Annual Review of Literature on Fats, Oils, and Soaps. II.

REPORT OF THE LITERATURE REVIEW COMMITTEE *

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Physiology and Biochemistry

Reviews. The subjects of general discussion and review articles pertinent to this division are: fats to energy (Lehninger—*J. Agr. & Food Chem. 1,* 1194), lipide metabolism (Artom—*Ann. Rev. Biochem. 22,* 211), biochemistry of the fats (Kaufmann—*Fette u. Seifen 55,* 673; *Grasas y aceites 3,* 5), synthesis of fatty acids and fats in ripening oilseeds (Hilditch—*Chemistry & Industry 1953,* 320), mechanism of fatty acid oxidation and synthesis, and carbon dioxide fixation (Lardy—*Proc. Natl. Acad. Sci. U. S. 38,* 1003), polymerized marine animal oils as edible oils (Täufel—*Fette u. Seifen 54,* 689), clinical use of fat injected intravenously (Italic *et al.*—*Arch. Internal Med. 89,* 353), investigations on carbohydrate, fat and protein metabolism with radioactive and stable isotopes (Müller & Niklas—*Deut. Z. Verdauungs- u. Stoffwecksellcrankh. 12,* 293), fat synthesis from small molecules (Popjak—*Biochem. Soc. Symposia 1952,* 37), mechanism of synthesis and destruction of fatty acids (Martins—*Fette u. Seifen 55,* 1), biological oxidations (Slater—*Ann. Rev. Biochem. 22,* 17), fatty acid catabolism and the citric acid cycle (Breusch—*2nd Congr. intern. biochim. Chim. biol. III, Paris, 1952,* 35), composition of natural fats (Kartha—*J. Sci. Ind. Res. India, 11A,* 354; *12A,* 126, 242), body fat in adult man (Keys & Brozek—*Physiol. Rev. 33,* 245), essential fatty acids and their relation to pyridoxine (Sinclair—*Biochem. Soc. Symposia No. 9,* 80), chemistry and metabolism of the essential fatty acids (Abu-Nasr & Holman—*Ann. Rept. Hormel Inst. 1951-52,* 34), fat soluble vitamins (Baumann—*Ann. Rev. Biochem. 22,* 527), researches on the composition of animal fats in New Zealand (Shorland—*J. Sci. Food & Agric. 4,* 497), defective fat absorption in man (French—*Biochem. Soc. Symposia No. 9,* 30), fat embolism (Denman & Gragg—*Arch. Surg. 57,* 525), arteriosclerosis and cholesterol metabolism (Schettler—*Deut. med. Wochschr. 78,* 989), and obesity (Mayer—*Physiol. Revs. 33,* 472).

Fat Nutrition. The fat nutrition problems studied pertain to desirability in the diet, amount compatible with good nutrition, essential fatty acids, nutritive value, and relationships to other dietary constituents.

Rats fed 22.7% fat diets grew as rapidly as rats consuming high carbohydrate diets (3-4% fat) although they consumed 4.8-5.7% less calories (French *et al.*—*J. Nutr. 51,* 329). This increase in efficiency of utilization of diet was also associated with a decrease in life span. Increased efficiency of feed utilization on adding fats to diets was also demonstrated with steers (Willey *et al.*—*J. Animal Sci. 11,* 705) and with poultry (Pepper *et al.*—*Poultry Sci. 32,* 1084). Another study with rats showed that a 40% fat ration in comparison with isocaloric rations with 5% fat produces better weight gains at either room temperature or near freezing (Page & Babineau—*Can. J. Med. Sci. 31,* 22). Another test on chicks indicated that rations with added fat are equal to basal diet without fat (Seidler & Schweigert—*Poultry Sci. 32,* 449). Experiments on raising baby pigs with synthetic milks containing zero to 30% fat levels showed that best growth is at about 10% fat and at zero fat level all the pigs die (Nelson *et al.*—*J. Animal Sci. 12,* 771).

Calves have shown no ill effects from consuming homogenized milk containing 3.5% of vegetable oil for a period of over 45 days; but complete substitution of butterfat with the oil results in depletion of vitamin A and tocopherol in the blood plasma and causes various syndromes which are not corrected with vitamin B complex, antibiotics, tocopherols, grains or choline (Gullickson *et al.*—*J. Dairy Sci. 36,* 599). In tests on effect of reconstituting skim milk with various fats and oils, it was found that the total lipides of the plasma in calves was highest with either whole milk or soybean oil reconstituted milk, lowest with hydrogenated fat, and intermediate with milks reconstituted from butter oil and lard (Jacobson *et al.*—*Ibid.* 832).

A substitute milk, for feeding calves, made by replacing 80% whole milk with a whey product plus fat caused only slight reduction in growth and a slight tendency to diarrhea; even complete replacement of whole milk without decrease in growth is possible but tendency to diarrhea increases considerably (Young—*Ibid.* 600).

High fat, high calorie emulsions as the sole diet have been developed for oral feeding of selected patients (Kuhl *et al.*—*J. Clin. Nutr. 1,* 218). The efficiency (bicycle ergometer test) of four adult Japanese, accustomed to less than 10% of their calories as fat was not reduced with diets supplying 32-82% of the calories as fat (Kawakami *et al.*—*Hyogo J. Med. Sci. 1,* No. 2, 51).

In spite of the beneficial results produced by fat in lowering the mortality rate of rats following exposure to x-irradiation no concomitant improvement is evident in other x-irradiation injuries such as lower hemoglobin level or leukocyte count (Cheng *et al.*—*J. Nutr. 48,* 161). Deuel, Jr. *et al.* (*Science 117,* 254) suggests that the x-irradiation protection mechanism of fats may be due to epidermal metabolism, because other protectants, such as, cystine, ascorbic acid, and vitamin P also have favorable action in the nutrition of the skin. Blood coagulation defects following total body x-irradiation in the dog are partially relieved by intravenous infusion of 2.5% solutions of soybean phosphatide (White *et al.*—*Proc. Soc. Exptl. Biol. Med. 83,* 384).

Several investigators used rat growth as a measure of nutritive value of fats. Accordingly, Nieman *et al.* (*Proc. Koninkl. Ned. Akad. Wetenschap. 55C,* 587, 598, 605) found rats to grow exceedingly well when the dietary fat was butterfat produced from dairy cows maintained on May grasses. Sunflower oil containing its natural phosphatides induced better growth than refined phosphatide-free oil (Buckman—*Masloboino Zhirovaya Prom. 18,* No. 4, 9). Ethyl esters of the fatty acids derived in the production of fatty alcohol from spermaceti were shown to be as nutritious as soybean oil (Akiya—*J. Japan,*

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Soc. Food & Nutr. 3, 153). Isoöleic acid derived from partially hydrogenated peanut oil was metabolized as well as normal oleic acid (Phatak & Patwardhan—*J. Sci. Ind. Res., India 11B,* 533).

The food value of fish oils as measured by *in vitro* digestion experiments (Sasaki *et al.*—*J. Japan Soc. Food & Nutr. 3,* 139) and growth of rats (Higashi & Kaneda—*Bull. Japan Soc. Sci. Fisheries 16,* 311) was lowered by deodorization with the aeration processes. Japanese margarine is poorer than butter for supporting reproduction in the mouse (Mori—*Med. & Biol. Japan 26,* 124). The severe muscular dystrophy that develops in calves given cod liver oil is attributed to a general effect of polyunsaturation (Blaxter *et al.*—*Brit. J. Nutr. 7,* 287).

The nature of a "vitamin A-like factor" in lard was studied by two laboratories. Lowe & Morton (*Biochem. J. 55,* 681) did not detect A, but Herb *et al.* (*J. Nutr. 51,* 393) did. The latter group attributed the vitamin A activity of lard to hitherto unrecognized typical vitamin A. Wheat germ oil and oleic acid concentrates appeared quite potent in a "vegetable oil factor" required for maximum growth of chicks (Carver & Johnson—*Poultry Sci. 32,* 701). Fat is essential to dogs to prevent abnormal appearance of the skin and hair, and to decrease susceptibility to infection (Hansen *et al.*—*Texas Repts. Biol. Med. 9,* 491, 516, 545, 555). An abnormal amount of fat formation from carbohydrates in rats fed a fat-deficient diet was markedly decreased by feeding a small amount of tartronic acid (Wesson—*Endricrinology 47,* 302).

Hansen & Wiese (*Am. J. Dis. Children, 86,* 322) suggest that evaluation of nutritional requirements of infants and children for the essential fat be based on determination of the blood levels of linoleic and arachidonic acids. The action of arachidonic acid is more effective than linoleic or linolenic acids in reëstablishing hepatic lipase deficiencies which occurred in essential fat deficiency (Saka & Sipahioglu—*Am. J. Physiol. 174,* 49). In essential fat deficiency the hexaene acids of the brain phospholipides decrease, whereas in the liver, kidney, and carcass di-, tetra-, penta-, and hexaene decrease and the triene contents vary only slightly (Beauvallet & May—*Rev. can. biol. 12,* 6; *J. Physiol. Paris, 44,* 210). Newly observed symptoms, or pathological conditions developing, during essential fat deficiencies involve the profuse secretion of cerumen in hamsters (Christensen & Dam—*Acta Physiol. Scand. 27,* 204) and abnormally low capillary resistance in rats (Kramer & Levine—*J. Nutr. 50,* 149). The skin changes in rats maintained on essential fatty acid deficient diets were similar to those seen in phrynoderma in man, but this was not the case in either vitamin A or pyridoxine deficiencies (Ramalingaswami & Sinclair—*Brit. J. Dermatol. 65,* 1).

A 20% corn oil, potassium deficient diet produces the typical potassium deficiency symptoms as well as greater myocardial necrosis and fibrosis than an isocaloric 5% corn-oil diet containing same amount of potassium (Perdue & Phillips—*Proc. Soc. Exptl. Biol. Med. 81,* 405). Lack of fat in the diet lowered utilization of dietary calcium (Rao & De—*Indian J. Med. Res. 40,* 235). Calcium metabolism is not significantly different in isocaloric diets containing 45, 91, and 135 grams of fat, respectively (Fuqua & Patton—*J. Am. Diet Assoc. 29,* 1010). An increase in adrenal cholesterol in rats fed rapeseed oil was shown to be produced from the erucic acid which the oil contained (Carroll—*J. Biol. Chem. 200,* 287).

Tests to confirm an alleged growth effect of detergents in livestock feed show that 0.20% alkyl benzene sulfonate in pig rations increases growth rate whereas levels of 0.10 or 0.40% are ineffective (Beeson—*J. Animal Sci. 12,* 619), whereas with poultry no growth effect was observed in tests at any level for many detergents (Stern & McGinnis—*Poultry Sci. 32,* 26).

FAT ABSORPTION. Tests with infant food show that mono- and diglyceride emulsifiers improve the amount of fat absorbed but do not influence the rate of absorption (Sager—*Z. Kinderheilk. 71,* 541). A commercial emulsifier, "Tween 80," accelerates absorption of butterfat in man as measured by time required to reach peaks in concentration of lipides in serum after ingestion of 50 grams of the fat (Brien *et al.*—*Gastroenterology 20,* 287). Intestinal absorption of fat-soluble vitamins appears to be related to the fat intake, but when fat absorption is impaired the absorption of fat soluble vitamins may be induced by administration in aqueous dispersions (Pomeranze & Lucarello—*J. Lab. & Clin. Med. 42,* 700). However, another study indicated that the use of aqueous emulsions improves absorption of carotene, but not tocopherol (Hebert & Morgan—*J. Nutr. 50,* 175).

The course of hydrolysis of triglycerides in the rat and dog was studied using microtechniques to follow liberation of free acids, diglycerides, monoglycerides and glycerol (Desnuelle & Constantin—*Biochim. et Biophys. Acta 9,* 531). The data were interpreted to indicate that fatty acids and partial glycerides are absorbed simultaneously.

In studies on the effect of the absence of bile and pancreatic juice, Pessoa *et al.* (*Am. J. Physiol. 174,* 209), found that neither was indispensable for absorption of fats or fatty acid; furthermore, the absence of either one resulted in the secretion of endogenous fat in the intestines. Bernhard & Ritzel (*Helv. Physiol. et Pharmacol. Acta 11,* 166) from similar work suggested that blocking of the secretion of endogenous fat in the intestine is an important but hitherto unknown function of bile. Also, in absence of bile, only one fourth as much absorbed fat is transported via the lymphatic pathway as compared to normal conditions (Bergström—*Acta Physiol. Scand. 28,* 279). Other work on the relationship between pancreatic juice and fat metabolism includes the records of the activity of pancreatic lipase on dietary fats (Shimizu—*J. Japan. Biochem. Soc. 23,* 103), as well as the behavior of two pancreatic esterases towards various fatty acids (Hofstee—*J. Biol. Chem. 199,* 357, 365).

Borgström's (*Acta Physiol. 25,* 291, 315) studies in which carboxyl labeled fatty material is traced during absorption show: (1) free fatty acids leave the stomach slower than glycerides; (2) fat appearance in the lymph from ingested fatty acid is more prolonged but to the same total extent as from ingested glycerides; (3) the lymph phospholipides increase during fat absorption but are partly derived from plasma lipides; and (4) the longer chain acids of C_{14} to C_{18} acid mixtures are incorporated in phospholipides to a greater extent than the short. Using a similar technique to study precursors for triglycerides during intestinal absorption, Reiser & Williams (*J. Biol. Chem. 202,* 815) found that monoglycerides, or fatty acid esters of dihydroxyacetone, fed as such, were 73% hydrolyzed and appear in the lymph as triglycerides. This hydrolysis and synthesis of triglycerides is believed to take place in the intestinal mucosa. Label technique with deuterium was used to demonstrate that neither free glycerol nor glycerophosphate is a significant precursor of the lipides of the intestines (Buensod *et al.*—*Helv. Physiol. et Pharmacol. Acta 11,* 45).

In studies on fat fed intravenously, Waddell *et al.* (*Am. J. Physiol. 174,* 39; *175,* 299) found that clearance from the blood is influenced most by the emulsifying agent used, and that while the liver and spleen remove a major portion of such fat, other tissues are capable of removing only small quantities. Arrigo & Pontremoli (*Arch., E. Maragliano patol. e clin. 7,* 391) using intravenous injections of emulsified coconut oil observed that liver, kidney, and muscle effect the resynthesis of fats whereas lungs and blood have a function of accumulation and passive transport, respectively. Ingested radioactive iodine labeled fat reaches a maximum in blood in six hours (has half life of 16-22 hours), then most is deposited in fat depots and liver (Hoffmann—*J. Lab. Clin. Med. 41,* 521). Intravenously administered egg yolk phospholipides disappear from the blood stream of dog at a half time rate of 6-8 hours, and deposit in the liver with smaller amounts going to lung or spleen (Zilversmit—*Arch. Biochem. & Biophys. 46,* 261).

INTERMEDIATE METABOLISM. Much of the work on intermediate metabolism of fats pertains to behavior of fat in the liver. Administration of 6% gelatin, 2% casein, or 0.18% DL-threonine with a casein-sucrose fatty-liver producing ration effectively reduced the accumulation of liver fat (Harper *et al.*—*J. Nutr. 50,* 383). In this work glycine, serine, glycocyamine, choline, and betaine were less efficient. Suboptimal intake of lysine and threonine resulted in fatty livers in rats held on low-protein or low amino acid rations (Singal *et al.*—*J. Biol. Chem. 200,* 867). In such cases choline and methionine are lipotropic with protein but less effective with amino acid diets. Fat was removed from protein-deficient fatty livers by the adequate intake of choline, but this cure did not influence the liver cell damage (Koch-Weser *et al.*—*J. Nutr. 49,* 443). Development of fatty liver in dogs because of hypophysectomy-thyroidectomy was prevented by administering two grams of methionine or 25 grams of pancreas (Feinberg *et al.*—*Proc. Soc. Exptl. Biol. Med. 81,* 729). Observations on the low oxidase activity of fatty livers of choline-deficient animals were discussed with regard to the lipotropic effect of choline as being due to an increased rate of fatty oxidation (Artom—*J. Biol. Chem. 205,* 101, *Nature 171,* 347; Humoller & Zimmerman—*Am. J. Physiol. 174,* 199; van Hung—*J. Physiol., Paris 45,* 154).

Some of the work on biological oxidation of fats deals with the enzymes involved and factors which affect their activity. Lynen *et al.* (*Angew. Chem. 64,* 687) identified and isolated a β-keto-hydrase and a β-keto-thiolase, that are active in fatty acid metabolisms. The fatty acid activating enzyme which in the presence of coenzyme and adenosine triphosphate catalyzes the formation of acyl coenzyme A from a wide variety of fatty acids during oxidation has been obtained from beef liver in a highly purified form (Mahler *et al.*—*J. Biol. Chem. 204*, 453; Drysdale & Lardy—*Ibid. 202*, 119). This oxidation system requires the co-oxidation of an intermediate of the citric acid cycle (Judah & Rees—*Biochem. J. 55*, 664), and these intermediates may overcome the oxidation blocking action of malonates (Cheldelin & Beinert — *Biochim. et Biophys. Acta 9*, 661). Fasting accelerates fatty acid oxidation in surviving liver slices but not in kidney slices (Geyer *et al.*—*J. Biol. Chem. 200*, 271). Potassium and lithium greatly increase the fat oxidation by liver, whereas the former only increases the metabolism in kidney (*Ibid. 205*, 81). Adrenaline catalyzes oxidation of fatty acids by liver homogenates (Harel-Ceddaha—*Compt. rend. 236*, 2114).

All tissues, including brain and skeletal muscle oxidize endogenous fat *in vitro* (Volk—*J. Biol. Chem. 195*, 493). This was demonstrated by administering labeled palmitic acid to fasted rats and removing various tissues thereafter for respiration tests. Fatty acids containing a triple bond are split at this bond when biologically oxidized *in vivo* (Bernhard & Gloor—*Helv. chim. acta 36*, 296).

Clément & May (*J. Physiol., Paris, 45*, 79) demonstrated that fat containing conjugated double bonds, such as tung oil (75% eleostearic acid), can aid in tracing the metabolism of lipides. The development in the organism of a triethenoid conjugated from conjugated tetraethenoid acid was discovered in this work. Mead *et al.* (*J. Biol. Chem. 205*, 683) developed evidence to confirm the belief that linoleic acid is not synthesized by weanling rats; however, arachidonic acid may develop from linoleic acid by the addition of a two-carbon fragment.

When labeled acetate is injected intraperitoneally in rats, maximum incorporation into fatty acids and cholesterol occurs in 30 minutes (van Bruggen—*Ibid. 200*, 31. This information was developed to serve in planning and interpreting biological studies. A significant positive correlation was found between the initial concentration of glycogen and the ability of liver slices to synthesize fatty acids from acetate (Haugaard & Stadie—*Ibid. 199*, 741). According to Brady *et al.*—*Ibid.* 421) aerobic synthesis of fat with liver enzymes is stimulated with magnesium, diphosphopyridine nucleotide, cytochrome c, and citrate, whereas calcium and fluorine are inhibitory. Anaerobically the inhibitory materials cause only a moderate depression in rate. Incorporation of labeled phosphate into the lipides of the brain required oxidizable substrate, phosphate acceptor, magnesium ion, and cytochrome c, and is greatly accelerated by presence of fluoride ions (Dawson—*Biochem. J. 55*, 507). Hypertonic media, low calcium ion concentration and glucose inhibited the action. Hyperthyroid rats, prefed high carbohydrate, low fat diets, incorporated acetate into fatty acids at the same low range as is displayed by fasted normal rats (Spirtes *et al.*—*J. Biol. Chem. 204*, 705). Diabetic rats were restored to normal with respect to fatty acid formation from acetoacetate by insulin injection (Chen *et al.*—*Ibid. 205*, 383). The synthesis of phospholipides by livers from choline-deficient dogs is stimulated by administration of choline (DiLuzio & Zilversmit—*Ibid.* 867). In this work synthesis of fat was not affected by choline deficiency or the addition of choline *in-vitro*. Some data have been recorded in preliminary work on determining the optimum conditions for formation of radioactive cholesterol and fatty acids from labeled acetate by rat liver homogenates (Bucher—*J. Am. Chem. Soc. 75*, 498).

