Annual Review of Literature on Fats, Oils, and Soaps. Part 2

Report of the Literature Review Committee*
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Physiology and Biochemistry

REVIEWS. The reviews pertaining to this section of the communication were found in the following texts: the metabolism of fats (Frazer—*Cantor Lecture of The Royal Society of Arts, Feb. 2, 1948*); work on fat and fat metabolism reported in the German literature during the war period (Thomas & Weitzel—*Fiat Rev. Ger. Sci. Biochem. Pt. 1, 1939-46,* 57 pp.); an annual review of lipid metabolism (Chaikoff & Entenman—*Ann. Rev. Biochem. 17,* 253); catabolism of fatty acids (Tripp—*Univ. Microfilm Pub. No. 844,* 52 pp.); integration of the metabolism of carbohydrates, fats, and amino acids (Dickens—*Repts. Progress Chem. 42,* 197); interrelation of carbohydrate and fat metabolism (Deuel & Morehouse—*Advances in Carbohydrate Chem. 2,* 119; Riddle *et al.*—*Carnegie Inst. 1947,* 128 pp.); fat in nutrition (Eckstein —*J. Am. Med. Assoc. 137,* 1220); nutritive value of fats (Mukherjee—*Indian Soap J. 13,* 200); mechanism of fat acid oxidation (Leloir—*Enzymologia 12, 263*); fat metabolism (Bernhard — *Schweiz. Apoth.-Ztg. 86,* 157); essential fatty acids (Bernhard — *Z. Vitamin-, Hormon-u. Fermentforsch. 1,* 199); biological significance of fatty acids (Fachini — *Olii Minerali, grassi, saponi, colori, e vernici 25,* 18); and physiology of adipose tissue (Wertheimer & Shapiro —*Physiol. Revs. 28,* 451).

DESIRABILITY OF FAT IN THE DIET. Observations that a mobile arctic military force voluntarily took about 40% of their calories as fat suggested that diets high in fat were desirable in cold climates (Kark *et al.*—*J. Applied Physiol. 1,* 73). The investigators felt doubtful that rations containing more than 40% of the calories as fat would be acceptable even in the arctic. Samuels *et al.* (*J. Nutr. 36,* 639) recorded that animals on high fat as compared to high protein or carbohydrate diets were capable of more physical effort or longer survival during subsequent fasting. The protein-fed individuals survived for the shortest period. Investigations on the relation of fat to economy of food utilization by French *et al.* (*Ibid. 35,* 83) associated increased weight gain, increased gains of fat and energy, and decreased heat production with high fat diets, using test rations containing 2 to 30% fat. In observations on experimental dental caries, diets containing fat were associated with less caries, healthier appearance, and a higher growth rate than fat-free rations (Granados *et al.* — *Acta Path. Microbiol. Scand. 25,* 453). A decrease of fat in dairy cow rations to less than 300 g. per day caused average reductions of 11 and 23%, respectively, in milk and butterfat produced (Leroy & Bonnet—*Ann. Agron. 17,* 455). Optimum dietary fat was about 400 g. per day.

Broquist & Snell (*J. Biol. Chem. 173,* 435) and Axelrod *et al.* (*Ibid. 175,* 265) demonstrated that oleic acid replaces biotin for several lactic acid bacteria. The latter also explained the biotin-like activity of the lipid fraction of plasma in terms of its fatty acid content. According to the former, egg white blocks the utilization of the oleic acid. Trager's (*J. Bact. 56,* 195) work on growth of lactic acid bacteria showed that lysolecithin blocked the growth promoting effect of biotin and had a slight stimulating effect when oleic acid or plasma fat was used to promote the growth of the bacteria.

The relationships of fat to other dietary components were the text of several investigations. Six sheep rations having the same amounts of protein and made isocaloric by reciprocal variations of fat and carbohydrate, but containing 3, 4, 5, 6, 7, and 8% fat, were equal in utilization of protein and energy (Swift *et al.*—*J. Animal Sci. 7,* 475). In tests on mice fed low caloric intakes, extra calories in the form of protein caused a greater growth response than equivalent calories supplied as fat or carbohydrate (Bosshardt—*J. Nutr. 36,* 773). In testing self selection of diet by rats the use of an unpopular fat caused the animals to select more casein and sucrose (Scott & Verney—*Ibid. 36,* 91). Hydrogenated vegetable oil was more generally liked by young rats than butterfat, corn, or cottonseed oils.

Rats restricted to a single foodstuff or combination plus water survived as follows: no food 4.3 days, galactose 6.2, margarine 32.4, and galactose plus margarine 69.3 days (Richter—*Science 108,* 449). Adding glucose to the margarine diet did not improve survival. Therefore, there was some beneficial effect of galactose on fat metabolism which was not common to all carbohydrates. A significant increase in liver glycogen obtained on adding 10-15% fat to basal

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diets of rats was interpreted as indicating that fats have a favorable influence on glycogen synthesis in the liver (Abelin—*Helv. Physiol. et Pharmacol. Acta 5,* 412). However, administration of vegetable oils to rabbits produced hyperglycemia and hypothermia, and relatively large doses appeared to be toxic (Stohlman—*J. Pharm. & Exptl. Therap. 93,* 346).

A fat-free diet containing solutions of the B vitamins when supplemented with fat allowed a greater weight gain and a reduction of deleterious skin and fur changes in rats (Euler *et al.*—*Z. physiol. Chem. 280,* 177). In the same tests a small amount of yeast was a better supplement than fat. Diets high in fat or carbohydrates had no influence on the concentration of ascorbic acid in the tissues, while high protein diets reduced tissue ascorbic acid content (Samuels—*J. Nutr. 36,* 205). In a comparison of the effect of butter and margarine on calcium metabolism, dietary butter caused a higher retention of calcium and lower retention of phosphorus than did margarine (Westerlund—*Kgl. Lantbruks-Högskol. Ann. 14,* 325).

In recent years it was asserted that butter might be more desirable than margarine because butter might contain a growth promoting factor, identified as vaccenic acid. Presently, vaccenic acid was isolated from tung oil and its spectral absorption described (Groot *et al.*—*Rec. trav. chim. 66,* 633; Boer *et al.*—*Voeding 9,* 60).; it was synthesized (Ahmad —*J. Am. Chem. Soc. 70,* 3391); and its configuration identified as the trans form (Rao & Daubert—*Ibid.* 1102). The vaccenic acid isolated from tung oil had no nutritive effect; thus, suggesting that growth-promoting observations on summer butter apparently were due to an impurity other than this acid (Boer —*cited above*). Kentie's (*Netherlands Milk Dairy J. 1,* 118) contributions to this problem favored the belief that a growth promoting unsaturated acid existed in butter. His evidence was based on obtaining a growth promoting effect, which was destroyed by hydrogenation, from the liquid fractions of butter. The workers at the University of Wisconsin (Nath *et al.*—*J. Nutr. 36,* 761; *J. Dairy Sci. 31,* 793; Geyer *et al.*—*J. Biol. Chem. 169,* 227) still find that summer butter contains a growth factor not present in other fat; their new data indicate that the growth improvement was produced by some factor other than vaccenic acid. They also recorded the vaccenic acid content of various fats. In contrast to the above, several groups of investigators were unable to confirm the work showing that butter contains a growth factor not evident in other fats. Deuel *et al.* (*J. Nutr. 35,* 301) found no differences in growth rate of rats fed diets containing butterfat as compared to cottonseed oil, and they were not able to stimulate growth by administration of vaccenic acid. Clinical observations by Leichenger *et al.* (*J. Am. Med. Assoc. 136,* 388) revealed no differences in butter and margarine on growth and health of 267 children over a two-year test period. Euler *et al's.* (*Arkiv. Kemi Mineral. Geol. 24A,* No. 15, 9 pp.; *Z. Vitamin-, Hormon-, u. Fermentforsch. 1,* 474) tests were on rats and covered a three-year period. Vaccenic acid did not affect growth and butter was not superior to margarine for growth, fertility, or longevity.

The new work on essential fatty acids was mainly on the effects of exclusion of these acids from the diet. Lecoq *et al.* (*Compt. rend. soc. biol. 141,* 449) found that the neuromuscular disturbance in rats deprived of these essential fatty acids is similar to that seen in avitaminosis A or E. Under the same conditions, Hess & Viollier (*Helv. Chim. Acta 31,* 381) observed that plasma lipase activity was diminished to 50% of the normal level. Loeb (*Permanente Foundation Med. Bull. 5,* 136) raised rats on a high saturated fat diet; and, in curing their symptoms of essential fatty deficiency with small amounts of corn oil, he found that the treated rats stored more fats than the deficient rats. The unsaturated acids, when fed in small amounts, were effectively retained and conserved. Kummerow *et al.* (*J. Nutr. 36,* 523) proposed that the nutritive value of oxidized or spoiling fats be evaluated on the basis of their ability to cure acrodynia, the principal symptom of essential fatty deficiency.

FAT-SOLUBLE VITAMINS. The physiology and biochemistry of the fat soluble vitamins were not included within the scope of this review. However, some communications which contained information regarding their relation to the fats, their determination and distribution in fats are included because these are of interest to fat chemists.

Hydroperoxides up to a peroxide value of 45.0 did not inhibit the action of vitamin A in chicks (Halpern & Biely—*J. Biol. Chem. 174,* 817). This suggested that some other compounds present in deteriorating fats decreased the biological action of vitamin A. In this work water emulsions of the vitamin had a greater biological value than its vegetable oil solutions. The latter observation was confirmed by Popper & Volk (*Proc. Soc. Exptl. Biol. Med. 68,* 564). Cattle utilized vitamin A alcohol and the natural ester of vitamin A equally well, but β-carotene, a precursor of the vitamin, was not utilized as efficiently (Ross *et al.*—*J. Dairy Sci. 31,* 111). Dietary soybean oil depressed the utilization of carotene by lactating cows (Squibb *et al.*—*J. Dairy Sci. 31,* 421). In pregnant rats, 2.5% cholesterol in the diet inhibited the movement of vitamin A to the fetuses (Williamson—*J. Biol. Chem. 174,* 631).

New analytical data on vitamin A in fats were: a record of the vitamin A potency of butters sold on the retail markets of Syracuse, New York (Herrington—*N. Y. Agr. Exptr. Sta. Farm Res. 11,* No. 4, 1), the effect of season, breed, and species (cow, buffalo, goat) on the vitamin A potencies of Indian butterfats (Sarkar—*J. Dairy Sci. 31,* 165), the vitamin A potencies of Cuban butterfat, liver oils of Cuban sea sharks (Angulo *et al.*—*Food Research 13,* 1), dog fish livers (Swain—*Fisheries Res. Board Can. Prog. Repts. Pacific Coast Sta. 73,* 57), fur seal oil (Miyauchi & Sanford—*Com. Fisheries Rev. 9,* No. 11, 5), and in the various lobes of shark livers (Kini & Jayaraman—*J. Sci. Ind. Res. 6B,* No. 5, 66).

Corral (*Inform. quim anal, Madrid 2,* 42) recorded data on vitamin A in tuna liver oil which gave a comparison of results by spectroscopic and Carr-Price methods. Collaborative comparison of the same type with margarine showed better agreement by the latter method (Rice—*J. Assoc. Off. Agr. Chem. 31,* 621). Similar work on cod liver oil by Boulanger & Equidt (*Bull. soc. pharm. Lille 1946,* No. 2, 16) indicated that this latter method gave erroneous results on old and deteriorated oils. On such samples the results should be checked spectrophotometrically. Morton & Stubbs (*Biochem. J. 42,* 195) issued meth-

ods for correcting spectrophotometric determinations for irrelevant absorption. The permanence of color obtained in the Carr-Price test for vitamin A was improved by the presence of glycerol 1, 3-dichlorohydrin (Antoniani *et al.—Olearia 1948,* 405).

The antirachitic action of coconut oil was attributed to its ability to make phosphorus more utilizable for bone formation (Dutta — *Ann. Biochem. Exptl. Med., India, 8,* 69). A patented stable provitamin D composition comprised a 1:1 mixture of 7-dehydrocholesterol and cholesterol (Rosenberg & Woessner — *U. S. 2,434,015*).

Rats on vitamin E-deficient diets fed cod liver or linseed oil developed a severe pigmentation of adipose tissue, and lesions of the skeletal muscles, which could be cured by administering tocopherols (Filer *et al.* — *Biol. Anti-oxidants, Trans, 1st Conf. 1946,* 67). The work on analytical methods for vitamin E were: a record of the absorption spectra of the tocopherols (Rosenkrantz—*J. Biol. Chem. 173,* 439), a method of chromatographically separating tocopherols (Kofler—*Helv. Chim. Acta 30,* 1053) and modifications of the Rawlings (Rawlings *et al.—J. Am. Oil Chem. Soc. 25,* 24), and Furter-Meyer (Ruiz & Ralha—*Rev. espan. fisiol. 3,* No. 1, 45) methods for determining vitamin E.

ABSORPTION OF FATS. In tests on nutritional effects of heated fats ordinary lard and lard heated to 350° C. were compared as the fat components of rat diets at 43% levels (Lane & Ivy—*Federation Proc. 7,* 69). When fed with milk and bread there was little difference in food intake, skin lesions, ocular signs of vitamin A deficiency or the post-mortem histology of the tissues. With synthetic diets the heated fat group ate less and consequently their body weight curves were below that of the controls. Deuel *et al.* (*J. Nutr. 35,* 295) suggested that the poor digestibility of rapeseed oil was related to the poor absorbability of the erucic acid fraction. This oil was found to have the lowest coefficient of digestibility of any fat liquid at ordinary temperature, which was investigated on rats. *In vitro* studies of digestibilities of peanut, sesame, cottonseed, and soybean oils, and lard with lipases gave practically the same results with pancreatic lipase, but with castor bean lipase heated oils showed a lower digestion rate (Liebenthal & Adolph—*J. Chinese Chem. Soc. 15,* 161). In a similar test with pancreatic lipase and with olive oil alone, the formation of diglycerides was very rapid, monoglycerides appeared much more slowly and liberation of glycerol was very slow and incomplete (Desnuelle *et al.—Compt. rend. soc. biol. 141,* 1242). Glycerides made from fatty acids prepared by the oxidation of paraffins were split by pig pancreas lipase just as are natural fats (Schulte—*Biochem. Z. 318,* 220).

Salamanca *et al.* (*Trabajos inst. nacl. cienc. med., Madrid 3,* 23, 59) evaluated the extent to which 0.75 g. of dehydrocholic acid per day improved fat absorption by patients with various diseases. During this test it was observed that this treatment improved the absorption of both fat and calcium. In tests with bile fistula dogs, 3.0 g. of bile preparations, including desoxycholic acid, were completely ineffective in reducing steatorrhea; whereas, fresh ox bile effected a 50% reduction in fat excretion (Heersma & Annegers—*Am. J. Physiol. 153,* 143; *Proc. Soc. Exptl. Biol. Med. 67,* 339). In these dogs daily fecal fat increased linearly as dietary fat was increased and was a constant amount equal to that excreted on a fat-free diet plus 58% of the dietary fat.

The absorption of fats in dogs deprived of pancreatic secretion was not improved by administration of folic acid (Douglas & Pratt — *Proc. Soc. Exptl. Biol. Med. 68,* 171). Experimental interruption of the mesenteric lymph drainage also did not alter fat absorption for it did not affect the fecal fat (Clarke *et al.—Am. J. Physiol 153,* 264). These data are relevant to the Frazer hypothesis which regards fat absorption as a function of the portal as well as the intestinal fat circulation. Both of the above reports were also concerned with the theories of the mechanism of steatorrhea in sprue and other diseases where there is poor fat absorption.

