10.—THE CHEMICAL COMPOSITION AND NUTRITIVE VALUES OF FOOD-FISHES AND AQUATIC INVERTEBRATES.

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INTRODUCTION.

The Reports of the U. S. Commissioner of Fish and Fisheries for 1880 (Washington, 1883) and 1883 (Washington, 1885) contain preliminary accounts of the progress of an investigation of the chemical composition and nutritive values of American food-fishes and aquatic invertebrates, the details of which are given herewith. The investigation in its present status includes: (1) Chemical analyses of the flesh of American food-fishes and invertebrates; (2) experiments upon the digestibility of the flesh of fish; (3) studies of the chemical constitution of the albuminoids of the flesh of fish.

Analyses have been made of the flesh of 123 specimens of American fishes belonging to 52 species; of 3 specimens and 2 species of European fishes, and of 64 specimens representing 11 species of American mollusks, crustacéans, etc. Two of the European specimens were of a species included in the American fishes. The total number of specimens of fish analyzed is, therefore, 126, belonging to 53 species. These, with the invertebrates, make 190 specimens, belonging to 64 species. Since, in many cases, analyses were made of more than one specimen, the actual number analyzed is larger than these figures imply.

Nearly 1,000 different species of fish are used for food in the United States. When we consider that almost no other analyses of American food-fishes have been made (I am aware of but two); that different specimens of the same species vary considerably in composition, so that several analyses of each are necessary to show the ranges of variation and the average composition under different circumstances of locality, season, size, age, sex, etc.; and that, from both chemical and economical standpoints, studies of the constitution of the ingredients of the flesh and of other tissues are needed to make our information at all complete, it is evident that the work here reported can be regarded as only the beginning of a much-needed research.

Along with these studies, a series of analyses of meats, dairy products, and other food materials, animal and vegetable, have been undertaken at the instance of the U. S. National Museum, to furnish data for illustrating and explaining its food collections. These analyses form an important economical supplement to the investigation herewith reported, because of the desirability of data for comparisons of fish with other foods. Some of the principal results are embodied in the tables of composition of food materials in Part II.

The studies of the digestibility of the flesh of fish were carried out in the physiological institute of the University of Munich. I am indebted to Professor Voit of that university, not only for the hospitalities of his laboratory but also for kind assistance. As the details of the experiments have been published elsewhere, only the main results are recapitulated here.

An investigation upon the constitution of the flesh of fish was begun in the physiological institute of the University of Heidelberg, where opportunities were furnished through the courtesy of Professor Kühne, to whom also I wish to express my indebtedness. The investigation has been continued in the laboratory of Wesleyan University, but has not reached that stage of completion which would make the publication of results satisfactory. Circumstances may hereafter permit its further prosecution, and the outcome may be combined with other studies, including those of dietaries of which fish forms or should form a part.

All of the work of investigation here reported, except that upon the digestibility of fish, was performed at Middletown, Connecticut, in the chemical laboratory of Wesleyan University.

While the work has been constantly under my immediate supervision, and much of it has been done by myself, the larger part of the details have been skillfully and faithfully performed by my assistants, Messrs. G. P. Merrill, W. H. Jordan, J. H. Long, Miles Beamer, E. B. Voorhees, E. W. Rockwood, and especially C. D. Woods. The last-named gentleman has performed the larger portion of the work of analysis and calculation of results besides contributing very materially to the elaborating of the methods of analysis and assisting in numerous other ways, including the preparation of diagrams and reading of proofs.

Thanks are due to Mr. F. T. Lane, of New Haven, Connecticut, Mr. J. F. Ely, of Baltimore, Maryland, to Messrs. Dorlon & Shaffer, of New York, and to Mr. E. G. Blackford, fish commissioner of the State of New York, for a large number of specimens of fish and invertebrates generously furnished for analysis, and for valuable information as well.

Especial thanks are due to Mr. Blackford, not only for a very considerable number of specimens and for information which was extremely helpful, but also for a gift of $100, which was used in defraying some of the incidental expenses of the analysis of invertebrates.

I wish also to acknowledge the generous contribution of Mr. A. R. Crittenden, of the firm of Wilcox, Crittenden & Co., of Middletown, Connecticut, of $100, which was used in defraying part of the incidental expenses of the analyses of fish.

PART I.

THE CHEMICAL COMPOSITION OF FOOD-FISHES, MOLLUSKS, CRUSTACEANS, ETC.

SECTION A.—AMERICAN FISHES.

1. NAMES OF AMERICAN FISHES AND NUMBER OF SPECIMENS ANALYZED.

In most of the tabular statements and discussions I have followed the arrangement of families given by Jordan and Gilbert in their Synopsis of the Fishes of North America, Bulletin No. 16 of the U. S. National Museum, 1883.

LIST OF SPECIES AND NUMBER OF SPECIMENS OF EACH.

The following is a list of the species analyzed, with the number of specimens of each, including both fresh and preserved fish:

	No. of specimens.
Acipenseridæ:	
Acipenser sturio oxyrhynchus, Sturgeon	1
Catostomidæ:	
Moxostoma velatum, Small-mouthed red-horse	1
Clupeidæ:	
Clupea harengus, Herring	2
pilchardus, Sardine	1
vernalis, Alewife	2
sapidissima, Shad	7
Salmonidæ:	
Osmerus mordax, Smelt	2
Coregonus clupeiformis, Whitefish	1
sp., *tullibee* or *artedi*, Ciscoe	1
Oncorhynchus chouicha, California salmon	5
Salmo salar, Salmon	7
subsp. *sebago*, Land-locked salmon	2
Salvelinus namaycush, Lake trout	2
fontinalis, Brook trout	3
Esocidæ:	
Esox lucius, Pike	1
reticulatus, Pickerel	2
nobilior, Muskellunge	1
Anguillidæ:	
Anguilla rostrata, Eel	2
Mugilidæ:	
Mugil albula, Mullet	1
Scombridæ:	
Scomber scombrus, Mackerel	10
Scomberomorus maculatus, Spanish mackerel	1
Orcynus thynnus, Tunny	1

	No. of specimens.
Carangidæ:	
Trachynotus carolinus, Pompano	2
Pomatomidæ:	
Pomatomus saltatrix, Bluefish	1
Stromateidæ:	
Stromateus triacanthus, Butter-fish	1
Centrarchidæ:	
Micropterus salmoides, Large-mouthed black bass	1
dolomieu, Small-mouthed black bass	1
Percidæ:	
Perca fluviatilis, Yellow perch	2
Stizostedion vitreum, Wall-eyed pike	1
canadense, Gray pike	1
Serranidæ:	
Roccus lineatus, Striped bass	6
americanus, White perch	2
Centropristis atrarius, Sea bass	1
Epinephelus morio, Red grouper	2
Sparidæ:	
Lutjanus blackfordi, Red snapper	3
Stenotomus chrysops, Porgy	3
Diplodus probatocephalus, Sheepshead	2
Sciænidæ:	
Sciæna ocellata, Red bass	1
Menticirrus saxatilis, Kingfish	1
Cynoscion regale, Weakfish	1
Labridæ:	
Hiatula onitis, Blackfish	4
Gadidæ:	
Phycis chuss, Hake	1
Brosmius brosme, Cusk	1
Melanogrammus æglefinus, Haddock	6
Gadus morrhua, Cod	10
Microgadus tomcod, Tomcod	1
Pollachius virens, Pollock	1
Pleuronectidæ:	
Hippoglossus hippoglossus, Halibut	5
Platysomatichthys hippoglossoides, Turbot	1
Paralichthys dentatus, Flounder	2
Pseudopleuronectes americanus, Flounder	1
Petromyzontidæ:	
Petromyzon marinus, Lamprey eel	1
Raiidæ:	
Raia sp., Skate	1

The whole number of specimens analyzed for this report thus amount to 123, belonging to 53 species. One specimen was, however, of French origin, while two specimens of European fish have been analyzed in connection with the present investigation, so that the latter actually includes analyses of 125 specimens. This report contains also an analysis of American halibut by Professor Chittenden. We have, therefore, analyses of 124 specimens of American fishes belonging to 53 species.

NAMES AND SYNONYMS.

Of the specimens of fishes analyzed in connection with the investigation whose details are reported here, a considerable number were found in fish markets in Middletown, Connecticut. These were mostly of common species whose names were well known to us. By far the larger number were supplied through the kindness of Mr. E. G. Blackford, fish commissioner of the State of New York, who gave with each specimen the common name, and in some cases the Latin name. Species with which we were not familiar, or the names of which were for other reasons a matter of doubt, were referred to Dr. W. N. Rice, professor of natural history in this college, who was so kind as to either identify them himself or have them identified under his supervision by an assistant or advanced student. Professor Rice tells me that the specific differences are sometimes difficult to distinguish in specimens that have been distorted in packing and transportation, so that it is not impossible that errors may have been made. I can not believe, however, that with the literature of the subject, and many typical specimens in the college museum, conveniently at hand and freely used, many or serious mistakes could have occurred.

There may perhaps be no obligation in a monograph on the chemistry of fish to lay much stress upon the natural history of the subject; but I had desired to group the specimens in accordance with their natural relationships, and especially to put the analyses of the same species together, thinking that such a comparison of the chemical characters would be of interest, and hence desired to have the classification as correct as might be. In the following list of American fishes the names given in Dr. Jordan's Catalogue of Fishes of North America* have been adopted.

I am under obligations not only to the gentlemen named, but also to Prof. D. S. Jordan and Dr. T. H. Bean for assistance in the preparation of the list of synonyms.

In preliminary reports of the present investigation published in the reports of the U. S. Commissioner of Fish and Fisheries for 1880 and 1883, some of the Latin names employed differ from those here given. The list contains the names used in this report with Latin and English synonyms. Where the names in former reports differ from those here used they are included in the list of synonyms. The English names are mostly those given by Jordan and Gilbert. The French and German names are taken from Günther's Catalogue, except that one or two of the German names are as given by Linné.

*Report U. S. Commissioner of Fish and Fisheries for 1885, pp. 787–973.

LIST OF NAMES OF AMERICAN FISHES ANALYZED.

Acipenser sturio oxyrhynchus Mitch. Common sturgeon; French, Esturgeon; German, Stör. No. 238.

Moxostoma velatum Cope,* *Moxostoma velata* Jordan, Man. Vert. Small-mouthed red-horse; Buffalo fish. No. 258.

Clupea harengus Lin. Common herring; Whitebait (young). French, Hareng; German, Hering. Nos. 33, 47.

Clupea pilchardus Walb. Sardine; Pilchard. French, Sardine; German, Pilchard. No. 87.†

Clupea vernalis Mitchill; *Clupea mattowocca* Günther, Study of Fishes, p. 659; *Pomolobus vernalis*, Goode & Bean. Alewife; Branch herring; Gaspereau. Nos. 5, 220.

Clupea sapidissima Wilson, Günther, Study of Fishes, p. 659. *Alosa sapidissima* Cope. Common shad. Nos. 6, 10, 32, 212, 221, 245, 249.

Osmerus mordax Mitchill (Gill); *O. viridescens* Günther. American smelt. Nos. 23, 207.

Coregonus clupeiformis Mitchill (Milner); *C. albus* Günther. Common whitefish. No. 18.

Coregonus sp. (*tullibee* or *artedi?*‡); *Argyrosomus* Jor., Man. Vert. Cisco; Lake herring. No. 111.

Oncorhynchus chouicha (Walb.) Jor. & Gil.; *O. quinnat*, Günther. California salmon; Quinnat salmon; King salmon; Columbia salmon; Sacramento salmon; Chinook salmon; Tyee salmon; Fall salmon (male); Spring salmon; Winter salmon; Saw-Kwey; Chouicha. Nos. 27, 29, 96, 233, 241.

Salmo salar Linn. Common Atlantic salmon. Fr., Saumon; Ger., Lachs, Salm. Nos. 14, 35, 36, 77, 78, 279, 280.

Salmo salar subsp. *sebago* Girard. Land-locked salmon. Nos. 40, 41.

Salvelinus namaycush (Walb.) Goode; *Salmo namaycush* Günther; *Cristivomer namaycush* Jor., Man. Vert. Lake trout; Mackinaw trout; Great Lake trout; Longe (Vermont); Togue (Maine). Nos. 17, 255.

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* This specimen was sent to us by Mr. Blackford, fish commissioner of the State of New York, as a buffalo fish from Cleveland, Ohio. The natural inference would be that it came from somewhere in that region, perhaps from Lake Erie or one of the Great Lakes. It was here identified as *Myxostoma velata* Cope, seeming to conform more closely to the description of that species as given by Jordan, Manual of Vertebrates, 1880, than to the closely related *Ictiobus*, to which the buffalo fishes proper belong. I understand that the differences between this and some of the species of *Ictiobus* are such that one not a specialist in ichthyology might mistake the one for the other. That any such mistake could have been made, however, seems to me very improbable, as this specimen was examined with care. I have, however, changed the spelling to *Moxostoma*, thus following Jordan & Gilbert's Synopsis since published.

† This specimen was, or at least purported to be, of French origin, and should more properly be classed with European specimens. It was included in the tables of American fishes, because analyzed with them.

‡ This specimen was sent by Mr. Blackford as Cisco, or Lake herring, *Argyrosomus tullibee*, from Lake Erie. The name *A. tullibee* is given by Jordan, Man. Vert., 1880; but Jordan & Gilbert in their Synopsis designate the same species as *Coregonus tullibee*, Tullibee, Mongrel Whitefish. Dr. Bean informs me that this is rare, and I find in Jordan and Gilbert's Synopsis the Lake herring or Cisco designated as *C. artedi*. The descriptions of the two species represent them as very similar, and it is not at all impossible that our specimen may have been *artedi* rather than *tullibee*. I do not, at this writing, find any note of the identification of the specimen here, and consider it safest to designate it as *Coregonus* species, leaving the specific name in question.

Salvelinus fontinalis (Mitch.) Gill & Jor.; *Salmo fontinalis* Günther. Brook trout; Speckled trout. Nos. 24, 254, 256.

Esox reticulatus Le Sueur. Common Eastern pickerel; Green pike. Nos. 100, 224.

Esox lucius Linn. Pike, Pickerel* (Vermont, New York, etc.). Fr., Brochet; Ger., Hecht. No. 98.

Esox nobilior Thompson; *Esox estor* Günther. Mascalonge; Muskallunge; Musquallonge; Maskinonge. No. 45.

Anguilla rostrata Le Sueur; *A. bostoniensis* Günther. Common eel. Nos. 4, 217.