Living yeast and rat liver show a parallelism between coenzyme A levels and capacity to synthesize sterols and total lipides (Klein & Lipmann—*J. Biol. Chem. 203*, 95, 101). During liver respiration the C_5 to C_{22} acids including mono-, di-, and trienoic C_{18} acids are converted to corresponding acyl coenzyme A derivatives, but C_2 to C_3 monoacids and C_8, C_9, and C_{10} dicarboxylic acids do not take part in this reaction (Kornberg & Pricer—*J. Biol. Chem. 204*, 329). The acyl coenzymes A esterify α-glycerolphosphate in absence of adenosine triphosphate, conenzyme A, or fatty acid; but esterification of the free fatty acid requires the presence of both coenzyme A and adenosine triphosphate (*Ibid.* 345).

Studies on the seasonal variation in the composition of groper liver oil showed increases in vitamin A, cholesterol, unsaponifiable, and phospholipides after spawning when total oil content decreases. This is interpreted to indicate that fat is mobilized but other lipides are not (Shorland—*Biochem. J. 54*, 673).

From studies on synthesis of butter fat, Kleiber *et al.* (*J. Biol. Chem. 195*, 707; *197*, 365, 371; *203*, 339) demonstrated that carbonate, acetate, or propionate can be precursors; and Balmain *et al.* (*Nature 168*, 1083) found that acetate and glucose conversion to fat in mammary tissue was accelerated by insulin.

CHOLESTEROL METABOLISM. Results from different studies on the factors influencing cholesterol absorption did not seem quite consistent. Kim & Ivy (*Am. J. Physiol. 171*, 302) reported that oleic acid facilitates absorption to a greater extent than corn oil, and the inclusion of cholic acid further aids cholesterol uptake of the acid. Swell & Frich (*Ibid. 174*, 51) studies indicate that presence of free fatty acids in the diet decrease whereas lard increases cholesterol absorption. Kinsell *et al.* (*J. Clin. Nutr. 1*, 224; *J. Clin. Endrinol. and Metabolism 12*, 909) recommend diets high in vegetable oils to reduce serum cholesterol and phospholipides. Among other studies cholic acid (Roseman *et al.*—*Am. J. Physiol. 175*, 307), and combinations of choline and inositol facilitated absorption of cholesterol; and soybean sterols (Hernandez *et al.*—*Proc. Soc. Exptl. Biol. Med. 83*, 498; Peterson *et al.*—*J. Nutr. 50*, 191), adenosine 5-monophosphate (Calhoun *et al.*—*Texas Repts. Biol. Med. 11*, 207), and powdered thyroid (Weiss *et al.*—*Endocrinology 50*, 192) significantly decreased absorption or decreased amount of cholesterol in serum and liver. Feeding rats rape seed oil increases the cholesterol content of the adrenals and liver, but not in various other tissues or in the blood (Carroll—*Endocrinology 48*, 101).

Cholesterol fatty livers were produced in rats by feeding a 5% cholesterol diet for six months (Clément *et al.*—*J. Physiol., Paris, 45*, 76). In this and other work distribution and composition of the lipides in the various cells were determined (Clement *et al.*—*Compt. rend. 234*, 2006; Schotz *et al.*—*J. Biol. Chem. 204;* Rice *et al.*—*Ibid. 201*, 867).

High sebum-cholesterol values were found in children up to 14 years of age (Lincke—*Arch. Dermatol. u. Syphilis 195*, 540). X-ray diffraction patterns of myelin indicated a structure involving alternate layers of phospholipide-cholesterol complex and nonlipide material (Finean—*Experientia 9*, 17).

Injected labeled sodium acetate is continuously incorporated into cholesterol of fertile hens' eggs during the latter half of incubation (Stokes *et al.*—*J. Biol. Chem. 200*, 683). Liver from hypophysectomized rats incorporated acetate in cholesterol at a much slower rate than livers from normal rats (Tomkins *et al.*—*Ibid. 199*, 543). The rate in normal surviving liver is markedly greater at pH 6.0-7.2 than at 7.2-7.4 (Curran—*Ibid. 200*, 17). An observation that prefeeding of cholesterol reduces ability of surviving liver of rats to synthesize cholesterol from acetate has suggested that synthesis in the liver is under homostatic regulation by dietary cholesterol (Tomkins *et al.*—*Ibid. 201*, 137). In similar tests dietary dehydroisoandrosterone, 7-dehydrocholesterol, and cholestenol reduced ability of the liver to form cholesterol from labeled acetate without affecting conversion to carbon dioxide (*Ibid. 203*, 781). This reduction in ability to convert acetate to cholesterol of the above mentioned compounds and also squalene is not accompanied with an increase in the total quantity of liver cholesterol (Langdon & Block—*Ibid. 202*, 77). A method of degrading cholesterol to study positions of carbon atoms derived from carbon-labeled acetate was developed by Cornforth *et al.* (*Biochem. J. 54*, 590, 597). This work showed that carbons 2, 4, 6, and 10 are derived from carboxy-carbon and carbon atoms 1, 3, 5, and 19 from the methyl-carbon of acetate. Schwenk *et al.* (*Arch. Biochem. Biophys. 37*, 247; *40*, 334) isolated 3β-,5α-dihydroxy-6-oxocholestane from commercial cholesterol, and designed a procedure for concentrating carbon-14 cholesterol from perfusions of livers and other organs. Other work on biosynthesis of cholesterol showed that squalene is a precursor in the process (Tomkins *et al.*—*J. Am. Chem. Soc. 74*, 6145; *J. Biol. Chem. 202*, 487; Langdon & Bloch—*J. Biol. Chem. 200*, 129, 135; Woodward & Bloch—*J. Am. Chem. Soc. 75*, 2023).

A study on oxidation of cholesterol with carbon labeled material shows that the 4-carbon is eliminated from the body in feces; the 26-carbon is mostly expired in the air as carbon dioxide with a small amount going into the intestines; in surviving liver slices and other tissue most of the 26-carbon is converted to carbon dioxide; and bile is an obligatory requirement for passage of cholesterol from the intestinal tract to the lymph (Siperstein *et al.*—*J. Biol. Chem. 198*, 93, 105, 111).

LIPIDE METABOLISM IN DISEASE. Several investigators suggest that a low fat and low cholesterol intake aids in the control of atherosclerosis and arteriosclerosis (Steiner—*J. Kentucky State Med. Soc. 51*, 359; Morrison—*Ann. Internal Med. 37*, 1172; *Reeves*—*Am. J. Dig. Diseases 20*, 286). However, one study on 24 elderly patients with diabetes and advanced arteriosclerosis indicated that there is no correlation between total cholesterol, or its esters, phospholipides, or lipoproteins of the serum and severity or progress of the arteriosclerotic process (Kinsell *et al.*—*Calif. Med. 77*, 5). They also found that intake of a large amount of vegetable oil by patients reduces serum cholesterol esters and phospholipides. Feeding of squalene, a precursor of cholesterol, to rabbits neither increased atheromas nor increased aortic plaques which are associated with arteriosclerosis (Kritchevsky *et al.*—*Arch. Biochem. Biophys. 44*, 241).

The methods proposed for control of atherosclerosis or associated abnormal pathology are: feeding ferric chloride which inhibits absorption of ingested cholesterol (Siperstein *et al.*—*Science 117*, 386); feeding dihydrocholesterol (Siperstein *et al.*—*Circulation 7*, 37); injecting hyaluronidase (Seifter *et al.*—*Proc. Soc. Exptl. Biol. Med. 83*, 468); administration of inositol (Felch *et al.*—*Am. Heart J. 44*, 390); combinations of lipotropic agents (Morrison *et al.*—*Angiology 4*, 123, 130); a certain fraction of cholesterol-extracted crude brain (Gordon *et al.*—*J. Lab. Clin. Med. 4*, 583), all of which suppress hypercholestrolemia; or administration of sitosterol (Pollak—*Circulation 7*, 696) which inhibits absorption of cholesterol by forming separable crystal complexes. Tests showed that α-tocopherol does not provide a beneficial adjunct in the prophylaxis of atherosclerosis (Moses *et al.*—*Angiology 3*, 397).

Morrison *et al.*—(*J. Lab. Clin. Med. 39*, 550) reported that normal subjects and patients suffering from noncoronary diseases had a serum phospholipide-cholesterol ratio of more than one while most of those with proven coronary thrombosis had a ratio of less than one. However, Jackson and Wilkinson, Jr. (*J. Am. Geriatrics Soc. 1*, 447) believe that the lower average ratio found in certain disease states are the result of their average hypercholesterolemia and are not unique to those diseases related to atherosclerosis. High serum cholesterol is very common in arteriosclerotic arteritic patients but its degree shows no relation to age or the severity of the vascular lesions (Fontaine *et al.*—*Quaderni sci. Smeraldo No. 13-14*, 3). Page & Brown (*Circulation 6*, 681) believe that high resistance to atherosclerosis in rats is due to a lack of tissue response to the infiltrating lipides.

Other work on atherosclerosis pertained to the lipoprotein abnormality in the disease. Barbagallo-Sangiorgi & Caiozzo (*Policlinico, Sez. med. 59*, 342) attributed the disease to a liability of bonds between lipides and proteins. Data presented by Keys (*J. Gerontol. 7*, 201) showed that the trends in serum cholesterol and abnormally large lipoproteins are: to be low in early adulthood, rise to a maximum in the fifties, and show lower values in the sixties. These data are developed to serve as a basis for comparison with diseased states. The large lipoprotein content of the serums of patients with rapidly progressive multiple sclerosis was higher than in 82% of normal subjects; whereas, patients with less active disease had normal amounts (Arid *et al.*—*Neurology 3*, 22). Thermal injury increases serum cholesterol and large lipoprotein levels (Redmond *et al.*—*J. Lab. Clin. Med. 42*, 112).

Increase of large particles in blood was related by Marder *et al.* (*Gastroenterology 20*, 43) to the relative degree of hydrolysis and they believe that additional lipase may alter the size. Plasma esterases have been found responsible for the fatty acid formation which occurs during clearing (Brown *et al.*—*J. Biol. Chem. 204*, 423). Because reduction of large low density lipoproteins occurs on treatment with heparin also suggests that enzymes play a part in conversion of lipoprotein (Boyle *et al.*—*Proc. Soc. Exptl. Biol. Med. 81*, 475). Nikkila (*Scand. J. Clin. & Lab. Invest. 4*, 369) developed data on conversion of low density to high density lipoproteins and discussed the findings with regard to the large lipoproteins occurring in atherosclerosis.

Administered estrogens generally lower serum cholesterol, total lipides, and large low density lipoproteins (Barr *et al.*—*Trans. Assoc. Am. Physicians 65*, 102; Marett & Vivas—*U. S. Armed Forces Med. J. 4*, 1439).

A simple analytical method involving paper electrophoresis was devised to study the lipoproteins of atherosclerotic patients (Raynaud *et al.*—*Bull. mens. soc. med. hop., Paris 69*, 394). Ultracentrifugal lipoprotein patterns of the serums of many normal, hypertensive, and hypothyroid animals of various species and chickens were recorded and discussed with regard to hypertension (Lewis *et al.*—*Am. J. Physiol. 171*, 391).

Fatty infiltration of the liver of alcoholics is inhibited by administration of choline (Post *et al.*—*Gastroenterology 20*, 403). In rats administration of ethyl alcohol causes an increase and methyl alcohol a decrease of liver fat; whereas, with guinea pigs the reverse happens (Eger & Zündorf—*Med. Monatsschr. 7*, 420). In cirrhotic patients with fatty infiltration of the liver a single large dose of choline or methionine increases the turnover of phospholipides; whereas, in normal persons such an effect is not evident (Cayer & Cornatzer—*Gastroenterology 20*, 385). Albino rats born in a laboratory at 3,990 meters elevation developed a fatty degeneration of liver during the first three days of life and most of them died (Chiodo & Sammartino—*Acta Physiol. Latinoamer. 2*, 229). Copper as colloidal copper or a salt given intraperitoneally prevented liver lipidosis in rats due to arsenic (Ciaccio & Petrell—*Boll. soc. ital. biol. sper. 28*, 131). In fatty degeneration of liver caused by administration of carbon tetrachloride, administration of choline, inositol, or methionine (Hartmann *et al.*—*Nawnyn-Schmiedebergs Arch. exptl. Pathol. u. Pharmakol. 212*, 167; *217*, 98; Hartman—*Helv. Med. Acta 17*, 407) did not reduce fatty liver development but accelerated removal of neutral fat from the liver and the restoration toward normal of the plasma phospholipides. Reabsorption of fat from fatty livers caused by carbon tetrachloride administration is more rapid in animals fed lard than in others fed oil (Bonomi—*Boll. soc. ital. biol. sper. 28*, 1332). Fatty livers may occur following aureomycin and terramycin therapy in chronic hepatic diseases (Shorov & Sutherland—*Gastroenterology 18*, 598). A development of fatty livers which follows the administration of ethionine to fasted rats is inhibited by adrenalectomy (Wool & Goldstein—*Am. J. Physiol. 175*, 303). This observation was discussed with regard to the adrenals as factors in fat mobilization.

Diseases characterized by severe jaundice are attended with a high inverse relation between percentage of serum cholesterol and serum bilirubin (Zieve—*J. Lab. Clin. Med. 42*, 134; Guilini & Pace—*Arch. sci med. 95*, 491). A hypolipemia encountered in non-jaundiced malignant livers is thought to be the result of decreased neutral fats, liver destruction, and malnutrition (Goldbloom *et al.*—*Am. J. Dig. Diseases 20*, 354). In obstructive jaundice and acute cholangitis the lipide phosphorus level in the plasma increases (Bonelli—*Minerva med. 1953*, [*I*] 1569). Liver phospholipide turnover in patients with acute hepatites was not increased in five out of six cases by large doses of choline or methionine (Cayer & Cornatzer—*Gastroenterology, 18*, 79). During progress of carcinogenesis in liver, oxidation of fatty acids therein is abolished (Waterman *et al.*—*Enzymologia 15*, 307).

The observation that patients with celiac disease absorb unsaturated acid but not saturated acids has suggested that the diseases appear not to be concerned primarily with a disturbed absorption but a defect in intermediary metabolism (Weijers & van de Kamer—*Centraal Inst. Voedingsonderzoek T.N.O. No. 113*, 9). In 45 children with various forms of tuberculosis the decreased unsaturated-saturated fatty acid ratio was restored by streptomycin treatment (Boi—*Ann. ital. pediat. 3*, 148). The administration of thymus extracts to five children with exudative diathesis favorably influenced the equilibrium of the fatty acids in the blood (Macciotto—*Rev. clin. pediat. 51*, 754). Treatment of peptic ulcer patients by a high-fat, cholesterol diet did not cause disturbance in phospholipide, cholesterol, or other serum fractions (Goldbloom—*Gastroenterology 20*, 79). High fat diets tend to alleviate the effects of increased thyroid activity (Kennelly & Maynard—*J. Nutr. 49*, 599). Obesity caused by hypothalamic injury in rats results from reduced capacity to mobilize fat (Mankin *et al.*—*Endocrinology 47*, 443).

Mice of strains with a tendency to obesity do not increase oxygen uptake in response to greater caloric intake on a high fat diet as do other strains (Lynn, Jr. *et al.*—*J. Nutr. 51*, 65). A discussion on human obesity dealt principally with psychic aspects that induce lipophia (Pennington—*J. Clin. Nutr. 1*, 100).

High fat diets, principally saturated fats, markedly protect against the toxic and diabetogenic effects of alloxan as compared with a high carbohydrate diet (Rodriquez *et al.*—*J. Nutr. 51*, 441). In this work high fat diets rich in unsaturated fatty acids had an aggravating action. Cochrane *et al.* (*J. Clin. Nutr. 1*, 295) recommended that the fat in the diets of diabetic patients should be from vegetable sources. The oxidation rate of lipides in the surviving livers of alloxan-diabetic rats was inversely proportional to the amount of glycosuria of the rats (de Groot & de Jongh—*Sem. hôp Paris, Med. dans le monde 29*, No. 1, 23). The sugar level and normal and large lipoprotein content in the intercellular fluid in the blood of healthy and diabetic individuals of various ages has been recorded.

LIPIDES IN MICROBIOLOGY AND PLANTS. Five independent occurrences of *Neurospora* mutants requiring unsaturated fatty acids were found (Lein *et al.*—*Arch. Biochem. Biophys. 45*, 434). Four of six strains of anaerobic cocci were unaffected by presence of fatty acids; the other two grew much better and the morphology was affected by presence of fatty acids (Wildy & Hare—*J. Gen. Microbiol. 9*, 216). The oleic acid necessary for the growth of *corynebacterium Q* can be replaced by several fatty acids with either *cis* or *trans* configuration, but unsaturated acids with chain lengths either two carbon

CHARACTERISTICS OF FATS AND OILS

Oil or Fat Source	% Oil or Fat	Specific Gravity	Refr. Index	Acid No. or (% Free Fatty Acids)	Sapon. No.	Iodine No.	SCN No.	Acetyl No. or (OH No.)	R.-M. No.	Polenske No.	% Unsaponifiable	Melting Point	Misc.
Aceituno tree seed kernel[1] *Simarouba glauca*	55-65	0.908^{25}	1.4596^{40}	(0.68)	192.2	57.6			1.4	5.0	0.4	28	
Caragana arborescens seed[5]	11.8		1.4744^{25}		185.9	141.7					2.9		
Celery seed[7]	17	0.9282^{25}	1.4803^{25}	(8.6)	193.2	90.0					6.4		
Cinnamomum Camphora seed[8]	41.8	$0.9307^{23/4}$	1.4498^{23}	7.7	289.5	6.6					2.2	20-22.5	
Citrullus colocynthis seed[9]	18	$0.9200^{25/25}$	1.4741^{25}	1.77	191.6	129.1		15.1			1.01		
Coffee grounds[10]	20-25			0.27	180.7	97.6					5.84		
Filbert kernel[13]	63.7				192.3	88.1					0.5		
Fish, Skipper, white meat[14] *Cololabis saia*	7	0.9320^{13}	1.4782^{20}	2.7	195.3	128.8	74.8				0.98		
Same, red meat	15.5	0.9331^{13}	1.4771^{20}	3.5	197.8	130.4	81.2				1.11		
Hedgehog[15]													
Subcutaneous		0.9131- $0.9208^{20/4}$	1.4662- 1.4688^{26}	0.7-1.6	190.6- 195.6	55.7-63.1							
Internal body		0.9131- $0.9213^{20/4}$	1.4612- 1.4780^{20}	0.8-2.7	193.6- 197.9	59.7-66.0			6.5	0.72	0.35		
Hibiscus manihot seed[16]	10.8	$0.9321^{20/4}$	1.4750	1.52	191.5	105.9					2.11		
Hickory kernel[17]													
White	64.2			2.18	189.3	116.2							
Bitter	60.2			2.32	192.1	110.6							
Jatropha curcas seed[18]	38	0.919- 0.924^{15}	$1.468\text{-}9^{25}$	3.5-4.5	190-210	98-110					0.5-1		
Jute seed[19]													
Corchorus capsularis	15	0.923^{28}	1.4661^{25}	(8.5)	184.6	104.6		27.3	0.16		5.4		
Corchorus olitorius	15	0.9184^{28}	7.4724^{25}	(16.2)	191.7	119.2		19.8	0.21		5.0		
Kerguelen cabbage seed[20] *Pringlea antiscorbutica*	13-25.1		$1.474\text{-}5^{25}$	8.3-9.6	180-187	144.8-149.9					1.7		
Mallotus phillipinensis seed[21]	22-24	0.9347^{30}	1.5105^{30}	5.7	178.3	183.2		49.2			1.75		(CO) No. 26
Mallotus phillipinensis seed[22]	40-50			6.4	195.0	166.8		15.7					(CO) No. nil
Litsea japanica seed[24]		$0.9562^{15/4}$	1.4450^{20}	5.8	238.6	18.6					3.9		
Rock Lobster hepatopancreas[25]	7.4-21.4					157.4-171.1					3.1-8.3		
Rock Lobster gonad	4.8-11.2					146.5-186.3					4.3-9.6		
Luffa amara seed[26]	18.4	$0.9131^{30/30}$	1.4730^{25}	18.4	192.7	105.3		11.6	0.26		1.5		
Macauba fruit pulp[27] *Acrocomia sclerocarpa*	11.2	0.9126^{25}	1.4631^{25}	86.8	196.5	80.8					1.2	25	
Nasturtium seed[13]	7				158.7	74.5					3.8		
Ocimum sanctum seed[29]	17.8	0.9063^{30}	1.4789^{30}	2.0	181.7	173.0	104.6	12.1	1.2	0.2	2.3		
Onion seed[30]	18.6	0.9226^{20}	1.4773^{20}	(1.7)	193.7	117.0			0.7	0.5			
Patuaua fruit[31] *Jessenia bataua*	9.2	0.9156^{25}	1.4693^{25}	11.4	196.2	81.3		24.3			1.3		
Penicillium chrysogenum mold[32]	2.7	$0.9175^{20/4}$		58.8	176.7	89.0						10-12	
Perilla nankinensis seed[16]	27	$0.9343^{20/4}$	1.4828^{20}	2.1	195.3	191.8					1.54		
Pigeon egg yolk, dried[33]	40.4	0.9291^{26}	1.467^{26}	15.4	207.1	78.3			3.03	1.4	5.03		
Rice bran[35]		0.912- 0.913	1.455^{26}	34.1-36.4	186.2-187.6	100.0					4.3	31-36	
Rye, aleurone cells[36]	3.5			97.6	176.6						8.1		
Steculia urens tree seed kernel[40]	25	0.9143^{30}	1.4587^{30}	1.8	195.8	74.2		45.0			0.53		
Trichosanthes dioica seed[42]	29.3		1.5009^{40}	0.61	196.6	128.2					1.64		Diene No. 26.7
Humpback whale (com. oil)[43]				(1.6)	196.0	134.4					0.6		
Sperm whale meat[45]	1.6				138.0	85.6					35.3		
Sperm whale meat[45]	28				124.6	77.4					39.3		
Sperm whale milk[45]	30			0.27	185.7	161.5					0.74		
Whole wheat[46]	1.5-2.47	0.9190- 0.9231^{25}	1.4758- 1.4822^{20}		174-182	113-123							
Yerba Mate seed[47] *Ilex paraguariensis*	16.1	0.9152^{25}	1.4720^{25}	4.4	192.7	116.7		8.0			0.55		