Some work on fecal fats indicated that considerable amounts might be of endogenous origin. Chipault & Lundberg (*Ann. Rept. Hormel Inst. 1946-47,* 35) fed fat-free diets to human subjects until fecal fat fell to an approximately constant level, and then observed the changes brought about by feeding triolein. This produced an increase in total lipids and fatty acids which at first were liquid at room temperature, but later on in the test the fatty acids were solid at room temperature. Van de Kamer (*Centraal Inst. Voedingsonderzoek T.N.O. Utrecht Pub. No. 71,* 15) designed analytical procedures for separating of fatty acids and triglycerides from feces and determining their molecular weights. His experiments on human subjects indicated that on a margarine diet the molecular weight of fecal fatty acids was 235-245, and on a butter diet 240-250. The molecular weights of the fatty acids had some clinical significance, for they fell from 280 to 256 during improvement of a patient with endemic sprue. Analysis of mucosa and villi of cattle and human intestines indicated that 10 and 6.5-17%, respectively, of the dry weight was lipids which contained 6-20% unsaponifiable material and the remainder was largely phospholipids (Bernhard & Bullet — *Helv. Physiol. Pharmacol. Acta 5,* 422). Zilversmit *et al.* (*J. Biol. Chem. 172,* 637) observed that absorption of various fatty acid mixtures by rats did not affect the amount and turnover of the phospholipids in the mucosa or the villi of the small intestines. Thus the tests failed to support the hypothesis that phospholipids were obligatory intermediates in the passage of absorbed fat through the intestinal wall.

Rats absorbed lecithin 57-75% more slowly than inorganic or organic phosphates (Artom & Swanson — *J. Biol. Chem. 175,* 871). The lecithin containing radioactive phosphorus was prepared for this test by injecting rats and rabbits with large doses of P^{32}; this deposited in the liver lecithin and was extracted.

Jones *et al.* (*Ann. Internal Med. 29,* 1) demonstrated clinically that fat absorption in humans can be improved by adding emulsifying agents to the fat. They pointed out that this method of improving fat absorption could be useful in conditions of malnutrition caused by disturbances such as celiac disease, sprue, inflammatory diseases of the jejunum or ileum, etc. When an emulsifying agent was administered to rabbits with cholesterol, blood cholesterol levels became two to three times as high as those obtained without the emulsifier, and the animals exhibited an earlier and more severe degree of atherosclerosis (Kellner *et al.—Proc. Soc. Exptl. Biol. Med. 67,* 25).

The above two reports merely confirm past observation that lipids and other water-insoluble material were more readily absorbed when emulsifiers were present.

One series of communications described the manufacture of fat emulsions for parenteral nutrition (Collins *et al.—J. Lab. & Clin. Med. 33,* 143; Geyer *et al.—Ibid.* 153, 163, 175; Mann *et al.—Ibid.* 1503). The emulsions contained up to 30% fat, lecithin was the emulsifier, and emulsified particles of below 2 μ. in diameter were obtained by using high-pressure homogenization. When tested in dogs and rats, it was tolerated well and did not produce the granulomatous lesions observed following the intravenous administrations of fat emulsion. Tolerance curves for the preparation were recorded for the dog, the rat, and the rabbit. In continuing this study, a group of workers (Geyer *et al.—J. Biol. Chem. 176,* 14) observed that 71% of C^{14} injected as trilaurin containing C^{14} was expired as carbon dioxide. This was interpreted to suggest that the emulsified fat was utilized immediately after injection. Meng & Freeman (*J. Lab. & Clin. Med. 33,* 689) also described manufacture of a fat emulsion for intravenous injection; emulsification was at high pressure, three different emulsifiers were used, and the nontoxicity of the preparations was demonstrated on dogs. Nontoxic emulsions for the same purpose, but containing fat, protein, and glucose were prepared by Shafiroff *et al.* (*Proc. Soc. Exptl. Biol. Med. 69,* 387). In parenteral fat emulsion manufacture the rigid exclusion of free fatty acids and soaps was advised because of their adverse effects on the capillaries of the lungs (Jefferson & Necheles—*Proc. Soc. Exptl. Biol. Med. 68,* 248). The physiological effects of lecithin which is often used in parenteral mixtures should be characterized to better establish suitability, because Capraro & Pasargiklian (*Arch. fisiol. 46,* 140) found that large intravenous doses lower basal metabolism and increase lipid consumption.

DEPOSITION. The deposition of yellow fat in hogs was attributed to accumulation of trienoic acids in these depots as a result of high concentrations of the acids in the food fats (Beadle *et al.—J. Biol. Chem. 175,* 221). Samples of yellow fat contained as much as 11.4% linolenic acid; and in experimental reproduction of the condition by feeding ground flaxseeds, hog depot fats were produced with 24.7 to 27.6% of the fatty acid present. The bone marrow cavities of rabbits were said to serve as storage space for mobile supplies of lipids; because fat-depleted rabbits when put on a high fat diet flooded these spaces with reserve fats of the same iodine value as the food fat (Newlin & McCay—*Arch. Biochem. 17,* 125). Analyses of human bone marrow fats by Bernhard & Korrodi (*Helv. Chem. Acta 30,* 1786) showed no differences which could be attributed to diseases, or status of nutrition.

Cottonseed, sesame, and hydrogenated peanut oil in diets of cows produced increases in the iodine values and decreases in the Polenské values of the butterfats produced (Anantakrishnan—*Arch. Biochem. 18,* 35). The effect of hydrogenated coconut oil was to lower the number of fatty acids up to C_{14} and increase the oleoglycerides.

Lungs of dogs, cats, guinea pigs, and monkeys, after absorbing a high-fat meal, contained many patchy areas of oil (Weld—*Can. J. Res. 26E,* 274). These were present interstitially, in alveolar walls and alveolar spaces, and resembled pulmonary fat embolism.

INTERMEDIATE METABOLISM. Bernhard & Bullet (*Helv. Chim. Acta 30,* 1784) demonstrated that fatty acid formation takes place in the intestinal tract. The evidence was based on isolation of deuterium containing fatty acids from the intestines and livers of rats whose body water was labeled with deuterium and whose sole food was lipid-free bread. The observation of LeBreton & Clement-Champougny (*Compt. rend. soc. biol. 141,* 729) that desaturase apoenzyme activity in the liver and the intestinal mucosa of the rabbit fluctuates in amount during digestion and during fasting may also be related to fat synthesis in these organs. In *in vitro* tests with liver slices, additions of insulin afforded an increase of fatty acid synthesis when the medium contained pyruvate, thus indicating that insulin might be concerned with the synthesis of fat (Bloch & Kramer—*J. Biol. Chem. 173,* 811).

When incubated in serum enriched with deuterium oxide, adipose tissue synthesized fat containing the labeled hydrogen (Shapiro & Wertheimer—*J. Biol. Chem. 173,* 725). The rate of introduction was greater in adipose tissue from rats on a diet accelerating fat synthesis in the body.

Labeled carbon, C^{14}, administered to rats in the form of inorganic carbonates, appeared in part in the body lipids (Schubert & Armstrong—*Science 108,* 286). A small fraction was incorporated in the saturated fatty acids and to a lesser extent in the unsaturated acids. The C^{14} content of the carboxyl carbons of the saturated acid was about twice as high as the average for that of all the fatty acid carbons. The C^{14} in the glycerol portion was ten times that of the corresponding mixed fatty acids.

In studies on mobilization of fats in fasted rats white body fat was used up faster than interscapular fat, and the process could be accelerated by injections of either anterior or posterior hypophysis or adrenalin extracts (Clement—*Compt. rend. soc. biol. 141,* 255, 317; Clement & Schaffer—*Ibid.* 320). This action was diminished or abolished by section of the sympathetic nerve, thus suggesting that the effect was exerted through the nervous system. The work of Hodge *et al.* (*Proc. Soc. Exptl. Biol. Med. 67,* 137; *68,* 332) on this subject pertained to lipid changes in the liver during fasting. Fasting mice lost about a third of their body weight in five days and the liver weight decreased logarithmically. The liver lipids, however, first increased and then decreased to less than the normal value on the third to fifth day. There was a considerable decrease in phospholipids during the five days, but it followed liver weight loss in such a fashion that the phospholipid concentration remained approximately constant. The amounts of lecithin and cephalin decreased in proportion. Under normal conditions, according to Bollman *et al.* (*Ibid. 67,* 308), the phospholipid turnover in the liver of rats averaged close to 5% per hour. The above information on liver phospholipids was of interest in connection with the hypothesis that the fatty acids were transported in the body by means of phospholipids. However, Chaikoff *et al.* (*Ibid. 68,* 6) observed that plasma phospholipids were not above normal in the diabetic state, and interpreted this as contrary to the concept that phospholipids were agents for the transport of fatty acids. These workers (Zilversmit *et al.—J. Biol. Chem. 176,* 193, 209)

believed that liver phospholipids were concerned with the utilization of fat in the liver itself. Their evidence was based on the observations that choline stimulated lecithin turnover in the liver but not in the plasma and if the lipotropic action operates through phospholipids then removal of liver fat under influence of choline does not involve an increased transport of fat from liver to tissue *via* plasma phospholipids. In this work the turnover of various phospholipids in the liver and plasma of dogs was measured.

Much of the new information on fat metabolism dealt with prevention of fatty livers and the relation of the process to fat metabolism. According to Hall & Drill (*Proc. Soc. Exptl. Biol. Med. 69,* 3), liver contained a factor, other than protein and choline, influencing fat metabolism which will cure dietary fatty livers, for it reduced liver fat to a greater extent than could be attributed to the protein and choline content of the extracts used. Liver tissue from normal and depancreatized dogs did not behave, *in vitro,* the same in respect to the fat changes until the pancreatic extract, lipocaic, was added to the liver from the depancreatized dog (Lombroso & Bocchiotti —*Science 107,* 90). Synthetic diets in which the protein was replaced by mixtures of amino acids caused fatty livers which were cured by the methyl donors, methionine or choline chloride (Rose *et al.* — *Proc. Soc. Exptl. Biol. Med. 67,* 198). In an investigation on the relationship of methyl donating ability, i.e., cure of fatty livers, to chemical structure dimethylpropiothetin and diethylthetin were quite active, whereas methylethylthetin was less active (Maw & du Vigneaud—*J. Biol. Chem. 176,* 1037). Ethanolamine, methylethanolamine, and dimethylethanolamine effected lipid phosphorylation in the liver as much as or more than choline; thus these functioned like methyl donors (Artom & Cornatzer—*Ibid.* 949). Methionine and methoxinine in large amounts (0.5% of the diet) lowered liver fat to the same degree, but in smaller amounts (50 mg. per day) the animals fed methoxinine died in 12-20 days (Schaffer & Critchfield—*Ibid. 174,* 489). Adding 50 mg. of methionine to the methoxinine group permitted survival but the general well being of the rats was not as good as that of those whose diet was supplemented by methionine alone. From studies on lipotropic pancreatic factor, Pavlov (*Byull. Eksptl. Biol. Med. 23,* 357; *24,* 312) records that the factor lowered liver fat and cholesterol; the phospholipids were unchanged; and the glycogen rose considerably. Sodium nucleinate acted as a lipotropic factor (Leites & Rossinskaya — *Biokhimiya 13,* 152); its action was accompanied by an increase of liver phospholipids. Leites & Mirer (*Ibid.* 264) reported that the lipotropic action of casein was completely checked by the introduction of small amounts of cholesterol in the diet.

High liver fat deposition occurred in dogs on a high casein diet when there was a vitamin B complex deficiency (Drill & Loomis—*J. Nutr. 35,* 333). Excess liver fat was removed and liver function was restored by administering yeast extracts. A synthetic nursing formula for pigs containing casein produced fatty livers and had to be corrected by addition of choline (Johnson & James—*J. Nutr. 36,* 339). The work of MacFarland & McHenry (*J. Biol. Chem. 176,* 429) indicated that some fatty livers resistant to choline could be cured by special beef liver extracts or by the administration of biotin and folic acid. Dogs fed bacon exclusively developed fatty livers and kidney and bladder stones which were not modified with vitamin A, thiamine, or pancreas extract but were cured by providing 25 g. of raw liver to the dogs daily (Groen—*Science 107,* 425).

Hypothyroidism, produced both by thyroidectomy and by thiouracil feeding, resulted in a marked deposition of cholesterol and a smaller increase of fat in livers of rats (Hander—*J. Biol. Chem. 173,* 295). In a comprehensive investigation on the relation of endocrine glands to the production of fatty livers, thyroidectomy was said to prevent a deposition of excess fat in the liver, adrenalectomy and hypophysectomy were accompanied by partial protection; castration in the male had no definite effect and ovariectomy stimulated deposition of liver fat (Shipley & Chudzik—*Arch. Biochem. 16,* 301).

A 10-year record on clinical treatment of cirrhosis of liver indicated that low fat diets and supplements of lipotropic substances such as choline, cystine, and methionine are most effective (Steigmann — *J. Am. Med. Assoc. 137,* 239). Another clinical review recorded that fatty liver subjects did not differ from normal subjects in their ability to methylate glycocyamine to creatine, and methionine excretion was the same in both (Astrup—*Acta Med. Scand. 130,* 12).

Some of the biochemical studies of nonglyceride lipids treated the distribution and character of these in the body. Carter *et al.* (*J. Biol. Chem. 170,* 269, 285, 295) isolated dihydrosphingosine from the cerebroside fraction of beef brain and spinal cord, determined its structure, suggested possible bioprecursors, and synthesized some related compounds. Sphingosine isolated from the brain as well as spleen was a mixture of hydrosphingosine and unsaturated sphingosine (Thannhauser & Boncoddo — *Ibid. 172,* 135, 141). Sinclair (*Ibid. 174,* 343, 355) recorded the lecithin, cephalin, and sphingomyelin contents of human plasma, and of beef, dog, pig, and turkey sera. Foa *et al.* (*Arch. Biochem. 19,* 209) found no difference in the total lipids, phospholipids, sphingomyelin, lecithin, cephalin, and cholesterol in the brain of normal and choline-deficient rats. The results were used to demonstrate that brain hemorrhages in choline-deficient rats were not due to an insufficient supply of phospholipids.

In a study on intermediate products of metabolism, Witter *et al.* (*J. Biol. Chem. 176,* 485, 493, 501) demonstrated a cleavage of triacetic acid into acetoacetic and acetic acids by liver homogenates and by enzymes isolated from liver. This was the first demonstration of the biological activity of an open chain polyketonic acid which could be formed by "multiple alternate" β-oxidation of fatty acids. Because of these findings and the fact that triacetic ester was rapidly metabolized by liver, it was suggested that it appears necessary to accommodate this type of compound in the theories of fat metabolism. Meister & Greenstein (*Ibid. 175,* 573) found that liver and kidney extracts catalyzed the hydrolysis of ?, 4-diketovaleric acid yielding nearly equivalent amounts of pyruvic and acetic acids. On the basis of this he suggested that workers should pursue the possibility of α, γ-oxidation of fatty acid as an alternate to the pathway of β-oxidation.

Viale (*Fisiol e med., Roma, 15,* 149) observed that in human subjects administration of 20 g. of palmitic acid caused no variation in the acetone or acetoacetic

acid in the blood but β-hydroxybutyric acid increased after eight hours. Bernhard & Vischer (*Helv. Chim. Acta 29,* 929) on feeding behenic acid, (C_{22}), prepared by hydrogenation of erucic acid with deuterium, to rats found that the deuterium appeared in the C_{14}, C_{16}, and C_{18} acids of the body fats. The above observations were interpreted to support the β-oxidation theory. Chaikoff *et al.* (*J. Biol. Chem. 174,* 1045) studied the conversion of fatty acids to glucose in alloxan-diabetic rats using palmitic acid labeled at the sixth carbon with C^{14}. The observation that only a very small amount of the 6-carbon of palmitic acid appeared in the urinary glucose as compared to one-sixth when the C^{14} was fed as bicarbonate carbon was interpreted to suggest the incorporation of the sixth carbon of palmitic acid into glucose did not involve an intermediate carbon dioxide fixation.

