LEVINE

RECEIVED FEBRUARY 24, 1955

In an earlier paper[3] we reported that the addition of one equivalent of trifluoroacetic acid to two or more equivalents of phenyllithium in refluxing ether gave none of the expected trifluoroacetophenone. Instead some or all of the following cleavage products were obtained: benzoic acid, benzophenone, triphenylmethane and tetraphenylethylene.

It has now been found (Table I) that a mixture of trifluoroacetophenone and benzoic acid is obtained when one equivalent of trifluoroacetic acid is added to two equivalents of phenyllithium (Standard Addition Technique) at 0°. When the reaction temperature is decreased to −40 or −65°, the yield of ketone is increased at the expense of the cleavage product, benzoic acid. Similar reactions were effected using perfluoropropionic and perfluoro-*n*-butyric acids.

Since the use of the standard addition technique in the reaction between perfluoro-*n*-butyric acid

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[2] Monsanto Chemical Co., Fellow, 1953–1954.

[3] T. F. McGrath and R. Levine, THIS JOURNAL, **77**, 3634 (1955).

TABLE I

REACTIONS OF PERFLUORINATED ACIDS (ONE EQUIVALENT) WITH PHENYLLITHIUM (TWO EQUIVALENTS)

			Products, %		
n	Temp., °C.	Method	C_nF_{2n+1}-COC_6H_5	C_6H_5-CO_2H	$(C_6$-$H_5)_2$-CO
1	25	R. A.[a]	15[c]	16	9
	0	R. A.	47[c]	20	0
	0	S. A.[b]	50[c]	20	0
	−40	R. A.	49[c]	14	0
	−40	S. A.	62[c]	15	0
	−65	R. A.	53[c]	16	0
	−65	S. A.	73[c]	13	0
2	25	R. A.	0	76	0
	−65	S. A.	41[d]	44	0
3	25	R. A.	0	90	0
	−65	S. A.	16[e]	56	0
	−100	S. A.	2[e]	30	0

[a] R. A. = reverse addition technique. [b] S. A. = standard addition technique. [c] B.p. 151–152° (J. H. Simons and E. O. Ramler, THIS JOURNAL, **65**, 389 (1943)); 2,4-dinitrophenylhydrazone, m.p. 173.8–174.2° (from 60–70° petroleum ether). *Anal.* Calcd. for $C_{14}H_9O_4N_4F_3$: N, 15.82. Found: N, 15.94. In the last cited reference the m.p. of this derivative is reported as 94.5–95.5°, but no analysis is reported. [d] B.p. 159–161° (J. H. Simons, W. T. Black and R. F. Clark, THIS JOURNAL, **75,** 5621 (1953); 2,4-dinitrophenylhydrazone, m.p. 111.8–112.4° (from 60–70° petroleum ether). *Anal.* Calcd. for $C_{15}H_9O_4N_4F_5$: N, 13.86. Found: N, 14.10. In the last cited reference the melting point of this derivative is reported as 119–120°. [e] B.p. 171–172° (see ref. in footnote *d*); 2,4-dinitrophenylhydrazone, m.p. 86.2–87.2° (from 60–70° petroleum ether). *Anal.* Calcd. for $C_{16}H_9O_4N_4F_7$: N, 12.33. Found: N, 12.48.

TABLE II

DIPHENYLPERFLUOROALKYLCARBINOLS, $C_nF_{2n+1}C(OH)(C_6H_5)_2$, BY THE ADDITION OF METHYL PERFLUOROALKANOATES TO PHENYLLITHIUM

						Carbon, %		Hydrogen, %	
n	Carbinol yield, %	B.p., °C.	Mm.	M.p., °C.	Formula	Calcd.	Found	Calcd.	Found
1	88	109–110	1.5	74–74.7[a,b]					
2	87	140–143	11	84–84.5[b]	$C_{15}H_{11}OF_5$	59.60	59.56	3.64	3.31
3	84	113–115	3		$C_{16}H_{11}OF_7$	54.54	54.53	3.13	3.33