COMPOSITION OF THE FATTY ACIDS

Oil and Fat Source	Common Saturated Acids			Common Unsaturated Acids			Other Fatty Acids
	C_{14} Myristic	C_{16} Palmitic	C_{18} Stearic	$C_{18}(-2H)$ Oleic	$C_{18}(-4H)$ Linoleic	$C_{18}(-6H)$ Linolenic	
Aceituno tree seed[1] *Simarouba glauca**		——31.7——		59.1	3.3	0.35	
Acorn[2] *Quercus alba*		10.0	2.0	48.0	——40——		
Camel mesentery[3] *Camelus bactrianus*	6.3	28.8	27.4	26.4	1.9	0.9	C_{20} 1.6, $C_{14}(-2H)$ 0.5, $C_{16}(-2H)$ 3.2, $C_{20\text{-}22}$ unsatd. 3.0
Camelina sativa seed[4]	Trace	5.2	1.8	23.9	14.5	33.4	C_{20} 1.2, C_{22} 0.6, $C_{16}(-2H)$ 2.4, $C_{20}(-2H)$ 13.8, $C_{22}(-2H)$ 3.2
Caragana aborescens seed[5]		3.1	6.2	6.2	67.1	2.3	C_{20} 1.0, C_{22} 2.9, $C_{16}(-2H)$ 0.2, $C_{20}(-2H)$ 0.2
Carum copticum seed[6]		5.3		23.9	20.1		Resin acids 2.6, petroselenic 48.1
Celery seed[7]		11.7		30.5	9.7		Petroselenic 41.1
Citrullus colocynthis seed[9]	1.2	8.9	5.6	17.2	65.0		$C_{14}(-2H)$ 0.9, $C_{16}(-2H)$ 1.2
Coffee grounds[10]		32.0	7.6	8.2	46.3		$C_{16}(-2H)$ 0.9, C_{20} and above 5.0
Deer body[3]	4.4	25.1	35.4	25.2	2.6	2.5	C_{20} 1.5, $C_{14}(-2H)$ 0.5, $C_{16}(-2H)$ 2.8
Elaeis melanococca fruit pulp[11]	1.0	32.6	4.7	47.5	12.0	0.8	C_{20} 0.5, $C_{16}(-2H)$ 0.9
Erysimum canescens seed[12]		10.5		44.0	2.0	2.4	$C_{22}(-2H)$ 29.0
Filbert kernel[13]		3.0	4.0	82.0	11.0		C_{20} and higher 1
Hickory kernel[2] *Carya cordiformis*		6.0	1.0	72.0	19.0		C_{20} and higher 0.5
Jute seed[19]							
Corchorus capsularis		12.0	4.6	28.7	41.3	4.7	C_{20} 4.4, C_{24} 0.9, C_{26} 1.2
Corchorus olitorius		16.9	3.7	9.1	62.5	0.9	C_{20} 4.0, $C_{20}(-2H)$ 1.8, C_{24} 1.1
Kerguelen cabbage seed[20]* *Pringlea antiscorbutica*	——4.5——		2.6	14.4			C_{20} 0.7, C_{22} 0.5, $C_{16}(-2H)$ 3.7, $C_{20}(-2H)$ 11.2, $C_{22}(-2H)$ 11.5
Lespedeza seed[23]		——14.0——		27.0	46.5	12.5	
Nasturtium seed[13]		0.5	0.5	7.0	2.0		C_{20} plus 1, $C_{20}(-2H)$ 20, $C_{22}(-2H)$ 69
Neem tree seed[28] *Melia indica*	Trace	16.2	14.6	56.6	9.0		C_{20} 3.4
Ocimum sanctum seed[29]		6.9	2.1	9.0	66.1	15.7	
Python intestine[34]	1.0	20.0	11.0		——59.0 (−2.4 H)——		C_{20} 1, $C_{16}(-2H)$ 4, C_{20} plus 4
Rice bran[35]		14.2	2.6	45.8	36.2	0.8	C_{24} 0.5
Safflower seed[37]		5.1	6.5	7.5	78.5	0.1	C_{20} 0.5, C_{22} 1.2, $C_{16}(-2H)$ 0.1, $C_{20}(-2H)$ 0.3, $C_{22}(-2H)$ 0.2
Seal blubber[38] *Lobodon carcinophagus*	4.7	10.1	2.1		——30.6 (−3.0 H)——		$C_{14}(-2H)$ 3.2, $C_{16}(-2.3H)$ 19.8, $C_{20}(-7.9H)$ 19, $C_{22}(-10.5H)$ 10.5
Seal blubber (elephant-seal)[39]	1.1-6.3	8.2-14.0	2.1-4.6		——32.9-44.4 (−2.1 to −2.7 H)——		C_{12} 0-0.4, C_{20} 0-0.7, C_{22} 0-0.2, $C_{14}(-2H)$ 0.6-2.3, $C_{16}(-2\text{ to }-2.2H)$ 8.2-17.8, $C_{22\text{-}24}(-4.9\text{ to }-10.8H)$, 5.9-14
Steculia urens tree seed kernel[40]	4.7	17.8	2.0	66.6	2.4		C_{24} 1.57, resin acids 5.0
Strophanthus (various species) seed[41]	0.1-0.2	11.9-13.4	4.5-8.1	35.5-43.5	26.4-30.4		C_{20} 2-3.1, hydroxy $C_{18}(-2H)$ 6.5-13.5
Finner whale milk[44] *Balaenoptera physalus*	2.4-10.0	14.0-17.6	2.9-3.7		——26.6-37.2 (−2.8 to −3.3 H)——		C_{12} 7, C_{20} 0.3-0.8, $C_{14}(-2H)$ 1-2.4, $C_{16}(-2.8\text{ to }-2.9H)$ 6.7-8.1, $C_{20}(-6\text{ to }-8.2H)$ 17.6-21.5, $C_{22}(-10.1\text{ to }-11H)$ 14.6-15.9
Yerba Mate seed[47] *Ilex paraguariensis*		10.1	3.8	34.0	49.2		C_{12} 0.9, C_{20} 0.6, $C_{16}(-2H)$ 1.5

* Based on glycerides in total oil.

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atoms longer or four shorter than oleic acid, or with the double bond one or two atoms nearer the carboxyl than the 6,7-position, are incapable of replacing the oleic acid for growth of this organism (Broughton & Pollock—*Biochem. J. 53,* 261). Unsaturated fatty acids induce pigment formation by *Serratia marcescens* at 27-40°; whereas, saturated fatty acids do not (Linnane & Still—*Australian J. Sci. 16,* 27). Either vegetable or animal fats can play a role in pigment formation from *p*-aminobenzoic acid by growing cultures of mycobacteria (Mayer *et al.*—*Proc. Soc. Exptl. Biol. Med. 83,* 378).

Mycobacterium tuberculosis, human Aoyama B, was adapted to propionic, valeric, isovaleric, caproic, capric, stearic and oleic acids; and evidence for both β- and ω-oxidations of the acids by the bacterium were observed (Iida—*Kekkaku 27,* 643).

Lactobacillus arabinosus, which requires biotin, accepts oleic, elaidic, and various more unsaturated acids instead of biotin, but does not use these acids to synthesize biotin (Hofmann—*Record Chem. Progr. 14,* No. 1, 7). Analysis of the fatty acids in these bacteria show: palmitic 37, stearic 2, cis 11, 12-octadecadienoic 20, lactobacillic 31, and unaccounted 10%. The bound lipides of *Lactobacillus casei* are composed of the fatty acids: palmitic 23, *cis*-vaccenic 38, stearic 4, and lactobacillic 16% (Hofmann & Sax—*J. Biol. Chem. 205,* 55). The biotin requirement of a cholineless mutant of *Neurospora crassa* can be replaced by sodium or potassium oleate to a much greater extent than by palmitate or stearate (Sankar *et al.*—*J. Sci. Ind. Res., India, 11B,* 63). The oxygen uptake and photosynthetic uptake of carbon dioxide by the purple bacteria, *Rhodobacillus palustris,* in fatty acid substrate increases in approximate proportion to the number of carbon atoms from C_2 to C_{12} of the fatty acid (Tsukamoto—*J. Biochem., Japan, 39,* 339).

Lauric, myristic, palmitic acids, as well as an optically active β-hydroxymyristic acid were isolated from hydrolyzates of the phospholipide moiety of the hemorrhagic agent from *Escherichia coli* (Ikawa *et al.*—*J. Am. Chem. Soc. 75,* 1035).

Four thousand minimum lethal doses of tetanus toxins were rendered nontoxic by mixing with 3750 γ of alkali salts of various fatty acids at pH 8.5 and kept for two hours at 33° (Zirm *et al.*—*Naturwissenschaften 39,* 235). The antifungal activity of ascosin is suppressed by the presence of unsaturated fatty acids while saturated fatty acids do not show such action (Hickey—*Arch. Biochem. & Biophys. 46,* 331). Saturated fatty acids from C_1 to C_6 in 0.005 mol. concentrations do not inhibit deoxyribopolynucleotidase; whereas, lauric and myristic acids produce complete inhibition and palmitic, stearic, oleic, and ricinoleic acids progressively effect a gradually diminishing inhibition which is discernible even at a concentration of 0.001 mole (Lente & Bella—*Boll. soc. ital. biol. sper. 27,* 357).

Slices of cotyledons from both developing and germinating peanuts when incubated with C^{14} labeled acetate, glucose or fructose incorporated this radioactive carbon in the fatty acids synthesized (Newcomb & Stumpf—*J. Biol. Chem. 200,* 233). Butyrate, valerate, caproate, and propionate also contribute to synthesis of fatty acids in this process but to a much lesser extent.

Castor bean lipase selectively splits off unsaturated fatty acids from peanut, safflower, and linseed oil until at the 50% stage of hydrolysis; from thereon it is only partially selective (Nizamuddin & Kulkarni—*Paintindia 3,* No. 1, 75). Such hydrolysis is accelerated by acetic acid, hydrochloric acid, manganese sulfate, citric acid, phosphates, glycine, ammonia sulfate, acetate, gum arabic, and ascorbic acid (Ramakrishnan *et al.*—*J. Indian Chem. Soc. 29,* 400, 403, 405). Optimum pH for synthesis of amyl butyrate by this lipase is 5.2; for hydrolysis a pH of 4.8 is optimum.

Various molds as *Aspergillus niger, A. flavus, A. oryzae,* and *A. fumigatus,* when grown on castor-cake, synthesize butyl oleate if oleic acid and butyl alcohol are added to the medium (Ramakrishnan & Banerjee—*Ibid.* 397).

Purified oat lipase spits off only one butyric acid from tributyrin at pH 7.4 and it does not hydrolyze either mono- or dibutyrin at that pH (Martin & Peers—*Biochem. J. 55,* 523; Peers—*Nature 171,* 981).

Characteristics and Composition

GENERAL AND COMPREHENSIVE. The communications dealing principally with analytical methods and composition of fatty materials are reviewed in this section. Some new information on analytical methods and composition analysis of soaps, and determination of rancidity is found in other sections of the review because it is more pertinent to the text of other divisions. For convenience of presentation some new composition and characteristics data are presented in tabular form.

Among general and comprehensive reports, much cooperative work was published on standardization and revision of the official analytical methods of the German Society for Fat Science (Pardum—*Fette u. Seifen 55,* 29, 290, 293; Baltes—*Ibid.* 365, 517, 687); a second edition of the German standard methods was published (Wissenschaft Verlag, Stuttgart 1952); new developments in fat analyses were reviewed (Hashimoto—*J. Oil Chemists' Soc. Japan, 1,* 142); uniform methods for analysis of fats, greases and soaps used in the leather industry were proposed (Binko—*Tech. Hlidka Kozeluzska 24,* 289); the sensitivity of microanalytical reactions of interest in the field of fats was discussed (Gorbach *et al.*—*Grasas y aceites 3,* 187); a report of the American Oil Chemists' Society Spectroscopy Committee contains a few minor changes for the method (Stillman *et al.*—*J. Am. Oil Chemists' Soc. 30,* 352); technique requirements in various States for the use of the Babcock fat test for milk were reviewed (Herried & Heinemann—*Ill. Agr. Expt. Sta. Circ. No. 709,* 4); American methods of processing lard were discussed with regard to German evaluation of quality (Wurziges & Lindemann—*Fette u. Seifen 55,* 190); the history of the development of the Buckeye moisture meter for determining the moisture of oil-bearing materials was reviewed (Ledbetter *et al.*—*J. Am. Oil Chemists' Soc. 30,* 442); and British specifications for sunflower-seed oil have been issued (Brit. Standards Inst.—*Brit. Standards 1939,* 15 pp).

Also of general interest is a description of a large scale continuous laboratory extractor which is useful in providing large samples for laboratory investigations (Kamphausen—*Chemistry & Industry 1953,* 1053).

ANALYSIS OF THE FAT SOURCES. A quick determination of moisture utilizes a "Buhler Thermical Balance" which permits weighing the sample without removing it from the oven (Francois & Pasquier—*Bull. mens. inform. ITERG 7,* 11). At 115-125° the results are obtained in 5-10 minutes. An investigation on the effect of time of contact, moisture in the sample, and amount of grinding for determination of moisture of rapeseed with calcium carbide has indicated that results are 2-13.5% lower than those of the official oven method (Francois & Juillard—*Ibid. 6,* 427). The antipyrine method of determining body water *in vivo* permits, through correlations, the approximation of moisture content of hog carcass, and fat content, and thickness of back fat (Kraybill *et al.*—*J. Applied Physiol. 6,* 27). A fairly constant relationship also occurs between moisture and fat content of herring (Brandes & Dietrich—*Fette u. Seifen 55,* 533).

A Bauer mill, officially approved by the American Oil Chemists' Society for grinding soybeans for oil determinations when operated at high temperature and forced grinding at its maximum rate, induces high oil percentages on analysis of the samples and causes considerable darkening of the oil (Collins—*J. Am. Oil Chemists' Soc. 30,* 154). A procedure for analysis of castor beans basically comprises slow grinding and drying a five-gram sample two hours at 130° in a forced draft oven for determination of moisture; extraction with carbon tetrachloride for two hours, regrinding, and re-extracting another two hours in the fat determination; and using the standard American Oil Chemists' Society method for free fatty acids in the oil (Demint *et al.*—*Ibid 30,* 225).

In investigations on selection of solvents for Soxhlet fat determinations. ligroine was the most efficient industrial solvent for babassu oil and petroleum ether for palm and palmkernel oil (Pinto—*Bol. tec. inst. agron. norte, Brazil, No. 22,* 7). In this work benzene, acetone, chloroform, and butanol were efficient and selective for certain oils. An improvement in the refractometric determination of oil content of olives pertains to the introduction of the Waring Blendor in making the treatment with Halowax oil (Kaloyereas & Cruess—*J. Am. Oil Chemists' Soc. 30,* 339).

Simple modifications were made on the Soxhlet apparatus for speeding-up routine determination of crude fat in foods (Nagahara & Taira—*Japan Analyst 2,* 131). Investigations on whey cheese (Buchholz & Smith—*Z. Lebensm.-Untersuch. u. -Forsch 96,* 245), chocolate products (Hadorn & Jungkunz—*Rev. intern. chocolat. 7,* 289), dry mycelium of *Penicilium javanicum* (Cioffi—*Biol. Latina, Milan, 5,* 267), and baked dog food (Hoffman—*J. Assoc. Offic. Agr. Chemists' 36,* 208) have shown that a preliminary digestion with hydrochloric acid is necessary for complete analytical recovery of the fat.

In a study of Babcock methods the glacial acetic acid, Illinois, Minnesota, perchloric acid, Nebraska, Kniaseff, Pennsylvania state and modified Pennsylvania procedures gave extreme variations for fat in ice cream that fell outside the proposed limit of accuracy of 0.2% as compared to Mojonnier determinations (Meiser & Lucas—*Can. Dairy Ice Cream J. 31,* No.

5, 39). The Babcock method for fat in homogenized milk is said to require standardization and correction of procedure for adding acid and shaking sample in order to give consistent results between collaborators (Hynds—*J. Assoc. Offic. Agr. Chemists' 36,* 185). Data have been recorded on the influence of centrifuge speed, centrifuging procedure, specific gravity and amount of acid, and procedure for mixing in the Babcock tests, and recommendations are made for improvement of accuracy on the basis of these data (Heinemann—*J. Dairy Sci. 36,* 450). A test by 16 technicians shows that there are significant variations in estimating the dimensions of the upper meniscus in reading the amount of fat in the test (Herreid—*Ibid.* 183). Modification of this test by using sulfuric acid containing a small amount of a quaternary ammonium compound for the digestion and glymol to flatten the meniscus permits satisfactory results and requires less skill (Wildasin *et al.—J. Dairy Sci. 36,* 87). The Babcock tests using detergents to release the fat from the emulsion are said to give results in better agreement with the Roese-Gottlieb method than the common Babcock method (Sager & Sanders—*Can. Dairy Ice Cream J. 32,* No. 3, 74; *Proc. 45th Convention Milk Ind. Foundation, Lab. Sect. 1952,* 29; Kanninen & Lawrence—*Milk Dealer 42,* No. 9, 48).

Some work on determination of fat and other lipides is on biological material. According to Colin & Polonovski (*Ann. biol. clin., Paris 10,* 267) the estimation of the number of chylomicrons by using an ultramicroscope is the simplest and the most rapid, of the various methods employed for blood fat (nephelometry, liprocrit, chromic acid oxidation, and phosphovanillic reaction in sulfuric acid). A centrifugal technique to separate sediment and stain with Sudan III is used in a microscopic technique to detect lipide material in urinary sediment (Parrish & Alpert—*J. Am. Med. Assoc. 152,* 1713). A colorimetric determination of fatty acids is based on oxidation in a household pressure-cooker by a solution of potassium dichromate in 74% sulfuric acid, dilution, and reading of the color (Kibrick & Skupp—*Arch. Biochem. Biophys. 44,* 134). A density gradient method for small amounts of lipides depends on measuring the density of lipide dissolved in chloroform by suspension in gradient solutions of cadmium chloride of different concentrations (Gibor & Kirk—*Mikrochem. ver. Mikrochim. Acta. 40,* 182). A potentiometric titration for microgram determination is developed for fatty acids and is demonstrated in analysis of liver fatty acids (Grunbaum—*Anal. Chem. 25,* 480). Fecal fatty acids are extracted with acetone, precipitated as the uranyl salts, and their concentration is estimated by colorimetric determination of the metal (Goiffon *et al.* — *Ann. biol. clin., Paris, 10,* 422). Schlenk (*Pharm. Ztg.-Nachr. 88,* 802) recommends that the butyrometer be used to determine fats in emulsions, feces, blood, etc. A special tube is used in a micro lipide extraction method to eliminate loss through transfer (Mitchell — *Nature 172,* 124).