Some studies developed information on the proper requirements for *in vitro* action of the fatty oxidase complex of rat liver. According to Lehninger & Kennedy (*Ibid. 173,* 753) tissue suspensions in water showed no activity even when supplemented with adenosine triphosphate, magnesium, and phosphate buffer, but were highly active when suspended in saline solution. The oxidizing action of kidney homogenates was inhibited by fluoracetates or fluorobutyrates of the fatty acids (Kalnitsky & Barron—*Arch. Biochem. 19,* 75).

Normal, odd numbered, and branched chain hydroxy fatty acids were oxidized by cyclophorase preparations from kidney and liver and the time and oxygen up take were recorded (Grafflin & Green—*J. Biol. Chem. 176,* 95; Atchley—*Ibid.* 123). The data were consistent with complete oxidation and with Knoop's theory of successive β-oxidation. Another report on this type oxidation suggested that a slight preliminary oxidation of the cyclophorase substrate will initiate the reaction on the fatty acids (Knox *et al.*—*Ibid.* 117).

Thomas & Weitzel (*Hoppe Seyler's Z. physiol. chem. 282,* 170, 180, 185, 192, 200, 206, 208, 215) studied fat metabolism from the standpoint of succinic acid excretion in the urine. This acid occurs regularly in urine and the amount present was reduced on feeding normal fatty acids and increased with synthetic food fats.

FAT METABOLISM IN DISEASE. Thannhauser (*New England J. Med. 237,* 515) reviewed the clinical significance of determination of serum neutral fat, phosphatides, cerebrosides, cholesterol, cholesterol esters, and total fatty acids. Levels in various diseases and in absence of disease were tabulated. A comparison of fatty acids, total cholesterol, and iodine values of the fatty acids in the serum of diabetic and normal persons, by Travia *et al.* (*Arch. Sci. Med. 84,* 289) showed no significant differences except for the iodine values of the fatty acids which were a little higher in diabetic persons. Alloxan diabetic rats were ameliorated by high-fat diets (Janes & Prosser—*Am. J. Physiol. 151,* 581).

Parenteral administration of liver extracts improved the absorption of fat in sprue patients (Black *et al.*—*Quart. J. Med. 16,* 99). Nicotinic acid and riboflavin given in injection produced no improvement.

The behavior of blood cholesterol was of interest in relation to atherosclerosis and arteriosclerosis. Since stability of cholesterol in the blood was a factor involved in these diseases Nedzvetskii (*Biokhimiya 12,* 314) devised a test for this purpose. The evaluation depended on the amounts of cholesterol removed from the blood serum during precipitation of the protein with silver sulfate. The cholesterol was very stable in dog's serum and much less so in that of the rabbit. According to Moreton (*Science 107,* 371) high fat diets accelerate the onset of atherosclerosis by producing the temporary appearance of large lipid particles in the blood which were easily retained and built upon the arterial intima. In rats 5-10% cholesterol and 0.5-0.6% propylthiouracil, alone or combined, fail to produce arteriosclerotic lesions even though the cholesterolemia produced was as high as six times normal (Horlick & Havel—*J. Lab. Clin. Med. 33,* 1029). Atherosclerosis was produced in young chickens by administration of the hormone diethylstilbesterol even on low-fat and low-cholesterol diets (Horlick & Katz—*J. Lab. Clin. Med. 33,* 733). These chickens showed higher levels of blood cholesterol than controls.

Chemically produced tumors appeared more slowly in rats when the fat in the diet was hydrogenated coconut oil than when it was corn oil (Griffin & Baumann—*Cancer Res. 7,* 731).

MICROBIOLOGY AND ENZYME OBSERVATIONS. Foster & Wynne (*J. Bact. 55,* 495) reported that oleic, linoleic, and linolenic acid strongly inhibited the germination of spores of six strains of *Clostridium botulinum;* linolenic was the most active and stearic acid was completely inactive. Lembach (*Zentr. Bakt. Parasitenk, I Abt. Orig. 152,* 266) recorded the names of many bacteria which were destroyed by sunflower, castor, and cod-liver oils. Sphingomyelin enhanced the growth of tubercle bacilli *in vitro* (Dubos—*J. Exptl. Med. 88,* 73).

A study of microbiological fat formation in *Fusaria* revealed no relationship between sterol and fat formation (Nord *et al.*—*Arch. Biochem. 17,* 345). In 2.5-5% glucose solutions the fat and sterol formation was parallel, while on a 10% solution there was an increase in fat but not sterol after the first week.

Rosenfeld (*Ibid. 16,* 263) attributed the transformation of naturally occurring fatty acids in marine sediments to the activity of anaerobic bacteria. In these sediments saturation of the acids increased with depth, and this corresponded with age.

Cruess & Sugihara (*Ibid. 16,* 39) found that when the oxidase of olive tissue was properly purified it behaved like a phenolase rather than a peroxidase. In a study of germinating soybeans, Holman (*Ibid. 17,* 459) recorded the changes in fat content, iodine value of fat, linoleic and linolenic acid contents of the fat, chlorophyll, carotenoids, lipoxidase, and catalase.

According to Holman (*Ibid. 15,* 403) lipoxidase oxidation of linoleic acid produced totally conjugated linoleic acid hydroperoxides. Methods of estimating lipoxidase activity, developed by Smith (*Ibid. 17,* 75), depended on spectral changes produced in linoleic and bixin during coupled oxidation by the lipoxidase.

Composition and Characteristics

Owing to the overlapping nature of the information regarding composition, characteristics, and methods of analysis some of this material appears in other sections of this review. For example, the section on biochemistry contains some data on characteristics, that

on deterioration contain methods for testing spoilage and stability; the introduction contains references to comprehensive treatises which present analytical information; and the detergent section includes the analytical methods for soap products.

The readers should also note that some data have been tabulated in charts appended to this section of the review for convenience of presentation.

ANALYSIS OF FATTY MATERIAL. Some data were both of physiological and commercial interest. For instance, school shark liver contained 23.1-60.7% oil which represented 66.8-93% of the total oil reserves of the fish (Oliver & Shorland—*Biochem. J. 43,* 18). Ester-fractionation analyses of some of these oils indicated that the liver lipid fatty acids contained a higher content of palmitic and C_{18} unsaturated acids, but less stearic acid than the head and body lipids. Similar work with fresh water eels, of various length, showed that total oil content increased with maturity, from 7 to 23% (Shorland & Russell—*Biochem. J. 42,* 429). In the migrant eels the oil was fairly uniformly distributed between head, trunk, and tail, but in the immature eels the tails, which make up 40-43% of the total weight, contained about 70% of the total oil reserve. Similar information on dolphins was reveiwed (Andre--*J. recherches centre inatl. recherches sci. 1947,* 65; Andre & Maille—*Ibid.* 71). The Norwegian Fisheries Research Laboratory (*Tids. Hermetikind 34,* 161) published the analytical data obtained on 526 samples of brislings.

A study on the effect of growth factors on the yield and oil content of poppy seed by Gericke (*Z. Pflanzenernahr. Dungung, Bodenk. 40,* 19) showed that among the fertilization elements, phosphorus seemed most important for development of seed and oil therein. In studying the oil-forming process in the seeds of flax and sunflower, Ruchkin (*Trans. Kirov Inst. Agr. U.S.S.R. 20,* 165) observed that longer nights and prolonged lowering of temperature increased the iodine value of seed oils. This increase in iodine value was the direct result of accumulation of linolenic and decrease of linoleic acids. The average oil content of Turkish castor beans was 64% (Bucak & Baytop—*Farmakolog, Istanbul, 18,* 87).

Among analytical procedures for oleaginous material two communications treated grinding of seeds. With tung fruit, when grinding in a Wiley-Bauer mill, a correction of 0.37% must be subtracted from the oil content obtained, but no correction appeared to be necessary in the case of Wiley-Raymond ground material. McKinney *et al.* (*J. Am. Oil Chem. Soc. 25,* 265). Collins (*Ibid.* 124) designed mechanical improvements for the Bauer mill to eliminate coarse material from the sample and to prevent loss of sample.

One study on various methods of determining fat in ground material revealed that results differed as much as 2.41% for a total fat content of 10-12%, this amounted to a variation of about 20% (Antener & Hogl—*Mitts. Gebiete Lebensm. Hyg. 38,* 207). Lowest values were obtained by cold extraction according to Achermann, and the highest values were by the alcohol-ether method of Terrier. The first yielded only free fat, while the latter's extract contained phosphatide-sugar complexes. In similar work on fish meals, Stansby (*J. Assoc. Offic. Agr. Chemists 31,* 606) obtained acetone extraction results which were superior to those obtained with ethyl ether, and he recommended further study of the acetone procedure to establish optimum precision. On fish, Voth (*Ibid.* 334) recorded that ether extraction after a preliminary acid treatment gave suitable results in the fat determination. A rapid control procedure for fish liver, comprising triturating the sample with anhydrous sodium sulphate and extraction with ether gave results within 1.0% of those obtained by Soxhlet extraction (Chiavarelli—*Ann. chim. applicata 37,* 274). A new procedure for vegetable material was based on saponifying the sample, filtering, precipitating the fatty acids with lead acetate, liberating them with nitric acid and recovery (Marcille—*Chim. anal. 29,* 225).

Two new apparatus were designed for analytical fat extraction. A separatory extraction funnel containing a sintered glass filter disk above the stopcock was proposed as equipment in cases where Soxhlet extraction is too long (Micaelli & Desnuelle — *Bull. mens. ITERG 1948,* No. 7, 31). For a micromethod Hsiao (*Science 107,* 24) adapted a 100 ml. Kjeldahl flask and a vial with a sintered glass bottom for the sample hung within a second shorter vial to a condenser as apparatus for use in a manner similar to that of the larger Soxhlet equipment.

Attention was attracted to the 2% error in the Gerber butyrometric milk fat determination. The suggestions for improving the accuracy included a modification of the procedure (Hostettler & Hanni—*Mitt. Gebiete Lebensm. Hyg. 38,* 354), an equation to correct the results (Brouwer — *Netherlands Milk & Dairy J. 1,* 98), a recommendation that the Gerber fat content be multiplied by 0.98 (Tamsma *et al.*—*Ibid.* 78), and adjustment by reducing the amount of sample taken (Roeder—*Z. Lebensm.-Untersuch. u. -Forsch. 88,* 361). Here in the United States it was pointed out that the sampling and Babcock testing methods in the various states were not uniform (Heinemann *et al.*—*J. Dairy Sci. 30,* 963). Work on the various rapid methods for fat analysis in cheeses indicated that the Roeder method gave values higher than those of the Gulik and the Weibull methods, and adjustments were recommended on the basis of the data obtained (Bernaerts—*Netherlands Milk & Dairy J. 2,* 99). Simplification of the Mojonnier method for cheese by directly weighing the sample in a Mojonnier tube yielded results agreeing with the official A.O.A.C. method (Horwitz & Knudsen — *J. Assoc. Offic. Agr. Chem. 31,* 300). A study of the official method for milk fat in milk chocolate indicated that a small amount of fat remained unextracted, so repeated extractions with centrifuging and decanting of the solvent were proposed (Ferris—*Ibid.* 728).

In a scheme for the analysis of sunburn-preventive creams the lanolin, fatty acids, and glycerides present were calculated from the amount of unsaponifiable fatty acids and glycerol present in chloroform extract (Newburger—*Ibid. 30,* 683).

The various committees of the American Oil Chemists' Society submitted reports of collaborative testing and discussions on modifications of the standard A.O.C.S. methods. These included reports on uniform methods (King—*J. Am. Oil Chem. Soc. 25,* 214), on analysis of commercial fats and oils (Mehlenbacher —*Ibid.* 144) on seed and meal analysis (*Ibid.* 319) and on spectroscopic analysis of soybean, linseed, and cottonseed oils, beef fat, and lard (Stillman — *Ibid. 14*). The American representatives on the fat and

oil commission of the International Union of Chemistry also published a report for the American Oil Chemists' Society (F. D. Snell—*Ibid.* 226). Modifications in the official and tentative methods for fatty materials made by the Association of Official Agricultural Chemists during their fall meeting of 1947 were also published (*J. Assoc. Offic. Agr. Chem. 31,* 70). Micromethods for determination of fat, phospholipids, glycolipids, sterols, and fatty acids in biological tissue, were issued by Kretchmer (*J. Am. Oil Chem. Soc. 25,* 404).

QUALITY AND COMPOSITION OF FATS AND OILS. Some communications dealt with methods of evaluating oils. The sediment problem was the main text of a discussion on sampling tank cars of soybean oil (Freyer—*Soybean Digest 7,* No. 10, 18). Loury & Piquard (*Oleagineux 2,* 560) favored azeotropic distillation with toluene for a precise determination of moisture in fats. The rapid moisture determination on refined and crude oils, and lecithin by the Karl Fischer reagent had a precision of ±0.4% (Brobst—*Anal. Chem. 20,* 939). Spectrophotometric measurement of color done by a single reading at 550 mμ. was reproducible and so easy that it should replace the Lovibond system (Agee—*J. Am. Oil Chem. Soc. 25,* 271). Natural bleaching earth made from English Earth XL000 brand and activated earth made from Special Filtrol clay were adopted as A.O.C.S. official earths for the bleaching test (King—*Ibid.* 12). The bleach color was recommended as a quality criterion in cottonseed oil trading to take the place of refined color (King—*Ibid.* 4). Molines (*Trav. Lab. Natl. Matieres Grasses ITERG 1948,* 82 pp.) and Desnuelle & Molines (*Oleagineux 2,* 64) in a review on the "dilution index" of oils showed this to be a function of the lecithin content, and demonstrated its utility for determining refining losses. This value is based on the amount of sample necessary to abruptly change the surface tension of a definite amount of refined oil. A new test by Naudet *et al.* (*Bull. mens. ITERG 1947,* No. 12, 30) employing the same principle, was named the "concentration index." It depended on using an oil of known dilution index and determining the amount of this oil that will cause a "break" in the surface tension when added to 15 g. of the sample under investigation. This concentration index with the acidity of the oil, was related to the amount of caustic required for the refining and the washing necessary by the Wesson refining process. In a comparison of the Wesson and cup refining loss analyses of crude cottonseed and soybean oils, the former test gave results that were more reproducible and more indicative of the neutral oil content of the crude oils (King & Wharton—*J. Am. Oil Chem. Soc. 25,* 66).

Methods for determining metals in fats were improved. For iron, copper, and nickel analysis in lard Lupton *et al.* (*Ibid.* 216) designed electrical ashing equipment and analyzed the ash according to the Kolthoff & Lingane polarographic method. For copper, iron, manganese, nickel, and tin O'Connor *et al.* (*Ibid.* 408) added magnesium nitrate to the oil so as to yield a carrier for the ash and applied the line-width method to the spectrochemical analysis of the ash. Two colorimetric methods for determining phosphorus in oils were based on ashing and the production of molybdenum blue in solutions of the ash. Ashing was done by oxidation with perchloric and nitric acids (Frampton *et al.*—*Ibid.* 219) and by a method similar to that used in Kjeldahl-nitrogen practice (Molines & Desnuelle—*Bull. mens. ITERG 1948,* No. 2, 1) respectively. Known colorimetric and gravimetric methods for determining nickel in fats were reviewed by Silva (*Rev. brasil quim, S. Paulo 24,* 85).