Mugil albula Linn.; *M. lineatus* Günther. Striped mullet. No. 126.

Scomber scombrus Linn.; *Scomber scomber* Günther. Common mackerel. Fr., Maquereau vulgaire; Ger., Makrele. Nos. 8, 13, 30, 39, 42, 94, 95, 219, 230, 261.

Scomberomorus maculatus (Mitch.) Jor. & Gil.; *Cybium maculatum* Günther. Spanish mackerel. No. 43.

Trachynotus carolinus (Linn.) Gill; *T. pampano* Günther. Common pompano. Nos. 234, 263.

Pomatomus saltatrix (Linn.) Gill; *Temnodon saltator* Günther. Bluefish; Greenfish; Skipjack. No. 12.

Stromateus triacanthus Peck; *Poronotus triacanthus* Gill. Butter-fish; Dollar-fish; Harvest-fish; La Fayette. No. 90.

Micropterus salmoides (Lac.) Henshall†; *M. salmoides* Jor. & Gil.; *Huro nigricans* Günther. Large-mouthed black bass; Oswego bass; Green bass; Bayou bass. No. 53.

Micropterus dolomieu Lac.†; *M. salmoides* Jor., Man. Vert; *Grystes fasciatus* Günther; *M. achigan* Rafinesque. Small-mouthed black bass. No. 91.

Perca lutea Raf.‡ (vide Günther, Study of Fishes, p. 375); *Perca americana* Schranck. Yellow perch; American perch; Ringed perch; Perch. Fr., Perche; Ger., Barsch. Nos. 127, 208.

Stizostedion vitreum (Mitch.) Jordan & Copeland; *Lucioperca americana* Günther. Pike perch; Wall-eyed pike; Dory; Glass-eye; Yellow pike; Blue pike; Jack salmon. No. 52.

Stizostedion canadense (Smith) Jor.; *Lucioperca canadensis* Günther. Pike perch; Gray pike; Sauger; Sand-pike; Horn-fish. No. 257.

Roccus lineatus (Bloch) Gill; *Labrax lineatus* Günther. Striped bass; Rockfish; Rock. Nos. 7, 19, 225, 237, 248, 260.

Roccus americanus (Gmel.) Jor. & Gil.; *Morone americana* Gill; *Labrax rufus* Günther. White perch. Nos. 44, 46.

Serranus atrarius (Linn.) Jor. & Gil.; *Centropristis atrarius* Günther. Sea bass; Blackfish; Black sea bass. No. 251.

Epinephelus morio (Cuv.) Gill; *Serranus morio* Günther. Red grouper. Nos. 114, 271.

Lutjanus blackfordi Goode & Bean. Red snapper. Nos. 20, 26, 242.

Stenotomus chrysops (Linn.) Bean; *Pagrus argyrops* Günther; *Stenotomus argyrops* Gill. Porgy; Porgee; Scup; Scuppaug. Nos. 15, 31, 262.

Diplodus probatocephalus (Walb.) Jor. & Gil.; *Sargus ovis* Günther. Sheepshead. Ger., Schafbrassen. Nos. 48, 250.

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* About Lake Champlain, in New York and Vermont, and, for aught I know, elsewhere, the *Esox lucius* is popularly known as "pickerel." This specimen was called by Mr. Blackford, from whom it was received, "Large pickerel."

† These two, *M. salmoides* and *M. dolomieu*, have occasioned us some perplexity. (Compare Jordan, Man. Vert., and Jor. & Gil., Synopsis.) They were received at different times and identified as above stated; one may have been mistaken for the other, but this seems to me so improbable that I use the names as given.

‡ Our common yellow perch has been designated in previous reports as *P. fluviatilis*, but I find that authorities (Jor. & Gil., Synopsis 524) have come to regard it as distinct from the European species of that name.

Sciæna ocellata (Linn.) Günther; *Sciænops ocellatus* Gill. Red bass; Channel bass; Red-horse. No. 270.

Menticirrus saxatilis (Bl. & Schn.) Jor.; *Umbrina nebulosa* Günther. Kingfish; Whiting; Barb. No. 252.

Cynoscion regale (Bl. & Schn.) Gill; *Otolithus regalis* Günther. Weakfish; Squeteague; Gray trout. No. 273.

Hiatula onitis (Linn.) Jor. & Gil. Blackfish; Tautog; Oyster-fish. Nos. 38, 205, 244, 269.

Phycis chuss (Walb.) Gill; *P. americanus* Günther. Hake; Codling; Squirrel-hake. No. 113.

Brosmius brosme (Müller) White. Cusk. No. 110.

Melanogrammus æglefinus (Linn.) Gill; *Gadus æglefinus* Günther. Haddock; Fr., Eglefin; Ger., Schellfisch. Nos. 16, 21, 88, 229, 259, 275.

Gadus morrhua Linn.; *Gadus callarias* Linn. Common cod. Fr., Morue; Ger., Dorsch (young and fresh), Stockfisch (dried), Leberdan (salted), Kabljau (old and fresh). Nos. 3, 11, 25, 34, 37, 79, 80, 206, 228, 243.

Microgadus tomcod (Walb.) Gill; *G. tomcodus* Günther; *Microgadus tomcodus* Gill. Tomcod; Frost-fish. No. 99.

Pollachius virens (Linn.) Günther; *Pollachius carbonarius* Gill. Pollock; Coal fish; Green cod. Fr., Colin; Ger., Kohler. No. 81.

Hippoglossus hippoglossus (Linn.) Jor.; *Pleuronectes hippoglossus* Günther; *H. americanus* Gill. Halibut. Fr., Fletan; Ger., Heilbutt. Nos. 1, 9, 28, 211, 218.

Platysomatichthys hippoglossoides (Walb.) Gill. Turbot; Greenland halibut. No. 94.

Paralichthys dentatus (Linn.) Jor. & Gil.; *Pseudorhombus dentatus* and *P. ocellaris* Günther. Common flounder. Nos. 2, 22.

Pleuronectes americanus (Walb.) Günther; *Pseudopleuronectes americanus* Bleeker. Winter flounder; Mud dab. No. 253.

Petromyzon marinus Linn. Lamprey eel; Great sea lamprey; Sea lamprey. Fr., Lamproie; Ger., Neunauge. No. 236.

Raia sp. Skate*. No. 247.

2. METHOD OF ANALYSIS OF THE FLESH OF FISHES.

During the course of the earlier part of the work here recorded a not inconsiderable amount of labor was devoted to the study of the methods of analysis. After a time the information thus obtained and, what is perhaps of as much consequence, the getting of the routine well in hand enabled us to turn out the analyses rapidly and with what seemed to us reasonable accuracy, at least so far as the principal determinations, moisture, nitrogen, ether extract, ash, sulphur, phosphorus, chlorine, etc., are concerned. The methods employed were as follows:

PREPARATION OF MATERIAL FOR ANALYSIS.

Separation of flesh (edible portion) from refuse (bones, skin, entrails, spawn, etc.).—The specimens as received at the laboratory were weighed. The flesh was then separated from the refuse and both were weighed. There was always a slight loss in the separation, due to evaporation, and to slimy and fatty matters and small fragments of the tissues that adhered to the hands and to the utensils used in preparing the sample. Perfect separation of the flesh from the other tissues was difficult, but

* This specimen consisted of only a part of the animal, left lobe of body, and we were unable to identify the species with certainty.

the loss resulting from this was small, so that, though the figures represent somewhat less than the actual amount of edible portion in the specimens, yet the amount thus wasted was doubtless less than would be left unconsumed at an ordinary table.

The reasons for rejecting the skin, which generally has considerable nutritive value, were that its chemical constitution is different from that of the flesh which we wished first of all to study, and that circumstances forbade our entering into the examination of the tissues other than flesh, valuable as their study would be. Nor is this omission entirely without warrant even from the economical standpoint, since, so far as I have observed in this country, the skin is not usually eaten. With the closer domestic economy that increased density of population must bring, people will become more careful to utilize such materials.

DRYING.

Partial drying.—In each case one or more samples of 50 to 100 grammes each, selected from different portions of the freshly chopped flesh, were weighed on a watch glass or small sauce plate and heated from 24 to 48 hours in an ordinary drying oven at a temperature of about 96° C., in a current of dry hydrogen. They were then allowed to cool and stand in the open air, but carefully protected from dust, for about 12 hours, when they were again weighed, pulverized, sifted through a sieve with circular holes .5 mm. in diameter, bottled, and set aside for analysis. The material in this condition constituted what was termed the "partly dried" sample. A few of the fattest samples, however, could not be worked through so fine a sieve. For these either a coarser sieve was used or the substance was crushed as finely as practicable and bottled without sifting.

Drying in hydrogen and in air.—The especial object in drying in hydrogen was to prevent possible oxidation of fats, whereby the latter would be rendered insoluble in ether or the accuracy of the calculations impaired. That this is at all necessary in animal tissues, or when it is necessary and when not, I am not prepared to affirm. In the early part of the work we arranged an apparatus for drying in hydrogen as a precaution, and although comparative trials in air and in hydrogen did not show large differences in results, the apparatus was so convenient that we have used it throughout the investigation in the partial drying of the material to be used in the determination of water, fat, nitrogen, and ash.

As drying in air is more convenient for larger quantities and answers perfectly well for certain determinations, as sulphur, phosphorus, and chlorine, a sufficient quantity of material for these determinations was prepared by drying in air. This was effected by weighing 200 grammes or more of the freshly chopped substance at the same time that the portion was taken for the drying in hydrogen. With the exception that the drying was conducted in the air the treatment of the samples was the same as that described above.

Water and water-free substance.—For the complete drying, from 1 to 2 grammes of the partly dried material were weighed in small drying bottles and dried in hydrogen for two periods of about 2 hours each. It is extremely difficult to get an absolutely constant weight, though we find that the object is in most cases approximately attained in the above method. The total moisture and water-free substance are computed from the partial drying in hydrogen and from the final drying.

Examinations of the analytical details will show a number of cases in which the percentage of water-free substance in the portions used for the various determinations differs from those given in the water determination. This is due to the fact that some time intervened between the determinations, and that our experience shows that though reasonable care was used to procure bottles with well-fitting glass stoppers to hold the partly dried material, yet the moisture in the latter was likely to change on standing in the laboratory and that neither the use of rubber stoppers nor that of paraffin on the glass stoppers sufficed to prevent this so completely as to make us feel safe in using the substance after it had stood for some days, without redetermination of the water.

It is only just to say that although no little pains has been taken in this laboratory to learn how to make accurate determinations of water in animal and vegetable substance, we are far from satisfied with the success of our efforts. Indeed, I am inclined to regard this as one of the decidedly difficult determinations, so far as accuracy is concerned.

NITROGEN, PROTEIN, ALBUMINOIDS, ETC.

The nitrogen was determined in the partly dried substance (partial drying in hydrogen) by the soda-lime method.

It is customary to compute the albuminoids or protein (nitrogenous substances) by multiplying the nitrogen by 6.25. In our analyses this factor has, in general, appeared to be very nearly correct. I have thought it best, for the present purpose, to state the percentages of nitrogen and of protein as calculated by multiplying these by 6.25, and also to estimate the "albuminoids, etc." by difference. For the latter, the remainder left after subtracting the sum of ether extract and ash from the water-free substance, or the sum of water, ether extract, and ash, from the fresh substance, is used. This is not absolutely correct, but is more nearly so than the product of nitrogen by 6.25 would be.

The importance of correct estimation of the nitrogenous matters led us to spend a not inconsiderable amount of time in the study of the sources of error and means of avoiding them, especially in the use of the soda-lime method for determining nitrogen in animal tissues.

Sources of error in the soda-lime method and means for avoiding them.—As the investigations of these questions have been published in detail elsewhere,* a recapitulation of the results and conclusions will perhaps suffice here. For this purpose I quote from an article in the American Chemical Journal: †

The experimental and other considerations presented in this and the previous articles on the determination of nitrogen by soda lime may be conveniently summarized, after first recalling the probable reaction by which the nitrogen is changed to ammonia and the principal sources of error in the operation:

(1) It seems decidedly probable that the change of nitrogen to ammonia is effected by union, at high temperature, with water vapor yielded by the soda lime (or slaked lime in case the latter is used). It is essential that the contact between nitrogenous distillation products and water vapor be sufficient and at not too high or too low temperature to insure conversion of all the nitrogen to ammonia, and that the ammonia be not dissociated or oxidized. The main objects, then, are to secure complete ammonification and to avoid dissociation and oxidation.

(2) The chief difficulty in the way of complete ammonification of protein compounds appears to be the formation of gases which do not readily yield their nitrogen to be united with the hydrogen of the water vapor. With certain other classes of nitrogenous compounds, as leucine and its congeners, alkaloides, amines, and amido and azo compounds, this difficulty is greater and sometimes apparently insuperable. The tendency of protein compounds to be decomposed by heat and other agencies into leucine, amines, etc., appears to explain the difficulty frequently found in getting all their nitrogen into the form of ammonia by heating with soda lime. The evident means to secure complete ammonification must be sufficient contact with soda lime at proper temperature.

(3) The danger of dissociation of ammonia evidently increases with increase of temperature and time of exposure, and is probably diminished by presence of water vapor and other diluting gases. If this be so, the danger will be avoided by measurably rapid combustion at not too high heat, and by keeping the ammonia in contact with sufficient moisture from the soda lime until it leaves the heated tube.

(4) Leaving out of account substances such as nitrates, nitro-compounds, etc., whose nitrogen is imperfectly converted into ammonia by soda lime, even in the presence of organic matter, and assuming palpable errors of manipulation to be avoided, such as (*a*) loose packing of asbestos plug, which would allow particles of soda lime to be swept into the acid bulb; (*b*) heat at anterior end of the tube so low as to permit ammonia to be retained with moisture about the cork, or so high as to char the cork and give rise to acid or alkaline distillation products; (*c*) use of soda lime containing nitrates or nitrites, which may, according to circumstances, either furnish nitrogen to be transformed into ammonia or oxygen to burn the ammonia formed from the nitrogen of the substance; (*d*) use of distilled water containing ammonia for rinsing the acid bulb; (*e*) imperfectly cleaned or incorrectly calibrated burettes; the principal sources of error above discussed involve loss of nitrogen, and may be recapitulated thus:

I. Loss from imperfect ammonification of the nitrogenous substance, due to—

a. Incomplete decomposition of the substance, part of the nitrogen being (from coarseness of the particles of the substance, imperfect mixing with the soda lime, insufficient heat, or other cause) left behind in the charred residue.

b. Change of nitrogen into compounds other than ammonia, either such as may remain in the tube, *e. g.*, cyanogen, or volatile distillation products which escape

* Notes on the soda-lime method for determining nitrogen, W. O. Atwater and C. D. Woods, Am. Chem. Journal, vol. 9, p. 311. Note on the absorption of ammonia by acid solution in nitrogen determinations with soda lime, I. S. Haynes, *loc. cit.*, 10, p. 111. On certain sources of loss in the determination of nitrogen by soda lime, W. O. Atwater and E. M. Ball, *loc. cit.*, 9, p. 319. On sources of error in determinations of nitrogen by soda lime, and means for avoiding them, W. O. Atwater, *loc. cit.*, 10, pp. 197 and 262.