The Schoenheimer & Sperry method for determination of cholesterol was modified for application to analysis of microtome sections (Cavanaugh & Glick—*Anal. Chem. 24,* 1839). A spectrometric determination for serum cholesterol comprises treatment with acetic acid, *p*-toluene sulfonate, acetic anhydride, and sulfuric acid and reading the optical density of the color developed at 550 mμ (Pearson *et al.—Anal. chem. 25,* 813). A similar method makes use of treatment with sulfuric acid, acetic acid and ferric chloride (Zlatkis *et al.—J. Lab. & Clin. Med. 41,* 486). A method of estimating cholesterol and 7-dehydrocholesterol is based on Lieberman Burchard reaction for total sterols, the Rosenheim-Callow test for the second, and glycerol dichlorohydrin reaction for the last (Sobel *et al.—Anal. Chem. 25,* 629).

In investigations on determination of total fat in soap stock, liberation of fatty material and extraction with trichlorethylene was quickest, the butyrometric method proved difficult because impurities appear in the fat, and extraction with dioxane required too much time (Ducos—*Bull. mens. inform. ITERG 7,* 124). To determine free or uncombined acid in aluminum soap with a soxhlet apparatus, dry acetone must be used as the solvent (Mysels *et al.—Anal Chem. 25,* 173).

EVALUATION TESTS. Determinations of moisture in fats by the Kaufmann and Funke and a modified Fischer methods gave good results, but the former was more economical (Kaufmann —*Pharm. Zentralhalle 91,* 379). Other activities on moisture determination were description of an azeotrope distillation method (Meelheim & Roark—*Anal. Chem. 25,* 348), and estimations from pressure developed from the reaction with calcium carbide in closed systems (Dangoumau *et al.—Oleagineux 8,* 211; Klockmann—*Fette u. Seifen 55,* 52). An evaluation method designated "impurities in edible oils" comprises determination of moisture by drying at 105°, and determination of sediment via centrifuging a solution of the oil in petroleum ether (Carocci-Buzi—*Olii minerali, grassi, e saponi, colori, e vernici* 29, 69).

Desnuelle *et al.* (*Bull mens. inform. ITERG 7,* 219, 247) reviewed and criticized the four best known methods for laboratory refining loss determinations and modified the Linteris-Handschumacker absorption method by adding moisture to the alumina adsorbent and using chloroform instead of ether as the solvent. Complications occur when oxidized acids are present. The American Oil Chemists' Society method, "the refining test," was modified for application to babassu oil (Pinto—*Bol. tec. inst. agron. norte, Brazil, No. 22,* 37). The American Oil Chemists' Society Committee on refining failed to develop a method for solvent extracted cottonseed oil and suggested that it is the responsibility of the seller to specify the method used by the buyer in test refining of official samples (James *et al.—J. Am. Oil Chemists' Soc. 30,* 451).

Soybean oil from frost damaged beans is more or less green and because of years of unusual early frosts the trade has devised grading systems specifically for the green oils. Recently Melvin *et al.* (*J. Am. Oil Chemists' Soc. 30,* 255) proposed spectrophotometric methods for grading these green oils and Stillman (*Ibid.* 159) has determined the influence of chlorophyll on Lovibond color determination and on the bleached color test.

A method for determining residual trichloroethylene extraction solvent in oils comprises dissolving in xylene, distillation, treating distillate with pyridine and sodium hydroxide, and measuring the red color formed with a spectrophotometer (Bonilauri & Carola—*Olii grassi e saponi, colori e vernici 29,* 35). Methods for determining DDT and related substances have been modified for analysis of fat for such contamination (Petrosini—*Rend. Accad. sci. fis. e mat. 18,* 186; Mattson *et al.—Anal. Chem. 25,* 1065). Residual methyl esters that develop from the use of sodium methylate as a catalyst for rearrangement of fatty acids in glycerides are determined by saponification, recovery of methanol by distillation and estimation by oxidation with chromotropic acid (Allen & Buswell —*J. Am. Oil Chemists' Soc. 30,* 123). Gorbach (*Fette u. Seifen 55,* 541) designed a scheme for separating metal groups from fats and oils and for their spectral analysis.

Some fats and oils are evaluated on the basis of their vitamin content. Collaborative studies on determination of vitamin A in margarine by the blank oil method and chromatographic procedure are reviewed by Wilkie (*J. Assoc. Offic. Agr. Chemists' 36,* 820). An investigation of colorimetric methods by Schulte & Sachmann (*Fette u. Seifen 55,* 603) has shown the influence of fat, determination as alcohol or acetate, effect of concentration, absorbant, etc., and the Moor method was selected as the most suitable. A method for oils containing tocopherols includes separation of the tocopherols chromatographically so as not to affect the vitamin A determination (Ewing *et al.—Anal. Chem. 25,* 599). A survey of New Zealand butters contains the seasonal variation, effect of breed, storage, etc., on the vitamin A potency (McDowell & McDowall—*J. Dairy Res. 20,* 76).

In the determinations of vitamin A of fish liver oils with glycerol dichlorohydrin about 1/71 and with Carr-Price method about 1/20 of the results are due to kitol and correction should be made accordingly (Fujita & Ooyama—*J. Biochem., Japan, 40,* 151, 157; Ooyama—*Kitasato Arch. Exptl. Med. 24,* 413, 415).

CHEMICAL CHARACTERISTICS. Modifying the Rosenmund-Kuhnhenn iodine value determination for tung oil by addition of mercuric chloride to the oil prior, rather than after, the addition of reagent induces results in good agreement with those obtained by quantitative catalytic hydrogenation (Planck et al.—*J. Am. Oil Chemists' Soc. 30,* 417). The Kaufman iodine value agrees with that of the Wijs method when the procedure is carried out at 20-30° with excess halogen (Watanabe—*J. Chem. Soc. Japan, Ind. Chem. Sect. 54,* 322). Experience with the pyridine dibromide method has shown the effect of reaction time and amount of excess reagent, that halogen substitution seems to occur in oxidized oils, that in absence of reagent the mercuric acetate catalysts promote oxidation to reduce the iodine number, and that presence of sulfur without chloroform causes high and erratic results (Lips—*J. Am. Oil Chemists' Soc. 30,* 399). A procedure for determining iodine value in aqueous solution is based on emulsifying the fat sample with apricot gum in 0.2 normal hydrochloric acid and titration with iodine monochloride solution (Gengrinovich & Yudovich—*Aptechnoe Delo 1952,* No. 5, 17). The Scotti method (Mayerhoffer—*Olearia 5,* 353) was modified for semimicro analyses; and the Wijs method (Whalley & Ellison—*J. Oil & Colour Chemists' Assoc. 35*, 596) for microdeterminations. A new improved method for measurement of unsaturation by hydrogenation involves use of newly designed apparatus, *n*-alkyl esters of monobasic fatty acids as solvents and palladium-carbon catalysts (Pack & Planck—*J. Am. Oil Chemists' Soc. 30*, 461).

The fatty material recovered by acidifying the soapstock by-product of alkali refining of coconut oils have iodine values as much as 100% greater than that of the corresponding refined oil (Kuber & Newby—*J. Am. Oil Chemists' Soc. 30*, 246; Jakobsen—*Ibid.* 316). This is because the seed coat of coconut kernels which contains relatively larger amounts of unsaturated fat, deteriorates most in storage and transportation, and hence its larger contribution of free acids to the refining foots causes high unsaturation in the product.

A micro estimation of unsaturated fatty acids is based on the observation that these prevent the color change of Nile blue solutions from blue to red in the presence of sodium carbonate (Goiffon & Couchoud—*Ann. biol. clin., Paris, 11*, 327).

A study of specific rotation of ricinoleic acid and castor oil led to development of the factor 31.4 which when multiplied by the specific rotation of a castor oil gives the hydroxyl value of the oil (Bolley—*J. Am. Oil Chemists' Soc. 30*, 396). A review of the application of the hydroxyl value to the study of fatty acids was prepared by Anders (*Ind. vernice, Milan, 6*, 206).

DETECTION OF ADULTERATION. The olive oils extracted from press residues contain waxes which are not saponifiable and are of low solubility thus supplying a means of identification of the oil (Vizern—*Ann. fals. et fraudes 46*, 31). Test for this oil is based on the turbidity produced by the unsaponifiable in 85% ethanol at room temperature. No turbidity is obtained with virgin olive or peanut oil whereas extracted olive oil and most other vegetable oils give more or less turbidity in the test. Ultraviolet absorption spectras of virgin, pressed, and refined olive, almond, rapeseed, and linseed oils and cacao butter are recorded as fundamental data for distinction of these oils (Wolff & Wolff—*Bull. mens. inform. ITERG 6*, 379). Argentine olive oils have Bellier values that vary from 5.0 to 13.8 (Testa & Marsico—*Rev. fac. agron. y vet. Univ. Buenos Aires 13*, 226). Data on seven other common oils are from 12.6 to 26.6 (Amato & de Almeida—*Rev. inst. Adolfo Lutz 2*, 107). Another publication contains Bellier values on peanut oils, olive oils, and various mixtures of these, and a discussion of the data with regard to detection of adulteration of olive oil (Loew—*Ind. y Quimica 13*, 132).

In India addition of a minimim of 5 per cent sesame oil to edible hydrogenated oil is compulsory so as to obtain a definite depth of red color in the Baudouin test. This permits easy detection of dairy fat adulteration through addition of commercial hydrogenated fat. Kane (*J. Am. Oil Chemists' Soc. 30*, 382) reviewed the history of this test. He with Bhide (*J. Sci. Ind. Res., India, 12B*, 68) recommended that the law should stipulate that 0.5% raw oil be used instead of 5.0% processed oil so as to induce a more uniform color in the test. Mathur & Tilara (*J. Am. Oil Chemists' Soc. 30*, 447) reported that clay and bleaching earths may give identical bleaching with considerably different affect on Baudouin test of the bleached oils. This and other reactions of sesame oil may become negative as the result of hydrogenation because of destruction of sesamol (Povolini & Isidoro—*Olii minerali, grassi e saponi, colori e vernici 28*, 137, 140; *29*, 33). However, some sesamin still remains and can be detected by a Pavolini reaction even when the original sample contained only five percent sesame oil.

Argemone oil, a toxic product, is detected in mustard oil by development of an orange to red color on treatment with concentrated hydrochloric acid and potassium bromide-potassium perbromate solution (Mitra *et al.*—*Sci. & Culture 17*, 522). Using more potassium permanganate in the Kaufmann & Fiedler method of detecting rapeseed oil improves it sufficiently to detect 10% of the oil in olive or peanut oils (Hadorn *et al.*—*Z. Lebensm.-Untersuch. u. -Forsch. 97*, 365). The method is based on converting the erucic acid of the oil to dihydroxybehenic and identification of the latter. Another method of detecting rapeseed oil is to cool a solution of the potassium soaps, derived from the sample, in acetone containing 10% water (Vizern & Guillot—*Compt. rend. 236*, 813; *Oleagineux 8*, 197). In this test large crystals are produced except with rapeseed oil samples which yield small crystals and peanut oil with five percent or more rapeseed oil forms an emulsion. The Tortelli & Jaffe reaction for fish oils and the Villavecchia *et al.* test for drying oils are positive for raw grapeseed oil, but on refining and decolorization the reactions become negative (Romani & Valentines—*Olii minerali, grassi e saponi, colori e vernici 30*, 5). A simple method for detection of adulteration of tung oil depends upon the amount of material left in solution during a single crystallization from light petroleum at —70° (Hilditch & Mendelowitz—*J. Oil & Colour Chemists' Assoc. 35*, 555). The application of instruments for determination of dielectric constant for approximating soybean oil in almond oil, rosin in tall oil, etc., was reviewed (Clever—*Fette u. Seifen 54*, 785).

Much work is being done on detection of adulteration of butter fat. The technique for detecting adulteration with coconut oil which is based on the melting points of the sterols has been improved so that as little as five percent of this adulterant can be detected (Cannon—*J. Assoc. Offic. Agr. Chemists' 36*, 181). A yield of about one-third as much precipitate of urea complexes from butter fats in comparison to other fats has indicated that this technique may characterize adulteration of butter (Holasek & Ibrahim—*Fette u. Seifen 55*, 601). A spectral method of detecting margarine fats in butter is based on the former having three peaks in the triene absorption range compared to two peaks for butterfat (Lembke *et al.*—*Milchwissenschaft 8*, 118). Kummerow (*Proc. 45th Ann. Convention Milk Ind. Foundation Lab. Sect. 1952*, 9) indicated the interpretations that can be made from fatty acid content, iodine value, saponification value, and other characteristics with regard to detecting foreign fats in butterfat.

Kartha (*J. Sci. Ind. Res., India, 11B*, 346) voiced objections to the law on use of sesame oil as a tracer in hydrogenated fat, so that butter oil adulteration can be easily detected, because milk fat from cows fed sesame oil cake may give a false sesame oil test and the test in actually adulterated butter oils becomes negative on processing or storage. He with others (*Ibid. 12B*, 178) suggested that tyrosine ethyl ester is a better tracer for the purpose.

Work in the United States has indicated that the amount of eggs in alimentary pastes may be estimated on the bases of lipide phosphorous content (Munsey—*J. Assoc. Offic. Agr. Chemists' 36*, 760) or on the choline content (*Ibid.* 766), and that the accuracy of the method based on lipide phosphorous content (Despaul *et al.*—*J. Agr. & Food Chem. 1*, 621) is unaffected by six months of storage. However, European workers consider the method unsatisfactory because of gradual disappearance of these materials during storage (Aker *et al.*—*Z. Lebensm.-Untersuch. u. -Forsch 97*, 373; Hadorn & Jungkunz—*Mitt. Lebensm. Hyg. 44*, 1).

PHYSICAL PROPERTIES. Measurements of the refractive indexes of several saturated and monounsaturated fatty acids and their methyl esters have been used to develop equations for calculating the characteristics for any temperature from the datum at one temperature (Craig—*Can. J. Chem. 31*, 499). Tests by Desnuelle & Naudet (*Bull. mens inform. ITERG 7*, 181) show that mucilaginous substances in raw oils do not affect the refractive index but lower results are obtained when traces of solvents are present.

The dielectric constant measurements of fatty acids in various solvents have been used to indicate the amount of association that occurs in each system at various temperatures (Phadke—*J. Indian Inst. Sci. 34*, 189, 293, *35A*, 31; Stepanenko & Bogdanov—*Zhur. Fiz. Khim 26*, 1472,1477). These reports contain data from tests on many saturated and unsaturated acids, some structural isomers of normal acids, and ricinoleic acid.

The observation that the resonance absorption of methyl esters of palmitic and stearic acids at 6000 Mc./sec. decreases to zero at 40° above the melting points is attributed to rotation of the molecule about the long axis, and failure of ethyl esters to show the absorption is believed to be the result of steric hindrance to rotation (Buchanan — *Nature 171*, 695). Similar work at 0.57 to 8.6 Mc. on lauric, palmitic and stearic acids shows that the velocities at each temperature is independent of the frequency and that the so-called resonant dispersion may appear at the higher intensities (Yoshioka & Hirano—*Mem. Inst. Sci. Ind. Res. Osaka Univ. 10*, 41). Such treatment of vegetable oils shifts the fluorescence of the chlorophyll it may contain from yellow to blue, of carotene from yellow to purplish blue, and of xanthophyll from orange-yellow to blue (Maffei & Buonsanto—*Olearia 7*, 132).

X-ray and thermal examination of various fatty materials were made in order to observe the polymorphism. Chaulmoogric and hydnocarpic acids show no evidence of polymorphism; the glycerides exist in α-, β'-, and β-forms and in addition the triglycerides exist in a vitreous form (Gupta & Malkin—*J. Chem. Soc. 1952*, 2405). Glycerides containing one elaidyl or petroselaidyl individual usually form the familiar α-, β'- and β-forms but the β'-forms are lacking in some (Minor & Lutton —*J. Am. Chem. Soc. 75*, 2685). A so-called "vitreous" phase was not confirmed in this work.

A new viscosimeter, named ''Visco-scale'' is discussed with regard to problems of rheology of fats (Heinze—*Fette u. Seifen 55,* 719). Extrusion of strongly worked shortening through capillaries under a constant air pressure and at constant temperature gives consistency curves which are independent of radius or length of the capillaries (Soltoft — *Proc. Intern. Rheol. Congr. 1948,* No. 2, 273; No. 3, 72).

Dilatometric studies on oleic acid and its isomers show that the melting dilation of cis acids is less than the trans acids; with cis acids it is less for acids with double bonds further from the carboxyl end; and the trans acids do not follow this pattern (Singleton & Ward—*J. Am. Oil Chemists' Soc. 30,* 592). In studies on the thermal expansion of body fats no differences were found between internal and subcutaneous fats of man, dog, rat, rabbit and guinea pig, but significant differences according to location occurred in the steer, pig, and lamb; and high values for the modules of thermal expansion were characteristic of the latter species (Fidanza *et al.*—*J. Applied Physiol. 6,* 252).

Method and apparatus were designed for Wiley melting determination which makes use of electromagnetical stirrers and improves temperature control means (Kleinert — *Rev. intern. chocolat. 7,* 302). Hajek (*Chem., Prague, 8,* 204) discussed the melting and drop points of fats with regard to polymorphy, moisture and homogeneity.

New observations on growth of stearic acid crystals have confirmed a spiral mechanism of growth and that growth is in steps of 45-47Å height (Anderson & Dawson—*Proc. Roy. Soc., London, A218,* 255; Verma & Reynolds—*Ibid. 66B,* 414; *Nature 171,* 486).

Molecular films of fatty materials were studied to determine their physical characteristics. Kipling & Norris (*J. Colloid Sci. 8,* 547) discuss area of each molecule cross section in fatty acid monolayers on water with regard to inclined chains and vertical arrangement, and propose modification in the vertical structure hypothesis. Work with impure stearic acid films on water has shown that the temperature under which a limiting area per molecule is obtained is lowered by the presence of palmitic acid; and with cobalt or copper salts in the aqueous phase the compressibility characteristics of the films are affected (Allen & Haigh—*Research, London, 6,* 395). Gerovich *et al.* (*Zhur. Fiz. Khim 25,* 1198, 1289) found that fatty acids form bimolecular films on silver nitrate solutions and have recorded the properties of such films made with several saturated fatty acids. Barium, calcium, aluminum and mercuric ions decrease wettability of stearic acid built-up films because of their effects on orientation of layers (Inaba—*Bull. Chem. Soc. Japan 26,* 43). In similar work Sasaki & Matsuura (*Bull. Chem. Soc. Japan 24,* 274) classified metal ions into two groups according to their effects on the pressure-area curve for the unimolecular films of stearic acid, and determined the rigidity and effect of dissolved dyes on the films. Calcium, barium, and magnesium cause films to condense, whereas a second group of metals, aluminum, copper, iron, zinc, and others, cause the film to expand. The spreading isotherm, adsorption and desorption of lauric acid have been determined and the data are discussed with regard to the Gibbs equation (Saraga — *Mem. services chim. etat, Paris 37,* No. 1, 29). Surface potentials of spread in adsorbed gaseous films of lauric acid films were determined and also discussed as mentioned directly above (Michel —*Mem. services chim. etat, Paris 37,* No. 1, 55).

The isosteric heats of sorption have been calculated for the even-numbered C_8 to C_{18} saturated fatty acids, and discussed with regard to liquid solution, solid solutions and transition systems (Arnell—*J. Phys. Chem. 57,* 641). The observations are explained in terms of normal crystal forces and partial melting points.

The solubilities of oleic and linoleic acids at —5.3° in 16 organic solvents and for linoleic acid at —50° in 14 solvents have been recorded (Hoerr & Harwood — *J. Phys. Chem. 56,* 1068). An equation was developed that expresses the distribution ratios of fatty acids between cyclohexane and methanol (Yamaketa & Aida—*Bull. Inst. Chem. Res. Kyota Univ. 31,* No. 1, 59). In this work it is assumed that fatty acids form dimers besides monomers in the cyclohexane layer but only monomers in the methanol layer.

Various fatty acids alter the iodine-color reaction of sweet-potato starch as follows: those of less than six carbon atoms permit a blue reaction; caprylic and caproic cause a purple-red; and palmitic and stearic acids give a strong purple color (Tataoka & Nikuni—*J. Fermentation Tech. 30,* 486). Saturated fatty acids precipitate amylose as an amylose-fatty acid complex in which the amylase is not hydrolyzable with α-amylase (Nikuni *et al.*—*J. Agr. Chem. Soc., Japan, 26,* 186).