A method for determining soap in oils, based on shaking the sample in petroleum ether with sulfuric acid and measuring the increase of the acidity of the washed oil was considered better than determination of sodium ion after ashing (Desnuelle *et al.*—*Bull. mens. ITERG 1947,* No. 6, 29). Wolff (*Oleagineux 3,* 197) determined the amount of soap by mixing oil with acetone and bromophenol blue indicator, and titrated the upper layer of the mixture from blue to a yellow end point with 0.01 N hydrochloric acid in a water-acetone solution. The use of Nile blue for the colorimetric determination of soap in oils was suggested by Goiffon (*Ann. biol. clin. Paris 6,* 282).

Low temperature solvent fractionation of corn oil and analysis of the 19 glyceride fractions produced data which agreed closely to a random system of distribution of acids among the glycerides (Doerschuk & Daubert—*J. Am. Oil Chem. Soc. 25,* 425). Similar work on gray seal oil indicated that most of the fatty acids appeared only once in any triglyceride, or a so-called wide distribution (Hilditch & Pathak—*J. Soc. Chem. Ind. 66,* 421). Meara (*J. Chem. Soc. 1948,* 722) discovered that in the mono-unsaturated triglycerides of palm oils, the unsaturated acid may be found in both alpha and beta positions, whereas, in mono-saturated-diunsaturated the saturated acid in the alpha position greatly predominates over the beta isomers. Two reviews on the structure of fats were principally on methods of calculating fatty acid distribution in fats (Cuvier—*Oleagineux 3,* 126) and on molecular constitution as related to properties (Hawkes—*S. African Ind. Chemist 1,* No. 3, 45).

A. R. S. Kartha & K. N. Menon (*Proc. Indian Acad. Sci. 27A,* 279) recorded the ratios of the trisaturated glycerides to the cube of the content of saturated acids of 14 different fats. The ratio appeared to be constant for a given fat and was independent of the environment in which the fat was produced. Jenning's (*Paper Trade J. 126,* No. 8, 137) analyses of tall-oils indicated that the composition of the fatty acid fractions remained constant regardless of season and geographical source, whereas the percentages of rosin acids in the oil varied with the locality of collection.

The new applications of chromatographic separation to segregation of fat constituents has resulted in the development of better technics. Holman (*Arch. Biochem. 17,* 301) demonstrated that saturated acids, stearic, palmitic, myristic and lauric acids could be separated by displacement from charcoal. Picric acid was considered the most suitable displacing agent. With similar technic, Ramsey & Patterson (*J. Assoc. Offic. Agr. Chem. 31,* 441) worked with the C_{11} to C_{19} fatty acids and separated quantitatively, mixtures of even numbered and mixtures of the odd numbered acids. They used a column of silicic acid as the adsorbent, a mixture of furfuryl alcohol and 2-aminopyridine as the immobile solvent and *n*-hexane as the mobile solvent. Using a buffered silica gel column and mixture of chloroform and butanol as a moving

phase, Moyle *et al.* (*Biochem. J. 43,* 308) separated, identified, and estimated the acids in a mixture containing the C_2 to C_8 members. Partial separation of isomeric forms of valeric acid was also achieved. Good results on lower fatty acids were also obtained by Peterson & Johnson (*J. Biol. Chem. 174,* 775) who used sulfuric acid and water as the solvents. These technics on lower fatty acids were intended for work on biological materials and butter fat. In adsorption analysis of the ethyl esters of soybean oil fatty acids, Reinbold & Dutton (*J. Am. Oil Chem. Soc. 25,* 117, 120) obtained fractions with iodine values as high as 200. With binary synthetic mixtures of ethyl stearate, oleate, linoleate, and linolenate fractionation was achieved. In this case, the separation of the oleate-linoleate mixture was of special interest for this cannot be fractionated by distillation methods. A review on chromatography and its application to the separation of fatty acids, unsaponifiable, and bodied oil was written from 58 literature references (Appell—*Chimie & industrie 60,* 36).

Mhaskar *et al.* (*J. Indian Chem. Soc. 25,* 84) demonstrated that the Kartha & Menon method has an accuracy of ±5% as determined on known synthetic mixtures. This method was a modification of the Hilditch procedure in which mono- and diazelao glycerides were determined on the oxidized glycerides. In working with periodate oxidation analysis in which the unsaturated acids were hydroxylated, Witteoff *et al.* (*J. Am. Chem. Soc. 70,* 742) reported that the hydroxyl groups were more proximal in the low melting forms of 9,10-dihydroxy- and 1,9,10-trihydroxyoctadecanes than in the higher melting forms. The hydroxylated forms of oleic compounds were high-melting, whereas, those of elaidic were low-melting. A micro-analytical method of detection of oleic and linoleic acids was based on a standard potassium permanganate oxidation, identifying the oleic and the linoleic acids, respectively, with dihydroxystearic and sativic acids formed (Gorbach & Malissa — *Mikrochem. ver. Mikrochim. Acta 33,* 145). These were separated by fractional crystallization and identified. Stainsby (*Analyst 73,* 429) used a permanganate oxidation followed by titration of the acidic glycerides after removal of the steam-volatile acids to determine the linoleic acid content of fats. Holman & Burr (*Arch. Biochem. 19,* 474), reported that maximum conjugation of polyunsaturated acids was produced with concentrations of potassium hydroxide of 22-23 g. per 100 c.c. This work was done in connection with analytical procedures and greatly improved the sensitivity of the arachidonate determination.

Niemierko (*Acta Biol. Exptl., Warsaw, 14,* 207) applied the Bertram technic in a micromethod for determination of saturated acids. In analyzing the lipids of human tubercle bacilli, Poglar (*Biochem. J. 42,* 206) fractionally crystallized the derivatives obtained by converting the acids into acetol esters, and treating the latter with reagents for ketones, such as semicarbazide or 2,4-dinitrophenylsemicarbazide.

The components of refined soybean lecithin were analyzed by fractional solvent extraction and analysis of the fractions (Scholfield *et al.*—*J. Am. Oil Chem. Soc. 25,* 368). The acetone insoluble material was divided into alcohol-soluble and alcohol-insoluble portions, and these portions were distributed between hexane and methanol by countercurrent liquid-liquid extraction. Lecithin, cephalin, and sugars or glycosides appeared in the alcohol soluble portion and the hexane contained inositol containing phosphatides and sugar or glycosides. The approximate composition of one sample of soybean phosphatides was lecithin 29, cephalin 31, and inositol phosphatides 40%. Chargaff *et al.* (*J. Biol. Chem. 175,* 67) described technics for demonstrating, following chromatography on filter paper, the presence of nitrogenous lipid constituents (choline, ethanolamine, serine). Swain (*Can. Chem. Process Inds. 32,* 553) used chromatographic technic to analyze the unsaponifiable fraction of marine oil. The unsaponifiable matter of dog fish liver oil was adsorbed on alumina. Dichloroethylene eluted cholesterol and vitamin A. The remaining material was readily eluted with ether, and it indicated that 60-90% of the original unsaponifiable consisted of glyceryl ethers. Karnovsky *et al.* (*J. Soc. Chem. Ind. 67,* 104, 144, 193), using crystallization and distillation methods also recorded that a substantial part of the unsaponifiable matter of fish liver oils was glycerol ethers. A saturated hydrocarbon of formula, $C_{29}H_{60}$, was isolated from the unsaponifiable fraction of coffee oil (Neu—*Pharmazie 3,* 82). Shea butter contained a C_{32} unsaturated hydrocarbon (Andre & Pradain—*Compt. rend. 225,* 642). Data on the distillation properties of cholesterol esters in a molecular still were recorded to supply basic data for analyses (Fletcher *et al.*—*Anal. Chem. 20,* 943).

A collaborative report on determination of gossypol in cottonseed products favored a Smith simplification of the Coleman procedure (Tenent—*J. Am. Oil Chem. Soc. 25,* 249). These methods were based on spectrophotometrically measuring the color produced by gossypol with aniline. The Boatner *et al.* method, based on the absorption spectrum of the reaction product from antimony trichloride and gossypol in chloroform, was demonstrated by Hall *et al.* (*Ibid.* 457) with data from applications to oils, raw seeds, and meals. The ultra-rapid method of Podolskaya, using Fehling's solution, in a comparison with the aniline gave, respectively, 0.39-1.18 and 0.45-1.25% gossypol in 22 Belgian Congo cottonseed products (Neirinckx—*Bull. Agr. Congo Belge 39,* 819). In each individual sample the figure was consistently slightly lower by the former method.

PHYSICAL CHARACTERISTICS. Polymorphism properties of fatty materials attracted new investigations, which developed fresh data on melting points and X-ray patterns of the different crystalline forms of several glycerides. In general, the views as to the number of forms and melting points agreed with the postulations and data of Malkin and his co-workers; the differences were slight and pertained to the association of melting points with diffraction patterns, and in the nomenclature. Clarkson & Malkin (*J. Chem. Soc.* 1948, 985) repeated some of the work in which solid modifications of simple triglycerides were identified by X-ray and thermal data. In addition, the data were interpreted to indicate that the concept of Lutton and Longenecker & Daubert of a glassy or vitreous state of triglycerides was untenable. The idea of a glassy or vitreous state was attributed to the effect of certain mixtures of crystals occurring between the quick transitions. In using glycerides of odd acids, the transitions were much slower and less difficulty was experienced in determining the melting points. Daubert & Sidhu's (*J. Am. Chem. Soc. 70,*

1848) recent contribution along this line was a record of the diffraction characteristics of 1,3-dielaidin. Data from products prepared by direct synthesis and elaidinization of 1,3-diolein agreed and confirmed Malkin relative to existence of these in β- and β'-forms. Lutton and co-workers' new contributions on this subject were a postulation of a new type of crystalline structure for saturated glycerides (*Ibid.* 248) and data on polymorphic forms of monosaturated glycerides (*Ibid.* 2445) and mixed saturated glycerides (*Ibid.* 2441). He suggested that where mixed triglycerides show abnormally large, long spacing values, they should be considered triple-chain-length structures analogous to C_{18} triglycerides, instead of the typical double-chain-length structures. This also led to the postulation of a "chair" type of arrangement for the unsymmetrical compounds in contrast to the Malkin or generally accepted "tuning fork" arrangement. The work on the monoglyceride indicated there were four forms which had notable differences in thermal behavior but only minor differences in diffraction pattern. The mixed saturated glycerides in some individual forms varied several degrees in melting point depending on the degree of stabilization, which was said to account for the reporting of more characteristic thermal points for a given glyceride than could be substantiated by X-ray diffraction patterns.

The other physical tests on fats covered a wide variety of characteristics. Leikola & Pirinen (*Suomen Kemistilehti 21A*, 41) determined the solubility of castor oil in various alcohols, esters, ethers, chlorinated hydrocarbons, carbon disulfide, and aliphatic and aromatic hydrocarbons. The results were discussed on the basis of suitability of types of petroleum and petroleum fractions as solvents for the oil. The solubilities of the C_{10} to C_{18} saturated acids in water at 25 and 50° were determined preliminary to the study of hydrolysis of soap solutions (John & McBain—*J. Am. Oil Chem. Soc. 25*, 40). Free fatty acids and their esters were found to absorb almost equal amounts of carbon dioxide and these solubilities were a little more than that of the gas in water (Ouellet & Dubois—*Can. J. Res. 26B*, 54). The interfacial tension of solutions of small amounts of stearic acid in pure paraffin oil decreased with initial temperature increases to a low value, but at higher temperatures when thermal agitation became pronounced interfacial tension increased (Trillat & Brigonnet—*Compt. rend. 225*, 1005). This phenomenon was explained as orientation of the polar stearic acid at the interface and on further heating and agitation a displacement from the surface, leading to return of the high surface tension. Unimolecular films of fatty compounds decreased in viscosity with increase in temperature except those of fatty alcohols which acted like certain proteins (Joly—*J. chim. phys. 44*, 206). A study of the dipole moments of stearic and oleic acids at 25 to 79°C. indicated that the degree of the molecule association of these acids could be calculated from the figures [Stepanenko *et al.*—*J. Phys. Chem. (U.S.S.R.) 21*, 893]. The dielectric constant of butter was affected by the content of air and water and the state of the water-in-oil emulsion in the butter (Mohr & Hennings—*Milchwissenschaft 2*, 173). This characteristic provided information needed for the control of emulsion state and quality of continuous process butter. An apparatus designed to give complete vapor pressure curves on 1-2 drops of pure liquid was applied to the lower alkyl esters of the C_6-C_{18} saturated fatty acids (Bonhurst *et al.*—*Ind. Eng. Chem. 40*, 2379). The relationships between the vapor pressures, densities, and viscosities indicated that the forces governing these three properties have some factor in common. The solidification-point curves of mixed C_{34} and C_{36} acids have been determined and complete this series of data for fatty acids from 8 to 36 carbon atoms (Schuette *et al.*—*J. Am. Oil Chem. Soc. 25*, 64). The Ramon spectrograms of oleic and elaidic acids indicated *cis*- and the *trans*-structure, respectively, for the acids (van den Hende—*Bull. soc. chim. Belges 56*, 328). A study of the frothing of various oils and oil mixtures for frying led to the postulation that frothing, except that due to poor refining, was due to the presence of fatty acids of considerably different chain lengths (Naudet *et al.*—*Bull. mens., ITERG, 1948*, No. 6, 32).

CHEMICAL CHARACTERISTICS. Wolff's (*Oleagineux 3*, 607) demonstration of the use of the potentiometer in acidimetry of fats contained information on the effects of solvents, dilution, temperature, etc. Applications of the technic to soap, sulfonates, and amides of fatty acids were pointed out. Ames & Licata (*J. Am. Oil Chem. Soc. 25*, 203) recorded that there was close correspondence between acid numbers determined colorimetrically and potentiometrically. Snell (*Ibid.* 103) and Pollak *et al.* (*Paper Trade J. 126*, No. 10, 51) found potentiometric superior to colorimetric methods for the acid, saponification and rosin values of tall oil, because of visual color endpoints, were doubtful with this oil. Saturated lime water was recommended as a standard solution for determination of acidity of olive oils (Peral—*Inform. quim. anal., Madrid, 2*, 2). Standardization was unnecessary because concentration at different temperatures could be taken from tables. Hampton (*J. Oil & Colour Chem. Assoc. 31*, 219) issued procedures for determination of the acidity and saponification values of stand oils.

A new procedure for the determination of the saponification value of cottonseed oils was based on hydrolysis in isopropanol-potassium hydroxide solution, adding ethylene or propylene glycol to give a 50-50 mixture of alcohol and glycol, and back-titrating with a standard alcohol-glycol solution of hydrochloric acid, using aniline blue as the indicator (Frampton & Martin—*Anal. Chem. 20*, 661). An investigation on the influence of various solvent alcohols on the saponification results indicated that propanol was advantageous with respect to time and accuracy; butanol-alkali solutions stored poorly, and with ethanol solvent about one-third more saponification time was required than with isopropanol as the solvent (Andre & Maille—*Oleagineux 3*, 525, *Bull. soc. chim. France 1947*, 725). Paquot (*J. recherches centre natl. recherche sci. 1947*, 131) showed that during injudicious saponification of fats, attack may occur at the double bond, lactones could develop, and other side reactions might take place to yield erroneous saponification values. An automatic 25-c.c. pipet was designed to facilitate routine saponification value determinations (Laurent—*Bull. soc. chim. France 1947*, 593).