† Am. Chem. Journal, vol. 10, p. 277.

ammonification and pass through the acid solution unabsorbed, or, if absorbed, are not accurately determined by the titration or other means used to find the amount of nitrogen in the solution.

c. Escape of nitrogen in the free state.

II. Loss of ammonia through—

a. Dissociation at high heat in the combustion tube.

b. Oxidation by air present in the tube before, or introduced in aspirating to wash out ammonia after the combustion.

c. Neutralization by acid products, *e. g.*, of sugar, where the latter is used in the combustion.

d. Incomplete absorption by the acid solution.

(5) Complete decomposition of the substance has, in our experience, been readily secured by pulverization fine enough for it to pass through a sieve of 1 mm. aperture; thorough mixing with soda lime; avoiding the shaking by which the particles gather at the top of the soda lime; and heating to low redness.

(6) With sufficient soda lime, not too dry, we have found no reason to fear the formation of cyanides, nor have we been able to obtain any indication of the escape of free nitrogen when the operation is properly conducted, although it might, perhaps, occur by oxidation of ammonia if there were nitrates or nitrites present, or if aspiration with air were done while tube and contents are hot. Turning off the flame before aspirating has, in our experience, sufficed to avoid oxidation by air. At least, if ammonia has been oxidized, the quantity has been too small to be detected.

(7) When sugar is used, acid products may be formed in quantities large enough to impair the accuracy of the determinations. With ordinary animal and vegetable protein compounds, provided enough soda lime is employed, the use of hydrogen, or sugar, or other substances for supplying gases, either to expel air, or to yield nascent hydrogen to form ammonia with the nitrogen, or to dilute the ammonia and prevent dissociation, or to wash out the ammonia, appears to be unnecessary. The danger of loss by incomplete absorption of the ammonia by the acid solution appears to be very small indeed, even when the development of gases is very rapid, provided sufficient acid solution be used.

The chief sources of loss appear to be from incomplete ammonification and from dissociation of the ammonia formed.

(8) The first of these two difficulties is a serious one. With protein compounds, the great trouble is evidently the formation of volatile decomposition products which do not readily yield their nitrogen to form ammonia with hydrogen. This is easy to understand when we consider that protein compounds are prone to yield cleavage products such as leucine and its congeners, compounds allied to the alkaloids, amido compounds, etc.; and that it is very difficult to get all the nitrogen of these latter into the form of ammonia with soda lime, evidently because of their proneness to form compounds that resist the ammonifying action.

With alkaloids and allied compounds, leucine and other amido compounds, amines, and azo and nitro compounds, complete ammonification is not always effected even with the utmost care. Concerning peptones our experience does not enable us to speak; but for the protein of ordinary animal and vegetable substances, including casein, proper precautions appear to insure complete ammonification of the nitrogen. The important condition appears to be sufficient contact with heated soda lime (*i. e.*, with water vapor at high temperature).

This contact is best secured by (*a*) intimate mixture of substance with soda lime; (*b*) close packing so as to avoid open space inside the tube; (*c*) providing a reasonably long anterior layer of soda lime; (*d*) heating this latter to dull redness before bringing the heat to bear upon the substance, and keeping it hot until the combustion is done. In order to insure the maximum of surface for contact it is well to have the anterior layer consist of coarse particles of soda lime containing enough lime to prevent fusing together. It is possible that too long heating may result in expelling the water from the soda lime, so that there will not be enough in the latter part of the operation to insure complete ammonification.

Though it is desirable to avoid coloration and turbidity of the acid solution, these do not necessarily imply incomplete ammonification, nor does their absence prove perfect combustion. With proper care to insure contact between soda lime and substance, we have almost never found the solution so colored as to seriously interfere with titration.

(9) Ammonia may be dissociated and nitrogen lost by either too high heating or by conducting the operation so slowly as to leave the ammonia exposed for a long time to heat. It seems probable that the presence of water vapor, as of other gases, would tend to prevent dissociation of the ammonia, and that the danger of long heating may be partly due to reduced supply of moisture from the anterior layer of soda lime after the latter has been heated for some time.

(10) A vacant space in the tube (channel as ordinarily recommended) may cause serious loss. This loss is greater the higher the temperature and the longer the time of combustion. It is probably due not only to incomplete ammonification of distillation products through lack of contact with the soda lime, but also to dissociation of ammonia. With the channel the flow of the gases is slower and they are exposed to heat longer than when the tube is packed full. Add the possible lack of water vapor when the heating is long continued, and the loss by dissociation is very clearly explained. When the tube is closely packed, the flow of gases reasonably fast, and the operation conducted at a temperature sufficient to heat the tube only to dull redness, there appears to be no considerable loss by dissociation, even with a long anterior layer (20 or 30 cm.) of soda lime.

Concerning reagents, apparatus, and manipulation, a few words will suffice.

1. *Soda lime.*—The soda lime made by mixing one part of ordinary caustic soda with two and a half parts of quicklime by the process described,* costs very little for materials and labor, and serves the purpose very satisfactorily. In sifting it is conveniently divided into a finer portion to be mixed with the substance, and into coarser particles to be used for the anterior layer. It bears heating without fusing so much as to leave any considerable open space in the tube if closely packed at the outset. Varying proportions of soda lime, from one part to two and one-half parts of lime to each part by weight of soda, have made no difference in the results of the analyses. We have obtained equally good results with the mixture of sodium carbonate and slaked lime as described by Johnson, and see no reason why slaked lime as recommended by him should not be generally efficacious as it has proven in the cases cited by him and in those tried by ourselves. Our reason for adhering to the ordinary soda lime has been the impression that by filling the anterior portion of the tube with coarse particles of the rather difficultly fusible material, more complete contact is insured between nitrogenous distillation products and the heated water vapor from the soda lime. The old theory that enough soda should be mixed with the lime to make the mixture easily fusible does not stand the test of experience.

In testing the purity of soda lime by sugar, as is sometimes recommended, there is danger of error both from the presence of nitrogen in the sugar and from formation of acid distillation products.

2. *Tubes and charging.*—For ordinary combustions, tubes of from 35 to 40 cm. in length do very well. The method of charging the tube upon which we have gradually settled, after numerous trials with tubes of different lengths and charged in different ways, is explained in the accompanying tabular statement:

	Centimeters.
Length of tube	40
Asbestos and fine soda lime	4
Mixture, fine soda lime and substance	16
Rinsings, fine soda lime	4
Anterior layer, coarse soda lime	12
Asbestos, open space, plug	4

* Amer. Chem. Journal, 9, 312.

With a shorter tube the divisions may be made proportionately shorter. We intend to have at least forty parts by weight of fine soda lime for every part of substance in the "mixture." About 0.4 and 0.6 gramme of flesh (water free), or corresponding amounts of other materials, we find convenient. The importance of fine pulverization of substance, intimate mixture with soda lime, filling the tube compactly so as to have no channel, avoiding the shaking by which particles of the substance might be brought to the top of the soda lime, and heating until no charred material is left, is insisted upon. An anterior layer of coarse soda lime, 12 cm. long, has proven very satisfactory. The anterior layer should be well heated before the heat is applied to the mixture of soda lime and substance, and kept hot until the combustion is done.

3. *Heat and time of combustion.*—A "low red" heat ordinarily suffices. Heating to bright redness brings danger of loss of ammonia by dissociation, though in our experience, when the tube is closely packed and the operation not too slow, we have found practically no difficulty in getting all the nitrogen as ammonia even at high heat. But with a channel in the tube the loss by high heating has been considerable.

Ordinarily, three-quarters of an hour is ample for the combustion, and an hour the extreme limit, according to the experience in this laboratory. Rapid combustion is less and long heating more dangerous than is frequently taught. With an ordinary Knop and Arendt (four bulb) bulb apparatus containing 10 cc. of acid solution, of which little over half was required to neutralize the ammonia, the ammonia was completely absorbed even when the combustion lasted only 12 minutes. Serious loss may result from too long heating, especially if there be open space in the tube or the temperature is high.

4. *Determination of the ammonia.*—In the combustion of ordinary protein compounds with the precautions stated above, practically all the nitrogen is converted into ammonia, and its determination by titration is easy. We find it well, however, to use concentrated solutions and to avoid excess of water in rinsing out the bulbs. The quantity of concentrated acid solution required is small and the tension in the combustion tube during the heating consequently slight, which is a convenience; while, with the small quantity of solution in titrating, the color reaction is sharp and the determination easy and accurate. Freshly prepared cochineal solution is the most satisfactory indicator we have found. Very narrow burettes, in which 10 cc. occupy from 30 to 40 cm., have decided advantages for convenience and accuracy when concentrated solutions are used.

Accuracy of measurement of solutions.—The danger of error in measuring the standard acid and alkali is greater than is sometimes supposed. The results of our observations may be briefly summarized:*

(1) Leaving temperature out of account, uniformity and accuracy of delivery depend upon the completeness with which the liquid is removed from the inner walls of the tube. The amount of adhering liquid is greater the larger the extent of the interior surface to be drained; the greater the amount of dirt, grease, etc., on this surface; the more rapid the outflow and the shorter the time allowed for the after flow, *i. e.*, for the adhering liquid to drain down. When the tubes are not clean and the delivery is rapid the amount of adhering liquid may be so large and so variable as to materially affect the measurements. But with clean, narrow tubes and fine jets the uniformity, and hence the accuracy, are all that could be desired.

* See article on Burettes and Pipettes by W. O. Atwater and C. D. Woods, Journal of Anal. Chem., vol. I, p. 373.

(2) With a float, or, as is more convenient, a simple device such as a black and white reflecting surface of paper held behind the burette, and sights to insure that the level of the eye shall be the same as that of the meniscus, or, indeed, by using proper care without float or other help, reasonably accurate reading is easy even with burettes of ordinary width.

(3) With very narrow burettes, well cleaned and provided with fine jets, it is easy without float, reflector, sights, or other helps for reading, to make measurements with a probable maximum error of .001 to .002 cc. in 10 cc. For accurate measuring of small quantities of solutions, therefore, the narrow burette is decidedly advantageous.

In the determinations of nitrogen by the soda-lime method we have found it convenient to employ quite concentrated solutions of standard acid. For this we have, after some years' experience, settled upon a 10 cc. burette of about 5 mm. internal diameter graduated to .05 cc. For standard alkali, which we make more dilute, we employ a somewhat wider burette. Since the narrow burettes of ordinary thickness are apt to get broken, we find it advisable to have them made of thick glass.

For the ordinary work of analysis, burettes of the usual width (when they are kept clean and when the measurements by which they are calibrated and those in the ordinary routine of analysis are made in the same way) give tolerably good results. It is only when especial accuracy is desired that the narrow burettes and the precautions above suggested (regarding cleanness of the burettes and either slow drawing off of the solution through narrow jets or other means to avoid error from the afterflow) are needed. Of course, the greater dilution of solution which may be used in the wider burettes compensates more or less completely for the larger error involved in their use. But where, for the sake of sharpness of the color reaction or for other reasons, as, for instance, to avoid pressure on the combustion tubes, it is desirable to use very small quantities of concentrated solutions, the narrow burettes offer decided advantages.

Since most of the analyses were made, the method of Kjeldahl has come into use, and is now employed in this laboratory in preference to the soda-lime method, though we find it advantageous to use the latter from time to time as a check.

FATS, ETHER EXTRACT.

The fats were extracted with ether, which, after various trials with chloroform, benzine, and carbon disulphide, we are persuaded is the most convenient solvent for the purpose.

The determinations were made in the material which had been dried in hydrogen. Generally, from 0.3 to 1.0 grammes was used for the extraction. The operation was conducted in an apparatus similar to that described by Johnson.* The corks and filter paper were always treated

*Am. Jour. Sci., 13, 1887, 190.

with ether before using. We have found it convenient, however, to duplicate the apparatus, using several at once. A rectangular box of zinc or galvanized iron, 120 cm. long, 20 cm. wide, and 25 cm. high, and provided with eight pipes of block tin which serve as worms, makes a very good cooler for the ether. The radiation of heat from the water is perhaps sufficient to keep it cool enough to condense the ether, but we generally have a current of water running through the cooler when in use.

The point at which the extraction is completed we have not always found easy to determine. The methods ordinarily recommended, of evaporating a drop of the ether after it percolated through the substance, either on a piece of paper or on a clean watch-glass, and noting whether a transparent spot or a residue remains, have not in our experience been satisfactory. We prefer to continue the extraction for such time as experience has indicated to be usually sufficient, and then remove the flask and substitute another, repeating this latter operation until the new flask shows no gain in weight after the extraction has been continued for some time. When the extraction is believed to be complete, the apparatus is taken off from the condensing tube, the inner tube holding the substance is taken out, a test tube substituted, the apparatus put back in place, and the ether in the flask is again warmed, allowed to condense and run back into the test tube, and thus most conveniently recovered for subsequent use. The small portion of ether still adhering to the extract in the flask is removed by heating in a current of hydrogen in the apparatus used for drying.

What other substances besides fats are thus extracted from the flesh of fish, oysters, etc., is a matter which I have not investigated, contenting myself for the present with simply calling the material extracted by ether, ether extract. As the analytical details show, the material used for fat determination was dried in the hydrogen before extraction with ether. By this means two possible sources of error are avoided, to wit:

(1) Certain fatty substances, as is well known, are rendered insoluble or very difficultly soluble in ether by being heated in air. This alteration, due, I suppose, to oxidation, is very marked in many vegetable substances. Thus I have found the larger parts of the fats of linseed, maize, and grasses to be rendered insoluble in this way. To what extent any of the fats of the animal tissues which we have analyzed would be thus affected is a matter which I regret to have been unable thus far to study. That the error by drying in air would be large seems to me improbable.