[a] See ref. in footnote *c* of Table I. [b] Recrystallized from 60–70° petroleum ether.

and phenyllithium at −65° gave only a 16% yield of the expected ketone and 56% yield of benzoic acid, the reaction was repeated at −100°. Under these conditions the formation of both the ketone and benzoic acid were repressed. However, it is interesting to note that a 30% yield of benzoic acid was still obtained (Table I). It also was found that the addition of two equivalents of phenyllithium to one of trifluoroacetic acid and its two higher homologs (reverse addition technique) at reaction temperatures of 25 to −65° gave either a mixture of the phenyl perfluoroalkyl ketone and cleavage products or only the cleavage product, benzoic acid (Table I).

The reactions between the three homologous methyl perfluoroalkanoates ($C_nF_{2n+1}CO_2CH_3$, n = 1–3) and phenyllithium were studied next. When one equivalent of methyl trifluoroacetate was added to one equivalent of phenyllithium in refluxing ether, diphenyltrifluoromethylcarbinol was obtained in 88% yield (based on phenyllithium). The carbinol also was obtained in 77% yield when the phenyllithium was replaced by phenylmagnesium bromide. Equivalents of methyl trifluoroacetate and its two higher homologs also were treated with two equivalents of phenyllithium to give the corresponding carbinols in the yields listed in Table II.

Since the carbinols probably are formed by the reaction of phenyllithium with ketonic intermediates, experimental conditions were investigated which might give phenyl perfluoroalkyl ketones as the major reaction products. Two methods were studied: (1) addition of an equivalent of the perfluorinated ester to an equivalent of phenyllithium (standard addition technique) at −40° and (2) addition of an equivalent of phenyllithium to an equivalent of the fluorinated ester (reverse addition technique) at 25°. As may be seen in Table III, a mixture of ketone and carbinol was obtained from most of these reactions. It also has been found that a 67% yield of trifluoroacetophenone and no carbinol was obtained from the reaction of methyl trifluoroacetate and phenylmagnesium bromide using the reverse addition technique at 25°.

It also has been possible to prepare 2-picolyl perfluoroalkyl ketones ($2\text{-}C_5H_4NCH_2COC_nF_{2n+1}$, $n = 1$ (89%); $n = 2$ (83%); $n = 3$ (87%)) by the addition of two equivalents of 2-picolyllithium to one equivalent of the appropriate methyl perfluoroalkanoate at 25°. A two to one molar ratio of base to ester was employed since this ratio of reactants had been employed so successfully for the acylation of 2-picoline and related tar bases.[4,5] These 2-picolyl ketones form copper salts with copper(II) ion and hence may find some application as chelating agents.

TABLE III

ALKYL PERFLUOROALKYL KETONES, $C_nF_{2n+1}COC_6H_5$, AND DIPHENYLPERFLUOROALKYLCARBINOLS, $C_nF_{2n+1}C(OH)$-$(C_6H_5)_2$, FROM EQUIVALENTS OF ESTERS AND PHENYLLITHIUM

			Products, yield, %	
n	Method	Reacn. temp., °C.	Ketone[c]	Carbinol[d]
1	R. A.[a]	25	58	10
	S. A.[b]	−40	64	0
2	R. A.	25	31	29
	S. A.	−40	15	44
3	R. A.	25	18	36

[a] R. A. = reverse addition technique. [b] S. A. = standard addition technique. [c] Constants agree with those listed in the footnotes of Table I. [d] Constants agree with those recorded in Table II.

Experimental

Phenyllithium.—This reagent was used as an approximately one molar solution in anhydrous ether unless otherwise indicated.

I. Reactions of Perfluorinated Acids with Phenyllithium. (A) Addition of **Trifluoroacetic Acid** (**One Equivalent**) to **Phenyllithium** (**Two Equivalents**) at −65° (**Standard Addition Technique**).—Trifluoroacetic acid (22.8 g., 0.2 mole), dissolved in 50 ml. of anhydrous ether, was added over a one-hour period to a rapidly stirred ether solution of

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[4] N. N. Goldberg, L. B. Barkley and R. Levine, THIS JOURNAL, **73**, 4301 (1951).