Among activities on determination of unsaturation in fats were two modifications of the Wijs iodine value method, wherein acetic acid was used to accelerate the

FAT ACID COMPOSITION

Oil or Fat Source	Common Saturated Acids			Common Unsaturated Acids			Other Fat Acids
	C_{14} Myristic	C_{16} Palmitic	C_{18} Stearic	$C_{18}(-2H)$ Oleic	$C_{18}(-4H)$ Linoleic	$C_{18}(-6H)$ Linolenic	
Amaranathus polygamus seed[1]	4.8	7.7	6.8	31.6	38.8		C_{20} 0.50
Asclepias cornuti seed[3]		5.1	2.7	83.6	7.8		C_{26} 0.8
Fish:							
School shark[10] *Galeorhinus australis* Liver	1.3-3.9	15.2-17.1	3.4-6.5	——26.5-31.7 ($-2.4H$)——			C_{20} 0.1-1.5, C_{22} trace, $C_{14}(-2H)$ 0.6-1.2, $C_{16}(-2H)$ 5.3-6.2, $C_{20}(-4$ to $6H)$ 15.5-20.7, C_{22} (Av. of -6.5 to $-9.6H)$ 19.6-25.3
Body and head	0.2	7.8	19.0	——13.5 ($-2.2H$)——			C_{20} 5.2, C_{22} 3.4, $C_{14}(-2H)$ 0.2, $C_{16}(-2H)$ 5.2, $C_{20}(-6.1H)$ 22.8, $C_{22}(-12H)$ 22.7
Soupfin shark liver[11] Fat female	3.3	17.7	1.6	——25.3 ($-3.7H$)——			C_{20} 0.7, $C_{14}(-2H)$ 0.5, $C_{16}(-3.1H)$ 9.4, $C_{20}(-8H)$ 24.4, $C_{22}(-10.3H)$ 15.9, $C_{24}(-10H)$ 1.2
Thin female	3.5	17.3	3.6	——23.1 ($-2.6H$)——			C_{20} 1.2, C_{22} 0.4, $C_{14}(-2H)$ 1.0, $C_{16}(-2H)$ 8.6, $C_{20}(-6.5H)$ 17.2, $C_{22}(-9.8H)$ 17.5, $C_{24}(-10H)$ 6.4, $C_{26}(-10H)$ 0.2
Foetuses	3.3	18.5	2.2	——17.5 ($-3.4H$)——			C_{20} 0.5, C_{22} 0.1, $C_{14}(-2H)$ 0.7, $C_{16}(-2H)$ 6.3, $C_{20}(-8.3H)$ 20.9, $C_{22}(-10.6H)$ 25.5, $C_{24}(-10H)$ 4.6
Herring viscera[12]	5.8	15.7	2.8	——31.8——			C_{20} 0.3, $C_{14}(-2H)$ 1.4, $C_{16}(-2.5H)$ 10.5, $C_{20}(-2.1H)$ 22.4, $C_{22}(-10.5H)$ 9.3
Grapefruit of West India[14] Foster variety	0.8	28.9	2.1	25.1	36.6	5.9	C_{20} 0.6
Marsh variety	1.2	27.5	2.9	21.1	39.3	5.9	C_{20} 2.1
Helianthus annus seed[15]	0.4	4.3	5.5	49.4	40.4		
Horse-chestnuts[16]		4.5	3.7	65.8	21.6	2.3	
Human bone marrow[18]	1.8	22.4	5.7	70.0			C_{12} 0.1
Ipomoea hederacea seed[19]		5.9	20.4	44.0	14.5	6.0	C_{20} 7.8, C_{22} 1.3
Lime seed of West India[14]	0.3	26.1	9.6	11.1	39.3	13.1	C_{20} 0.5
Millet seed, Italian[22] *Sataria italica*		10.6	14.0	20.8	36.4	6.1	C_{20} 6.3, C_{22} 1.2
Muskrat scent gland[23] *Ondatra zibethicus rivalicius*	6.8	23.1	0.2	24.2	5.4		C_{10} 0.2, C_{12} 0.3, C_{24} 0.2, $C_{12}(-2H)$ 0.3, $C_{14}(-2H)$ 0.2, $C_{16}(-2H)$ 8.1, $C_{24}(-2H)$ 1.4, $C_{26}(-2H)$ 3.0, $C_{24}(-4H)$ 3.1, $C_{26}(-4H)$ 1.0, unanalyzed (22.5)
Neat's foot[24]	0.7	16.9	2.7	64.4	2.3	0.7	C_{20} 1.0, $C_{14}(-2H)$ 1.2, $C_{16}(-2H)$ 9.4, $C_{20-22}(-?H)$ 1.6
Nigella sativa seed[25]	0.3	6.3	2.4	44.5	36.0		
Ocimum Canum seed[25]		20.5	3.1	62.9	4.5	5.8	C_{20} 1.8
Okraseed (from Texas)[26] *Hibiscus esculentus*	3.8	33.1	0.5	41.8	13.2		C_{20} 7.9 (?)
Samo from India[27]	0.7	21.2	4.6	45.5	20.4		
Orange seed of West India[14]		23.8	8.3	24.8	37.1	5.3	C_{20} 0.7
Pili nut[29] *Canarium ovatum*	0.1	33.6	21.9	43.3	0.7		C_{20} 0.4
Pine tree seed kernel[25] *Pinus gerardiana*		3.7	1.2	52.3	42.8		
Putranjiva roxburghii seed[31]		7.1	12.2	47.4	15.3		C_{20} 2.1
Radish seed[32] *Raphanus sativus*		1.3	1.4	60.4	4.5	3.6	C_{20} 3.0, C_{22} 3.4, $C_{22}(-2H)$ 22.0
Rape seed[33]		2-4.5		12.5-24	9-16	7-10	C_{18} to C_{24} 3.5-7.5, $C_{16}(-2H)$ 0.5-2.5, $C_{20}(-2H)$ 4-11.5, $C_{22}(-2H)$ 37.5-52.5, $C_{22}(-4H)$ 0.5-1.5
Ringworm shrub seed[25] *Cassia alata*		9.9		37.3	37.8		C_{24} 15 0
Rubber seed[35] *Hevea brasiliensis*		11.8	5.4	20.8	54.9	7.1	
Seal blubber, Grey[36] *Halichoerus grypus*	3.7	10.5	2.0	——30.8 ($-2.7H$)——			$C_{14}(-2H)$ 1.6, $C_{16}(-2.2H)$ 15.5, $C_{20}(-5.7H)$ 16.5, $C_{22}(-10.6H)$ 18
Tea seed[37]	1.0	9.9	1.1	70.2	16.5		C_{20} 0.3
Turtle body (of Mexico)[40] *Chelone mydas* (summer)	9.4	17.2	7.0	——32.4 ($-2.6H$)——			C_{10} 0.8, C_{12} 10.2, C_{20} 1.4, $C_{14}(-2H)$ 0.9, $C_{16}(-2H)$ 9.9, $C_{20}(-6.2H)$ 10.8
Chelone mydas (winter)	8.2	16.7	5.6	——38.0 ($-3.1H$)——			C_{20} 3.5, $C_{14}(-2H)$ 4.4, $C_{16}(-2H)$ 13.6, $C_{20}(-6.5H)$ 10.0
Caretta caretta	6.6	21.8	15.5	——31.4 ($-3.7H$)——			C_{20} 1.9, $C_{14}(-2H)$ 3.5, $C_{16}(-2H)$ 18, $C_{20}(-1.3H)$ 1.3
Lepidochelis olivacea	1.8	26.1	5.5	——40.1 ($-3.1H$)——			$C_{16}(-2H)$ 11.7, $C_{20}(-5H)$ 14.8
Whale, antarctic[41]	9.3	15.6	2.3	——36.9 ($-2.4H$)——			C_{12} 0.3, C_{20} 0.2, $C_{14}(-2H)$ 2.6, $C_{20}(-7H)$ 12.2, $C_{22}(-9.8H)$ 6.8, $C_{16}(-2H)$ 14
Safflower, wild[42] *Carthamus oxycantha*	0.7	3.1	3.6	55.8	36.8		
Yeast[44]	0.1	25.6	5.9	54.5	5.7	0.7	C_{20} and higher satd. 5.1, $C_{16}(-2H)$ 1.3, C_{20-22} unsatd. 1.1

Oil or Fat Source	% Oil or Fat	Specific Gravity	Refr. Index	Acid No. or (% free fat acids)	Sapon. No.	Iodine No.	(SCN) No.	Acetyl No. or (OH No.)	R.-M. No.	Polenske No.	% Unsapond.	Solidification Point (Melting Point)	Diene No.
Amaranthus polygamus seed[1]	4.3	0.9109^{25}	1.4893	9.6	182.2	100.7		29.3			1.89	2	
Argyreia speciosa seed[2]	21.3	0.9377^{22}		8.88	189.1	122.1		8.1			1.4	17	
Asclepias cornuti seed[3]	19.2	0.928^{15}		(18.9)	191	118		18.7				(15)	
Bear, American black[4]		$0.8776^{100/15}$	1.4689^{20}		197.6	96.0	75.2					(22)	
Bosvia octandra seed[5]	0.91				175.2	76.5*	54.1*				10.0		
Buchnerodendron speciosum seed[6]			1.4699^{40}	11.2	200.9	101.4		3.9	1.47		0.7		
Celtis integrifolia seed[5]	6.12				187.1	144*	82.1*				2.1		
Chaetacme microcarpa seed[5]	6.4				189.7	152.7*	83.8*				2.6		
Cherimoya tree seed[7] *Annona cherimolia*		0.9142^{15}	1.4687^{25}	1.35	176.5	98.0	65.5	25.0	0.2	0.36	2.2	—12	8.4
Chrozophora plicata seed[5]	38.5				195.2	112.5*	71.4*				0.7		
Evening-primrose seed[8] *Oenothera biennis*	21	$0.9313^{20/20}$	1.4782^{20}			152.1					2.4		
Fish livers Dog fish[9]	23-51	0.9150-0.9278[25]	1.4790-1.4885[25]	(0.6-8.8)	171.5-184	160-184		5.7-18.7	0.8-1.9	1.1-2.0	1.4-4.7		
Garcia vahl seed kernel[13]	53-56			1,1	189.2-192.4	177-178					0.76		81.5
Grewia villosa seed[5]	0.8				184.6	113.4*	78.3*				3.9		
Helianthus annus seed[15]	52.5	0.9147^{35}	1.4732^{25}	6.4	194.7	111.6	79.1	3.6	0.51		0.55		
Horse-chestnuts[16]	5.0	$0.91214^{15/4}$	1.4637^{40}	3.9	180.3	103.8	75.6	6.0			1.24		
Hsiang-p'u seed[17] *Typha augustata*	20.3	0.9256^{25}	1.4740^{25}	19.1	194.0	130.8		10.7	0.22	0.42	3.64		
Ipomoea hederacea seed[19]	9.4	0.918^{20}	1.474^{20}	3.5	190.5	121.5		5.2			2.0		
Lallemantia seed[20]	30.0	0.9259^{20}		5.6	188.7	179.4					0.9		
Linseed of Hungary[21]	40.3-42.1		1.4864-1.4904^{20}		187.5-193.0	177.5-181.0	113.8-116.9				0.7		
Millet seed, Italian[22] *Sataria italica*	6	0.9156^{25}	1.468^{25}	14.2	192.9	120.4		32.6			2.8		
Nigella sativa seed[25]	31	0.9184^{35}	1.4660^{21}	40.6	196.9	116.9		24.3	4.1		0.4		
Ocimum canum seed[26]	11.6	0.9102^{26}	1.4715^{25}	8.6	189.1	93.8		0			0.48		
Okraseed (from Texas)[26] *Hibiscus esculentus*	14.5-16.0	$0.9170^{25/25}$	1.4689^{25}	(3.1)	199.3	90.7	59.2	8.7		0.32	1.03		
Same (from India)[27]	14.8	0.9183^{30}	1.4704^{30}	12.2	194.4	78.0		5.6			1.23		
Onion seed[28]	17.9	0.9289^{15}	1.4730^{25}	(1.9)	197.5	111.9					1.2	—15	
Peach seed kernel[28]	43.8	0.9207	1.4688^{25}	(0.21)	193.5	102.6					0.68		
Peanut kernel (of Argentine)[28]	41.1			(1.7)	168.3	96.7							
Pine tree seed kernel[25] *Pinus gerardiana*	50.6	0.9198^{30}	1.4699^{25}	1.15	191.9	120.3	83.0	3.7	0.22		0.64		
Pumpkin seed[30] *Cucurbita maxima*		0.914^{15}		0.87	189.4	132.6	79.2				0.51	—17.5	
Putranjiva roxburghii seed[31]	41.8	0.9075^{30}	1.4795^{30}	7.2	190.1	87.1		8.7	0.66				
Radish seed[32] *Raphanus sativa*		0.9173^{30}	1.4704	0.94	178.5	103.1	79.0	2.8	0.61		0.24		
Rice Bran[34]	13-17	$0.9166^{25/25}$	1.4708^{25}	(0.11)	187.6	102.3	75.7	(5.0)			2.7		
Ringworm shrub seed[25] *Cassia alata*	5.0	0.8898^{30}	1.4681^{25}	9.2	165.4	91.3	63.8	13.7	0.08		4.4		
Rubber seed kernel[35] *Hevea brasiliensis*	48.4	$0.9158^{30/4}$	1.4697^{30}	35.2	192.0	132.9	77.8	(12.5)			1.6		
Sphaeranthus indicus seed[25]	5.0	0.9298^{30}	1.4882^{25}	14.0	179.4	117.4	80.5	25.8	1.24		1.85		
Tiger body[38]		0.9122^{30}			195.9	56.8		12.5	2.8	0.6	0.74	43-44	
Tomato seed[39]	25	0.923^{20}	1.4735^{20}	8.0	198	120.5							
Trema guineensis seed[5]	28.1				191.4	116.8*	72.3*				2.7		
Turtle body (of Mexico)[40] *Dermatemys mawii*		0.9218^{15}	1.4560^{40}	0	183.0	83.0						(15)	
Caretta caretta		0.9281^{15}	1.4634^{40}	14.0	189.0	76.6					3.0	(30-34)	
Chelone mydas (summer)		0.965^{15}	1.4580^{40}	0	198.4	73.5					0.84	(23-26)	
Chelone mydas (winter)				2.1	183.5	89.2					2.2	(17-20)	
Lepidocheles olivacea		0.9301^{15}	1.4582^{40}	0	181.6	93.3					1.86	(25-27)	
Safflower, Wild *Charthamus oxycantha*		0.9175^{35}	1.4715^{30}	1.3	195.0	112.8	80.2	3.0	0.8		0.4		
Ungnadia speciosa seed[43]		0.9051^{25}	1.4760^{20}	12.2	193.9	76.8					6.1		
Zizphus spina-christi seed[5]	29.4				188.0	89.3*	69.1*				1.1		
Zizphus xylopyra seed[45]	10	0.9121^{25}	1.4725^{d}	10.7	192.8	84.4		16.6	1.0	0.2	0.8		

* Data from the freed fatty acids.

absorption of iodine (Reutenauer & Regent—*Oleagineux 3,* 379; Hiscox—*Anal. Chem. 20,* 679). In a comparison of such a method with the Hübl procedure the contact times required were, respectively, 60 minutes and 2 or more hours (Lutz—*Anais assoc. quim. Brasil 6,* 181). Savary & Ferrari (*Oleagineux 3,* 134) successfully applied the Kaufmann bromine method to the determination of the iodine value of tung oil. A new modification of the bromine method pertained to arsenometric retitration of excess bromine (Korpaczy—*Kem. Lapja 4,* 106). Velasco & Ruiz (*Anales real. soc. espan. fis. y. quim. Ser. B 44,* 275) devised mathematical equations for the velocity of addition of bromine to olive oil. Deviations from the standard velocity curve for fresh oils were caused by rancidity and acidity. A new procedure for iodine value determinations made use of special chlorine solutions as the reagents (Reutenauer & Regent—*Bull. mens. ITERG., 1948,* No. 4, 35). The Winkler procedure which is the standard method of the German dispensatory was slightly simplified (Awe *et al.*—*Suddeut. Apoth.-Ztg. 88,* 155). Newly issued micromethods for iodine and thiocyanogen values were based on the Rosenmund & Kuhnkenn and the Kaufmann procedures, respectively (Niemierko—*Acta Biol. Exptl. Warsaw 14,* 199).