COMPOSITION. The limits of accuracy of the crystallization technique for determination of the fatty acid composition of fats was evaluated by tests on fats synthesized from pure glycerides to simulate some natural fats (Cama *et al.*—*J. Sci. Food Agr. 4,* 321). The validity of this technique is established.

Purification of palmitic acid was discussed in relation to thermal analyses of binary and ternary systems of alkyl esters of fatty acids (Neirinckx & Struelens—*Bull. agric. Congo Belge 43,* 987). Phase diagrams have been constructed for binary saturated triglyceride systems (Kerridge—*J. Chem. Soc. 1952,* 4577) and for ternary systems of stearic, palmitic, and oleic acids (Ravich & Vol'nova—*Doklady Akad. Nauk S.S.S.R. 86,* 325). These indicate eutectic temperatures and compositions and should be useful in analyses by crystallization. Binary freezing point diagrams with heat of fusion data have been determined for mixtures of α- and β-eleostearic acids and for mixtures of the acetamides of these acids (Mod *et al.*—*J. Am. Oil Chem. Soc. 30,* 368).

Greenbank (*Intern. Dairy Congr. Proc. 13th, 3,* 1269) discussed the composition of the fractions derived at various temperatures in the fractional crystallization of butterfat. Countercurrent liquid-liquid fractionation was applied to the lipides from human placenta for the determination of the composition of the phospholipides (Cole *et al.*—*Biochem. J. 55,* 17), and to brain lipides for quantitative separation of cholesterol (*Ibid. 54,* 449). A difference in the behavior of various fatty acid coordination compounds in the system isooctane-aqueous alcohol was suggested as offering possibilities for the separation of cis and trans isomers, and saturated from unsaturated fatty acids (Nichols, Jr.—*J. Am. Chem. Soc. 74,* 1091). Fatty acid complexes with many inorganic compounds have been discussed with regard to their structures, properties, and uses (Kaufmann & Lüssling—*Fette u. Seifen 55,* 90). The urea complex precipitation technique was used for the isolation of cis and trans forms of erucic acid from rape oil (Skellon & Taylor—*Nature 171,* 266).

The theory of polarography was reviewed with regard to possible uses in the analysis of fats and related materials (Kaufmann & Baltes—*Fette u. Seifen 55,* 153). The technique was used for the estimation of tocopherols in vegetable oils (Knobloch *et al.*—*Chem. Listy 46,* 718).

Pedersen (*Arch. Pharm. Chemi 60,* 498) reports that monostearin is most conveniently determined in fats by a technique using periodate oxidation. Montequi & Doadrio (*Inform. quim. anal., Madrid, 6,* 31) find that free glycerol interferes in that technique and must be removed by washing with sodium sulfate solution, or glycerol must be separately determined to make the necessary corrections. The 2-monoglycerides are not determined in the periodate method for monoglycerides, but perchloric acid isomerization converts mixtures of 1- and 2- to 90% 1-monoglyceride and total monoglyceride is obtainable from the analysis of the isomerized mixture and multiplying the results by 1.15 (Martin—*J. Am. Chem. Soc. 75,* 5483).

General and comprehensive articles describe the use of chromatography in oil and fat analyses: Kaufmann *et al.* (*Fette u. Seifen 55,* 85) have illustrated and described paper chromatographs obtained in the analysis of the fats and fatty acids important to the coating industry; Govindarajan (*Proc. Sym. Indian Oils Fats Natl. Chem. Lab., Poona, 1951,* 242) reviewed the literature on use of the technique in the fat and oil industry; and Holman (*Ann. Rpt. Hormel Inst. 1951-52,* 31) told of the progress for separation of sterols and monoglycerides. A simple chromatographic determination of C_{10} to C_{20} saturated fatty acids is based on adsorption on silica gel and distinction with use of bromo thymol blue indicator (Nijkamp—*Nature 172,* 1102). A vapor phase method for C_{12} to C_{22} saturated acids uses a spiral column containing a mixture of ''celite'' and high-vacuum silicone grease as the absorbent (Cropper & Heywood—*Ibid.* 1101). Separations of mixtures of saturated fatty acid and mixtures of unsaturated fatty acid were made using filter paper impregnated with petroleum hydrocarbon, boiling point 140-70°, as the adsorbent and pairs of solvents in the mobile phase (Inoue & Noda — *J. Agr. Chem. Soc. Japan 26,* 634). Attempts to chromatographically segregate mixed fatty acids by working with their hydroxamic derivatives yielded only slight separations (Grinsteins — *Latvijas PSR Zinatnu Akad. Vestis 1949,* No. 2, 65). Separation of mixed acids as their 2,4-dinitrobenzenesulfenyl chloride derivatives on magnesium sulfate was very well defined and the technique is the basis for a method of analysis which is named the ''isolation method'' (Simons & Quackenbush—*J. Am. Oil Chemists' Soc. 30,* 614).

A scheme based on paper chromatographing and establishing position with various reagents has been worked out for separating fatty acids, chlorophylls, carotenes, vitamins, sterols, terpenes, higher alcohols, etc. (Spitari & Nunez—*Compt. rend. 234,* 2603). Similar schemes were designed for separation of the components of biochemical lipides (Hack—*Biochem. J. 54,* 602), for partition of ethanolamine- and choline-containing phospholipides (Lea & Rhodes—*Ibid.* 467), and for determining the individual tocopherols and associated substances in oil extracted from cereal products (Eggitt & Ward—*J. Sci. Food & Agr. 4,* 569).

Fillerup & Mead (*Proc. Soc. Exptl. Biol. Med. 83,* 574) demonstrated use of a silicic acid column for fractionating plasma lipids into sterol esters, triglycerides, sterols, fatty acids, and phospholipides. Borgstrom (*Acta physiol. Scand. 25,* 101) evaluated the efficiency of sugar, magnesium oxide, and silicic acid for like separations from various oils. Sucrose and alumina columns were used with several organic solvents as eluants in the analysis of the components of lipides of algae (Kathen —*Arch. Mikrobiol. 14,* 602). Silicic acid chromatography was used for examining whale liver oils for vitamin A, provitamin D_1, etc. (Brachi—*Biochem. J. 54,* 459).

Spectrophotometric activities with their purpose are being merely cited here because description of methods and data require too much detail. The new procedures of Herb & Riemenschneider (*Anal. Chem. 25,* 953) are for determining fatty acids containing from two to five double bonds in lipides of fluids and tissues of living plants and animals. A semimicroprocedure for measuring two, three, and four double bond fatty acids in three millimeters of blood serum is described by Weise & Hansen (*J. Biol. Chem. 202,* 417). Hammond & Lundberg (*J. Am. Oil Chemists' Soc. 30,* 433) recorded absorption peaks of methyl docosahexaenate and its alkali isomerized product to demonstrate the technique and develop data fundamental in analyses. O'Connor *et al.* (*Ibid.* 182) proposed equations which correct the "end" or "background" absorption of highly absorbing triene conjugated acids and demonstrated the method by analyses of several mixtures of cottonseed and dehydrated castor oils. Similar work was published by May (*J. Chem. Phys. 49,* 464). Infrared spectra data together with chemical evidence were used to confirm the structure of α-eleostearic acid as 9-cis, 11-trans, 13-trans and β-eleostearic acid as the 9-trans, 11-trans, 13-trans acid (Bickford *et al.*—*J. Am. Oil Chemists' Soc. 30,* 376; Paschke *et al.*—*Ibid.* 97). Like work was done in assigning cis and trans structures to acids with one or two double bonds (Ahlers *et al.*—*J. Appl. Chem. 3,* 433), and for analysis of linseed oil (Desnuelle & Massoni—*Peintures, pigments, vernis 29,* 41). Ultraviolet spectrophotometry methods were recommended for determination of conjugated bonds in tung, linseed, and dehydrated castor oil (*Ibid. 28,* 372). Simplifications were proposed for the technique of alkali isomerization in the spectral analysis of oils (Vandenheuvel & Richardson—*J. Am. Oil Chemists' Soc. 30,* 104). The infrared absorption spectra of isolated serum lipoproteins were discussed with regard to the lipides that may be present (Freeman *et al.*—*J. Biol. Chem. 203,* 293).

Inaccuracies occur in the determination of constituents of sperm oil by splitting and steam distillation; because very highly unsaturated constituents disappear; some water soluble fatty acids are formed, and some of the unsaturated fatty acids are converted to trans isomers (Senda—*J. Oil Chemists' Soc. Japan 2,* 6).

Kartha (*J. Am. Oil Chemists' Soc. 30,* 280, 326) has published a modified technique for determination of glyceride types by the acetone-permanganate method, and republished his theories, reported in the last few reviews, on distribution of fatty acids in natural glycerides. Quimby *et al.* (*Ibid.* 186) has confirmed the glyceride composition of animal fats in agreement with Hilditch but in contrast with other teachings. Cepeda (*Grasas y aceites 3,* 125) reviewed the even distribution of fatty acid radicals on the glyceride radical and developed formulas, based on the laws of combinations and permutations, for calculating glyceride types assuming random distribution. The glyceride compositions were recorded for soybean oil (Venkitasubramanian—*J. Sci. Ind. Res. Ind. 11B,* 132) stillingia oil (Crossley & Hilditch—*J. Sci. Food Agr. 4,* 38) and Japan wax (Hirao & Adachi—*J. Osaka Inst. Sci. Technol. 1,* No. 2, 68).

Gunstone & Paton (*Biochem. J. 54,* 617, 621) suggested that the compositions of animal fats could lead to some systematic classification as is used as a basis for classifying parent plants. Accordingly, they point out that deer and camel fat are stearic acid rich and python fat is similar to amphibian or reptile fat. Data on eight varieties of oil from cottonseed grown at 13 locations during three years show that iodine value is negatively correlated with the temperature during growth and that the extent of this effect differs among the different varieties (Stansbury *et al.*—*J. Am. Oil Chemists' Soc. 30,* 120). The chemical characteristics of oils of five varieties of tung seeds raised in Florida were recorded (Dickey *et al.*—*Florida Agr. Expt. Sta. Bul. 503,* 5). Fourteen standard chemical characteristics are also reported for oils of four species of snakes native to Florida (Pollard & Young—*Quart. J. Fla. Acad. Sci. 15,* 134). Seasonal variations in the content of C_6 to C_{14} acids (Hansen & Shorland—*Biochem. J. 52,* 207), and the unsaturated fatty acids (McDowell—*J. Dairy Res. 20,* 101) of New Zealand butterfats have been measured. Summer butters contain 6-8% and winter butters 3.5% trans-octadecenoic acids (Cornwell *et al.*—*Arch Biochem. & Biophys. 46,* 364).

Some analytical studies were done on individual acids or groups of acids. Decanoic acid was isolated from mutton fat (Hansen & Cooke—*Biochem. J. 54,* 14), lauric acid from butterfat (Hansen & Cooke—*J. Sci. Food Agr. 4,* 351), eicosenoic acid from dolphin oil (Tsuchiya—*J. Chem. Soc. Japan, Ind. Chem. Sect. 54,* 672), an α-methyl-α,β-unsaturated acid from *Tubercle bacillus* (Cason *et al.*—*J. Biol. Chem. 205,* 435), a multibranched chain saturated acid from butterfat (Hansen & Shorland — *Biochem. J. 55,* 662), 12-methyltetradecanoic and 13-methyltetradecanoic acids from mutton fat (*Ibid.* 374) methyl docosahexaenate from hog brain phospholipides (Hammond & Lundberg—*J. Am. Oil Chemists' Soc. 30,* 438). Articles on identifying specific acids in certain fats and oils are on eicosenoic and docosenoic acids in peanut oil (Hopkins & Chisholm —*Can. J. Chem. 31,* 1173, several C_{20} to C_{24} highly unsaturated acids in the liver oils of ishinagi fish (Tsuchiya & Kato —*J. Chem. Soc., Japan, Ind. Chem. Sect. 55,* 232), C_{20} and C_{22} acids with four to five double bonds in the body oils of the fresh water fish, *Perca schrenki* (Crechenkin—*Zhur. Obshchei Khim 22,* 1244), petroselic acid in the fruit oil of *Anthriscus sylvestris* (Kurono *et al.* — *J. Pharm. Soc. Japan 72,* 1434); and C_6 to C_{16} acids in grape fusel oil (Cattaneo et al.—*Anales assoc. quim. argentina, 40,* 150).

Studies where structure of acids were determined were on: kamlolenic acid of Mallotus philipinenses which is a ω-hydroxy-9,11,13-octadecatrienoic acid (Gupta *et al.*—*J. Sci. Ind. Res., India, 12B,* 240), α-hydroxytetracosanoic acid of yeast cerebrin (Chibnall *et al.*—*Biochem. J. 55,* 711), and 14-hydroxypalmitic acid of beeswax (Toyama & Hirai—*J. Chem. Soc. Japan, Ind. Chem. Sect. 54,* 293).

Data on the tetraenoic, pentaenoic, and hexaenoic acids in the lipides of various tissues of lambs, hogs, and cattle show that lamb testes with 15.6% of hexaenoic acid is the richest source for this acid, but the most practical sources for isolation are beef testes and hog brain lipides for hexaenoic and hog liver lipides for arachidonic acid (Holman & Greenberg—*J. Am. Oil Chemists' Soc. 30,* 600). The pentaene acid content in milligrams per gram of total lipides in animal fats are rat serum lipides 32, rat corpuscle lipides 40, entire body fat of a rat 21, and entire body fat of a guinea pig 6 (Chevallier *et al.*—*Compt. rend. soc. biol. 146,* 1133). Nearly 50% of the acids of herring oil contain 20 or more carbons per molecule and about 15% had three or four double bonds (Swain—*Prog. Repts. Pacific Coast Sta., Fisheries Res. Board Can. 93,* 3; *94,* 24). Analysis has indicated that *Licania venosa* fruit oil contains 50% licanic acid (Bennett *et al.*—*Colonial Plant and Animal Products, London 1,* 232). Very comprehensive analyses were made on bees, caranda, crude candelilla, refined candelilla, ouricury and carnauba waxes (Findley & Brown—*J. Am. Oil Chemists' Soc. 30,* 291). Their hydroxy acid content, respectively, were 25, 41, 48, 17, 80, and 60-80% of the total fatty acids. The hydrocarbon, free alcohol, esters, acid esters, diesters, acid diesters and hydroxy diester contents were also recorded. A report on carnauba wax shows that it contains 38% normal acid and the percentage composition of this fraction is given (Murray & Schoenfeld—*Ibid.* 25). A wool wax from marino fleeces contained α-hydroxylauric acid 0.6, α-hydroxymyristic acid 3.8, α-hydroxypalmitic acid 18.3, and α-hydroxystearic acid 4.6% (Horn *et al.*—*Chemistry & Industry 1953,* 106).

Anders (*Seifen-Öle-Fette-Wachse 79,* 28) reviewed analytical methods for unsaponifiables in fats. Higher results for unsaponifiables from crucifer seed oils occur when petroleum ether is used instead of ethyl ether for extraction of unsaponifiable substances (André *et al.*—*Compt. rend. 235,* 665; *236,* 1695). The hydrocarbons of rice bran oil unsaponifiable material consists principally of squalene of formula $C_{30}H_{50}$ (Kaneko & Tsuchiya—*J. Chem. Soc., Japan, Ind. Chem. Sect. 54,* 737). The acetone insoluble material of the lipides of haddock flesh was analyzed (Lovern—*Biochem. J. 54,* 126; Lovern & Olney—*Ibid.* 128, 559, 686). The amount and composition is given for the phospholipides, and amounts of hydrocarbons, cholesterol. etc., are recorded.

Glyceroinositophosphoric acid was isolated from wheat germ oil (Faure & Morelec-Coulon—*Compt. rend. 236,* 1104). The inositol content of animal tissues range from 3.6 to 22.4 micromoles per gram (Taylor & McKibben—*J. Biol. Chem. 201,* 609).

A method for determining phospholipides in commercial lecithins is based on the difference from 100% of the sum of the percentages of acetone soluble, moisture and benzene insoluble (Stopper *et al.*—*J. Am. Oil Chemists' Soc. 30,* 408). Tests on crude and refined oils indicate that there is a linear relation between lecithin content and ash, and that factors can be derived through analysis for calculating the lecithin content of individual oils from percentage of ash (Rzhekhin & Chudnovskaya—*Masloboino Zhirovaya Prom. 18,* No. 1, 22).

Work on hydrocarbon constituents of oils pertain to: isolation of a highly unsaturated C_{49} or C_{50} hydrocarbon from sperm whale liver oil (Tsuchiya—*J. Chem. Soc., Japan, Ind. Chem. Sect. 55,* 312), identification of tetracosane in the unsaponifiable of oat oil (Schuette *et al.*—*J. Biol. Chem. 200,* 319), demonstration that hydrocarbons of cycad seed oil are principally those of C_{18} to C_{22} chain length (Tsuchiya & Okubo—*J. Chem. Soc. Japan, Ind. Chem. Sect. 54,* 591), and analytical method for determination of squalene (Wheatley—*Biochem. J. 55,* 637).

Analytical work on sterols included: data on the cholesterol content of marine animal oils produced in Norway (Thuesen—*Norsk Hvalfangt-Tidende 42,* No. 1, 25), assignment of a 5,7,22-unsaturation structure to a C_{29} sterol from *corbicula leana* oil (Toyama *et al.*—*Bull. Chem. Soc. Japan 25,* 355), and characteristics of fractions segregated from the mixed sterols of jute seed oil (Sen & Chakravarti—*J. Indian Chem. Soc. 28,* 727).

Fuhrman's (*Compt. rend. 235,* 722) analyses of the non-glyceride constituents of olive oil contains data on α- and β-chlorophyll, four carotenoids, phytosterols, alcohols, and hydrocarbons. The fat of both male and female castrated pigs contains the following hormones: 17-ketosteroids 12.3-16.9, estrone 0.39-0.63, estriol plus estradiol 0.8-1.19 milligrams per 100 grams (Pascoli—*Igiene moderna 45,* 190). Like work on butter shows: 17-ketosteroid 17.53-20.01, phenolic steroids 2.2-2.6 (*Ibid.* 327). Globoside, a sugar containing lipide, was isolated from human blood stroma (Yamakawa & Suzuki—*J. Biochem., Japan, 39,* 393).

The physical and chemical properties of gossypol and the analytical methods for its determination have been reviewed (Hoffpauir & Pons—*J. Assoc. Offic. Agr. Chem. 36,* 1108). In studies on the red pigmentation of cottonseed oils and effect of processing on these, a dark-red pigment resembling anthocyanin was isolated (Pominski *et al.*—*J. Am. Oil Chem. Soc. 30,* 365).

Detergents

MANUFACTURE. Suitable soaps are made from odorous and highly colored stock by either refining before or after the saponification. Methods applied to the crude stock involved a combination of hydrogenation, treatment with metal chlorites, and earth bleaching (Jackson & Bayer—*U. S. 2,646,435*), and treatment with 30% hydrogen peroxide (Sarmarin—*Masloboino Zhirovaya Prom. 18,* No. 1, 30). Processes in which deodorization and decolorization are done after the saponification involved treatment with sodium hypochlorite (Kawakami—*Japan 2727; 3738* ['*51*]), and hydrosulfite bleaching plus treatment with zinc compounds (Squire & Stengel—*U. S. 2,660,589;* Lever Brothers & Unilever Ltd.—*Brit. 690,207*). The drying of soap stock with high frequency electric current in the presence of powdered metal was patented (Sugitani—*Japan 4377* ['*51*]).

In using synthetic fatty acids for making soft soap a suitable product is obtained with 30% low fraction, C_9 to C_{11} acids, 30% main fraction, and 40% soybean fatty acids (Manneck—*Seifen-Öle-Fette-Wachse 79,* 99). Odorous fish oils, sperm oil, and wool grease are converted to odorless soap by means of the Varrentrapp reaction (Appuhn—*U. S. 2,640,840; Brit. 696,027, 696,050.* This comprises treating the stock with molten alkali to cause production of soap with lowering of the molecular weight of the fatty acid moiety.

The saponification step in soap making is accelerated in the presence of an emulsifier (Mikumo *et al.*—*J. Chem. Soc., Japan, Ind. Chem. Sect. 54,* 342; Sendo & Shinyo—*Japan 1631* ['*52*]). Alkali benzene sulfonate is mentioned as the emulsifier for the process. A soap for use with hard water is made by saponifying the fat stock with excess alkali, neutralizing the product with sulfonated coconut or palm oil, and salting-out with alkali phosphates (Okoe—*Japan 1729* ['*51*]).