(2) When the material extracted contains considerable quantities of water, or when commercial ether containing water is used, substances other than fats may possibly be dissolved. When and how greatly the presence of water would affect the results I can not tell, though I do not believe the error would be great in such substances as we are here dealing with.

The ether extract was nearly always more or less colored. How far this was due to chemical or physical changes in the fats, and how far to coloring matters extracted with them, I can not say.

As regards the difficulty of extracting with ether, our experience shows that many of the vegetable fats, as those of maize, wheat, etc., are easily extracted, while those of animal tissues are often more difficult to get into solution. The fats, or, more properly, the materials soluble in ether, are more readily extracted from oysters, clams, lean beef, etc., than from the flesh of the fatter fish and the fatter meats. In general, the greater the percentage of fat in a substance the more difficult the removal of the last traces. Mr. Woods remarks that "the flesh of eels was the hardest material to extract I have ever met." I should say that even the flesh of eel could hardly be much more difficult than the yelk of eggs, which, however, is of different composition. It is, I think, very important that the material to be extracted be fine, especially when it is hard and dry, as is often the case with partly dried flesh.

After the experience which we have had in extracting with ether, I am persuaded that correct results are far harder to obtain than is ordinarily believed. Indeed, I regard these determinations, like those of water, as among the more difficult ones with which we have had to do.

ASH.

The ash was determined by charring about 2 grammes of the partly dried material, extracting the charred mass with water, burning the residue at a high temperature, adding the solution, evaporating and burning at a faint red heat. The charring and burning were conducted in platinum capsules over a gas flame. The crude ash thus obtained was practically free from coal. No determinations of carbonic acid were made.

PHOSPHORUS.

A portion of the partly dried substance, usually about 1 gramme, was carefully burned in a platinum crucible with some 10 grammes of a mixture of equal parts of sodium nitrate and carbonate, previously proved free from phosphoric acid. The white mass was dissolved in water, acidulated with nitric acid, evaporated and treated with nitric acid again, the operation being repeated when necessary to remove chlorine, and the phosphoric acid then estimated with ammonium molybdate solution.

A number of experiments were made to test the accuracy of the determinations in the presence of such large quantities of sodium nitrate, etc., as are necessarily used. They were carried out by Mr. G. P. Merrill, then assistant in this laboratory and now curator in the U. S. National Museum. It will suffice here to give the outcome, which was briefly this:

At the temperature of the trials, which was in each case not far from

29° C., two precautions are necessary: (1) the use of a large excess of the molybdate solution (unless nitric acid alone should perform the same office), and (2) allowance of ample time for precipitation. Neglect of these precautions involves risk of loss of phosphoric acid The effect of higher temperature was not tested. Practically, we have used 25 cc. of molybdate solution and allow from 36 to 48 hours for the precipitation.

SULPHUR.

About 1 gramme of the partly dried substance was oxidized as for the determination of phosphorus. The cooled mass was dissolved in hydrochloric acid, and the sulphuric acid determined by precipitation with barium chloride.

It is well known that the presence of salts of the alkalies, including sodium chloride, when present in considerable quantities, may affect the precipitation of sulphuric acid by barium chloride, the precipitate of barium sulphate bringing down with it under some circumstances more or less of the alkaline salt. The ordinary means for avoiding this consist in diluting the solution, precipitating hot, and washing the precipitate with hot water. In view of the large quantity of sodium chloride present in these determinations, it seemed desirable to study the conditions under which pure and impure barium sulphate precipitates are formed a little more closely than had, so far as I am aware, been done. For this purpose a series of experiments was devised. The details were faithfully carried out by Mr. J. P. Bartlett, then a student in this laboratory and now chemist in the Maine State College Agricultural Experiment Station.

The plan consisted in taking a solution of sulphuric acid and determining the amount of acid both in the solution alone and after adding different quantities of sodium chloride. Comparative trials were made with concentrated and dilute solutions and by precipitating hot and cold. The sulphuric-acid solution used was the same as employed for nitrogen determination with the soda lime. The sodium chloride solution contained about 25 per cent. of sodium chloride, and the barium chloride solution about 20 per cent. of the ordinary crystallized salt. Without going into details of the experiments, it will suffice to say that, although when precipitated cold from concentrated solutions the barium sulphate is apt to be too heavy, *i. e.*, to bring down sodium chloride, yet, when precipitated hot, or even precipitated cold from dilute solutions, it was uniformly pure. This is in accordance with the previous observations on which general practice is based. Our determinations served simply to show the limits of concentration and amount of sodium chloride within which it is safe to work. It should be noted, however, that the solutions contained in all cases a small amount of free hydrochloric acid, and that only a small excess of barium chloride was used in the precipitation. Practically, the ordinary way as recommended by Fresenius is accurate for these determinations, even in presence of large amounts of sodium chloride, provided the proper precautions are observed. The experiments satisfied us that the presence of the sodium chloride in the determinations of sulphur, as we conducted them, did not interfere with the accuracy of the results.

CHLORINE

was determined by burning the partly dried substance in platinum evaporating dishes, as in the determinations of phosphorus and sulphur, and estimating the chlorine in the fused mass with ammonium sulphocyanide by Volhard's process.* Dr. J. H. Long, then assistant in this laboratory, but now professor of chemistry in the Chicago Medical College, by whom the determinations were made, carried out, at my request, a series of experiments which led to the observance of certain precautions and showed that with them very satisfactory results may be obtained in the determination of chlorine in such substances as those we were working with. The precautions are contained in the following statement of the method followed in the determinations of chlorine in fish flesh.

(1) The substance was very slowly fused with a mixture of potassium nitrate and sodium carbonate so as to avoid any possible loss by spirting. It was observed that when the platinum capsule, in which the ignition was carried on, was covered with a watch glass, small portions of the substance were thrown out against it unless the operation was conducted very slowly. With care, however, there was no considerable loss, as indicated by either the appearance of the watch glass or actual determinations with sugar and a known amount of chlorine.

(2) The fused mass was dissolved in chemically pure nitric acid, which was made quite dilute, since by using a stronger acid some chlorine could easily be driven off, as was found by experiment.

(3) To the solution thus obtained an excess of silver nitrate solution (decinormal or half decinormal) was added, and the whole boiled on the water bath for about 2 hours. This long boiling with excess of nitric acid, added after the silver nitrate, was found necessary to expel nitrous acid coming from the reduction of the nitrate in the fusion.

(4) After the boiling, the solution was allowed to become quite cold before titrating.

As the details of the experiments on the determinations of phosphorus, sulphur, and chlorine are somewhat extended and will probably be printed in full in another place, they are not inserted here.

PROXIMATE INGREDIENTS DIRECTLY DETERMINED.

In a number of the specimens determinations were made of the ingredients soluble in cold and hot water, and of the portion not dissolved by water, alcohol, or ether. The object was as much to test the meth-

* Leibig's Annaler, 190, 1.

ods commonly employed as to learn the amounts of the ingredients. The methods have proved unsatisfactory in many respects, and we have felt it advisable to make no more determinations by them than are indicated in the tables until the subject is worked up more thoroughly. For that matter, a satisfactory examination of the proximate constituents will involve the study of a good deal more than the compounds of the flesh. Considering the complicated character of the compounds concerned, the vagueness of our present knowledge of them, and the amount of preliminary work necessary before such an investigation can be got into good running order; and adding to all this the importance of studying the elementary composition of the organic compounds, and the mineral ingredients as well, it is clear that much labor will be necessary to reach the desired results. Those we have obtained will at least serve to compare with similar ones obtained by other analysts.*

Cold-water extract.—Of the freshly chopped substance, 33⅓ grammes were digested for 18 to 24 (generally about 20) hours in 500 cc. of cold water, and then filtered. The filtration was conducted at first through "coffee" filter paper, but we have found it better to use fine linen cloth, which has the advantages of more rapid filtration and of allowing the liquid to be squeezed through with proper care. The solids do not pass through the cloth more than through the filter paper, and by placing on a glass plate, scraping, and subsequent rinsing, they are separated much more easily and completely than they can be from the filter paper.

Albumen coagulated from cold-water extract.—The filtrate thus obtained was boiled and filtered through previously dried and weighed asbestos filters. After washing with ether, the filter with its contents was dried and weighed. That this method for determining albumen is accurate is by no means proven or even probable. Indeed, in some species of fish at least—and the same is true of other animals—the cold-water extract of the muscular tissues contains a form of albumen, or at any rate a substance or substances closely resembling albumen, which are not precipitated by boiling at all, except after the addition of large quantities of acid or salts. When the determinations in question were made, these substances had not been well studied, but I was persuaded that the method followed was not reliable for the determination of the actual amount of albumen, a view which studies, to be elsewhere discussed, have amply confirmed.

Extractive matters. Cold-water extract not coagulated by boiling.—The filtrate from the coagulated albumen was evaporated in platinum capsules and weighed. One portion was used for determination of the ash, which was done by charring at a low temperature, extracting with water, igniting the residue until it was well burned, adding the water solution, evaporating, igniting carefully at a low temperature, and weighing. The other portion was finely ground, dried in air to deter-

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* See Almén. *Analyse des Fleisches einiger Fische,* Nova Acta Reg. Soc. Sc. Ups., Ser. III, Upsala, 1877.

mine the percentage of water, and extracted with ether until free from fat, usually 2 or 3 hours. The crude extract, minus the water, fat, and ash, is reckoned as pure extract, and is designated as "extractive matters." It of course contains the albumen which was not coagulated, the other nitrogenous compounds, the carbohydrates, and whatever else, except fats and mineral matters, was taken from the flesh of the fish by the digestion in cold distilled water.

Hot-water extract. "Gelatin."—The residue left after the extraction with cold water was treated for 18 to 24 hours, generally about 20 hours, with distilled water at 100° or slightly below. It was then filtered through weighed asbestos filters, and the filtrate evaporated to dryness in platinum, and weighed as "crude gelatin." In this fat and ash were determined, and the pure extract, called in the tables "gelatin," estimated as in the cold-water extract. It should be stated that in both hot and cold water extracts the figures for total extract in the tables represent water-free substance, *i. e.*, crude extract minus water. I am inclined to think it would be better to determine both water and fat in the crude extracts in one operation by extracting with ether and noting the loss.

Insoluble protein.—The residue left after the extraction with hot water was treated with alcohol or ether, or both, dried, and weighed. Water, ash, and fat were then determined (except, of course, that fat was not determined in the cases where it had been previously extracted). The ash was determined by direct burning, it being assumed that the previous treatment with cold and hot water had sufficed to remove the easily fusible and volatile salts. The removal of the last portions of fat is often extremely difficult, and it is not impossible that in some cases traces were left and weighed as insoluble protein. The figures for total insoluble protein in the tables denote water-free substance.

It is perhaps superfluous to state that the determinations were all made in duplicate. The figures given in the tables which follow represent the averages of the closely agreeing results. The analytical details are given in the next chapter.

3. DESCRIPTIONS AND DETAILS OF ANALYSES OF SPECIMENS OF AMERICAN FISHES.

The usefulness of full statements of details of investigations of this sort is often insisted upon by chemists, and with justice. The attempt to properly collate and use results of other analyses of fish has impressed upon me anew and more strongly than ever the loss which such work often suffers from omission of details in reporting it.

The following data, regarding the analyses of fish and those of analyses of invertebrates, etc., beyond, have been compiled from our laboratory notebooks, the purpose being to make of them a faithful record of the facts regarding the specimens analyzed and the analytical results, and likewise to furnish such other data as, taken in connection with the descriptions of the methods of analyses, would afford reasonably ample means for judging of the correctness of the other evidence upon which the numerical statements and conclusions in the succeeding chapters are based.

The explanations in the chapter on methods of analysis will, it is hoped, suffice to make the statements clearly understood.

In a number of the determinations of nitrogen, ether extract, etc., the percentages of water-free substance, "Wfr," in the partly dried substance, "Pd," are slightly different from those stated in the water determinations. This apparent discrepancy is explained by the fact that the determinations in question were made later, and, in some cases, in other portions of the material.

A number of the earlier analyses, made while the methods were being tested and before the routine was well in hand, were more or less unsatisfactory. Several were discarded entirely. Those here given seemed to me sufficiently accurate to warrant their insertion.

In the "direct determinations of proximate ingredients" the results are such as to make the sum of extractive matters+albumen+gelatin+insoluble protein, etc., in several cases considerably more or less than 100, which, of course, indicates errors in the figures. As stated in the descriptions of the methods, these analyses were so unsatisfactory as to deter us from further attempts until opportunity should be given for the experimental study needed to improve the methods. Meanwhile I have thought it proper to state the results exactly as we obtained them and thus give the reader the same opportunity that I have to judge how much they are worth. Where the footings varied more than 5 per cent. from 100 in the water-free substance of the flesh, the figures for "insoluble protein" and the footings are excluded from the tabularized statements beyond. The remaining analyses show in the figures for flesh (water plus water-free substance) no variations exceeding 1¼ per cent.; indeed all but two come within less than 1 per cent. of 100, which seems to be close enough to entitle them at least to preservation until more accurate results are obtained.

The arrangement of the specimens in this chapter in numerical order has seemed most convenient for reference.

NOTES ON SPECIMENS OF FISH.

The following notes are from laboratory books. The numbers are those used in the tables of analyses. Other data are summarized in Table 1. In cases where several specimens were weighed separately, and only the sums or averages are stated in that table, details are cited here.

1. Halibut. Purchased in Middletown. The specimen was a portion of the posterior half of the body. Price, 15 cents per pound.
2. Flounders. Purchased in Middletown. Price, 10 cents per pound.
3. Cod. Purchased in Middletown. Price, 15 cents per pound.

4. Eels (salt water). Purchased in Middletown. Eleven dressed fish, *i. e.*, with heads, entrails, and skin removed. Price, 10 cents per pound.

5. Alewife. Purchased in Middletown. Price, 12 cents per dozen. Twelve whole fish weighed 2,566 grammes (5 pounds 1.5 ounces). The cost per pound was thus 2½ cents.