A method issued for the determination of the acetyl value on microsamples of fat was based on the standard Andre-Cook method (N. W. Gillam—*Australian Chem. Inst. J. & Proc. 14,* 319). Acetyl value studies on rye ergot oils extracted by various methods showed wide differences, because some of the hydroxyl groups were esterified, and this varied in different samples.

A scheme for the analysis of tall oil was issued with analyses of samples produced in nine plants in Finland during 1946 and 1947 (Kahila—*Finnish Paper Timber J. 30,* 144). Iodine, Reichert, and saponification values, and softening points of butterfats collected at monthly intervals over a period of four years from nine New Zealand factories were recorded (Cox & McDowall—*J. Dairy Res. 15,* 377). Analytical records of dairy fats in Turkey contained percentages of the fat in milk and the characteristics of this fat and butters from the cow, goat, sheep, and buffalo (Ungan—*Turk. Ijcn Tecrübi Biol.- Dergisi 6,* 81; Kiper—*Ibid.* 107; Bakos—*Tejasdasag 3,* 166). A study of the colostral fat of Sindhi and Gir cows during the first two days after calving showed increases in Reichert-Meissl, Polenské, and saponification values and decreases in iodine value and refractive index (Anantakrishnan & Kothavalla—*Indian J. Vet. Sci. 16,* 167).

SPECIFIC TESTS FOR DETECTION, IDENTIFICATION, AND ADULTERATION. Holmes & Pack (*J. Am. Oil Chem. Soc. 25,* 163) suggested that since the indexes of refraction and dispersion of tung oils were comparatively high, they could be used for identification, or to detect adulteration with other oils. A specific color reaction for shark-liver oil comprised the production of a blue to a deep red-violet color when a 10% solution of the sample in chloroform was treated with 10% titanium tetrachloride solution in acetylene tetrachloride (Malowan—*(J. Am. Pharm. Assoc. Sci. Ed. 37,* 88). Peanut, cottonseed, sesame, olive, castor, and linseed oils produced only slight red or brown colors. Ultra-violet spectrophotometric absorption curves of unhydrogenated fish oils before and after isomerization showed maximums characteristic of fatty acids with five and six double bonds which could be used to detect the oils and adulteration of animal and vegetable oils and fats (Lambert & Andrews—*J. Am. Oil Chem. Soc. 25,* 414). Testing for the presence of fish oils in admixture with raw linseed oil was of particular interest.

A method for identification of pressed and refined olive oil depended on obtaining yellow and sometimes greenish fluorescence from the chlorophyll and carotenoids in pressed oil, and the bluish fluorescence of hydrocarbons for refined oils (Ciusa—*Mikrochem. ver. Mickrochim. Acta. 33,* 159). A modification of the Fitelson's color reaction for teaseed oil was said to be sensitive to 3% admixtures of teaseed oil in olive oil (Hadorn & Jungkunz—*Mitt. Gebiete Lebensm. Hyg. 38,* 303). The Villavecchia reaction for detecting sesame oil was improved by increasing the strength of the hydrochloric acid solution used in the test (Dastur *et al.*—*Indian J. Vet. Sci. 14,* 94). Other studies showed that intensity of the color developed was not proportional to the quantity of sesame oil present.

One suggestion for the detection of fats made from synthetic fatty acids dealt with identification of the presence of nonesterified acids which could not be esterified with methanol (Sandermann *et al.*—*Pharmazie 3,* 211). The presence of β-side chains also indicates synthetic fats. Another method comprised saponification recovery of the fatty acids with ether, washing with saturated magnesium sulfate solution,

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and dilute sulfuric acid, and treating the dried oil residue with fuming hydrochloric acid and a small amount of furfural (Diemair & Schröder — *Deut. Lebensm. Rundschau 44,* 23). If the sample contained synthetic fat a green to blue-green color appeared at the mixing zone.

The mercaptans of rape seed oils can be detected by their property of blackening saturated silver nitrate solutions (Andre & Kogane-Charles — *Ann. agron. 17,* 393). Black mustard seed oil did not respond to this test. The method of detecting rape seed and other seed oils of the mustard family which depends on isolation of erucic acid was issued in a form for microchemical technic (Gorbach & Malissa— *Mikrochem. ver. Mikrochim. Acta 33,* 365).

A new method for determining butter fat in bread was similar to the procedure of the Association of Official Agricultural Chemists except that instead of carrying out the Reichert-Meissl distillation, butyric acid was isolated by chromatographic means (Munsey — *J. Assoc. Offic. Agr. Chem. 31,* 272). Breads containing no butterfat yielded 0-0.9 mg. butyric acid per gram of fat; fat from milk bread contained 15.2 mg. per gram.

A new characteristic of oils, the "aniline point," was for the purpose of detecting mineral in vegetable oils (Kane—*Current Sci. India, 17,* 150). This characteristic was described as the temperature at which a warm 50:50 mixture of sample and aniline will separate into two layers on cooling. Aniline points of vegetable oils were 3-16.7° and for mineral oils 92-108.8°.

A discussion on indications for contamination of peanut oil with other oils dealt principally with the limits of the physical and chemical constants for the oil (Vizern—*Oleagineux 2,* 442).

Methods and discussions on water insoluble acids in dried eggs and butter were connected with work on determining whether the respective products were made from sour eggs (Hillig—*J. Assoc. Offic. Agr. Chem. 31,* 731) and decomposed cream (Hillig & Ahlmann—*Ibid.* 739). The presence of free butyric acid in butter indicated that decomposed cream was in the mixture from which the butter was churned (*Hillig— Ibid.* 750). It was suggested that this butyric acid resulted from the breakdown of lactose, through lactic acid as an intermediate, and not from hydrolysis of the butyric acid of the fat.

Detergents

MANUFACTURE. The year's developments in soap manufacture included minor improvements in common processes. A patented procedure for cold saponification in a crutcher comprised treating the oil with insufficient potash lye and adding more lye to complete the saponification when the mass became liquid (Elliott & Blackman — *Brit. 575,949*). New equipment was designed to make soap by alcoholizing the fats and saponifying the esters (Bradshaw— *U. S. 2,452,724-5*). In such a process methyl esters of peanut oil fatty acids saponify quite rapidly. At 80-100°C. the methyl esters saponified in a few minutes whereas glycerides resisted saponification for over five hours (Micaelli *et al.—Bull. mens. ITERG 1948,* No. 4, 36).

Clouding of liquid potassium soaps was inhibited when the potash lye used in their manufacture was freed of potassium carbonate and the finished soap contained some unsaponified fatty acids and monoglycerides (Hustinx — *Brit. 601,651*). Soap more stable to rancidity was produced from olive oil foots bleached by potassium persulfate than from foots bleached with calcium hypochlorite (Tomaioti—*Rev. ital. olii vegetali, saponi 30,* 166). Water soluble phosphates were added to aqueous soap solutions containing lithium hypochlorite to inhibit precipitation of the hypochlorite (Soule — *U. S. 2,435,474;* they were added to "Lampon" shampoos (fatty acid-protein condensate detergents) to improve sudsing (Theiler— *Swiss 218,765*); and to hard water soaps to maintain the calcium salts of the water in a dispersed condition (Henderson & Maxwell — *U. S. 2,437,253*). Anglaret (*Bull. mens. ITERG 1947,* No. 11, 31) recorded that the calcium soaps in used laundry waters could be converted into sodium soaps by adding sodium carbonate and boiling. However, in actual laundry tests sodium carbonate did not reduce calcium soap deposition on fabrics nor prevent soap losses when laundering with hard water (Anglaret — *Teintex 13,* 239).

A new soap mill was designed to produce finely divided corrugated flakes (Tainsh—*U. S. 2,429,852*). A soap composition comprising hard soap and synthetic detergent was conditioned by addition of water-insoluble starch so that it could be milled with ordinary milling equipment (Hoyt—*U. S. 2,438,169*). A detergent powder of petroleum sulfonates and detergent alkali salt was rendered nondusting by spraying with dilute aqueous dispersions of glycol stearate (Eisenberger & Machlis—*U. S. 2,455,050*).

One communication on antiseptic soaps contained a discussion on 2% "G-11" soap (Maglio—*Soap Sanit. Chemicals 24,* No. 12, 44). "G-11" is a trade name for a halogenated dihydroxyphenyl methane. The superiority of this, as a germicidal soap ingredient, was based on the earlier discovery by Harden and coworkers (*J. Am. Chem. Soc. 54,* 4325; *59,* 2379), that the dihydroxyphenyl methanes were the only known series of phenolic germicides active at high dilution when in the form of their sodium salts. Baouman (*Industrie chimique 35,* 63) determined the characteristics of various water-phenolic-oil-soap systems. The data were intended to serve as a basis for designing manufacturing procedures for soaps containing cresyl antiseptics.

Clark (*Soap Sanit. Chemicals 24,* No. 8, 41) recommended ground cobs from white corn as an abrasive additive for hand soaps. New detergent briquettes patented by MacMahon (*U. S. 2,435,453; 2,444,836-7*) comprised various mixtures of alkali carbonates and phosphates. A dishwashing detergent contained sodium hydroxide, sodium zincate, and trisodium orthophosphate (Bennett— *U. S. 2,455,648*).

Vaughn *et al.* (*J. Am. Oil Chem. Soc. 25,* 44) recorded ternary diagrams of systems containing sodium carboxymethyl cellulose, sodium alkyl aryl sulfonate, and each of four alkali salts. These were for the purpose of developing detergent formulas. The products were said to surpass the fatty acid soaps in laundering efficiency.

In a corrosion rating of 15 commercial acid-resisting metals tested during sulfonation of nine vegetable oils and other organic compounds, "Monel" metal was outstanding (Friend—*J. Am. Oil Chem. Soc. 25,* 353). Uppal (*Indian Textile J. 57,* 1016) increased the rapidity of sulfonation in the manufacture of

Turkey-red oil by raising the reaction temperature and applying less acid than was commonly used.

Many reports on synthetic detergents were new patents which are listed here under the assignee or patentee for the convenience of presentation:

Allied Chemical & Dye Corp.
Sulfonated alkylated long chain polymeric olefins (*U. S. 2,439,457*). Petroleum nitrosation-sulfitation products (*U. S. 2,436,243; 2,443,716; 2,447,243; 2,447,308*).

American Cyanamid Co.
Reaction products of fatty acid amines and dimethyl maleate (*U. S. 2,438,091*). Alkaryl sulfonates (*U. S. 2,445,975*). Refining organic sulfonates (*U. S. 2,433,316*). Dialkyl sulfo-succinate (*U. S. 2,441,341*). Sulfonated derivatives of fat and hydrocarbons (*Brit. 587,271*). *N*-Sulfodicarboxylic acid aspartates (*U. S. 2,438,092*).

L. H. Bock *et al.*
Sulfonates of polymers of phenols, aldehydes, and ethylene oxide (*U. S. 2,454,541-6*). Polymers of condensation products of epichlorohydrin and fatty acid secondary amine (*U. S. 2,454,547*).

Boyle-Midway, Inc.
Mixtures of various synthetic detergent and trisodium phosphate (*U. S. 2,421,703*).

Burton T. Bush, Inc.
Quaternary ammonium compounds (*U. S. 2,435,583*).

Colgate-Palmolive-Peet Co.
Sulfonating with sulfuric oxychloride (*U. S. 2,434,746*). Sulfonating with a mixture of pyrophosphoric and sulfuric acids (*Brit. 585,662*).

Dobbelman, N. V.
Three per cent magnesium carbonate is added to salts of sulfated fatty alcohols (*Dutch 61,367*). Sulfonated secondary alcohols are added to soap (*Dutch 61,699*).

E. I. duPont de Nemours & Co.
Hydroxyalkyl ethers of hydrolyzed interpolymers of ethylene with vinyl esters (*U. S. 2,434,179*). Dialkyl esters of long-chain alkanephosphonates (*U. S. 2,436,141*).

S. M. Edelstein
Uses of fatty acid or fatty alcohol amides as dispersing agents (*U. S. 2,442,972*).

Emulsol Corp.
Fatty acid esters of hydroxy-alkyl amines (*U. S. 2,449,926*).

J. R. Geigy A.-G.
Fatty acid cyanoguanidines are hydroxyalkylated with sodium ethylate and glycide and then sulfonated (*U. S. 2,433,542*). α-Substituted benzylamine derivatives (*Swiss 214,904, 217,130-8*). Palm kernel fatty acid hydrazides are cyclized and then sulfonated (*Swiss 215,042*). Alkyloxyl methyl derivatives of o-hydroxy aromatic acids (*Swiss 219,930*).

General Aniline & Film Corp.
High boiling hydrocarbons are treated with chlorine and sulfur dioxide, and saponified (*U. S. 2,428,733*).

Gulf Oil Corp.
Fatty acid amine salts of alkyl phosphoric acids and other salts (*U. S. 2,442,024*).

Hercules Powder Co.
Sulfonated rosin substituted cyclohexanols (*U. S. 2,437,481*).

D. F. Holloway and K. H. Spitzmueller
In the preparation of acylated organic sulfates and sulfonate derivatives, the acylation reaction is carried out in a hydrocarbon solvent (*U. S. 2,441,816*).

K. G. Kudva and H. R. Kamath
A mixture of cashew nutshell liquid and fatty oil is sulfonated (*Indian 31,509*).

Quaker Chemical Products Corp.
Salts of alkylolamine boric acid esters (*U. S. 2,441,063*).

Rohm & Haas Co.
Amino ethers and their quaternary ammonium salts (*U. S. 2,416,264-5*).

Sandoz Ltd.
Fatty acid and other organic amines (*Swiss 218,573-8*).

Soc. pour l'ind. chim. á Bale.
Alkylbenzimidazoles are condensed with various organic compounds and sulfonated (*Swiss 215,567; 215,568; 216,303-6; 218,363*). Reaction products of hydroxymethyl fatty acid amides, triethanolamine and glacial acetic acid (*Brit. 600,707*). The same, including sodium salts of hydroxyalkyl sulfonates (*Brit. 600,706-7*). Dihydroxyalkyl sulfonates acylated with aliphatic acids (*Brit. 588,555*). Reaction of alcohols and 4-sulfophthalic anhydride (*Swiss 215,398*). *N*-Polyhydroxylalkyl aryl amines (*Brit. 589,535; Swiss 217,390-2*). Reaction product of stearic anilide, sulfuric acid, and *N*-methylolchloroacetamide (*Swiss 219,925*). *N-N'*-distearoylbenzidene and α,α'-dichlorodimethyl ether are condensed with pyridine or urea (*Swiss 219,857-8*). Reaction products of various organic compounds and stearoyl amides or amines (*Swiss 216,872, 216,940*). Quaternary ammonium compounds (*Brit. 586,688*).

Soc. d'innovations chim.
Sulfonated diaryl thio ethers (*Brit. 595,735*).

Soc. des usines chim. Rhone-Poulenc.
Arylaliphatic amino alcohols (intermediates for detergents) (*Brit. 595,962*).