Reutenauer (*Bull. mens. inform. ITERG 6,* 529) published data on losses incurred during salting-out of soaps made with various amounts of different grades of rosins, with oxidized fatty acids, and soaps containing both. The data are fundamental for design of the salting-out processes. Similarly Widaly (*Seifen-Öle-Fette-Wachse 79,* 79) showed that soaps of synthetic fatty acids require larger amounts of salt for salting-out than those from natural fatty acids. A salting-out process designed for a continuous soap making system comprises washing with brine in a tower containing separated stages, drawing off nigre, separating it into poorer brine and into neat soap, and recycling both of these in the soap making system (Lachampt—*U. S. 2,653,958; Brit. 685,295*).

Lyes from soap pans are hydrolyzed in an autoclave at 170-180° to convert the oil present into glycerol water and recover original soap present and the oil as soap (Bespyatov & Sukhoterin—*Masloboino Zhirovaya Prom. 18,* No. 4, 17). Soap is also recovered from waste liquids from soap plants by floating with air bubbles and skimming (Gibbs—*U. S. 2,637,737*).

The new information on refining and concentration of the glycerol produced in soap making is on ion exchange methods (Nagata *et al.*—*J. Chem. Soc., Japan, Ind. Chem. Sect. 54,* 338; N. V. Oetrooien Maatschappij Activit—*Brit. 690,008;* Reents—*U. S. 2,615,924*).

Several patents deal with the final steps of soap making. Application of a four-percent solution of polyethylene glycol of over 4000 molecular weight improved the milling (Kawakami—*Japan 7228* ['*51*]). A new aeration and extrusion apparatus for plasticizable material is applicable to making soap bars (Marshall—*U. S. 2,640,033*). A plodder for high moisture soaps operates with the soap at 70-120° and under vacuum (Compa—*U. S. 2,649,417*). A newly patented spray drier for detergents cools the dry particles to a low temperature to minimize tendency to cake, and also classifies the particles (Ledgett *et al.*—*U. S. 2,657,797*).

Lecithin is added to soap to produce transparency (Yamada & Yashimura—*Japan 5938* ['*51*]), and to inhibit deterioration (Semendyaeva—*Masloboino Zhirovaya Prom. 18,* No. 4, 15). Carboxydextrins, prepared by successive oxidations with acid and alkali from native cellulose is used to replace part of the fat in soap making (Antykov—*Zhur. Priklad. Khim. 26,* 848). Partial substitutes for soap fats are also made by alkali treatments of: sawdust (Ohshima—*Japan 6477* ['*51*]), methanol extracts of pine scraps (Huilerie raffinerie St.-Symphorien—*Fr. 893,209*), starches, cellulose and amino acids (Bellon & LeTellier—*Fr. 881,893*), rice polishings and powdered sea algae (Yasuda—*Japan 2728* ['*51*]), horny parts of corn (Linder—*Austrian 175,959*), mixtures of pyromucic acid and 2-furfuryl alcohol (Doumergue & Szabo—*Fr. 975,636*), wool waste or hair (Thiebaut & Bonnet—*Fr. 881,076*), fermented milk proteins (Gaithe—*U. S. 2,637,699*), and certain white earths (Kuwada & Sugawara—*Japan 5937* ['*51*]). Because of high saponin content shavings of jujube wood, *Zizyphus juazeiro,* are useful as a substitute for soap in laundering (Rosa & Iachan—*Annais assoc. quim. Brazil 10,* 236; *Rev. quim. ind., Rio de J., 22,* No. 252, 19). The residual bisulfite liquor, obtained from the manufacture of cellulose, in combination with colloidal clay and alkali salts is also used as a soap substitute (Guilbaud & Chene—*Fr. 893,260*).

A patented hard soap is made by saponifying a mixture of silicic acid, fats, and oils (Murata—*Japan 5037* ['*51*]). Hydrated sodium silicate is heated to produce an amorphous powder suitable for detergent use (Kasai—*Japan 782* ['*52*]). Persalts for detergent formulations are coated with rubber latex to prevent premature loss of oxygen (H. Guiot & Fils—*Fr.* 893,115). New patents were also issued for fluorescent whitening agents which can be added to soap to enhance whiteness or brightness of finished washes—(Thomas—*U. S. 2,624,710;* Ciba Ltd.—*Brit. 686,805;* Farbenfabriken Bayer—*Brit. 683,895;* J. R. Geigy, A. G.—*Swiss 281,724, 282,055, 283,402, 285,352-5, 286,322-4*).

Also of interest to soap makers are the patents on: Putting-up soap in packettes, disintegratable in water for single washing (Jurgenson & Abbott—*U. S. 2,636,007-8*); a mildew-resistant mineral-coated soap wrap (Thomas—*U. S. 2,662,040*); and two lather making devices (Mulfinger—*U. S. 2,624,617;* Holte—*U. S. 2,624,622*).

Some experimental work on manufacture of synthetic detergents is recorded. Burton and Byrne (*J. Soc. Leather Trades' Chemists 37,* 243, 321) in continuing their work of earlier years on sulfonation of castor have shown that: at 30° the reaction is principally at the hydroxyl group with concentrated sulfuric acid; acetyl sulfuric acid and chlorosulfonic acid react more at the double bond than sulfuric acid; there is no sulfonate formation when acetylated before treatment with 20% oleum; and at 50° lactones, lactides and estolides develop, chlorosulfonic acid being especially conducive to these. Herrera & Garcia (*Rev. cienc. apl. Madrid, 6,* 220; *Grasas y aceites 3,* 23) describe methods of converting extracted olive residue pulp oil to sulfonated detergents and describe the properties with regard to their use in washing. Komori *et al.* (*J. Oil Chemists' Soc., Japan, 1,* 73) sulfated several pure higher alcohols with sulfamic acid and recorded the surface tension and foaming power of each. Studies on making detergents by chlorosulfonation of kerosene and Diesel oil shows that: inferior products are obtained from paraffin; the reaction should be done in presence of light; and maximum yields occur at about 40° (Schleicher & Muzzio—*Bol. soc. chilena quim. 4,* 7). Xylenol fractions of low-temperature carbonized oils condensed with fatty alcohols can be sulfonated or condensed with eight moles of ethylene oxide to yield suitable detergents (Ishii & Nishiyama—*J. Oil Chemists' Soc., Japan, 1,* 129). Spada & Gavioli (*Farm. sci. e tec., Pavia, 7,* 441) transform fatty acids into substituted amides by heating with monoethanolamine and then chlorosulfonate.

Octyl, lauryl, and cetyl mercaptans, thiophenol and thio-*p*-cresol were treated with ethylene oxide in the presence of one percent of sodium and the surface active properties of the products are determined (Senda & Oda—*J. Chem. Soc., Japan, Ind. Chem. Soc. 55,* 94). Similar data is recorded on condensation products of lauric acid chloride with diethylenetriamine, triethylenetetramine, and higher homologs (Isoda *et al.*—*Ibid. 54,* 678).

According to Englert *et al.* (*J. Am. Oil Chemists' Soc. 30,* 337) the most satisfactory method of preparing arylalkyl detergent intermediates is by condensation of fatty acid chlorides with aromatics by means of the Friedel-Crafts technique.

Many alkylarylsulfonate detergents when used as conditioners in wet-twisting cotton tire cord improve the breaking strength of the cord (Ambelang *et al.*—*Ind. Eng. Chem. 45,* 204). Synthetic detergents are also used in the petroleum dewaxing process (Myers *et al.*—*U. S. 2,645,597-600*). The principal nonaqueous component of a fire extinguishing composition is the wetting agent, 2,4-diamyl phenol polyglycol ether (Maxey & Sander—*U. S. 2,624,706*).

Other literature on synthetic detergent manufacture is on newly patented manufacturing techniques and products. For convenience of presentation these are listed below under the name of the assignee or patentee:

Allied Chem. & Dye Corp.
A mixture of nitrosation-sulfitation products and alkylaryl pyridium compounds (*U. S. 2,626,244*). Polypropylene benzene sulfonates (*U. S. 2,626,900*).

American Cyanamid Co.
Sulfosuccinic acid polyesters of fatty acid monoglycerides (*U. S. 2,637,663*). Condensation products of fatty acid benzene sulfonamides with ethylene oxide (*U. S. 2,649,478*).

Anglo-Iranian Oil Co., Ltd.
Sulfonated alkyl hydroperoxide or alkyl naphthene peroxides (*U. S. 2,645,656, Brit. 685,621*). Sulfonation method for alkylaromatic compounds (*Brit. 680,613*).

Atlantic Refining Co.
Alkylated aryl sulfonates (*U. S. 2,655,530*).

Atlas Powder Co.
Oxyalkylene ethers of hydroxyl alkyl oxazoline compounds (*U. S. 2,636,038*).

Badische Aniline & Soda Fabrik
Hydrocarbon sulfohalogenation products (*Ger. 835,301, Cl. 12o*). Nonaromatic thiosulfonic salts (*Ger. 840,693, Cl. 12o*). Thio ether carboxylic acids (*Ger. 840,996, Cl. 12o*). Polymeric 2-propenesulfonic acid (*Ger. 842,048, Cl. 12o*). Alkylated hydrogenated aromatic compounds (detergent intermediates) (*Ger. 856,436, Cl. 12o*). Purification of paraffin sulfonates (*Ger. 859,452, Cl. 12o*).

Bigler, R.
Special mixtures of alkyl salts and sodium lauryl alcohol (*Swiss 284,368*).

Böhme Fettchemie G.m.b.H.
Neutralization of sulfonation products (*Ger. 859,451, Cl. 12o*).

California Research Corp.
Noncaking alkylaryl sulfonates (*U. S. 2,631,980*). Polymerization of propylene (starting materials for preparation of sulfonated alkylated aromatics) (*Brit. 679,068, 672,101*).

Cannesson, R.
A combination of anthracene sulfonate, rosin soap, and alkyl salts (*Fr. 893,444*).

Chimiotechnie union chim. du nord et du Rhone.
Methods for sulfonation (*Fr. 978,991-3*). Sulfonic acids of fatty chlorohydrins (*Fr. 978,996*).

Ciba, Ltd.
Partial esters of polybasic sulfide carboxylic acid (*Swiss 277,196-7, Cl. 24a*).

Colgate-Palmolive-Peet Co.
Mixture of alkyl sulfonate mono-fatty acid ester of polyhydric alcohol and sodium sulfate (*U. S. 2,619,469*). Noncaking synthetic detergent composition (*U. S. 2,625,513-14*). Combination of fatty monoester or monoether of a dialkanol piperazine and soap (*U. S. 2,634,239*). A reaction tower for manufacturing detergents (*U. S. 2,655,435*).

Collonges, R. S. A.
Mixture of sodium ethylolamides of fatty acids with ethylolamide of abietic acid (*Fr. 979,447*).

Deutsche Hydrierwerke A. G.
Quaternary ammonium compounds (*Ger. 847,899, Cl. 12q*).

Deutsche Gold- und Silber-Scheideanstalt vorm. Roessler
Alicyclic ketone alcohols (detergent intermediates) (*Ger. 859,615, Cl. 12o*).

E. F. Drew & Co., Inc.
Reaction product of hydroxyethyl sulfuric acid and a fatty acid (*U. S. 2,635,103*).

E. I. du Pont de Nemours & Co.
Polymeric quaternary ammonium salts (*U. S. 2,595,225*). Sulfated highly branched tridecanol (*U. S. 2,609,397*). Sulfated highly branched primary heptadecanol (*U. S. 2,633,473*). Other highly branched hydrocarbon sulfates (*U. S. 2,654,772*).

Etablissements P. Barnier & Cie.
Soluble sulfone derivatives from resins (*Fr. 897,114*).

Farbenfabriken Bayer
Paraffin sulfonates (*Ger. 847,444, 847,896, 849,243, 862,444, Cl. 12o*).

Farbwerke Hoechst vorm. Meister Lucius & Brüning
Separating nonaromatic carboxylic acids (*Ger. 833,805, Cl. 12o*). Separating nonaromatic sulfonamides (*Ger. 833,806, Cl. 12o*). Sulfochlorinating nonaromatic hydrocarbons (*Ger. 833,808, 839,351, Cl. 12o*).

First Ind. Drug. Manufg. Co.
Fatty alcohol condensed with polyethylene glycol (*Japan 1638* ['*52*]).

J. R. Geigy A. G.
Quaternary ammonium compounds (*Brit. 680,476*).

General Aniline & Film Corp.
Combination of alkali salts and *N*-palmitoyl-*N*-Cyclohexyl taurate (*U. S. 2,618,607*). Mixtures of nonionic detergents and alkali tetraborates (*U. S. 2,623,856*). Quaternary ammonium salts. (*U. S. 2,623,870*). Polyglycol ethers of alkyl phenol sulfides (*U. S. 2,629,743*).

General Mills, Inc.
Diquaternary compounds (*U. S. 2,617,806*). Mixtures of β-aminopropionate and alkylarylsulfonates (*U. S. 2,619,467*).

Gesellschaft Kohlentechnik m.b.H.
Amines of synthetic fatty acids (*Ger. 767,432, Cl. 12q*).

Goldschmidt A.-G.
2-Alkylthiobenzothiazole derivatives (*U. S. 2,617,807*).

Henkel & Cie.
Benzenesulfonamide derivatives (*Brit. 678,004*). Halogenated aliphatic or cycloaliphatic hydrocarbon sulfonates (*Ger. 765,128, Cl. 12o*).

High Molecular Chem. Assoc.
Nonionic products from alkylated polyvinyl alcohol (*Japan 3794* ['*52*]).

Hirano, H.
Sulfonation of pine root oil (*Japan 7009* ['*51*]).

Imhausen & Co. G.m.b.H.
Sulfohalogenation products (*Ger. 868,299, Cl. 12o*).

Imperial Chem. Industries Ltd.
Synthetic detergents thickened with polyvinyl maleate *U. S. 2,645,615*).

Ind. Mazional, Saponi e Appretti.
Special mixtures of inorganic salts and lauryl sulfate (*Ital. 465,655-6*).

Internat'l Minerals & Chem. Corp.
Guanidino substituted fatty acids (*U. S. 2,620,354*).

Jencsa, L. M.

Reaction product of naphthalene sulfonic acid, cellulose, and formaldehyde (*Fr. 891,564*).

Kao Soap Co.

Combinations of higher alcohol sulfonates and sodium sulfate (*Japan 5580* [*'51*]). Shampoo of sodium alkyl aryl sulfonate and alkali carbonate (*Japan 7041* [*'51*]).

Kayukov, I. S. *et al.*

Sodium 2-naphthalene sulfonate (*U.S.S.R. 78,370*).

Lech-Chemie Gersthofen

Salts of sulfinic acids from high-molecular sulfochlorides (*Ger. 859,459, Cl. 12o*).

Märkische Seifen-Ind.

Sulfonation of synthetic acids (*Ger. 766,546, Cl. 12o*).

Masetti-Zannini, A.

Alkylaryl sulfonates (*Ital. 468,692, 468,694, 468,721*).

Mikasa Chem. Ind. Co.

Sulfonation of animal and vegetable fats and oils (*Japan 2726* [*'51*]).

Monsanto Chem. Co.

Bis(Alkylthio) alkanes oxidized with alkyl sulfates (*U. S. 2,594,411*). Chloromethyl benzoate condensates (detergent intermediate) (*U. S. 2,612,516*). Polyglycol ethers of 7-ethyl-2-methyl-4-undecanol (*U. S. 2,617,830*). Tridecenyl alcohol (Intermediate) (*U. S. 2,624,766*). Alkyl benzenesulfonate (*U. S. 2,630,411*). Sulfation of aliphatic alcohols (*U. S. 2,634,287; Brit. 676,690*). Condensation products of ethylene oxide and tertiary alkyl mercaptan (*U. S. 2,637,701, 2,642,400; Brit. 683,884*). Polyethylene glycol thio ethers (*Brit. 692,414*). Branched higher alkanol sulfates (*U. S. 2,637,740*). Alkali metal and ammonium sulfates of hydroxy ethers (*U. S. 2, 644,831*). Alkanol amine sulfates (*U. S. 2,644,832*). Hydroxy ether sulfates (*U. S. 2,647,913*).

Muto, T.

Sulfonating light petroleum oil (*Japan 5629* [*'51*]).

Niederl, J. B. & Associates, Inc.

4,4-Dialklymorpholinium alkyl sulfates (*U. S. 2,602,791*).

N. V. Bataafsche Petroleum Maatschappij

Organic compounds containing phosphorus (*Dutch 69,357*). Purifying sulfonates (*Dutch 70,861*). Mono- and dialkyl sulfates from olefins (*Dutch 72,272*). Polyamines (*Brit. 658,422*). Sulfated residues of oxo synthesis of hydroxy alcohols (*Brit. 671,833*). Petroleum sulfonates (*Brit. 672,736*).

Paix & Cie.

Sulfonation of glycerides (*Fr. 980,205*).

Perlmuter, S. Z.

Method of sulfonation (*Fr. 877,532*).

Petrolite Corp., Ltd.

Oxyalkylated derivatives of resinous polymers of vinyl esters (*U. S. 2,602,079; 2,652,388; 2,652,418*).

Phillips Petroleum Co.

Alkylaryl sulfonate (*U. S. 2,628,200*).

Procter & Gamble Co.

Sulfonated diester of carbonic acid (*U. S. 2,626,264*). Fatty acid amide sulfonate (*Brit. 687,949*).

Prütz, A.

Salts of sulfates of aliphatic or aromatic-aliphatic alcohols (*Ger. 843,092, Cl. 12o*).

Purez Corp., Ltd.

Vacuum neutralization of detergents (*U. S. 2,613,218*).

Reichstein, I.

Reaction product of polyethylene glycol and petroleum sulfonates (*Swiss 281,601 Cl. 116h*).

Riedel-de Haën A.-G.

Amidines substituted by a sulfonyl radical (*Ger. 839,493 Cl. 12o*).

Rohm & Haas Co.

Sulfonated hydroxy aliphatic amides (*U. S. 2,632,766*).

Ruhrchemie A.-G.

Saturated terpene aldehydes and terpene alcohols (detergent intermediates) (*Ger. 827,800, Cl. 12o*). Neutralization of sulfonic and sulfuric esters (*Ger. 859,305, Cl. 12o*).

Scherbe, H. A.

Sulfates of monoglycerides (*Brit. 682,178*).

G. D. Searle & Co.

Quaternary salts of the phenothiazine type (*U. S. 2,590,125, 2,591,679*).

Shell Development Co.

Powdered sulfonated products (*U. S. 2,617,599*). Esters of phosphorus- and sulfur-containing oxy acids from oxo synthesis products (*U. S. 2,618,649, 2,623,894*). Synthetic detergent cakes (*U. S. 2,653,913*).

Shinriki, Y.

Synthetic detergent from petroleum (*Japan 4127* [*'51*]).

Soc. anon. d'innovations chim. dite: Sinnova au Sadic.

Alkaryl sulfonyl chlorides or alkaryl sulfonates (*U. S. 2,605,281*). Sulfonation of coconut and palm oils (*Fr. 874,464*). Continuous sulfonation with chlorosulfonic acid (*Ger. 834,245, Cl. 12o, Brit. 680,629*).

Soc. Anon. matieres colorantes et produits chim. Francolor.

Derivatives of 1,4-diamino-benzene-N-sulfonic acid (*U. S. 2,637,743*).

Soc. dite: Soc. Progil S. A.

Aromatic sulfonic acids and sulfones (*Fr. 893,369*).

Socony-Vacuum Oil Co., Inc.

Alkylthiophene sulfonates (*U. S. 2,614,084*).

Standard Oil Development Co.

Alkyl aryl sulfonates (*U. S. 2,612,531, 2,634,240; 2,655,525*).

Tomiyama, S. *et al.*

Sulfonated dry-distilled coal oil (*Japan 3668* [*'51*]).

Thibaud Gibbs & Co.

Betaine treated with urea, semicarbazides or other similar compounds and then treated with high molecular weight aliphatic or aromatic aldehydes (*Fr. 977,939*).

Universal Oil Products Co.

Aryloxyalkyl halides (*U. S. 2,598,049*). Polyalkylene glycol esters of nitrated alkylbenzoic acid (*U. S. 2,616,921*). Sulfonation with sulfur trioxide (*U. S. 2,616,936*). Alkylthiophene sulfonates (*U. S. 2,624,742*). Polyalkylene glycol esters of alkyltetrahydrophenylalkanoic acids (*U. S. 2,648,693*). Substituted carbamic acid esters (*U. S. 2,649,473*). Polycyclic alkyl arylsulfonic acids (*Brit. 682,477*).