6. Shad. Purchased in Middletown. Price, 20 cents per pound. Two whole fish.

7. Striped bass. Purchased in Middletown. One whole fish. Price, 20 cents per pound.

8. Mackerel. Purchased in Middletown. Four whole fish. Cost, 15 cents each.

9. Halibut. Purchased in Middletown. Sections of fatter portion of body. Price, 15 cents per pound.

10. Shad. Purchased in Middletown. One whole fish. Price, 8 cents per pound.

11. Cod. Purchased in Middletown. One fish with head and entrails removed. Price, 8 cents per pound.

12. Bluefish. Purchased in Middletown. One fish with entrails removed. Price, 10 cents per pound.

13. Mackerel. Purchased in Middletown. Two whole fish taken. Price, 18 cents per pound.

14. Salmon. Furnished by Mr. Blackford. Maine. One fish, entrails removed.

15. Porgy. Purchased in Middletown. Four whole fish.

16. Haddock. Purchased in Middletown. One fish, entrails removed. Price, 8 cents per pound.

17. Lake trout. Furnished by Mr. Blackford. Lake Ontario. Mr. Blackford described it as follows: "Salmon trout, *Cristivomer namaycush*, weighs 8 pounds 2 ounces. This is very plenty in the market at this season of the year. You will probably find spawn in it." The sample, a whole fish, weighed on receipt 7 pounds 15 ounces (3,600 grammes), and had evidently shrunk by loss of water and otherwise in coming. It had considerable spawn.

18. Whitefish. Furnished by Mr. Blackford. Lake Champlain. Mr. Blackford says: "White fish, *Coregonus clupeiformis*, weighs 2 pounds 15 ounces, caught at Alburgh Springs, Vermont, from Lake Champlain; is the great food-fish of the lakes and is in the finest condition at present season." The specimen consisted of one whole fish.

19. Striped bass. Furnished by Mr. Blackford. Bridgehampton, Long Island. Atlantic Ocean. Described by Mr. Blackford: "Striped bass, weighs 2 pounds 9 ounces, caught at Bridgehampton, Long Island, November 5, 1879. They are very plenty at this season and in their best condition." The specimen, one whole fish, weighed on receipt at Middletown 2 pounds 6.7 ounces, having evidently shrunk in transit.

20. Red snapper. Furnished by Mr. Blackford. Fernandina, Florida. One whole fish.

21. Haddock. Furnished by Mr. Blackford. Off Rockaway, Long Island. Atlantic Ocean. One fish with entrails removed.

22. Flounder. Furnished by Mr. Blackford. Amagansett, Long Island. Atlantic Ocean. The specimen, one whole fish, was rather old and the flesh very soft. It emitted some odor and looked "pasty" in drying. It is worthy of note in this connection that the percentage of "gelatin" was large.

23. Smelt. Furnished by Mr. Blackford. Hackensack River, New Jersey. Seventy-three whole fish.

24. Brook trout. Furnished by Mr. Blackford. "Cultivated trout." Six whole fish.

25. Boned codfish. Purchased April 8, 1880, in Middletown, Connecticut; in 5-pound packages; price 50 cents each, or 10 cents per pound. The following statements were printed on the box: "This package contains pure codfish, and that the best that can be cured. Great care is taken in the selection, curing, and packing,

and the fish is recommended to the consumer for its economy, convenience, cleanliness, and quality."

26. Red snapper. Furnished by Mr. Blackford. Eastern coast of Florida. One fish, entrails removed.

27. California salmon. Furnished by Mr. Blackford. Sacramento River, California. The specimen included only the edible portion of the anterior part of the body, and like No. 22 emitted some odor and in the drying swelled a great deal and became pasty.

28. Smoked halibut. Purchased in Middletown, Connecticut. Part of one side of fish, including skin and a few small bones.

29. Canned salmon. Purchased in Middletown. One can, said to contain 2 pounds; cost 45 cents. The sample had a good deal of oil. Flesh and oil were crushed together in a mortar; the oil was readily absorbed, so that the sample was easily worked. Weight of entire sample 870 grammes (1 pound 14.7 ounces) which would make actual cost of the contents of can about 23 cents per pound.

30. Mackerel. Furnished by Mr. Blackford. Off Cape May, New Jersey. Atlantic Ocean. Four whole fish.

31. Porgy. Furnished by Mr. Blackford. Rhode Island. Four whole fish.

32. Shad. Purchased in Middletown. Connecticut River. Price 10 cents per pound. One whole fish.

33. Smoked Herring. Purchased in Middletown. Six whole fish.

34. Salt codfish. Purchased in Middletown. Price 7 cents per pound. The specimen is of the kind known to the trade as "channel fish" and was said to have been caught in the deep water near George's Banks.

35 and 36. Spent (or foul) Salmon. Penobscot River, Maine. Four whole fish. Received November 18, 1880, from Government salmon-breeding establishment, through the courtesy of Mr. Charles G. Atkins, Bucksport, Maine. In an accompanying letter Mr. Atkins suggests that though "spent" salmon [the eggs having been removed by stripping] they were in better condition than those that have spawned naturally. From measurements made by Mr. H. L. Osborn, assistant in Natural History in Wesleyan University, I select the following as of interest in comparing the dimensions and weights of these with salmon in good condition: Nos. 35 *a* and 35 *b* were males; Nos. 36 *a* and *b*, females; portions of Nos. 35 *a* and *b* were sampled together and analyzed as No. 35. The same was done with Nos. 36 *a* and *b*, which were analyzed as No. 36.

Nos.	Greatest height of body.	Greatest width of body.	Least height of body.	Girth at tip of pectoral fin.	Girth at anterior end of dorsal.	Girth over anus.	Girth at posterior end of adipose fin.	Length to tip of middle caudal ray.	Length to base of middle caudal ray.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
35*a*	156	60	58	360	380	290	200	826	750
35*b*	154	58	57	355	365	285	190	830	750
36*a*	163	63	66	380	390	340	200	915	835
36*b*	166	64	67	400	395	315	210	896	813

37. Salt codfish. Purchased in Middletown. Near Nantucket. Atlantic Ocean. The fish is of the kind known as "boatfish" and was said to have been caught near the shore off Nantucket.

38. Blackfish. Furnished by Mr. Blackford. Stonington, Connecticut. Atlantic Ocean. Five whole fish.

39. Mackerel. Furnished by Mr. Blackford. Cape Cod. Atlantic Ocean. One whole fish.

40 and 41. Spent landlocked salmon. Eight whole fish. From Schoodic Salmon-breeding Establishment, Grand Lake Stream, Maine. Sample received from Charles

G. Atkins, who says, in letter dated Grand Lake Stream, Maine, November 27, 1880, "I send * * * four male land-locked salmon and four females, whose eggs have been taken from them by the artificial process. They are as near spent fish as we can get, but I think they are in better condition than those that have spawned naturally." The following measurements and weights indicate the size of the fish and proportions of flesh and refuse:

Nos.	Greatest length.	Girth at tip of pectoral fin.	Girth at anterior base of dorsal fin.	Girth at anus.	Edible portion.	Waste, entrails, etc.	Loss in cleaning.	Total weight.	Total weight in pounds and ounces.
	mm.	*mm.*	*mm.*	*mm.*	*Grms.*	*Grms.*	*Grms.*	*Grms.*	*Lbs. Oz.*
40*a*	520	285	292	216	745.1	767.5	17.4	1,530.0	3 5.9
40*b*	500	250	255	175	623.8	594.8	11.6	1,230.2	2 11.4
40*c*	510	265	278	220	754.3	741.9	10.4	1,506.6	3 5.1
40*d*	500	260	270	195	761.8	648.8	8.9	1,419.5	3 2.
41*a*	480	230	240	177	562.1	471.3	19.6	1,053.0	2 5.1
41*b*	460	220	225	175	494.7	401.7	6.7	903.1	1 15.8
41*c*	450	220	210	168	402.1	391.1	9.3	802.5	1 12.3
41*d*	450	210	200	160	442.9	409.4	11.4	863.7	1 14.5

Nos. 40*a*, 40*b*, 40*c*, 40*d*, were sampled together and analyzed as No. 40. The same was done with 41 *a*, *b*, *c*, and *d*, which were analyzed as 41.

42. Salt mackerel. Purchased in Middletown. The specimen was described as "No. 1 mackerel." Caught probably in September or October, as the barrel from which the sample was taken was marked as inspected at Chatham, Massachusetts, in October. Price, 12½ cents per pound.

43. Spanish mackerel. Furnished by Mr. Blackford. One whole fish.

44. White perch. Furnished by Mr. Blackford. Two whole fish, both of which were quite full of spawn.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	Total.
	Grms.	*Grms.*	*Grms.*
Flesh	128.7	142.7	271.4
Refuse............	208.0	279.0	487.0
Loss	6.7	5.0	11.7
Total	343.4	426.7	770.1

45. Muskellunge. Furnished by Mr. Blackford. St. Lawrence River. Mr. Blackford says: "It is not often found in our markets." One whole fish taken for analysis.

46. White perch. Furnished by Mr. Blackford. Four whole fish.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	*c.*	*d.*	Total.
	Grms.	*Grms.*	*Grms.*	*Grms.*	*Grms.*
Flesh	78.7	110.6	78.0	71.9	339.2
Refuse............	129.2	196.5	127.2	125.5	578.4
Loss	7.1	4.6	3.3	3.3	18.3
Total	215.0	311.7	208.5	200.7	935.9

47. Herring. Furnished by Mr. Blackford. Four whole fish.

Weighings in preparation for analysis.

Constituents.	a.	b.	c.	d.	Total.
	Grms.	*Grms.*	*Grms.*	*Grms.*	*Grms.*
Flesh	136.5	163.0	121.5	131.5	552.5
Refuse	142.0	129.0	83.0	143.2	497.2
Loss	5.9	10.2	5.5	9.5	31.1
Total	284.4	302.2	210.0	284.2	1,080.8

48. Sheepshead. Furnished by Mr. Blackford, Florida. One fish, entrails removed.

49. Turbot or Greenland halibut. Furnished by Mr. Blackford. Newfoundland One whole fish. The fish had been frozen and partly thawed.

52. Yellow pike perch or wall-eyed pike. Furnished by Mr. Blackford. Two whole fish, of which the heavier had considerable immature spawn.

Weighings in preparation for analysis.

Constituents.	a.	b.	Total.
	Grms.	*Grms.*	*Grms.*
Flesh	232.5	230.2	462.7
Refuse	369.2	273.5	642.7
Loss	9.8	7.5	17.3
Total	611.5	511.2	1,122.7

53. Black bass (large-mouthed black bass). Furnished by Mr. Blackford. One whole fish.

77 and 78. Salmon. Samples received from Mr. Atkins. Penobscot River, Maine. The specimen consisted of two females, whole fish, which were analyzed separately as Nos. 77 and 78. Mr. Atkins writes: "The two females, weighing 24 pounds, are in good condition, well fed and fat, though a little inferior to what might have been obtained in May or early in June. The salmon season is about closed and fish are scarce."

79. Desiccated cod. From Mr. A. R. Crittenden, Middletown, Connecticut. The specimen, called "Alden's Fresh Codfish" was a finely pulverized, yellowish-white material, of agreeable odor and attractive appearance. It was stated to be prepared by a process invented by Mr. Alden, of Gloucester, Massachusetts, well known for his connection with the invention of the process of manufacturing condensed milk. The commercial enterprise has, I am informed (October, 1881), since been transferred to the Hurricane Isle Fish Company, Rockland, Maine, which is now preparing the product under the name of "Evaporated Fish." Their process of manufacture is described in one of their circulars as follows: "The fresh fish are brought in daily as caught, to the island, which is 12 miles out at sea. They are at once dressed, while perfectly fresh, and the pure flesh put into a large open evaporating pan with a steam jacket. This pan is provided with steam machinery, which keeps the flesh in constant motion until it is sufficiently dried. During the process one-half pound of common salt is added to each 100 pounds of pure flesh, not, however, for the purpose of preserving the product, but simply to improve the flavor; more salt will be required while cooking. At no time is the heat in the pan allowed to reach that of boiling water. No destructive distillation takes place and nothing but water is removed from the fish. After removing the product from the evaporating pan it is sifted to remove any bones which may have accidentally been left in the flesh."

80. Desiccated cod—"Alden's Salt Cod-fish." Received from Mr. A. R. Crittenden, Middletown, Connecticut. This is said to be similar to No. 79, except that more

salt was added before drying. I infer that it is not prepared in this way to any great extent commercially.

81. Pollock. Furnished by Mr. Blackford. Coast of Massachusetts. Atlantic Ocean. One fish, head and entrails removed.

87. Sardines. Purchased in Middletown. One half-box containing 15 sardines said to have been packed in France. The oil was separated by draining, but in the preparation of the material for analysis as well as in the actual analysis it was, of course, impossible to accurately separate the oil belonging to the flesh from that in which they were packed.

88. Smoked haddock or "Findon baddie." Purchased in Middletown. One smoked haddock (3½ pounds), head and entrails removed. Price 12 cents per pound.

90. Butter-fish. Furnished by Mr. Blackford. East end of Long Island. Atlantic Ocean. Four whole fish.

Weighings in preparation for analysis.

Constituents.	a.	b.	c.	d.	Average.
	Grms.	*Grms.*	*Grms.*	*Grms.*	*Grms.*
Flesh	136.5	86.3	92.0	90.2	101.1
Refuse	101.0	65.0	72.0	71.0	77.4
Loss	3.0	2.7	2.2	2.0	2.5
Total	240.5	154.0	166.2	163.2	181.0

91. Black Bass (small-mouthed black bass). Furnished by Mr. Blackford. Seneca Lake, New York. Two whole fish.

Weighings in preparation for analysis.

Constituents.	a.	b.	Average.
	Grms.	*Grms.*	*Grms.*
Flesh	231.5	119.0	175.2
Refuse	267.5	147.3	207.4
Loss	5.0	2.5	3.8
Total	504.0	268.8	386.4

94. Canned fresh mackerel. Purchased in Middletown. The analysis was made of the total can contents, which weighed 468.5 grammes (1 pound 0.5 ounce) and contained some bone, which was, however, "perfectly soft and edible."

95. Salt mackerel. Purchased in Middletown. One 5-pound can labeled "Ocean Gem Mackerel." The can was marked as inspected "Gloucester, Mass., Mackerel, No. 2, 5 lbs. 1880." The fish were in the condition in which salt mackerel are ordinarily sold, except that the heads and tails were removed. Two fish were analyzed as follows:

Weighings in preparation for analysis.

Constituents.	a.	b.	Average.
	Grms.	*Grms.*	*Grms.*
Flesh	183	195	189
Refuse	38	40	39
Loss	2	2	2
Total	223	237	230

96. Canned Salmon. Purchased in Middletown. Columbia River, Oregon. One pound can. Price 20 cents. The contents weighed 474 grammes (1 pound 0.7 ounces).