Standard Oil Co. of Indiana
Sulfonated *m*-di-tert-butyl-benzene (*U. S. 2,429,691*).

Universal Oil Products Co.
Sulfonated alkylbenzenes (*U. S. 2,436,480*).

Visco Products Co.
Amine salt of a coumarone-indene resin-modified alkylated naphthalene sulfonate (*U. S. 2,435,925*).

J. B. Williams Co.
α-Hydroxy-ethers of fatty acids (*U. S. 2,435,828-9*).

Many of the communications on soap technic presented general information and are here listed for convenience of presentation.

Manufacture:

History of soap manufacture (Lubke—*Seifen-Öle-Fette-Wasche 74,* 79). History of the tallow acids industry (Skeen—*Soap Sanit. Chemicals 24,* No. 8, 45). Suitability of various fats for soapmaking (Wolff *et al.*—*Bull. mens. ITERG 1947,* No. 5, 22). Soapmaking by the cold process (Child—*Trop. Agr., Ceylon, 102,* 232). The Sharples continuous soap process (Frampton—*Soap, Perfumery & Cosmetics 21,* 154; McCutcheon—*Soap Sanit. Chemicals 24,* 93; Smith—*Chem. Inds. 63,* 786; Anon.—*Chem. Eng. 55,* No. 12, 107). The Victor Mills continuous soap process (Anon.—*Soap, Perfumery & Cosmetics 20,* 1090). A review of continuous soap systems Martinenghi—*Olearia 2,* 825). Saponification with carbonate (Hetzer—*Seifensieder-Ztg. 73,* 23). Drying soap (Moon—*Soap, Perfumery & Cosmetics 20,* 573). Soap plodder (Ghose—*Indian Soap J. 8,* 27). Chemical engineering in the soap industry (Mukherji—*Ibid. 12,* 253). Detergents from petroleum (Weil—*Petroleum Refiner 27,* No. 5, 261; Crowley—*Univ. Microfilms Pub. No. 866,* 134 pp.).

Non-fatty raw materials:

Builders (Foulon—*Allgem. Oel- u. Fett-Ztg. 38,* 400; Daugherty—*J. Chem. Ed. 25,* 482; Harris *Am. Dyestuff Reptr. 37,* 266). Trisodium phosphate (Skeen—*Soap Sanit. Chemicals 24,* No. 11, 46). Sodium silicate (Skeen—*Ibid.* No. 12, 46; Merrill—*J. Am. Oil Chemists' Soc. 25,* 84). Soap perfumes (Klein—*Soap Sanit. Chemicals 24,* No. 2, 50; Havrenne—*Ing. chim. 129,* No. 170, 97).

Special soaps:

Liquid soaps and shampoos (Cardew—*Soap, Perfumery & Cosmetics 21,* 574; Thomssen—*Soap Sanit. Chemicals 24,* No. 4, 44). Liquid hand cleaners (Lesser—*Ibid.* No. 6, 37). Dermatological action of skin cleaners (Schwartz—*Ibid.* No. 5, 33). Pine oil scrub soaps (DuBois & Morenz—*Ibid.* No. 8, 135). German tall oil soap (Noll—*Seifensieder-Ztg. 73,* 184). Household soaps and cleaners (Alperin—*Soap, Perfumery & Cosmetics 20,* 1190). Detergents for automatic washing machines (Tyler—*Soap, Sanit. Chemicals 24,* No. 4, 41). Waterless hand cleaners (Lesser—*Ibid.* No. 4, 48). Hotel cleaning (Anon.—*Ibid.* No. 11, 41). Specialty soap lines (Smith—*Ibid.* No. 10, 41). Aluminum cleaners (Karunina—*Myasnaya i Molochnaya Prom. 1947,* No. 6, 75). Saddle and leather soap (Lesser—*Soap, Sanit. Chemicals 24,* No. 3, 43). Dog soap (Lesser—*Ibid.* No. 1, 36). Dairy cleaners (Lesser—*Ibid.* No. 5, 40). Cleaning passenger train cars (Slawson—*Ibid.* No. 9, 40; Martin *et al.*—*Am. Ry. Eng. Assoc. Bull. 469,* 78). Detergents for cleaning air conditioning filters (Hoyt—*Soap, Sanit. Chemicals 24,* No. 8, 42).

Synthetic detergents:

Reviews (Speakman—*Chemistry & Industry 1948,* 456; Alperin—*Soap, Perfumery & Cosmetics 20,* 885; Leslie—*Mfg. Chemist 18,* 539) Report of the Society of Chemical Industry symposium on detergents (Liddiard—*Manuf. Chem. 19,* 202; Dutton—*Chem. Products 11,* 104; *Soap, Perfumery & Cosmetics 21,* 464; Anon.—*Chemistry & Industry 1948,* 250). Properties (Barker—*Soap Sanit. Chemicals 24,* No. 6, 46; Hintermaier—*Z. Lebensm.-Untersuch. u. -Forsch. 88,* 316). Manufacture, trade names and statistics (Leslie—*Manuf. Chemist 14,* 497). Types, uses, and properties (McCutcheon—*Chem. Inds. 61,* 811). Economic outlook (Sittenfield—*Ibid. 62,* 584). Trends in the field (Schwartz—*Am. Perfumer 51,* 261; *Soap. Sanit. Chemicals 24,* No. 4, 51; Braybrook—*Chemistry & Industry 1948,* 404). German synthetic detergents (Anon.—*Soap, Perfumery & Cosmetics 21,* 467; Perdue—*Ibid. 20,* 1088). Soaps *vs.* synthetic detergents (Sisley—*Olearia 1947,* 223; King—*Soap Sanit. Chemicals 24,* No. 2, 53). Soap and synthetic detergents in the textile field (Schwartz—*Soap, Sanit. Chemicals 24,* No. 2, 47). Synthetic bar detergent (Cardew—*Soap, Perfumery & Cosmetics 20,* 1205). Petroleum sulfonates (Sittenfield—*Chem. Eng. 55,* No. 6, 120). Petroleum derivatives of ethylene oxide condensates (Monerieff—*Soap, Perfumery & Cosmetics 21,* 1114). Sulfonated oils (Soderdahl—*Ibid.* 46). Sulfonated higher fatty alcohols (Martinenghi—*Olearia 1947,* 309). Quaternary nitrogen compounds (James—*Soap, Perfumery & Cosmetics 21,* 1127). Mersol and Mersolate (Manneck—*Seifensieder-Ztg. 73,* 21; Braun—*Pharmazie 3,* 215; Manneck—*Seifen-Öle-Fette-Wachse 74,* 73).

General aspects of wetting and detergency:

Reviews (Paice—*Chemistry & Industry 1948,* 691; Rideal—*Ibid.* 403; Harwood & Powney—*Chemistry & Industry 1948,* 579. Snell—*Sci. Counsellor 10,* 113.

LESSER KNOWN USES. The influences of the ingredients of the soap used as the emulsifier in the copolymerization of butadiene and styrene in the manufacture of synthetic rubber were evaluated (Wilson & Pfau—*Ind. Eng. Chem. 40,* 530). Replacing 10% of the palmitate soap with sodium linoleate reduced the polymeric conversion obtained in 12 hours 1.4% for each per cent of the sodium palmitate replaced. Linolenate soap exerted three times as great a retarding action as did linoleate. The monounsaturated fatty acid did not retard copolymerization. Hydrogenated soybean oil soap was equal in the process to highly purified saturated fatty acid soaps. Frilette & Hohenstien (*J. Polymer Sci. 3,* 22) plotted the course of the polymerization of styrene in potassium oleate solutions at various temperatures between 75 and 118°C. and determined the energy required for the process. The molecular weights of the polymers obtained were 200,000. The theoretical aspects regarding the role of the soaps in this type of polymerization were discussed by Staudinger (Chemistry & Industry 1948, 563).

Davis (*U. S. 2,445,740*) added a mixture of two detergents, propyl naphthalene sulfonic acid and an alkyl sulfosuccinamate, to latex to increase its wetting power on textiles. Detergents were added to flavoring oils (Hartman—*U. S. 2,433,744*) and to insecticides (Kaberg & Harris—*U. S. 2,447,475*) so that they go into solution in and with water. Synthetic

detergents were added to road oils and asphalts so they would more efficiently coat mineral aggregates (Lemon & Schuessler—*U. S. 2,436,046*). The use of some sulfonated detergents to emulsify a dry cleaning solvent of equal parts of carbon tetrachloride and water was patented (Fisher—*U. S. 2,450,505*).

In investigating the determination of hardness of water by titrating with soap solutions, Hanssen & Spruit (*Anal. Chim. Acta 2,* 330) found that errors up to 30% occur at hardnesses below five parts per million. They recommended, therefore, that a calcium chloride solution be added to reach a hardness compatible with accuracy; a correction is to be made for the calcium chloride added.

The wetting agent "Tween 80" favored the dispersed growth of tubercle bacilli in aqueous media (Dubos & Middlebrook—*J. Exptl. Med. 88,* 81). It was useful in preventing formation of large amorphous bacillary clumps or long bacillary strands. From similar tests Stattler & Youmans (*J. Bact. 56,* 235) found that "Tween 80" inhibited the growth of tubercle bacilli especially when the media contained glucose and glycerol. Part of the effect might have been due to the presence of free fatty acid, for purified "Tween 80" had a lesser effect. The "Tween 80" increased the bacteriostatic effect of 15 out of 20 bacteriostatic compounds, and with the purified Tween seven and 14 compounds were less bacteriostatic (Youmans & Youmans—*Ibid. 245*). Davis' (*Arch. Biochem. 15,* 359) examination of the bacteriostatic effect of the wetting agent toward tubercle bacilli produced evidence that free oleic acid might cause the inhibition. With rigid removal of oleic acid from the Tween and keeping at low temperatures to prevent hydrolysis the bacteriostatic effect disappeared.

The presence of anionic wetting agents increased the phenol coefficient of antiseptics such as merthiolate, mercurochrome, hexylresorcinol, etc. (Berthet —*Schweiz. Apoth. Ztg. 85,* 833).

PHYSICAL CHEMISTRY STUDIES. X-ray powder studies of the five phases of anhydrous sodium palmitate indicated that two basic structures occur (Nordsieck *et al.*—*J. Chem. Phys. 16,* 175). Both structures were liquid crystals, *i.e.,* crystals in the direction of the long spacing and liquid laterally. The examination of the structures in different phases suggested that the waxy phases contained structural restraints on molecular position and motion not present in the neat phases. Vand's & deBoer's (*Koninkl. Nederland. Akad. Wetenschap. Proc. 50,* 991) x-ray studies on soap crystals indicated that the cross-sectional spacing varied with the chain length; but with one form of potassium soaps the spacing did not increase with increasing chain length above 12 carbon atoms.

Vold & Heldman (*J. Phys. & Colloid Chem. 52,* 148) studied by electrical conductance measurements the phase system of anhydrous and hydrous saturated C_{16} and C_{18} soaps to locate phase transition. Neat and subneat soap took up four and three per cent water before going to soapboiler's neat soap. Waxy soap could not take up over 4.5% water nor exist as an equilibrium phase below 116°C. With 69% water a break at 83°C. indicated the completion of middle soap formation. A comparison of soap-water with soap-cetane systems showed that they have similar phase relations (Doscher & Vold—*J. Phys. & Colloid Chem. 52,* 97). Vosganiantz (*Oleagineux 3,* 13) reviewed and discussed MacBain's diagrams of soap phases.

Conductivity measurements were used in studies of the behavior of soaps in water solutions. Accordingly, McBain and coworkers (*J. Am. Oil Chem. Soc. 25,* 77, 141, 221) recorded the pH of solutions of sodium and potassium soaps of the C_{12}, C_{14}, C_{16}, and C_{18} saturated fatty acids. Adding hexane reduced the pH of the soap solutions slightly, while sodium and potassium chlorides only reduced pH in solutions of soaps that were less than saturated. The specific conductance of solutions of potassium laurate (KL), lauric acid (HL), sodium oleate (NaOl), and oleic acid (HOl) mixtures corresponded to the formation of the following soaps: 2KL·HL, KL·HL, 2NaOl·HOl, NaOl, 2KL·HOl, and 2NaOl·HL. These solutions were slightly alkaline even with 150 mol-per cent excess of acid. Each soap had a large temperature range between fair and high solubility; only the potassium laurate, myristate, and oleate, the potassium soaps of coconut oil and the sodium oleate were moderately soluble at room temperature. Brady and Huff (*J. Colloid Sci. 5,* 511) recorded the specific conductivity of lauryl sulfonic acid and potassium laurate at temperatures from 0 to 90°C. The critical concentration of these as determined by the conductivity passed through a minimum at about room temperature. Similar tests on 1-dodecansulfonic acid by Neff *et al.* (*J. Am. Chem. Soc. 70,* 1989) were compared with solubility data. According to the latter data the critical concentrations were higher probably because minute crystals passed into the filtrate. The activity of this compound increased rapidly to a critical concentration and then rose slowly thereafter. Electrical conductance tests with potassium 9,10-dihydroxystearate and potassium stearate indicated that substitution of hydroxyl groups in the middle of the chain of a fatty acid soap increased the critical concentration at which micelles formed (Gregory & Tartar—*J. Am. Chem. Soc. 70,* 1992). Ralston *et al.* (*J. Am. Chem. Soc. 70,* 977, 980, 983; *J. Phys. & Colloid Chem. 52,* 1494) determined the electrical conductivities of several fatty acid quaternary ammonium chlorides and the effect of many organic compounds on the values. Practically all the hydrocarbons tested undecylchloride, stearonitrile, stearamide, acetone, and methanol and acetonitrile lowered the critical conductance. These results were discussed in relation to the micelle theory and it was proposed that solubilization and micelle formation are allied phenomena.

Aqueous systems of detergents and insoluble organic compounds were studied by means of x-ray diffraction (Marsden & McBain—*J. Phys. & Colloid Chem. 52,* 110; Richards & McBain—*J. Am. Chem. Soc. 70,* 1338). Condensates of ethylene oxide with fatty acids or other organic compounds when in water and benzene gave isotropic solutions containing lamellar micelles as in solutions of ionic detergents, but some of the condensates did not show a lamellar structure in water alone. The nonionic detergents were poor solubilizers of water-insoluble organic compounds. When the organic compounds were polar their solubility was depressed by additions of alkali chlorides. With dimethyl phthalate-dilute potassium laurate systems (McBain & McHan—*J. Am. Chem. Soc. 70,* 3838) the solubility of the dimethyl phthalate was 20 times as much as could be dissolved by

the same weight of lauryl hydrocarbon. This was explained on the basis of both solubility in the hydrocarbon portion of the soap and adsorption on exterior polar groups of the small micelles. Nonionizing detergent solutions dissolved increasing amounts of dyes with increased concentration of detergent to a critical concentration, above this further solubility of the dyes was comparatively slight (McBain *et al.*—*J. Phys. & Colloid Chem. 52,* 12). Marsden & McBain's (*J. Am. Chem. Soc. 70,* 1973) x-ray studies of dodecyl sulfonic acid solutions indicated isotropic liquid below 23%, liquid crystals between 23 and 70%, and above 70% liquid crystals different from the preceding crystals. Debye's (*J. Colloid Sci. 3,* 407) observations on light scattering in soap solutions verified McBain's picture of these.