[5] N. N. Goldberg and R. Levine, *ibid.*, **74**, 5217 (1952).

phenyllithium (0.4 mole) cooled to −65° by immersion in a Dry Ice–acetone slurry. The mixture was stirred for two more hours at −65° allowed to warm to room temperature and poured onto a mixture of ice and excess concentrated hydrochloric acid. The layers were separated and the aqueous phase was extracted with several portions of ether. The combined ether extracts were dried over Drierite. The solvent was removed and the residue was distilled first at atmospheric pressure to give 22.5 g. (73%) of trifluoroacetophenone (b.p. 150–152°, 2,4-dinitrophenylhydrazone, m.p. 173.8–174.2°) and then at reduced pressure to give 3.1 g. (13%) of benzoic acid (b.p. 110–113° at 3 mm., m.p. 120.4–121.2° alone and when mixed with an authentic sample).

(B) **Addition of Phenyllithium (Two Equivalents) to Trifluoroacetic Acid (One Equivalent) at −65° (Reverse Addition Technique).**—Phenyllithium (0.4 mole in 800 ml. of ether) was added over a period of six to eight hours to a rapidly stirred solution of trifluoroacetic acid (22.8 g., 0.2 mole) in 300 ml. of ether and maintained at −65°. The mixture was then treated as described in experiment IA to give 18.3 g. (53%) of trifluoroacetophenone and 3.9 g. (16%) of benzoic acid.

II. **Preparation of Diphenylperfluoroalkylcarbinols. The Synthesis of Diphenyltrifluoromethylcarbinol.**—Methyl trifluoroacetate (25.6 g., 0.2 mole), dissolved in 50 ml. of ether, was added to rapidly stirred phenyllithium (0.4 mole) at such a rate that the ether refluxed gently throughout the addition. The reaction mixture then was refluxed for one-half hour, quenched and processed as described in experiment IA to give 44.2 g. (88%) of diphenyltrifluoromethylcarbinol, b.p. 109–110° at 1.5 mm., m.p. 74–74.7°. Similar sized runs with methyl perfluoropropionate and methyl perfluoro-*n*-butyrate gave 52.5 g. (87%) of diphenylperfluoroethylcarbinol and 59.2 g. (84%) of diphenylperfluoro-*n*-propylcarbinol, respectively.

III. **Ketones and Carbinols from Methyl Perfluoroalkanoates and Phenyllithium.** (A) **Addition of Phenyllithium (One Equivalent) to Methyl Trifluoroacetate (One Equivalent) at 25° (Reverse Addition Technique).**—Phenyllithium (0.2 mole in 800 ml. of ether) was added over a period of six to eight hours to a rapidly stirred solution of methyl trifluoroacetate (25.6 g., 0.2 mole) in 300 ml. of ether maintained at 25°. The mixture was then refluxed for one-half hour, quenched and processed as described in experiment IA to give 20.1 g. (58%) of trifluoroacetophenone, b.p. 150–152°, and 2.6 g. (10%) of diphenyltrifluoromethylcarbinol, b.p. 111–113° at 2 mm., m.p. 74.0–74.5°.

(B) **Addition of Methyl Perfluoropropionate (One Equivalent) to Phenyllithium (One Equivalent) at −40° (Standard Addition Technique).**—Methyl perfluoropropionate (35.6 g., 0.2 mole), dissolved in 50 ml. of ether, was added over a one-half hour period to rapidly stirred phenyllithium (0.2 mole) cooled to −40° by a Dry Ice–ethanol slurry. The reaction mixture was then allowed to warm to room temperature, refluxed for one-half hour and processed as described in experiment IA to give 6.8 g. (15%) of phenyl perfluoroethyl ketone (b.p. 159–161°, 2,4-dinitrophenylhydrazone, m.p. 111.8–112.4°) and 13.4 g. (44%) of diphenylperfluoroethylcarbinol (b.p. 140–143° at 11 mm., m.p. 84.0–84.5°).