98. Pickerel. Furnished by Mr. Blackford. Lake Ontario. One fish, entrails removed but containing spawn.

99. Tomcod. Furnished by Mr. Blackford. South side Long Island, New York. Atlantic Ocean. Four whole fish, females, with spawn.

Weighings in preparation for analysis.

Constituents.	a.	b.	c.	d.	Average.
	Grms.	*Grms.*	*Grms.*	*Grms.*	*Grms.*
Flesh	120.5	128.5	112.5	80.5	110.5
Refuse	182.0	188.5	164.0	143.0	169.4
Loss	4.5	3.0	1.5	3.2	3.0
Total	307.0	320.0	278.0	226.7	282.9

100. Pickerel. Furnished by Mr. Blackford. Seneca Lake, New York. Three whole fish.

Weighings in preparation for analysis.

Constituents.	a.	b.	c.	Average.
	Grms.	*Grms.*	*Grms.*	*Grms.*
Flesh	163.0	174.5	173.0	170.2
Refuse	127.5	174.5	134.5	145.5
Loss	5.9	4.5	3.2	4.5
Total	296.4	353.5	310.7	320.2

110. Cusk or torsk. Furnished by Mr. Blackford. Atlantic Ocean. One fish, entrails removed.

111. Cisco or lake herring. Furnished by Mr. Blackford. Lake Erie. Four whole fish.

Weighings in preparation for analysis.

Constituents.	a.	b.	c.	d.	Average.
	Grms.	*Grms.*	*Grms.*	*Grms.*	*Grms.*
Flesh	158.0	206.0	172.5	166.5	175.7
Refuse	110.5	154.5	150.5	121.0	134.1
Loss	3.0	5.5	5.0	3.5	4.2
Total	271.5	366.0	328.0	291.0	314.0

113. Hake. Furnished by Mr. Blackford. Off Long Island, New York. Atlantic Ocean. One fish, entrails removed.

114. Grouper. Furnished by Mr. Blackford. From Gulf of Mexico near Pensacola, Florida. One fish, entrails removed.

126. Mullet. Furnished by Mr. Blackford. Virginia. One whole fish.

127. Yellow perch. Furnished by Mr. Blackford. Lake Champlain. Four whole fish.

Weighings in preparation for analysis.

Constituents.	a.	b.	c.	d.	Average.
	Grms.	*Grms.*	*Grms.*	*Grms.*	*Grms.*
Flesh	89.0	118.0	116.0	98.0	105.3
Refuse	148.0	205.0	230.0	139.0	180.5
Loss	2.0	2.5	3.5	1.0	2.2
Total	239.0	325.5	349.5	238.0	288.0

205. Blackfish. Purchased in Middletown. One whole fish. Price, 12 cents per pound.

206. Rock cod. Purchased in Middletown. Eight miles southeast of Block Island, Atlantic Ocean. One whole fish, 4 pounds. Price, 10 cents per pound.

207. Smelt. Purchased in Middletown. Coast of Maine. Fourteen whole fish weighed 398 grammes (14 ounces).

208. Yellow perch. Purchased in Middletown. Portland, Connecticut. Six dressed fish, head, entrails, fins, and tails removed, weighed 302 grammes, averaging 50.3 grammes (1.8 ounces). Price, 15 cents per pound.

211. Halibut. Purchased in Middletown. George's Banks, Atlantic Ocean. Four slices weighing 8½ pounds from different parts of a fish which weighed dressed 17 pounds. The four pieces were selected to represent the average composition of the whole fish. Price, 20 cents per pound.

212. Shad. Purchased in Middletown. Delaware River. One whole fish. Price, 70 cents each.

217. Eels, salt-water. Purchased in Middletown. Northern coast of Long Island. Atlantic Ocean. Six fish, head, skin, and entrails removed, weighed 436 grammes, average 72.7 grammes (2.6 ounces). Price, 12½ cents.

218. Smoked halibut. Purchased in Middletown. Price, 18 cents per pound.

219. Canned salt mackerel. Furnished by H. B. & F. K. Thurber & Co., New York City. Twelve fishes in can, weighing 2,219 grammes (4 pounds 14.5 ounces). Head and tails removed. Two taken for analysis.

220. Alewife. Purchased in Middletown. Connecticut River. Four whole fish. Price, 12 cents per dozen.

221. Shad. Purchased in Middletown. Connecticut River. One whole fish, caught April 17. The first shad of the season were taken April 14. Price 20 cents per pound.

224. Pickerel. Purchased in Middletown. Connecticut River, East Haddam. Two whole fish. Price 12 cents per pound.

Weighings in preparation for analysis.

Constituents.	a.	b.	Average.
	Grms.	*Grms.*	*Grms.*
Flesh	144.0	145.0	144.5
Refuse	151.0	141.0	146.0
Loss	9.0	11.0	9.5
Total	304.0	297.0	300.0

225. Striped bass. Purchased in Middletown. Long Island Sound. One whole fish, weighing 2½ pounds. Price 20 cents per pound.

228. Cod. Purchased in Middletown. One fish, head and entrails removed. Price 10 cents per pound.

229. Haddock. Purchased in Middletown. One fish, entrails removed. Price 8 cents per pound.

230. Mackerel. Purchased in Middletown. Two fish, entrails removed but spawn left in. Price 15 cents each.

Weighings in preparation for analysis.

Constituents.	a.	b.	Average.
	Grms.	*Grms.*	*Grms.*
Flesh	201.0	166.0	183.5
Refuse	130.2	130.0	130.1
Loss	9.3	3.5	6.4
Total	340.5	299.5	320.0

233. California salmon. Furnished by Mr. Blackford. Sacramento, California. Sections of anterior portion of body.

234. Pompano. Furnished by Mr. Blackford. Pensacola, Florida. Gulf of Mexico. One whole fish.

236. Lamprey eel. Furnished by Mr. Blackford. Hackensack River, New Jersey. Two whole fish.

Weighings in preparation for analysis.

Constituents.	a.	b.	Average.
	Grms.	*Grms.*	*Grms.*
Flesh	202.0	450.5	326.3
Refuse	196.0	397.0	296.5
Loss	21.5	28.0	24.7
Total	419.5	875.5	647.5

237. Striped bass. Furnished by Mr. Blackford. North Carolina. One whole fish.

238. Sturgeon. Furnished by Mr. Blackford. Delaware River. Sections of anterior portion of body.

240. Canned tunny. Furnished by H. B. & F. K. Thurber & Co., New York City. One can "Tunny fish." The contents weighed 361.5 grammes (12.8 ounces).

241. Canned salmon. One-pound can "Columbia River Salmon." The contents of the can weighed 470 grammes (1 pound 0.6 ounces).

242. Red snapper. Furnished by Mr. Blackford. Pensacola, Florida. Gulf of Mexico. One fish, entrails, gills, etc., removed.

243. Cod. Furnished by Mr. Blackford. Long Island, Atlantic Ocean. One whole fish, weighing in New York 5¼ pounds.

244. Blackfish. Furnished by Mr. Blackford. Massachusetts coast, Atlantic Ocean. One fish, entrails removed.

245. Shad. Furnished by Mr. Blackford. Hudson River. One whole shad (3¼ pounds).

246. Shad roe from shad No. 245.

247. Skate. Furnished by Mr. Blackford. Long Island. Atlantic Ocean. Left lobe of body.

248. Striped bass. Furnished by Mr. Blackford. Long Island. Atlantic Ocean. One whole fish.

249. Shad. Furnished by Mr. Blackford. North Carolina. One whole fish.

250. Sheepshead. Furnished by Mr. Blackford. One whole fish.

251. Sea bass. Furnished by Mr. Blackford. Pensacola, Florida. Gulf of Mexico. One whole fish. Mr. Blackford says: "6½-pound grouper."

252. Kingfish. Furnished by Mr. Blackford. North Carolina. One whole fish.

253. Flounder. Furnished by Mr. Blackford. Rhode Island. Atlantic Ocean. One whole fish.

254. Brook trout, cultivated. Furnished by Mr. Blackford. South Side Club, Long Island. Three whole fish.

Weighings in preparation for analysis.

Constituents.	a.	b.	c.	Average.
	Grms.	*Grms.*	*Grms.*	*Grms.*
Flesh	63.0	64.0	53.5	60.2
Refuse	58.0	55.0	46.5	53.2
Loss	4.5	4.5	4.0	4.3
Total	125.5	123.5	104.0	117.7

255. Lake or Mackinaw trout. Furnished by Mr. Blackford. Lake Ontario. One fish (frozen when shipped, thawed before arrival), entrails removed.

256. Canada trout. Furnished by Mr. Blackford. Montreal, Canada. One whole fish.

257. Gray or pike perch. Furnished by Mr. Blackford. Cleveland, Ohio. (Lake Erie?) One whole fish.

258. Small-mouthed red-horse. Furnished by Mr. Blackford. Cleveland, Ohio. One fish, entrails removed. The specimen was called by Mr. Blackford "buffalo fish," but had the characters of *Moxostoma* rather than *Ichthyobus*, to which latter genus the buffalo fishes properly belong. The two are, I understand, very similar, so that the common names may very naturally be interchanged.

259. Haddock. Furnished by Mr. Blackford. Long Island. One fish, entrails removed.

260. Striped bass. Furnished by Mr. Blackford. Long Island. Atlantic Ocean. One fish, entrails removed.

261. Mackerel. Furnished by Mr. Blackford. Capes of Virginia. Atlantic Ocean. One whole fish.

262. Porgy or scuppaug. Furnished by Mr. Blackford. One whole fish.

263. Pompano. Furnished by Mr. Blackford. Pensacola, Florida. Gulf of Mexico. One whole fish.

269. Blackfish. Furnished by Mr. Blackford. Rhode Island. Atlantic Ocean. One fish, entrails removed.

270. Red bass. Furnished by Mr. Blackford. North Carolina. One whole fish. Flesh of one side used for analysis.

271. Red grouper. Furnished by Mr. Blackford. Pensacola, Florida. Gulf of Mexico. One fish, entrails removed. Flesh of one side used for analysis.

273. Weakfish. Furnished by Mr. Blackford. Long Island, Atlantic Ocean. Two whole fish.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	Average.
	Grms.	*Grms.*	*Grms.*
Flesh	252.5	175.0	213.7
Refuse	272.0	200.0	236.0
Loss	5.5	4.5	5.0
Total	530.0	379.5	454.7

275. Canned smoked haddock, "Findon Haddie." Furnished by H. B. & F. K. Thurber & Co., New York City. One pound can. The analysis was made of the total contents of the can which, as the gentleman who made the analysis states, "seemed to have been so treated as to soften the hard parts." The weight of the contents was 480.0 grammes (1 pound 1 ounce).

279. Salmon, female. Furnished by C. G. Atkins. Penobscot River, Maine. One whole fish.

280. Salmon, male. Furnished by C. G. Atkins. Penobscot River, Maine. One whole fish.

DETAILS OF ANALYSES OF FLESH OF FISH.

Herewith are full details of analyses of four specimens of flesh of fish transcribed from our laboratory books. They will serve to show what determinations were made and how they were recorded and the calculations made from them. Following them are summaries in tabular form of the determinations of all the specimens.

The details of the analyses of the proximate ingredients as directly determined are somewhat complicated, as may be seen from the illustrations given. The results are at best unsatisfactory, and it is not deemed desirable to tabulate the details in full.

LABORATORY NUMBER 20.

Name: Red snapper, *Lutjanus blackfordi*.
Locality: Fernandina, Florida.
Received: November 28, 1879, from Mr. Blackford.
Description: One whole fish.

Weighings in preparation for analysis.

	Grms.	Lb.	Oz.	Per cent.
Flesh	2, 104. 6	4	10. 2	60.00
Refuse	1, 388. 9	3	1. 0	39. 60
Loss	14. 0	....	0. 5	0. 40
Total	3, 507. 5	7	11. 7	100. 00

Analysis of flesh.

	Determinations	Average
Water, (Dried in hydrogen).	Partial drying.—95.5 grm. fresh substance, "Fr," = 22.5 grm. partially dried, "Pd." = 23.56 % Pd. in Fr.	
	Complete drying.— 1.1473 grm. Pd. = 1.1053 grm. Water-free, "Wfr." = 96.34 % Wfr. in Pd.	Av'ge 92.45 % Wfr. in Pd.
	Complete drying.— 1.1565 grm. Pd. = 1.0245 grm. Water-free, "Wfr." = 88.56 % Wfr. in Pd.	
	23.56 % Pd. in Fr. × 92.45 % Wfr. in Pd. = 21.78 % Wfr. in Fr., or 78.22 % Water in Fr.	
Nitrogen.	0.4792 grm. Pd. = 0.4430 grm. Wfr., gave 0.06574 grm. N. = 14.84 % N. 0.4820 = 0.4465 0.06622 = 14.80	Av'ge 14.82 % N. in Wfr. or 3.23 % N. in Fr.
Ether Ext.	0.9960 grm. Pd. = 0.9210 grm. Wfr., gave 0.0265 grm. Ext. = 2.87 % Ext. 0.9995 = 0.9243 0.0261 = 2.83 %	Av. 2.85 % Ext. in Wfr. or 0.62 % Ext. in Fr.
Ash.	3.073 grm. Pd. = 3.056 grm. Wfr., gave 0.178 grm. Ash = 5. 82 % Ash in Wfr. or 1. 27 % Ash in Fr.	
P_2O_5.	1.0187 grm. Pd. = 0.9418 grm. Wfr., gave 0.0200 grm. P_2O_5 = 2.13 % P_2O_5 1.0910 = 1.0083 0.0219 = 2.17	Av'ge 2.15 % P_2O_5 in Wfr. or 0.47 % P_2O_5 in Fr.
SO_3.	1.000 grm. Pd. = 0.8936 grm. Wfr., = 0.0192 grm. SO_3 = 2.15 % SO_3 1.0015 = 0.8949 = 0.0199 = 2.22	Av'ge 2.19 % SO_3 in Wfr. or 0.47 % SO_3 in Fr.
Albumen in cold-water Ext.	33.3 grm. Fr. = 7.26 grm. Wfr., gave 0.5305 grm. Alb. = 7.30 % Alb. 33.3 = 7.26 0.5310 = 7.31 %	Av'ge 7.30 % Alb in Wfr. or 1.59 % Alb. in Fr.

Extractives, etc., in cold-water Ext. 33.3 grm. Fr. = 7.26 grm. Wfr., gave 0.8855 grm. Ext. containing 0.267 grm. ash = 0.6185 grm. water and ash-free Ext. = 8.52 % Ext. in Wfr.