Waldmann, E. & Chwala, A.

Sulfonated higher imidazolines (*Austrian 160,231*).

W. B. Chemical Co.

Sodium-*N*-oleoyltaurine (rug shampoo gel) (*U. S. 2,625,515*).

W. & F. Walker, Ltd.

Sulfonation process (*Brit. 672,114*).

W. M. Waters

Synthetic detergent in cake form (*U. S. 2,643,229*).

Ward Blenkinsop & Co., Ltd.

Quaternary ammonium salt (*Brit. 669,321*).

Wyandotte Chem. Co.

Alkyl aryl sulfonate (*U. S. 2,629,697*). Alkyl-carboxymethyl-diethers of polyoxyalkylene glycols (*U. S. 2,653,972*).

Zimmerschied, A. J.

Alkyl thiophenes (*U. S. 2,585,292*).

Zschimmer & Schwarz Chem. Fabrik Dölau.

Sulfochlorination of saturated hydrocarbons and reduction to sulfinic acids (*Ger. 764,807*). Removing free sulfuric acid from crude alkylarylsulfonic acids (*Ger. 840,840, Cl. 12o*).

Various formulations are made for specific uses. A composition for removing silica scale from glass surfaces contains potassium fluosilicate, sodium acid sulfate, and sodium sulfate (Miller—*U. S. 2,656,289*). Corrosion of glass by detergent composition is inhibited by the presence of a fatty or other organic compound which has been treated with nitrosylchloride and a sulfite (Hassel—*U. S. 2,628,943*). One compound contained naphthalene, to prevent leaving a film on glass, and coumarin dyes to reflect light rays and give a polished appearance to the glass (Heidman—*U. S. 2,611,747*). A soap for polishing glass and metal surfaces contains fine-fibered hard wood (Frey — *Swiss 274,526, Cl. 38e*). Arnborger (*Svensk Farm. Tidskr. 57,* 417) recommends that ampules be washed with mixtures of nonionic and inorganic detergents. A new cleaning pad of metallic wool or other fibers is impregnated with detergent, and corn meal or wood flour (Fisher—*U. S. 2,621,355*). A stain remover contains soap, ammonia, ether, alcohol, and water (Mattei—*Ital. 467,435*). A rug cleaning detergent is formulated from synthetic detergents, calcium hypochlorite, and polyphosphate salts (Soule—*U. S. 2,634,238*). A germicidal detergent composition for dairy plant sterilization contains alkali phosphates and a germicidal quaternary ammonium halide (Marcoux—*U. S. 2,658,873*). A mixture of water, soap, and certain organic solvents is used for cleaning internal combustion engines (Brandes & Pattinson—*U. S. 2,626,225*). A noncombustible product for this purpose contains potassium and ammonia soap, and ethyl esters of soybean oil fatty acids (Sumimoto—*Japan 7135* ['*51*]).

Many communications contain general economic, descriptive, promotional, or manufacturing information. For convenience of presentation these are tabulated under the subject treated.

Definitions and standards:

Soap under the new patent law (Gray—*Soap Sanit. Chemicals 29,* No. 4, 54). Definitions in detergent chemistry (Stüpel—*Seifen-Öle-Fette-Wachse 78,* 599). Surface-active substances (Nethol—*Rev. farm., Brazil, 94,* 60). Standards for carbolic soap (*Brit. Standard 1910*), hard soap (*Ibid. 1911*), soap flakes (*Ibid. 1912*), soft soap (*Ibid. 1913*), and toilet soap (*Ibid.* 1914). Nomenclature of detergents containing sulfur (Hintermaier—*Fette u. Seifen 54,* 780).

Economic information:

Surveys of soaps *vs.* detergents (Sisley—*Industrie chim. Belge 18,* 225; Nebbia & Gestri—*Olearia 5,* 358; Heyworth —*Soap, Perfumery & Cosmetics 26,* 779; Breaden—*Perfumery Essential Oil Record 43,* 324). Fat for soap in relation to economic conditions (Tum—*Seifen-Öle-Fette-Wachse 78,* 164, 187). Soap from fatty acids (Reinish—*Soap, Perfumery & Cosmetics 26,* 682). Liquid detergents (Meredith—*Perfumery Essential Oil Record 43,* 404). Use of linseed oil fatty acids *vs.* soybean acids in soap. (Smith —*Am. Perfumer Essential Oil Rev. 59,* 289).

Manufacture of soap:

Physical chemistry of soap manufacture (Moreno—*Grasas y. aceites 3,* 35). Treatment of soap stock (Levin & Swearingen—*J. Am. Oil Chemists' Soc. 30,* 85; Bokov—*Masloboino Zhirovaya Prom. 18,* No. 1, 29). Continuous soap processes (Ramirez—*Grasas y aceites 3,* 196; Nichterlein—*Seifen-Öle-Fette-Wachse 79,* 182; Fock—*Ibid.* 414). Centrifuges in the fat and soap industries (Möller—*Fette u. Seifen 55,* 401). Use of tall oil in soap making (Pollak—*Soap Sanit. Chemicals 29,* No. 5, 42). Soft soap (Weber—*Seifen-Öle-Fette-Wachse 78,* 530). Washing powders (Zilske—*Ibid. 320*; Tegeder—*Ibid.* 316). Cooling soap (Zilske—*Seifen-Öle-Fette-Wachse 79,* 253; Schuck—*Ibid. 78,* 409; McCutcheon—*Soap Sanit. Chemicals 29,* No. 5, 111). Spray drying (Sharphouse—*Ibid.* No. 9, 85; Manneck—*Seifen-Öle-Fette-Wachse 79,* 297). Soap-plant instrumentation (Procopi—*Soap Sanit. Chemicals 29,* No. 9, 46). Preservation of fats, oils, and soaps (Henk—*Seifen-Öle-Fette-Wachse 79,* 249). Glycerol production Radfang—*Ibid. 78,* 224). Glycerol uses (Lesser—*Am. Ink Maker 30,* No. 8, 34).

Soap additives:

Foam producing additives (Smith—*Am. Perfumer Essential Oil Rev. 59,* 381). Effect of additives on foam of soap (Augustin—*Seifen-Öle-Fette-Wachse* 79, 76). "Tylose HBr" (Stawitz — *Seifen-Öle-Fette-Wachse 79,* 364, 390). High molecular phosphates (Uhl—*Fette u. Seifen 55,* 109). Sodium tetrapyrophosphate (Smith—*Am. Perfumer Essential Oil Rev. 60,* 215; Eglin—*Seifen-Öle-Fette-Wachse 79,* 130). Silicates (Smith—*Am. Perfumer Essential Oil Rev. 61,* 159). Sequestrants (Smith—*Ibid. 60,* 53). Metal complexing with ethylenediaminetetraacetic acid (Zussman—*Soap Sanit. Chemicals 28,* 79). Sodium perborate (Lesser —*Soap Sanit. Chemicals 29,* No. 4, 154). Optical brighteners (Sevens—*Ind. chim. Belge 18,* 22; Caspar—*Textil-Rundschau 8,* 22). Perfume oils for soap (Bergwein—*Seifen-Öle-Fette-Wachse 79,* 371, 392). Perfume fixing for soap (Schmidt—*Fette u. Seifen 55,* 180). Hexachlorophene in soap (Lord *et al.*—*Am. Perfumer Essential Oil Rev. 61,* 73; *Pharm. J. 169,* 115). 2,4-Dichloro-*m*-xylenol and hexachlorophene (Innes—*Soap Sanit. Chemicals 29,* No. 9, 42). 2,4-Dichloro-*m*-xylenol (Gemmell—*Ibid. 29,* No. 3, 95; *Soap, Perfumery & Cosmetics 25,* 1160). "Actamer," 2,2-thiobis (4,6-dichlorophenol) (Shumard *et al.*—*Soap Sanit. Chemicals 29,* No. 1, 34; Egan & Reed—*Ibid.* No. 7, 42. Antiseptic cleansers (Maglio & Hannegan —*Am. J. Pub. Health 43,* 426).

Synthetic detergents:

Review (Kling—*Angew. Chem. 65,* 201). Surface active agents of New Zealand (Barr—*J. New Zealand Inst. Chem. 16,* 121). Alkylaryl sulfonates in Jugoslavia (Stojkovic—*Nova Provizwodnja 2,* 140). Progress in the field of synthetic detergents (Stüpel—*Melliand Textilber 33,* 1025). New applications (Stüpel — *Seifen-Öle-Fette-Wachse 78,* 212). Monople oils (Griffiths—*Dyer 106,* 875). Physicochemical aspects of detergents in general (Doss—*Indian* Soap J. *18,* 12; Schwarz — *Seifen-Öle-Fette-Wachse 79,* 102; Longley — *Textile Chemicals and Auxiliaries 1952,* 255), of sulfated oils (Pingree—*Ibid.* 290), of anionic surfactants (McCutcheon & Speel—*Ibid.* 299), of nonionic condensation (Speel — *Ibid.* 318), of cationic finishing agents (Ackley — *Ibid. 334*), and tetrabutylnaphthalene sulfonate (Fukuzumi—*J. Chem. Soc., Japan, Ind. Chem. Sect. 54,* 728). Sulfonation and sulfation (Gilbert & Jones —*Ind. Eng. Chem. 45,* 2041). Manufacture and properties of dodecyl sulfates (Schon—*Soap, Perfumery & Cosmetics 26,* 676). Continuous production of synthetic detergents (Stüpel—*Fette u. Seifen 54,* 455). Synthetic detergents in cosmetics (Tschakert — *Seifen-Öle-Fette-Wachse 79,* 193; Tarring — *Perfumery Essential Oil Record 43,* 193). Amphoteric detergents for laundering and disinfecting (Schmitz—*Fette u. Seifen 55,* 10). "Permulgin" (Stein —*Seifen-Öle-Fette-Wachse 79,* 101, 129). Quaternary ammonia compounds in the food industry (Desbruxelles—*Echo brasserie 6,* 853; Benko—*Seifen-Öle-Fette-Wachse 79,* 228). Nonionic detergents (Rainey & Denoon—*Chem. & Eng. News 31,* 4521; Isoda—*J. Chem. Soc. Japan, Ind. Chem. Sect. 53,* 431; Waibel—*Mitt. chem. Forsch. -Inst. Wirtsch. Österr. 6,* 72; Wolfe & Marchant—*Can. Chem. Processing 37,* No. 8, 46; Rossi & Baldacci—*Ann. chim., Rome, 41,* 534; Dadachanji—*Indian Textile J. 63,* 100; Anderson—*Australasian J. Pharm. 34,* 630). Theory, physics and chemistry of detergency (Gomez-Herrera—*Seifen-Öle-Fette-Wachse 78,* 458; Rosano—*Mem. services chim. etat, Paris, 36,* 309; Harwood—*J. Textile Inst. 44,* P105; Stevenson—*Endevour 12,* 25; Stuffins—*Perfumery Essent. Oil Record* 44, 128).

Washing—theory and evaluation:

Structure and action of synthetic detergents (Gowdy—*Sewage and Ind. Wastes 25,* 15). Theory of washing (Linder—*Melliand Textilber. 31,* 58). Selection of detergent for specific application (Mankowich—*Ind. Eng. Chem. 44,* 1151). Analysis and evaluation (Stüpel—*Seifen-Öle-Fette-Wachse 78,* 1). Determining cleansing power of soaps (Hofmann—*Chemie, Prague, 8,* 25). Washing process and new detergents (Datow—*Seifen-Öle-Fette-Wachse 78,* 45). Soil carrying capacity of synthetic detergents (Stüpel—*Fette u. Seifen 55,* 501). Plain water prewashing in laundering (Viertel—*Fette u. Seifen 55,* 372). Wetting power (Rosano—*Mem. services chim. etat, Paris, 36,* No. 4, 437). Evaluation of detergency (Herrera—*Grasas y aceites 2,* No. 3, 78). Rate of solution of soaps and detergent action (Tum—*Seifen-Öle-Fette-Wachse 79,* 52). Washing action determined by the micro-Launder-O-meter Carriere—*Fette u. Seifen 55,* 448). Judging surface of washed fabric (Machemer—*Fette u. Seifen 55,* 591). Importance of chromaticity in evaluation of whiteness (Hemmendinger & Lambert—*J. Am. Oil Chemists' Soc. 30,* 163).

Applications:

Industrial cleaners (Pollack—*Seifen-Öle-Fette-Wachse 78,* 318; Henrion—*Ind. Chim. belge 17,* 265; Chatterji—*Indian Soap J. 18,* 121; Price—*Soap Sanit. Chemicals 29,* No. 3, 54; Anderson—*Ibid. No. 10,* 53). Cleaners used for cleaning the steamship "United States" (Rosen—*Ibid.* No. 3, 46). Detergent's use in dairies (Harding—*Ibid.* No. 4, 52; Minor—*Proc. State Coll. Wash. Inst. Dairying 21,* 25). Use in dairy and food plants (Schmetz —*Milchwissenschaft 7,* 250). Detergents in dry cleaning (Fulton *et al.*—*ASTM Bull. No. 192,* 63).

Analysis:

Control laboratories at soap factories (Boyle—*Soap Sanit. Chemicals 29,* No. 5, 52). Determination of types of synthetic detergents (Kortland & Dammers—*Chem. Weekblad. 49,* 341). Behavior of quaternary ammonia compound in presence of phosphates. Determination of pH and rH of oils and soap solutions (Schulz—*Seifen-Öle-Fette-Wachse 79,* 233). Analysis of bottle washing detergents (Jansen *et al.*—*Tijdschr. Brouwerij en Mouterij 12,* 31).

Effects of detergents in use:

Effect of detergents on sewage treatment processes (Manganelli—*ASTM Bull. No. 192,* 57). Action of detergents on gelatin and on collagen (Pankhurst—*J. Soc. Leather Trades Chemists 37,* 312). Skin reactions and skin protection with synthetic washing agents (Stüpel—*Chem.-Ztg. 77,* 782; *Fette u. Seifen 55,* 714). An article on hand injury includes effect of detergents (Carrie—*Ibid.* 196).

CHEMICAL ANALYSIS. Bauschinger (*Fette u. Seifen 55,* 229) determined the effect of alternate wetting and drying of the surface of soap bars on the physical and chemical characteristics of the bar. Most other analytical activity on finished soap pertains to determination of phosphate salts. According to Heinerth (*Ibid.* 165) phosphates can be precipitated almost quantitatively from concentrated aqueous solutions of laundering compounds with methanol. Reprecipitation yields pure phosphates which can be identified by qualitative tests and microscopic structure. A scheme by Etienne (*Ind. chim. belge 18,* 340) is based on separating each group (meta-, pyro- poly-, and orthophosphate) by fractional precipitation as barium salts at progressively increasing pH. Fractions are further purified by recrystallization or precipitation, and may be quantitatively analyzed. A procedure for pyrophosphates by Dewald & Schmidt (*Fette u. Seifen 54,* 679; *55,* 19, 500) is based on adjusting pH to 3.8, adding zinc sulfate, titrating with 0.1 *N* sodium hydroxide, and multiplying the titration with a factor which varies with the titration. This method has been adjusted for application in presence of per-compounds and disilicates, but cannot be used in the presence of ortho-, tripoly-, or glossy-phosphates. Benzylisothiourea hydrochloride gives a precipitate with sodium metaphosphate even in the presence of 50 times as much tripolyphosphate (Neu—*Ibid. 54,* 682). The reaction is sensitive to one part in 11,100. Metaphosphates can be determined by reaction with a commercial quaternary ammonium compound "Tego 103," in the presence of acetic acid (Neu—*Ibid. 55,* 17).

A method for determining perfume in soap comprises extraction with petroleum ether from aqueous solution, removing unsaponifiable from absolute alcohol solution by freezing, adding water, and determining the perfume by the paraffin-cake method (Bergwein—*Seifen-Öle-Fette-Wachse 78,* 489). Aldehydes used in perfumes are determined by titrating in 80% ethanol with *N* alcoholic hydrochloride acid until green to bromophenol blue, adding 10 ml. 0.5 *N* hydroxylamine solution, and titrating with 0.1 *N* alcoholic potassium hydroxide to a green (Klein—*Ibid.* 11).

Newly described methods for determining glycerol were based on oxidation with potassium permanganate (Marconi—*Chimion, Milan, 7,* 336), with metaperiodate (Erskine *et al.*—*Analyst 78,* 630), and with dimesoperiodate (Hartman—*J. Applied Chem. 3,* 308).

Infrared absorption spectra of various types of synthetic detergents were determined to serve in the laboratory identification of constituents of samples (Sadtler—*ASTM Bull. No. 190,* 51). A procedure for mixtures of alkoxysulfates and alkylarylsulfonates is based on isolation of the fatty alcohols of the former, and extraction of the latter from salt solution (Duperray—*Bull. mens. inform. ITERG 7,* 325). Hoyt & Water (*ASTM Bull. No. 192,* 56) determine alkylarylsulfonate or alkyl ester type detergents in soap mixtures by titration with a standardized cation detergent solution.

The Olatta-Pitha method for determining small amounts of "Sequesterene," ethylenediaminetetracetic, was modified for application to soaps and detergents (Dargey — *Soap Sanit. Chemicals 29,* No. 8, 81). Several studies on determination of the amount of anionic detergents in dilute solutions involve titrating dye complexes of the compounds. Lewandowski (*Ibid.* No. 4, 29) recommends a method of back-titration of the cationic-bromophenol blue combination for field use; Johnsons' (*Ibid.* No. 7, 114) method is based on the same complex but the measurement is colorimetric. The method of Iwasenko (*J. Assoc. Off. Agr. Chemists 36,* 1165) makes use of dichlorofluorescein as the dye used; similarly Lewis & Herndon (*Sewage & Ind. Wastes 24,* 1456) show that the acid dyes, Pontamine Fast Red 8BNL or Brilliant Blue FCF, can be used with sewage samples. Details for use of a methylene blue method and photometric reading were published by Degens, Jr., *et al.* (*J. Appl. Chem., London, 3,* 54).

PHYSICAL CHARACTERISTICS. The most suitable method for judging the soap color resulting from a soap stock is to prepare soap according to the laboratory method of Lachampt and determine Lovibond numbers after repeated graining out (Reutenauer—*Bull. mens. inform. ITERG 7,* 285).

Data on the spontaneous drying of soap cakes of various types was recorded by Martinenghi & Romanus (*Olearia 6,* 217). These are intended for design of spontaneous drying techniques.

An electron microscopic study of sodium soaps has shown that: the ribbon-like fibers of the soap occasionally form closed rings; the maximum widths of these fibers decrease as the molecular weights of the soaps increase; and the molecules are aligned with the long axis parallel and with their ionic ends adjacent to each other, thus forming bi-molecular laminae (Chwalow—*J. Phys. Chem. 57,* 354).

The specific and partial specific volumes for potassium laurate and lauryl sulfonic acid at 25° and 0.2° were determined and related to the osmotic coefficients of colloidal electrolytes by empirical equations (Lal—*J. Colloid Sci. 8,* 414).

Studies on the effect of the chain length on the surface tension properties of soap and detergents indicate that the highest effect with saturated compounds is at C_{12} or at C_{18} for the unsaturated chain, but if the solubilizing group (—COOH or —SO_3Na) is moved from the end to other positions on the chain the surface tension properties are altered (Paquot—*Mem. services chim. etat, Paris, 37,* No. 1, 91). Detergent and emulsifying properties are similarly related. Surface active properties, foaming and wetting properties, of alkyl sulfates are increased by introducing a sulfur atom or an alkyl group between the chain and terminal group (Bolle *et al.*—*Ibid.* 75). Addition of one or two chlorine atoms into the chain of a soap decreases the temperature dependence of surface tension of its solutions (Okazaki & Mikumo—*J. Chem. Soc., Japan, Ind. Chem. Sect. 54,* 344). The magnitude of interfacial tension lowering by soap for aromatic liquids is related to the surface tension effect of soap in water, but with ethyl benzoate the lowering is much less than would be expected from surface tensions of soap in water (Kazi & Desai—*J. Indian Chem. Soc. 30,* 209). With aqueous soap-insoluble alcohol systems, interfacial tension with various alcohols increases in the following order: butanol, isoamyl alcohol, hexyl alcohol, and *sec*-octyl alcohol.