Hattiangdi (*Current Sci. 16,* 222; *J. Phys. & Colloid Chem. 52,* 1481; *Proc. Indian Acad. Sci. 27A,* 23); and Hattiangdi & coworkers (*J. Colloid Sci. 2,* 467) recorded observations of alkali gels in organic compounds. With sodium oleate gels in pinene the water held in interfibrillary space was released by centrifuging. This syneretic process was retarded with isoalcohols; chlorinated hydrocarbons and cresols retarded it in some cases and accelerated it in others; while several ethers, ketones, and aromatic alcohols accelerated the syneresis. Opacity data were recorded also on the systems; and these were discussed from the standpoint of transitions from crystalline states to weak gels and subsequently to stable gels. Schulman *et al.* (*J. Colloid Sci. 3,* 383; *Trans. Faraday Soc. 42B,* 165) investigated similar systems by means of x-rays and with tests where the soap solutions were titrated to transparency with the various hydrocarbons. They showed that in solutions of less than about 27% water the structure was water spheres in hydrocarbon or close-packed uniform oil spheres in water. The conditions for inverting the phases with alcohols and phenols were recorded. Pink's (*Trans. Faraday Soc. 42B,* 170) records of the amount of water absorbed by benzene solutions of ethanolamine oleate showed that, above a critical temperature of 50°C., the increases were large.

Several investigators studied colloidal micelle formation in soap solutions by means of dye solubilization. Lambert & Busse (*J. Chem. Phys. 16,* 847) modified McBain *et al's.* procedure for this so that values could be obtained in 15 minutes and recorded solubilization isotherms for several commercial detergents. Kolthoff & Stricks (*J. Phys. & Colloid Chem. 52,* 915) also used a dye solubilization test and recorded critical concentrations of a large number of detergents. Arkin & Singleterry (*J. Am. Chem. Soc. 70,* 3965) used fluorescent dye in the test and observed critical concentration for micelle formation in plots of the fluorescent intensity against the square root of the soap concentration. Dye solubilization and dye titration technic were used by Merrill & Getty (*J. Phys. & Colloid Chem. 52,* 167, 774) when they showed that silicates decreased the critical concentration for micelle formation in soap solutions. The effect of the salts was interpreted as a common-ion effect, in accordance with law of mass action.

Jong & van Alphen (*Koninkl. Nederland. Akad. Wetenschap. Proc. 50,* 849, 1011) studied the effect of potassium chloride on sodium oleate solutions by means of viscosity measurements. With this procedure, as the concentration increased the viscosity rose to a maximum and then decreased. The method was used also to measure the effect of organic solvents on the soap solutions. Reichenberg (*Trans. Faraday Soc. 43,* 467) observed that impurities cause irrational observations on soap micelle formation when surface- and interfacial-tension-concentration curves were the criteria. Very pure compounds were required in this technic.

Harkins & coworkers (*J. Chem. Phys. 16,* 156, 644, 763) recorded new x-ray data on soap solutions and from these data designed a cylindrical model of the small soap micelle. A newly discovered x-ray diffraction band for soap solutions gave a Bragg spacing that was independent of the concentration and was close to the double length of the molecule or the so-called micelle thickness.

Soaps and detergents were studied from the standpoint of the mechanical properties of the surface layers formed by the solutions. These films were expanded by organic vapors (Dean & McBain—*J. Colloid Sci. 2,* 383), by organic interfaces (Addison & Hutchinson—*J. Chem. Soc. 1948,* 930, 943; Hutchinson—*J. Colloid Sci. 3,* 521, 531) and by phosphates (Matalon & Schulman—*Trans. Faraday Soc. 43,* 479) present in the soap solutions. This was explained as the effect of the compounds entering or dissolving in the surface film.

Bondi (*J. Chem. Phys. 16,* 157) recorded the solubility curves of sodium soaps in many organic solvents.

ANALYSIS OF SOAP CONSTITUENTS. Microprocedures were developed for the complete analysis of soap by Gorbach (*Mikrochem. ver. Mikrochim. Acta 34,* 30) and by Blank (*J. Am. Oil Chem. Soc. 25,* 438). Both analytical systems contained directions for moisture, total fatty acids, unsaponifiable, free alkali, filler, carbonates, and salt; and the latter author also included directions for determining rosin and some of the characteristics of the fatty acids. A semimicro method of determining borax in soap, by Blank & Griffin (*Ibid.* 327), was based on the fact that strontium metaborate is soluble in excess strontium chloride whereas both the strontium orthophosphate and silicate are quantitatively precipitated.

A method of determining the amount of fatty acids in soap comprised hydrolysis with concentrated hydrochloric acid, evaporation to dryness, and extraction of the dry fatty acids with alcohol (Braun—*Seifensieder-Ztg. 73,* 605). A quick method made use of Gerber equipment as used in the dairy industry (Wachsmuth & Robeyns—*J. pharm. Belg. N.S. 2,* 289). A polarographic procedure was based on precipitation of cadmium from a standard solution by the neutral soap and a polarographic determination of the resulting diminution of the cadmium wave (Fiala & Jancik—*Collection Czechoslov. Chem. Communs. 13,* 30).

Kelley & Blank (*J. Am. Oil Chem. Soc. 25,* 225) modified the titration procedure for silica in soap so as to reduce the influence of carbonates and phosphates on the titration. The procedure depends on the titration of silicic acid with hydrochloric acid in the presence of alkali fluorides. The modification constituted treating the ash of the sample with acid and neutralizing before preparing for the final treatment and titration. Procedures for tylose in soap, issued by Liby (*Chem. Obzor 22,* 213) contained a method

for qualitative microscopic detection and quantitative means based on hydrolysis and reduction of Fehling's solution. Treffler (*Soap Sanit. Chemicals 24,* No. 6, 43) issued notes on simple means for detecting soap, synthetic detergents, silicates, borax, phosphates, carbonates, etc. in cleaning agents.

Several volumetric methods for analysis of synthetic detergents were described. One consisted of titrating an anionic agent with a cationic agent, or *vice versa;* under such conditions that a colloidal precipitate was produced near the equivalent-point and solubilized or coagulated by a small excess of reagent (Lambert—*J. Colloid Sci. 2,* 479). Details for titration of the detergents issued by Barr *et al.* (*J. Soc. Chem. Ind. 67,* 45) included partitioning the dye-complexes formed with these into water-insoluble organic solvent and titrating them. Methylene blue was the dye used with anionic and brom-phenol blue with cationic active agents. Harper *et al.* (*Soap Sanit. Chemicals 24,* No. 2, 159) used similar technic for analysis of quaternary surface active and germicidal compounds. Eosin yellow was the dye used and titration was with an anionic compound. Cucci (*Soap Sanit. Chemicals 24,* No. 8, 129) modified a similar procedure for quaternary compounds by using especially made tablets as reagents so that the method could be applied in sanitary field work. That is, a usual concentration of the detergents in cleaning water could be determined at dairy plants, etc. A method for analysis of Igepon T was modified so that it could be applied to the determination of any detergent containing the sulfonic acid group (Shiraeff—*Am. Dyestuff Reptr. 37,* 411). The method was based on the reaction of the sulfonic acid group with certain organic amines which produce water insoluble salts. Hager *et al.* (*Anal. Chem. 19,* 885) described two qualitative and three quantitative methods for determination of quaternary ammonium compounds which depended on their reaction with potassium triiodide. DuBois (*Soap Sanit. Chemicals 24,* No. 11, 122) reviewed the methods in use and suggested methods for determination of quaternary ammonium detergents. A procedure for peptide-fat acid condensation products (Lampons, Maypons), was based on hydrolysis by acidifying to pH 1, adding ether, shaking, allowing to stand until the solution separates into three layers and analyzing the layers (Naudet & Desnuelle—*Oleagineux 3,* 458).

PERFORMANCE ANALYSIS. General papers on evaluation of performance of soaps were on scrub soaps (DuBois—*Soap 24,* No. 3, 134), synthetic detergents (Flett—*Chem. Eng. News 26,* 1368) and dish washing detergents (Walter—*Am. J. Publ. Health 38,* 246; Norris & Ruchhoft—*U. S. Pub. Health Repts. 63,* 97). One discussion on the relative merits of synthetic detergents and soap as skin detergents favored the soaps for they not only cleansed but also lubricated the skin, probably by depositing a unimolecular film of free fatty acid (Czetsch-Lindewald—*Mitt. Chem. Forsch. Inst. Ind. Osterr. 2,* 3). A discussion on skin soap dealt with the influence of the composition and the pH on cleaning action and irritation (Ruemele—*Soap, Sanit. Chemicals 24,* No. 1, 42). The author suggested that free alkali resulting from hydrolysis could not be the cause of irritation, but that such intrinsic properties as solubility, surface activity, and detergency were responsible factors.

Clark & Holland (*Am. Dyestuff Reptr. 36,* 734) recorded washing experiments indicating the effects of type of detergent, soil, and fabric, length of wash, temperature, etc., on the removal of soil. The data were to serve as a basis for devising detergent evaluation tests. From similar experiments, Bacon & Smith (*Ind. Eng. Chem. 40,* 2361) derived equations relating detergent action to concentration of detergent, mechanical force, and time for those conditions in which increased detergent concentration was accompanied by increased soil removal.

Detergency was determined for the C_{10} to C_{18} alkyl sulfates at 55°C. and for the C_{10} to C_{18} sodium soaps at 38 to 71°C. (Preston—*J. Phys. & Colloid Chem. 52,* 84). Detergency first increased with concentration and then leveled off at a critical concentration. This concentration was about that at which colloid formation began. In performance, guanidine soaps compared favorably with the corresponding alkali soaps (Poliakoff & Smith—*Ind. Eng. Chem.* 40, 335). The cost of the guanidine soaps, however, precludes their use as cleaning agents.

Detergency tests were utilized to determine the amount of soap saved by partly softening some laundry waters (Bo—*Tids. Textiltek 6,* 74). Similar tests were made to study the effect of soap builders (Foster *et al.*—*Can. J. Res. 26F,* 76). In hard water, relatively high concentrations of alkaline builders gave detergencies inferior to those of soap alone. In every instance the addition of builder before soap produced the same effect as builder with soap.

Noll (*Seifensieder-Ztg. 73,* 41) devised an apparatus for measuring the sudsing capacity of detergents. His data on some 50-cc. samples in 5% solutions were: washing powder 77, powdered soap 175, two ordinary soaps (208 and 274), and a sulfonated fatty alcohol 360 volume per cent of suds. The frothing of C_8 to C_{18} fatty acid soaps was studied by Aenlle & Fernandez (*Anales real soc. espan. fis. y quim. Ser. B44,* 191). Most stable suds occurred with the C_{16} and C_{18} fatty acid soaps. With changes in pH and temperature, the composition of suds of mixed soaps varied.

In comparison tests, a German synthetic fatty acid soap suffered greater loss in use, its suds were less stable, its cleaning power was inferior, and its odor was more disagreeable than those of an approximately similar soap made from coconut oil and lard fatty acids (den Otter—*Chem. Weekblad 43,* 740).

Leonard & Winch (*Am. Dyestuff Reptr. 37,* P202) demonstrated how wool scouring agents could be evaluated in a laboratory scouring train. Norris (*J. Textile Inst. 39,* P125) suggested that the scouring agent used should be judged with reference to the type of oil that must be removed from the oiled wool. For instance, nonionic detergents were efficient removers of mineral oil, but with oleined wool it was more economical to scour first with soda ash and then with a detergent.

A new performance test for dishwashing detergents was based on washing standard pieces of soiled glass wicking in an Atlas "Launder-Ometer" (Machlis & Michaels—*Soap Sanit. Chemicals 24,* No. 9, 42).

When tested according to the Price method (*J. Infections Dis. 63,* 301; *J. Am. Med. Assoc. 111,* 1993), 2% "G-11" germicidal soap was found to be very bacteriostatic and provided a good reduction of skin bacteria (Seastone—*Surg. Gyn. & Obst. 84,* 355; Clark *et al.*—*Surgery 22,* 360). When compared to ordinary soap for the reduction of pyogenic skin in-

fections, 386 subjects had about 25% less infections during a year when the 2% G-11 soap was used and the severity of these infections was less than during a year when ordinary soap was used (Fuller *et al.*—*Am. J. Pub. Health 38,* 1228). The manufacture of this soap was mentioned earlier in this section of the review.

The performance ratings of germicidal surface active agents dealt principally with their bactericidal or sanitizing action. A review on these contained information on their interaction with enzymes, toxins, erythrocytes, bacterial growth, and viruses; and with their bacteriostatic, bactericidal, and sanitizing activity (Glassman—*Bact. Rev. 12,* 105). The German literature of the war period on "invert soaps" and tetrazolium salts was reviewed with special emphasis on the application of these compounds to biochemical investigations (Jerchel—*Fiat Rev. Ger. Sci. Biochem., Pt. 1, 1939-46,* 59). Beck & Meier (Experientia *3,* 371) suggested that the mechanism of action of invert soaps was that they specifically reacted with lipoids of erythrocytes, whereas with yeast cells the reaction was by adsorption. An investigation on survival of the nonsporulating pathogenic bacteria, *Leptospira icterohaemorrhagiae,* showed that to obtain one-minute kills with various synthetic detergents the dosage had to be over 1,000 parts per million (Chang *et al.*—*J. Infectious Diseases 82,* 256).

In testing the bactericidal action of the surface active agents by means of phenol coefficient, Lind (*Food Technology 2,* 163) urged caution and the use of proper terminology for the test in its present form was still too presumptive; but Klimek & Umbreit (*Soap Sanit. Chemicals 24,* No. 1, 137) on the other hand produced evidence from the literature and original tests to refute the contention that the high phenol coefficient of quaternary germicides was fallacious. McCullough (*Am. J. Pub. Health 38,* 493) considered the disinfecting action of the quaternary compounds unreliable because they cause organisms to clump and then kill individuals within the clump very slowly, and because they are inactivated by less than 50 parts per million of milk, egg yolk, or gelatin. Similarly, Kivela *et al.* (*J. Bact. 55,* 565) demonstrated that the surface active agents were bacteriostatic and their effect on bacterial spores could be reversed by shaking the spores in distilled water or physiological saline solutions.

Weber & Black (*Soap Sanit. Chemicals 24,* No. 9, 137) in studies on germicidal action of quaternary surface active agents reported that the inhibiting action of lecithin was high, the effect of metals and salts was insignificant, and the bacteriostasis of the agents was high. Hucker *et al.* (*New York State Agr. Exper. Sta. Tech. Bull. 280,* 20 pp.; *281,* 21 pp.; *282,* 20 pp.) did quite comprehensive studies to characterize the action of quaternary ammonium compounds. The relative germicidal rates of 13 quaternary salts against vegetative cells and spores of *Escherichia coli, Aerobacter aerogenes,* and *Pseudomonas fluorescens* were presented. The rate of kill increased as the temperature was increased to 170°F., but the efficiency-temperature curves of the various agents were not parallel. Some of the commercial compounds were most active in the acid pH range, some reached optimum effects in both alkaline and acid range, while all were least effective at neutrality. Horse serum, skim milk, and soluble starch inhibited the germicidal activity to about the same degree when based on the actual percentage of organic materials present; cottonseed oil was less active. Certain of the quaternary salts were only partly inhibited and with increased concentration would still have germicidal properties in the presence of large amounts (10%) of organic matter.

Quaternary ammonium compound solutions were as effective as hypochlorite udder washes for reducing the plate count of milk (Kesler *et al.*—*J. Dairy Sci. 31,* 179). An investigation on dairy sanitation in general indicated that both germicides had high degrees of effectiveness in the presence of considerable concentrations of skim milk, but with increasing amounts of organic matter the effectiveness of the quaternary compound declined gradually whereas that of hypochlorite showed a sudden drop (Johns—*Can. J. Res. 26F,* 91).

Pneumococci were completely lysed and killed by cod-liver oil soap in 1:150,000 dilution (Solomides & Hirsch—*Compt. rend. soc. biol. 141,* 328).