33.3 grm. Fr. = 7. 26 grm. Wfr. gave 0.841 grm. Ext. containing 0.242 grm. ash. = 0.599 grm. water and ash-free Ext. = 8.25 % Ext. in Wfr. Av'ge 8.38 % Ext. in Wfr. or 1.81 % Ext. in Fr.

Gelatin in hot-water Ext. 33.3 grm. Fr. = 7. 26 grm. Wfr., gave 1.265 grm. crude gel. containing 0.056 grm. ash = 1. 209 grm. water and ash-free gel. = 16.65 % gel. in Wfr.

33.3 grm. Fr. = 7.26 grm. Wfr., gave 1.278 grm. crude gel. containing 0.056 grm. ash = 1.222 grm. water and ash-free gel. = 16.83 % gel. in Wfr. Av'ge 16.74 % gel. in Wfr. or 3. 65 % gel. in Fr.

Insoluble protein. 33.3 grm. Fr. = 7.26 grm. Wfr., gave 4.555 grm. crude insoluble protein ("Ins.") = 62.74 % crude Ins. in Wfr. 33.3 grm. Fr. = 7.26 grm. Wfr. gave 4.279 grm. crude Ins. = 58.94 % crude Ins. in Wfr. Av'ge 60.84 % crude Ins. in Wfr. or 13.25 Ins. in Fr.

Recapitulation of analysis of flesh.

Constituents.	Protein = N × 6. 25.		Albuminoids estimated by difference.	
	In water-free substance.	In fresh substance.	In water-free substance.	In fresh substance.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Water	....	78. 22	....	78. 22
Protein	92. 63	20. 17	91. 33	19. 89
Ether extract	2. 85	0. 62	2. 85	0. 62
Ash	5. 82	1. 27	5. 82	1. 27
Total	101. 30	100. 28	100. 00	100. 00

Proximate ingredients directly determined.

Constituents.	In water-free substance.	In fresh substance.	In fresh substance calculated to 100 p. ct.
Water	....	78.22	78.22
Albumen coagulated from cold-water extract	7.30	1.59	1.55
Extractives, etc., not coagulated in cold-water extract	8.38	1.81	1.81
Gelatin, hot-water extract	16.83	3.65	3.65
Insoluble protein	60.84	13.25	12.88
Ether extract	2.85	0.62	0.62
Ash	5.82	1.27	1.27
Total	102.02*	100.41*	100.00

LABORATORY NUMBER 52.

Name: Yellow pike perch or wall-eyed pike. *Stizostedion vitreum.*
Received: March 17, 1881, from Mr. Blackford.
Description: Two whole fish, of which the heavier had considerable immature spawn.

Weighings in preparation for analysis.

Constituents.	*a.*	*b.*	Total.		
	Grms.	*Grms.*	*Grms.*	*Lb. Oz.*	*Per cent.*
Flesh	232.5	230.2	462.7	1 0.3	41.21
Refuse	369.2	273.5	642.7	1 6.6	57.25
Loss	9.8	7.5	17.3	... 0.6	1.54
Total	611.5	511.2	1,122.7	2.75	100.00

Analysis of flesh.

Water, (Dried in hydrogen).
Partial drying.—61.9 grm. fresh substance, "Fr." = 13.1 grm. partially dried, "Pd." = 21.16% Pd. in Fr.
Complete drying.—1.0675 grm. Pd. = 1.0215 grm. Water-free, "Wfr." = 95.69% Wfr. in Pd.
Complete drying.—1.0565 grm. Pd. = 1.0120 grm. Water-free, "Wrf." = 95.79% Wrf. in Pd.
} Av'ge 95.74% Wfr. in Pd.
21.16% Pd. in Fr. × 95.74% Wfr. in Pd. = 20.26% Wfr. in Fr., or 79.74% Water in Fr.

Nitrogen. 0.6005 grm. Pd. = 0.5748 grm. Wfr. gave 0.03432 grm. N. = 14.67% N.
0.5995 = 0.5739 0.08413 14.66
} Av'ge 14.67% N. in Wfr. or 2.97% N. in Fr.

Ether Ext. 0.700 grm. Pd. = 0.6703 grm. Wfr., gave 0.0195 grm. Ext. = 2.31% Ext.
0.704 grm. Pd. = 0.6706 grm. Wfr., gave 0.0195 grm. Ext. = 2.31% Ext.
} Av. 2.31% ext. in Wfr. or 0.47% ext. in Fr.

Ash. 3.010 grm. Pd. = 2.954 grm. Wfr., gave 0.1995 grm. Ash = 6.75% Ash } Av'ge 6.75% Ash. in Wfr. or 1.37% Ash in Fr.

P_2O_5 0.9070 grm. Pd. = 0.8902 grm. Wfr., gave 0.0202 grm. P_2O_5 = 2.26% P_2O_5
0.9015 = 0.8848 0.0195 = 2.21
} Av'ge 2.24% P_2O_5 in Wfr. or 0.45% P_2O_5 in Fr.

SO_3 0.9030 grm. Pd. = 0.8863 grm. Wfr., gives 0.0388 grm. SO_3 = 4.38% SO_3
0.9035 = 0.8868 0.0394 4.48
} Av'ge 4.43% SO_3 in Wfr. or 0.90% SO_3 in Fr.

Albumen in cold-water Ext.
33.3 grm. Fr. = 6.7533 grm. Wfr., gives 0.4045 grm. Alb. = 1.21% Alb.
33.3 6.7533 0.3885 = 1.16%
} Av'ge 1.19% Alb. in Fr. or 5.87% Alb. in Wfr.

Extractives, etc., in cold-water Ext.
33.3 grm. Fr. = 6.7533 grm. Wfr., gave 1.2365 grm. crude Ext. = 3.70% cr. Ext.
33.3 grm. Fr. = 6.7533 grm. Wfr., gave 1.2420 grm. crude Ext. = 3.73% cr. Ext.
} Av'ge 3.72% cr. Ext. in Fr. or 18.36% cr. Ext. in Wfr.
0.4085 grm. crude Ext. gave 0.0105 grm. water = 2.57% water
0.4085 0.0065 fat = 1.63 fat
0.9280 0.2190 Ash = 24.22 Ash
} 28.42% = 71.58% pure Ext. in crude Ext.
18.36% crude Ext. = 13.14% pure Ext. in Wfr. = 2.66% pure Ext. in Fr.

Gelatin in hot-water Ext.
33.3 grm. Fr. = 6.7533 grm. Wfr., gave 1.2340 grm. crude gel. = 3.70% crude gel.
33.3 grm. Fr. = 6.7533 grm. Wfr., gave 1.2570 grm. crude gel. = 3.77% crude gel.
} Av'ge 3.74% crude gel. in Fr. or 18.46% crude gel. in Wfr.
0.9935 grm. crude gel. gave 0.0170 grm. water = 1.71% water
0.9935 0.0045 fat = 0.46 fat
1.2340 0.0710 Ash = 5.85 Ash
} 8.02% = 91.98% pure gel. in crude gel.
18.46% crude gel. = 16.98% pure gel. in Wfr. = 3.44% pure gel. in Fr.

* The excess above 100 is doubtless due in part at least to the ash of the albumen and insoluble protein from which the ash was not subtracted. The composition of the fresh substance is recalculated to 100 by subtracting this excess from the insoluble protein and albumen.

Insoluble protein.

33.3 grm. Fr. = 6.7533 grm. Wfr., gave 3.6755 grm. crude Ins. = 11.03% crude Ins.
33.3 grm. Fr. = 6.7533 grm. Wfr., gave 3.6700 grm. crude Ins. = 11.01% crude Ins.
} Av'ge 11.02% crude Ins. in Fr. or 54.39% crude Ins. in Wfr.

0.9245 grm. crude Ins. gave 0.0085 grm. water = 0.92% water
0.9245 0.0185 fat = 2.02 fat
3.2720 0.0380 Ash = 1.17 Ash
} 4.11% = 95.89% pure Ins. in crude Ins.

54.39% crude Ins. = 52.15% pure Ins. in Wfr. = 10.57% pure Ins. in Fr.

Recapitulation of the analysis of flesh.

Constituents.	Protein = N × 6.25.		Albuminoids estimated by difference.	
	In water-free substance.	In fresh substance.	In water-free substance.	In fresh substance.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Water		79.74		79.74
Protein	91.69	18.58	90.94	18.42
Ether extract	2.31	0.47	2.31	0.47
Ash	6.75	1.37	6.75	1.37
Total	100.75	100.16	100.00	100.00

Proximate ingredients directly determined.

Constituents.	In water-free substance.	In fresh substance.	In fresh substance, calculated to 100 pr. ct.
	Per cent.	*Per cent.*	*Per cent.*
Water		79.74	80.19
Albumen coagulated in cold-water extract	5.87	1.19	1.19
Extractives, etc., not coagulated in cold-water extract	13.14	2.66	2.68
Gelatin in hot-water extract	16.98	3.44	3.46
Insoluble protein	52.15	10.57	10.63
Ether extract	2.31	0.47	0.47
Ash	6.75	1.37	1.38
Total	97.20	99.44	100.00

Laboratory Number 247.

Name: Skate, *Raia* sp.?
Locality: Long Island, Atlantic Ocean.
Received: April 26, 1882, from Mr. E. G. Blackford.
Description: Left lobe of body.

Weighings in preparation for analysis.

	Grms.	*Lb. Oz.*	*Pr. ct.*
Flesh	996.0	2 3.2	46.32
Refuse	1,097.0	2 8.7	51.03
Loss	57.0	2.0	2.65
Total	2,150.0	4 11.9	100.00

Analysis of flesh.

Water (dried in hydrogen).

Partial drying.—100.00 grms. fresh substance, "Fr." — 20.99 grms. partially dried "Pd." = 20.99 % Pd. in Fr.
Complete drying.—1.0000 grm. Pd. = 0.8503 grm. Water-free, "Wfr." = 85.03 % Wfr. in Pd.
Complete drying.—0.9997 grm. Pd. = 0.8497 grm. Water-free, "Wfr." = 85.00 % Wfr. in Pd.
*Complete drying.—1.0000 grm. Pd. = 0.504 grm. Water-free, "Wfr." = 85.04 % Wfr. in Pd.
} Av'ge 85.02 % Wfr. in Pd.

20.99 % Pd. in Fr. × 85.02 % Wfr. in Pd. = 17.85 % Wfr. in Fr., or 82.15 % Water in Fr.

Nitrogen. 0.6000 grm. Pd. = 0.5101 grm. Wfr., gave 0.08301 grm. N. = 16.28 % N.
0.6000 = 0.5101 0.08313 16.29
*0.6000 = 0.5101 0.08316 16.30
} Av'ge 16.29 % N. Wrf. or 2.91 % N. in Fr.

Ether ext. 0.5000 grm. Pd. = 0.4251 grm. Wfr., gave 0.0332 grm. Ext. = 7.81 % Ext. { Av'ge 7.81 % Ext. in Wfr. or 1.39 % Ext. in Fr.
0.5000 = 0.4251 0.0332 = 7.81 %

Ash. 2.0000 grm. Pd. = 1.7004 grm. Wfr., gave 0.1079 grm. Ash. = 6.35 % Ash { Av'ge 6.38 % Ash in Wfr. or 1.14 % Ash in Fr.
2.0000 = 1.7004 0.1090 6.41 %

Recapitulation of analysis of flesh.

Constituents.	Protein = N × 6.25.		Albuminoids estimated by difference.	
	In water-free substance.	In fresh substance.	In water-free substance.	In fresh substance.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Water	....	82.15	....	82.15
Protein	101.82	18.17	85.81	15.32
Ether extract	7.81	1.39	7.81	1.39
Ash	6.38	1.14	6.38	1.14
Total	116.01	102.85	100.00	100.00

* The percentage of nitrogen found in the regular analysis was so large that these triplicate determinations were made later to confirm the results.

LABORATORY NUMBER 261.

Name: Mackerel, *Scomber scombrus.*
Locality: Capes of Virginia, Atlantic Ocean.
Received: Apr. 29, 1884, from Mr. E. G. Blackford.
Description: One whole fish.

Weighings in preparation for analysis.

	Grms.	*Ounces.*	*Per ct.*
Flesh	279.0	9.8	48.43
Refuse	290.0	10.3	50.35
Loss	7.0	0.3	1.22
Total	576.0	1 lb. 4.4	100.00

Analysis of flesh.

Water (dried in hydrogen).
{ Partial drying.—100.00 grms. fresh substance, "Fr." = 26.05 grms. partially dried, "Pd." = 26.05 % Pd. in Fr.
Complete drying.—0.9997 grm. Pd. = 0.9425 grm. Water-free, "Wfr." = 94.28 % Wfr. in Pd.
Complete drying.—1.0002 grm. Pd. = 0.9430 grm. Water-free, "Wfr." = 94.28 % Wfr. in Pd. } Av'ge 94.28 % Wfr. in Pd.
26.05 % Pd. in Fr. × 94.28 % Wfr. in Pd. = 24.56 % Wfr. in Fr., or 75.44 % Water in Fr.

Nitrogen. 0.6000 grm. Pd. = 0.5658 grm. Wfr., gave 0.07164 grm. N. = 12.66 % N. { Av'ge 12.66 % N. in Wfr. or 3.11 % N. in Fr.
0.6000 = 0.5658 0.07179 = 12.67 %

Ether ext. 0.5000 grm. Pd. = 0.4714 grm. Wfr., gave 0.0808 grm. Ext. = 17.14 % Ext. { Av'ge 17.13 % Ext. in Wfr. or 4.21 % Ext. in Fr.
0.5000 = 0.4714 0.0807 = 17.12 %

Ash. 2.0000 grm. Pd. = 1.8856 grm. Wfr., gave 0.0990 grm. Ash = 5.25 % Ash { Av'ge 5.23 % Ash in Wfr. or 1.28 % Ash. in Fr.
2.0000 = 1.8856 0.0980 = 5.20 %

Recapitulation of analysis of flesh.

Constituents.	Protein = N × 6.25.		Albuminoids estimated by difference.	
	In water-free substance.	In fresh substance.	In water-free substance.	In fresh substance.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Water	....	75.44	....	75.44
Protein	79.10	19.43	77.64	19.07
Ether extract	17.13	4.21	17.13	4.21
Ash	5.23	1.28	5.23	1.28
Total	101.46	100.36	100.00	100.00

Details of analyses of flesh of specimens of fish.