IV. **Preparation of 2-Picolyl Perfluoroalkyl Ketones. Synthesis of 2-Picolyl Trifluoromethyl Ketone.**—2-Picolyllithium[4,5] (0.4 mole in 800 ml. of ether) was added over a period of eight hours to a solution of methyl trifluoroacetate (25.6 g., 0.2 mole) in 300 ml. of ether maintained at 25°. The reaction mixture was refluxed for one-half hour and then quenched by pouring onto a mixture of ice and concentrated hydrochloric acid. The aqueous phase was made strongly basic by means of 20% sodium hydroxide solution, extracted several times with ether and the combined extracts dried over sodium sulfate. After removing the solvent and recovered 2-picoline, the residue solidified. In this way there was obtained 33.8 g. (89%) of 2-picolyl trifluoromethyl ketone (m.p. 113–113.4° (from 60–70° petroleum ether). *Anal.* Calcd. for $C_8H_6NOF_3$: N, 7.41. Found: N, 7.61). The ketone gave a copper salt, m.p. 219.5–220° (from 95% ethanol) when treated with aqueous copper(II) acetate solution.

From similar sized runs involving methyl perfluoropropionate and methyl perfluoro-*n*-butyrate the following ketones were obtained: 2-picolyl perfluoroethyl ketone (39.4 g., 83%, m.p. 98–98.8° (from 60–70° petroleum ether). *Anal.* Calcd. for $C_9H_6NOF_5$: N, 5.86. Found: N, 5.81; copper salt, m.p. 180.2–180.6° (from 95% ethanol)) and 2-picolyl perfluoro-*n*-propyl ketone (49.9 g., 87%, m.p. 92–92.4° (from 60–70° petroleum ether). *Anal.* Calcd. for $C_{10}H_6ONF_7$: N, 4.84. Found: N, 4.87; copper salt, m.p. 151–152° (from 95% ethanol)).

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The Friedel–Crafts Condensation between γ-Valerolactone and Toluene

BY DONALD D. PHILLIPS

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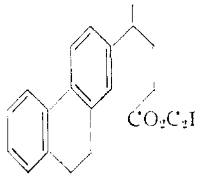
We recently[1] reported a convenient preparation of ester I by the Friedel–Crafts condensation of γ-valerolactone and 9,10-dihydrophenanthrene. That the alkylation had occurred *para* to the biphenyl-type link was established by an independent synthesis of I. We have read with some interest the report[2] that a similar condensation between γ-valerolactone and toluene gave exclusively the *meta* isomer, γ-(*m*-tolyl)-valeric acid (II). In view of the fact that we wish to use this reaction between γ-valerolactone and various aromatics for the synthesis of picenes of unambiguous structure, we felt it necessary to check the reaction with toluene and establish unequivocally the orientation in the product.



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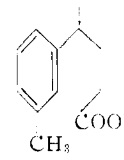
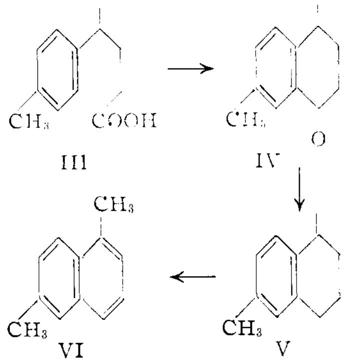


II

In our hands the condensation invariably resulted in the formation of the expected *para* isomer, γ-(*p*-tolyl)-valeric acid (III), and none of the reported[2] *meta* product could be obtained. At higher temperatures the yield of III was only slightly affected and the addition of excess aluminum chloride resulted merely in the formation of substantial amounts of the cyclized product IV.

The orientation in III was established by oxidation to terephthalic acid (isolated as the dimethyl ester) and by its conversion through the corresponding tetralone (IV) and tetralin (V) to 1,6-dimethylnaphthalene (VI). The infrared absorption spectrum of VI was identical to that of an authentic



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[1] D. D. Phillips and E. J. McWhorter, THIS JOURNAL, **76**, 4948 (1954).

[2] N. Chaudhuri, *Science and Culture*, **18**, 442 (1953).