Sodium oleate forms much smaller contact angles on paraffin than any other surfactants and alkyl aryl polyethylene glycol ether and alkyl polyethylene glycol thio ether, nonionics, form smaller contact angles than anionic detergents (Mankowich—*Ind. Eng. Chem. 45,* 2759). Interfacial tensions measured in this manner on these compounds are related to their wetting power.

Foam layers were separated repeatedly from aqueous solutions of sodium and potassium laurates and the surface tensions and composition determined (Raison—*Mem. services chim. etat., Paris, 37,* No. 1, 65). Curves of the data show inflexions attributed to hydrolysis of the soap, and to "acid soap." Formation of large micelles inhibit the rate of hydrolysis.

The spinnability of soap solutions is maximum at pH 10; at which point hydration, transparency, viscosity, and frothing are also at their highest values (Thiele & Lamp—*Kolloid-Z. 129,* 25).

Among related alkyl aromatic quaternary ammonium compounds there exists a linear relation between the number of carbon atoms in the alkyl group and the critical micelle concentration as has been previously reported for other long chain compounds (Ross *et al*—*J. Colloid Sci. 8,* 385). These critical micelle concentrations also vary with the polarity as determined by boiling points, melting points, dielectric constant, or dipole moments of the aromatic compounds that correspond to that radical in the quaternary ammonium salt. The critical concentration, as determined by conductivity, for sodium oleate at 25° was found to be 0.0015 *M* (Flochart & Graham—*J. Colloid Sci. 8,* 105), and for rosin soap at 40° was 0.011 *M* (Harva—*Kolloid-Z. 127,* 132). The curvature of the plot of specific conductance with concentration of aqueous sodium oleate solutions in presence of various concentrations of alcohol and salt is explained on the basis of competitive hydration by alcohol and salt (Bose—*J. Indian Chem. Soc. 30,* 39).

Klevens (*J. Am. Oil Chemists' Soc. 30,* 74) reviewed the literature and developed some additional data to show that critical micelle concentrations depend on chain length of all straight chain saturated surface active agents and that values are not changed by substitution near the hydrophilic head of the 1, 2, or 3 groups, even as large as hydroxyethyl, in place of amine hydrogen. Other observations are that the introduction of a double bond causes a slight increase in the critical micelle concentration and that progressively moving a hydrophilic group down a chain must be considered as if two chains are involved. Work by Klevens (*J. Chim. phys. 49,* 615) on association of different surface active agents containing 12 carbon atoms also are used to support the hypothesis that the degree of order is weaker in the cationic than in the anionic micelles and that variations in order are caused by electrolytes. He (*J. Am. Chem. Soc. 74,* 4624) also determined the effect of several electrolytes on solubilization of heptane by soap solutions.

X-ray studies of potassium laurate solutions has indicated that micelles form a loose close-packed arrangement with effective diameters of 27 Å (Anderson & Carpenter—*J. Am. Chem. Soc. 75,* 850). Light scattering by solutions of octyltrimethylammonium-octanesulfonate and -decanesulfonate indicates that the aggregates are not spherical (Anacker—*J. Colloid Sci. 8,* 402).

Viscometric measurements of solutions of sodium dodecyl sulfate were interpreted to indicate a spherical shape for the micelles (Kushner *et al.—J. Res. Natl. Bur. Standards 49,* 85). The effect of electrolyte is explained on the basis of dehydration of micelles as has been indicated by others from other data. Viscosity measurements with surface tension data were used to determine stability of elementary emulsion drops and emulsions (Cockbain & McRoberts—*J. Colloid Sci. 8,* 440). Stability was greatest at concentrations slightly greater than the critical micellar concentration. In investigations on viscosities of solubilized hexane, hexene, cyclohexane, and benzene in aqueous polysoap an anomalous behavior only with benzene is explained on the basis that it is solubilized by the polar regions of the polysoap molecules as well as by the lipophilic chain (Strauss & Layton—*J. Phys. Chem. 57,* 352). Viscosity technique was also used to study the stability of benzene emulsions in aqueous soap solutions as affected by alcohols.

Brown *et al.* (*J. Colloid Sci. 8, 491,* 508) developed a rotational viscosimeter capable of providing rheological data for surface films on solutions of surface active agents and with its use found that highest foam stability appears to be produced from solutions showing appreciable surface viscosity. Best results for foam stability and surface viscosity were obtained with detergent pairs, one of high solubility and the other much less soluble. These foams had low permeability to air.

Viscosities over wide ranges of temperatures have been recorded for 20% solutions of pure sodium soaps and commercial soaps (Demchenko *et al.—Masloboino Zhirovaya Prom. 18,* No. 3, 14; No. 5, 16) and coconut oil potassium soaps (Trusler—*J. Am. Oil Chemists' Soc. 30,* 100). In these, effect of salt is also recorded. Silicates decrease viscosity and turbidites of detergent mixtures but the two effects are not parallel or proportional (Getty & McCready—*Ibid.* 193).

McBain & Gupta (*J. Colloid Sci. 8,* 474) noted that benzene added to aqueous detergent solutions forms a primary turbidity which dissolves on further additions of hydrocarbon before the turbidity marking the limit of solubilization occurs. This intermediate turbidity is shown to be due to development of an acid soap which contains no benzene. Weiden & Norton (*Ibid.* 606) point out anomalities in turbidity points of aqueous nonionic detergent-aromatic systems which limit the validity of the turbidity criterion for determination of solubilization end points. Ekwell & Danielsson (*Acta Chem. Scand. 5,* 973) explain the early turbidity on adding hydrocarbons to aqueous soap solutions as a premicelle formation taking place at a so-called limiting association concentration which is below the critical micelle concentration. In studies of solubilities of hydrocarbon gases in soap solutions it was noted that when the system reaches the vapor pressure of the hydrocarbon there is one mole of the gas bound by a half mole of soap (Theile—*Fette u. Seifen 54,* 683).

Micelle formation was also studied by dye absorption techniques. Such results are lower than with surface tension methods (Raison—*Compt. rend. 235,* 1129). Different dyes may give different results on some surface active agents, possibly because of a difference in the mechanism by which micelles incorporate the dyes of different structure (Rigg & Liu—*J. Am. Oil Chem. Soc. 30,* 14). The method was used to determine the micelle behavior of alkyl sulfates and pyridinium chlorides of different chain lengths (Lange—*Kolloid-Z. 131,* 96; *132,* 45). Similar work on potassium alkanecarboxylates included also the effect of salts in the systems (Herzfeld—*J. Phys. Chem. 56,* 953). The technique was used with other measurements to determine kinetics of adsorption of soaps from solutions to air-water interface, so as to provide data for study of emulsions, detergency, and uptake of drugs by biological systems (Posner & Alexander—*J. Colloid Sci. 8,* 585).

Determination of critical micelle concentration by equilibrium dialysis permits measurements of free ions in equilibrium with micelle, measures inhomogeneity, and indicates the lower homologs which do not take part in micelle formation (Yang & Foster—*J. Phys. Chem. 57,* 628).

Bungenber de Jong *et al.* (*Proc. Koninkl. Ned. Akad. Wetenschap. 55B,* 317, 347, 360; *56B,* 203), published data on comprehensive studies of the association of gelatin with detergents in aqueous solution. The measurements on the effect of structure of the detergents; effect of presence of various salts (anions and cations), and various organic liquids; and influence of pH and the isolectric point of the gelatin are discussed with regard to coacervation, structure of micelle, intermediate layers, packing of micelles, etc.

Potassium soaps increase the concentration of potassium chloride required to coagulate arsenic trisulfide hydrosol (Faidysh—*Kolloid Zhur. 9,* 151).

Meader & Criddle (*J. Colloid Sci. 8,* 170) recommend determining force area curves of surface films of detergents as a means of studying the structure of a detergent or mixtures of detergents. Matalon (*Ibid.* 53) used this technique to show that materials such as cholesterol, may affect forced area films by solution or by complex formation.

PERFORMANCE TESTS. Foam by bubbling nitrogen through aqueous detergent solutions, in a new apparatus, is separated in an annular receiver where drainage rate, composition, average bubble size, and other characteristics may be measured (Walling *et al.—J. Phys. Chem. 56,* 989). With another new apparatus based on mechanically operated reciprocating sieves, rate of formation and disappearance, and volume of foam are measured (Götte—*Melliand Textilber. 32,* 210). The Schlacter & Dierkes' apparatus of similar design was demonstrated with data from many detergents (Machemer *et al.—Fette u. Seifen 55,* 665). Other activity on sudsing or foaming was on relation to micelle formation in soap solutions (Nakashima—*Rept. Osaka Munic. Inst. Ind. Res. 4,* No. 2, 49), foaming and detergency of alkylarylsulfonates and soaps as affected by carboxymethyl cellulose and water hardness (Vaugh *et al.—J. Am. Oil Chemists' Soc. 30,* 1), and a demonstration that foam systems containing at least two foaming components drain slower than one component foams (Sporck—*Ibid.* 190).

Fowkes (*J. Phys. Chem. 57,* 98) proposed a mechanism for wetting of cotton by detergent solution which permits prediction of sinking time of cotton yarn for a variety of wetting agents. The equations require data on the relation between concentration and surface tension of the solutions. The wetting properties of dibutylnaphthalene sulfonate, as measured by sinking time of cloth, are superior to that of Turkey red oil (Yuin & Chang—*Chinese Chem. Engr. 2,* No. 2, 11).

Burcik (*J. Colloid Sci. 8,* 520) relates detrrgency to the initial time rate of surface tension lowering of washing agents and explains the effect of electrolytes in the systems to the influence of the charge of the added negative ion. He suggests that most soils are oily in nature and that the first step in detergency is the removal of the oil by preferential wetting. A study of wetting, foam capacity, surface tension, and detergency tests has indicated that the latter are the best criteria in respect to removal of soil (Frotscher—*Chem. Tech., Berlin, 4,* 485).

Microscopic observations of removal of paraffin oil droplets from wool by Mansfield (*Australian J. Appl. Sci. 3,* 193) indicate detergents reduce contact angle until spheres form which are dislodged by agitation. The technique was used to determine the effect of salts and alkalies in the system and for the discovery that aeration detergency is an efficient process. Similar studies by Stevenson (*J. Textile Inst. 44,* T12) on soil removal are discussed with regard to complex formation being a factor in the process.

Hart & Compton (*Textile Res. J. 23,* 418) demonstrated that soil particle macro-occlusion in fabric structures is largely responsible for difficulty experienced in removing the soil in laundering and detergency tests. Another of their studies (*Ind. Eng. Chem. 45,* 597) shows that anionic cellulose derivatives and polyvinyl alcohol efficiently prevent soil redeposition during laundering and that redeposition is affected by temperature. In a similar publication Stüpel (*Fette u. Seifen 55,* 583) discusses terminology: suspending capacity, dispersing, peptization, etc.; and points out that soil retaining capacity of detergent solutions is improved by addition of inorganic alkaline salts.

An extensive review on soilage and soil removal from textiles with illustrations by black-white and color microphotography was published by Reumuth (*S.V.F. Fachorgan Textilber 6,* 245, 285; *7,* 85, 255, 303, 411, 457, 498). In an investigation on the role of the substrate in detergent processes: nonionics removed fine soil from metal quicker than large particles; in a charged system removal from the cathode was rapid but anode soil is not removed: below the isoelectric point nonmetal (nylon) was cleaned more readily than metal; anionics cleaned carbon soil from glass but not from metals; cationics promoted deposition of carbon soil on glass; and in comparison with carbon, sulfur soil was less readily removed while titanium soil was more readily removed (Fineman & Kline—*J. Colloid*

Sci. 8, 288; Fineman—*Soap Sanit. Chemicals 29,* No. 3, 50). In tests on efficiencies of detergents for inhibiting redeposition of ferric oxide, the order of effectiveness of the detergents is changed in the presence of cotton fabrics, but with carbon also present, redeposition is the same with and without cotton in the solution (Reutenauer—*Bull. mens. inform. ITERG 7,* 14). Soiled cloths for detergency tests by Yabe & Nishimura (*J. Oil Chemists' Soc., Japan, 1,* 124) were prepared with and without nap on the surface and contained carbon, anthracene, olive oil, and liquid paraffin. Reich and coworkers (*Ind. Eng. Chem. 45,* 137) illustrated the use of the Kubelka-Munk equation for interpretation of reflectance data in detergency tests. Because soil aggregation occurs on artificially soiled test cloths they find that a generalized form of the equation gives more suitable results. Tests show that soil removal from wool fabrics is best with ''unbuilt'' soap and ''built'' sodium lauryl sulfate products; ''built'' nonionics are next, and ''unbuilt'' sulfated oils are least effective (Furry & O'Brien—*Am. Dyestuff Reptr. 41,* 861).

Other publications on detergency of laundering soap show that carboxymethyl cellulose is very efficient for improving suspensive power of detergents (Reutenauer—*Bull. mens. inform. ITERG 7,* 223; Madsen—*Tidsskr. Textiltek. 10,* 243); that with polyethenoxy tall oil derivatives optimum soil removal is at chain length 13-14 ethenoxy units, and for optimum whiteness retention 14-15 ethenoxy units are desirable (Stoltz *et al.*—*J. Am. Oil Chemists' Soc. 30,* 271); and that with proper use saponins are efficient detergents and dyeing agents (Uppal & Mehta—*J. Sci. Ind. Res., India, 10B,* 190).

Radioactive tracer techniques were used in detergent chemistry: to determine adsorption of detergent ingredients on various textile fibers and human skin (Hopf & Burmeister—*Fette u. Seifen 55,* 178), for evaluation of the efficiencies of various surfactants in displacing water from steel (Smallwood and Eisler—*Soap Sanit. Chemicals 29,* No. 8, 48), and for measuring the effectiveness of metal cleaners (Hensley—*Iron Age 170,* No. 20, 151). Glassy hexametaphosphate adjusted to pH 8.4 with sodium carbonate improves the efficiency of a number of commercial soaps and synthetic detergents in removing radioactive soil (Segura *et al.*—*Chemistry & Industry 1953,* 1270).

Phelps *et al.* (*J. Home Ec. 45,* 174) find that deterioration of various cotton cloths from laundering is one-third that from wear. Tests for measuring corrosiveness of detergents on materials used in apparatus and on equipment are designed to conform as closely as possible to the time-temperature conditions prevailing in practical cleansing operations (Mohr & Wortmann—*Milchwissenschaft 8, 111*). The stability of oxygen in wash waters of active oxygen containing soap has been measured for the water alone and for practical washes of soiled fabrics (Widaly—*Seifen-Öle-Fette-Wachse 79,* 366). The presence of copper in the wash solution has a stabilizing effect on the active oxygen.

A literature summary on evaluation of dishwashing detergents contains information on five general methods for soil removal, eight methods of applying soil, seven types of washing machines, six different test surfaces, 15 soiling media, and a discussion on criteria (Harris—*Soap Sanit. Chemicals 28,* No. 12, 45). A test simulating realistic dishwashing was devised for determination of foam stabilization in the process (Sanders & Knaggs—*Ibid.* No. 6, 45). Tests recommended for glass detergents by de Vleeschauwr *et al.* (*Mededel. Landbouwhogeschool en Opzoekingsstas Staat Gent 17,* 566) include milliliter *N* sulfuric acid titration of one liter of one percent solution; number of submersions in detergent solutions required to remove milk films from glasses; and the Rahn method for determining bactericidal activity. They (*Ibid. 16,* No. 1, 80) also published results from investigating commercial and laboratory formulated dairy equipment detergents according to the above named tests and for the corrosion of copper, aluminum, and iron. Fineman (*ASTM Bull. No. 192,* 49) designed a dynamic test for detergency of hard surfaces involving use of a standard Launder-O-meter.

Detergents for certain uses are evaluated on the basis of bactericidal properties. The benzyl bromides of the C_6 to C_{18} monalkyl ethers of triethanolamine are useful detergents and germicides according to Sturm *et al.* (*Ind. Eng. Chem. 45,* 186). Among data on the bactericidal activity of quaternary ammonium chlorides derived from commercial fatty acids: C_{16} and tallow derivatives were superior; the bactericidal activity did not vary markedly with degree of unsaturation; and no single one was active against all organisms (Reck & Harwood —*Ibid.,* 1022). In similar work with alkyl (C_9-C_{15}) tolyl methyl trimethyl ammonium chlorides the bactericidal efficiencies were compared to phenol (Goetchius & Grinsfelder—*Applied Microbiol. 1,* 271).

The germicidal potency of quaternary ammonium compounds is reduced more by water hardness than by lower temperature (Humphreys & Johns—*J. Milk & Food Tech. 16,* 186; *Rev. can. biol. 11,* 517). This interference is much greater with calcium than with magnesium hardness (Chambers *et al.*—*Bact. Proc. 1953,* 13). The effect of water hardness on bactericidal activity of synthetic detergents may be overcome with chelating agents (MacGregor & Elliker—*Ibid.* 13; Shiba—*J. Fermentation Technol., Japan 31,* 151). Milk and other colloidal material interfere with the bacteriostatic action of laurylamine saccharinate (Gray & Taylor—*Appl. Microbiol. 1,* 211). Lecithin prevents the fungistatic action of sodium dodecylbenzene sulfonate (Cutter, Jr. & Wilson—*Yale J. Biol. Med. 23,* 277). A certain nonionic detergent, "D2," administered intravenously produces regression and healing of lesions of tuberculosis in guinea pigs, but showed sufficient liver toxicity to exclude its use in man (Rees—*Proc. Roy. Soc. Med. 46,* 581). Three strains of *Treponema pallidium* were just as susceptible to ordinary soap as they are to hexachlorophene soap (Keller & Morton—*Am. J. Syphilis, Gonorrhea, Venereal Dis. 36,* 524).

In bactericidal testing with practical procedures, use of wool, calcium alginate wool, or cotton swabs gives the same efficiency for swabbing bacteria from drinking glasses (Barnes—*Proc. Soc. Appl. Bact. 15,* 34). Bacterial cleanability can be investigated with P^{32} tagged bacteria (Redenour & Armbruster—*Am. J. Public Health 43,* 138).

Filicky *et al.* (*Taste & Odor Control J. 19,* No. 6, 1) recorded the minimum concentrations of various detergents in potable water that are perceptible by taste or odor and designed means of correcting the taste and odor. In this work, chlorine and active chlorine compounds intensified both whereas activated adsorbents removed odor and taste, being especially efficient at pH 5-8.

Hand washing tests on soap versus synthetics, which lasted four weeks, indicated that neither cause significant alteration in lipide secretions in this skin region (Johnsen & Kirk—*Soap Sanit. Chemical 29,* No. 5, 46). Approximately 0.1 milligram of soap per square centimeter remains on human skin after washing and rinsing (Hopf & Burmeister—*Fette u. Seifen 55,* 178). Textiles made from animal fibers retain more soap than those from plant or synthetic fibers. A new test for the effect of detergents on skin is based on the capacity to expose sulfhydryl groups of keratin (Van Scott & Lyons—*J. Investigative Dermatology 21,* 199).

Pharmacological observation from intraperitoneal injected and per oral administered ''Hyamines'' (Finnegan *et al.*—*J. Pharm. & Exptl. Therapeutics 109,* 422) and fatty polyoxyethylene glycol ether derivatives (Sweeney & Oster—*J. Am. Pharm. Assoc. 42,* 556) have been recorded.

Laboratory and practical observations were interpreted by several writers to indicate that commercial and household use of synthetic detergents has no effect on sewage treatment (Hurley—*Sewage & Ind. Waste 25,* 991; Flett & Hoyt—*Ibid.* 245; Gowdy—*Ibid. 15,* 255). Gaillard (*Ibid.* 992) suggested that extensive use of the synthetics may cause major difficulties in the operation of activated sludge units; and van Beneden (*Bull. centre belge etude et document eaux, Liege, 17,* 159) and Manganelli & Crosby (*Sewage & Ind. Waste 25,* 262) have determined the effect they have on various sewage microorganisms. Fuhrman & Rice (*Ibid.* 277) find that the detergents reduce per capita B.O.D. of sewage, reduce the percentage removal of B.O.D., suspend solids by the primary units, and have very little effect on the strength of primary effluents as measured by B.O.D. and suspended solids. The lethal dose of synthetic detergents to fish is 3-10 milligrams per liter and is not greatly different in natural and distilled waters (Leclerc & Devlaminck—*Bull. centre belge etude et document eaux, Liege, 17,* 165). For soap 10-12 milligrams per liter is lethal with distilled water, and 250-1000 milligrams per liter in natural waters containing calcium.