[Determinations of water, nitrogen, other extract (fat), and ash.]

Laboratory No. of specimen.	Water and water-free substance.			In water-free substance.					
	Partly dried substance "Pd." in fresh substance.	Water-free substance "Wfr." in partly dried substance.		Nitrogen.		Ether extract.		Ash.	
		Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*
1	23.70	87.91 88.04	87.98	13.46 13.45	13.46	10.59 10.58	10.59	5.53	5.53
2	17.56	94.79 94.61	94.70	14.35 14.34	14.35	3.71 3.75	3.73	7.67	7.67
3	17.20	96.06 95.99	96.03	14.97 15.02	15.00	1.70 1.61	1.66	7.62	7.62
4	32.64	92.89 92.10	92.50	10.19 10.20	10.20	34.20 34.26	34.23	3.04	3.04
5	25.89	93.09	93.09	12.66 12.56	12.61	16.16 15.60	15.88	6.08	6.08
6	31.30	96.86 97.06	96.96	9.87 9.78	9.83	35.87 35.46	35.67	4.26	4.26
7	22.43	93.54 93.50	93.52	14.24 14.25	14.25	7.52 7.44	7.47	5.51	5.51
8	22.75	93.74 93.78	93.76	13.70 13.74	13.72	10.38 10.23	10.34	4.67	4.67
9	31.08	96.06 96.13	96.10	9.94 9.92	9.93	35.43 35.39	35.41	3.83	3.83
10	36.40	95.48 95.45	95.47	9.19 9.18	9.19	39.06 39.14	39.10	4.26	4.26
11	17.61	94.34	94.34	15.52 15.47	15.50	2.31 2.46	2.39	7.60	7.60
12	22.67	94.96 95.04	95.00	14.39 14.44	14.42	5.85 5.73	5.79	5.91	5.91
13	28.36	90.85 90.65	90.75	10.85 10.93	10.89	27.24 27.28	27.26	4.83	4.83
14	34.22	95.86 96.09	95.98	9.56 9.58	9.57	37.90 37.98	37.94	3.35	3.35
15	21.96	92.44 92.57	92.51	13.78 13.70	13.74	7.13 7.22	7.18	6.88	6.88
16	20.20	97.23 97.75	97.50	15.09 15.06	15.08	1.05 0.65	0.85	5.82	5.82
17	37.04	84.30 84.14	84.22	9.06 9.02	9.04	40.10 40.18	40.14	4.33	4.32
18	34.01	88.70 88.76	88.73	12.15 12.16	12.16	21.54 21.48	21.51	5.36	5.36
19	21.97	92.70 92.73	92.72	13.41 13.38	13.40	10.50 10.48	10.49	6.66	6.66
20	23.56	96.34 88.56	92.45	14.84 14.80	14.82	2.87 2.83	2.85	5.82	5.82
21	19.76	90.93 90.94	90.94	14.81 14.76 14.75	14.77	0.78 0.77	0.78	8.72	8.72
22	15.88	94.10 94.18	94.14	14.13 14.17 14.11	14.14	5.33 5.03	5.18	8.63	8.63
23	20.51	96.70 96.72	96.71	13.27 13.36	13.32	9.75 9.76	9.76	10.08	10.08
24	23.58	95.21 95.22	95.22	13.24 13.26	13.25	11.61 11.61	11.01	6.33	6.33
25	47.27	96.52 96.65	96.59	9.18 9.22	9.20	0.72 0.70	0.71	50.72	50.72
26	25.00	90.40 90.88	90.64	13.90 14.01	13.96	8.58 8.58	8.58	5.86	5.86
27	44.40	84.09 83.97	84.03	8.76 8.75	8.76	51.51 51.66	51.59	2.80	2.80
28	50.26	97.43 97.33	97.38	6.04 6.03	6.04	31.89 31.92	31.90	31.01	31.01
29	35.46	96.35 96.12	96.24	9.89 9.84	9.87	32.94 31.85	32.40	5.24	5.24
30	26.66	97.01 96.98	97.00	11.23 11.26	11.25	27.03 27.05	27.04	5.02	5.02
31	31.00	90.41 90.45	90.43	10.75 10.78	10.77	28.05 28.02	28.04	4.81	4.81
32	33.78	86.53 86.65	86.58	9.87 9.92	9.90	34.63 34.37	34.50	4.58	4.58
33	71.61	93.42 89.38	91.40	9.04 9.01	9.03	24.20 24.16	24.18	20.15	20.15

Details of analyses of flesh of specimens of fish—Continued.

[Determinations of water, nitrogen, ether extract (fat), and ash.

Laboratory No. of specimen.	Water and water-free substance.			In water-free substance.					
	Partly dried substance "Pd." in fresh substance.	Water-free substance "Wfr." in partly dried substance.		Nitrogen.		Ether extract.		Ash.	
		Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*
34	47.66	97.32 97.32	97.32	8.59 8.57	8.58	0.51 0.55	0.53	53.82	53.82
35	25.44	97.22 97.16	97.19	12.38 12.40	12.39	17.65 17.66	17.66	4.51	4.51
36	23.87	91.27 91.34	91.31	12.86 12.99	12.93	13.02 12.94	12.98	5.36	5.36
37	47.47	97.80 97.95	97.88	8.93 8.89	8.91	0.94 0.94	0.94	52.43	52.43
38	24.14	95.41 95.49	95.45	13.41 13.42	13.42	12.17 12.22	12.20	5.54	5.54
39	36.96	97.39 97.33	97.36	8.48 8.47	8.48	45.33 45.23	45.28	4.11	4.11
40	....	94.34 94.29	94.32	11.72 11.68	11.70	18.25 17.99	18.12	5.76	5.76
41	....	92.72 92.78	92.76	13.25 13.27	13.26	9.46 9.26	9.36	5.76	5.76
42	58.80	98.27 98.37	98.32	5.88 5.82	5.85	39.21 38.95	39.08	22.76	22.76
43	33.36	95.64 95.60	95.62	10.77 10.75	10.76	29.55 29.56	29.56	4.71	4.71
44	25.72	94.72 94.72	94.72	11.76 11.82	11.79	23.09 23.05	23.07	4.56	4.56
45	27.02	87.88 87.85	87.87	13.56 13.60	13.58	10.67 10.73	10.70	6.03	6.03
46	24.82	97.81 97.58	97.63	13.58 13.59	13.59	10.39 10.45	10.42	5.27	5.27
47	31.45	98.47 98.46	98.46	9.85 9.88	9.87	35.50 35.60	35.55	4.83	4.83
48	31.32	89.43 89.22	89.33	11.91 11.89	11.90	24.21 23.82	24.02	3.93	3.93
49	33.83	85.87 85.82	85.85	8.26 8.24	8.25	50.43 50.29	50.36	4.47	4.47
52	21.16	95.69 95.79	95.74	14.67 14.66	14.67	2.31 2.31	2.31	6.75	6.75
53	24.86	86.08 86.04	86.06	14.55 14.53	14.54	4.45 4.49	4.47	5.57	5.57
77	44.40	82.17 82.65	82.41	9.42 9.52	9.47	40.74 41.22	40.98	4.26	4.26
78	36.80	94.97 94.82	94.90	9.63 9.79	9.71	38.51 37.89	38.20	4.19	4.19
79	....	84.80 84.70	84.75	14.68 14.73	14.71	2.28 2.25	2.27	9.69 9.87	9.78
80	....	88.40 88.30	88.35	13.01 13.06	13.04	5.57 5.51	5.54	13.41 13.38	13.40
81	28.70	83.50 83.60	83.55	14.41 14.42 14.39	14.41	3.24 3.21	3.23	6.47 6.43	6.45
87	45.10	96.65 96.70	96.68	9.11 9.13	9.12	29.17 29.10	29.14	12.90 12.79	12.85
88	29.20	96.45 96.50	96.48	13.56 13.59	13.58	0.62 0.62	0.62	13.09 13.11	13.10
90	32.20	92.85 92.90	92.88	9.59 9.61	9.60	36.84 36.76	36.80	3.80 3.83	3.82
91	32.05	84.35 84.30	84.33	13.77 13.81	13.79	9.71 9.66	9.69	4.98 4.87	4.93
94	35.20	90.50 90.50	90.50	9.87 9.87	9.87	27.29 27.26	27.28	10.27 10.06	10.17
95	72.00	77.70 77.80	77.75	4.67 4.69	4.68	49.19 49.24	49.22	21.98 22.20	21.09
96	38.70	98.25 98.30	98.28	8.47 8.49	8.48	38.54 38.55	38.55	9.18 9.49	9.34
98	23.89	84.60 84.55	84.58	14.75 14.81	14.78	2.84 2.90	2.87	4.99 5.14	5.07
99	25.20	73.20 73.23	73.22	14.93 14.96	14.95	2.05 2.11	2.08	5.34 5.30	5.32
100	21.26	94.85 94.85	94.85	14.60 14.65	14.63	2.58 2.58	2.58	6.22 6.06	6.14
110	18.51	97.20 97.15	97.18	15.11 15.10	15.10	0.95 0.93	0.94	5.02 4.94	4.98

Details of analyses of flesh of specimens of fish—Continued.

[Determinations of water, nitrogen, ether extract (fat), and ash.]

Laboratory No. of specimen.	Water and water-free substance.			In water-free substance.					
	Partly dried substance "Pd." in fresh substance.	Water-free substance "Wfr." in partly dried substance.		Nitrogen.		Ether extract.		Ash.	
		Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*
111	24.48	97.48 97.43	97.46	12.93 12.91	12.92	14.58 14.60	14.59	5.28 5.21	5.25
113	17.63	95.83 95.80	95.82	14.56 14.55	14.56	3.98 3.96	3.97	5.74 5.79	5.77
114	21.11	95.00 95.00	95.00	14.86 14.90	14.88	2.41 2.37	2.39	5.81 5.76	5.79
126	28.16	89.15 89.20	89.18	12.38 12.42	12.40	18.46 18.44	18.45	4.63 4.68	4.66
127	21.16	92.50 92.50	92.50	14.52 14.55	14.54	2.81 2.81	2.81	5.87 5.84	5.86
205	26.50	70.34 70.30	70.32	15.14 15.10	15.12	2.92 2.98	2.95	3.48 3.48	3.48
206	21.23	90.85 90.90	90.88	15.23 15.17	15.20	1.54 1.54	1.54	7.26 7.18	7.22
207	22.36	97.67 97.60	97.64	13.65 13.67	13.66	7.53 7.58	7.55	6.22 6.25	6.24
208	26.52	82.65 82.70	82.68	14.36 14.37	14.37	5.08 5.13	5.11	6.14 6.09	6.12
211	24.48	94.05 94.06	94.06	13.70 13.63	13.67	11.94 11.97	11.95	3.80 3.83	3.81
212	33.19	87.34 87.26	87.30	10.08 10.04	10.06	35.32 35.32	35.32	3.13 3.05	3.09
217	28.20	94.36 94.32	94.34	10.68 10.67	10.68	29.57 29.67	29.62	4.14 4.18	4.16
218	53.53	97.70 97.70	97.70	7.02 7.06	7.04	27.60 27.62	27.61	28.40 28.44	28.42
219	85.91	65.60 65.61	65.61	5.10 5.06	5.08	44.05 44.05	44.05	24.58 24.48	24.53
220	31.79	85.10 85.05	85.08	11.68 11.66	11.67	22.29 22.27	22.28	5.50 5.46	5.48
221	29.33	95.53 95.57	95.55	11.49 11.46	11.48	23.25 23.23	23.24	5.48 5.44	5.46
224	21.91	93.47 93.55	93.51	14.89 14.83	14.86	2.40 2.35	2.38	5.44 5.47	5.46
225	23.77	95.65 95.55	95.60	13.34 13.38	13.36	12.36 12.34	12.35	4.92 4.92	4.92
228	17.28	95.85 95.90	95.88	15.32 15.28	15.30	1.89 1.89	1.89	5.99 6.06	6.03
229	18.07	96.53 96.55	96.54	14.99 14.95	14.97	1.82 1.82	1.82	6.79 6.76	6.78
230	26.88	97.92 97.95	97.94	11.83 11.87	11.85	22.25 22.30	22.28	4.61 4.58	4.60
233	39.31	90.27 90.23	90.25	8.34 8.39	8.37	46.51 46.51	46.51	2.86 2.84	2.85
234	34.88	93.42 93.45	93.44	9.03 8.97	9.00	41.38 41.42	41.40	2.92 2.98	2.95
236	29.09	99.35 99.28	99.31	8.31 8.28	8.30	46.01 46.05	46.03	2.27 2.27	2.27
237	26.03	93.10 93.14	93.12	12.91 12.89	12.90	15.03 15.01	15.02	5.25 5.20	5.23
238	22.02	96.74 96.65	96.70	13.64 13.62	13.63	8.90 8.90	8.90	6.75 6.68	6.72
240	27.89	97.80 97.71	97.76	12.73 12.71	12.72	14.87 14.81	14.84	6.16 6.21	6.19
241	44.03	96.40 96.40	96.40	7.34 7.34	7.34	50.62 50.62	50.62	4.19 4.11	4.15
242	21.29	94.88 94.81	94.85	15.26 15.25	15.26	2.67 2.67	2.67	6.43 6.53	6.48
243	19.02	93.56 93.60	93.58	15.10 15.10	15.10	2.89 2.89	2.89	6.92 6.97	6.95
244	23.02	88.48 88.41	88.45	14.84 14.88	14.86	3.03 3.07	3.05	5.03 5.06	5.05
245	31.28	89.00 89.07	89.04	10.60 10.54	10.57	29.11 29.09	29.10	5.53 5.50	5.52
246	29.94	96.01 96.07	96.04	11.64 11.60	11.62	13.16 13.15	13.16	5.28 5.34	5.31
247	20.99	85.03 85.00	85.02	16.28 16.29 16.30	16.29	7.81 7.81	7.81	6.35 6.41	6.38

Details of analyses of flesh of specimens of fish—Continued.

[Determinations of water, nitrogen, ether extract (fat), and ash.

Laboratory No. of specimen.	Water and water-free substance.			In water-free substance.					
	Partly dried substance "Pd." in fresh substance.	Water-free substance "Wfr." in partly dried substance.		Nitrogen.		Ether extract.		Ash.	
		Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*
248	25.44	86.98 87.00	86.99	13.73 13.71	13.72	9.93 9.93	9.93	5.06 5.03	5.05
249	27.46	96.33 96.28	96.31	11.05 11.06	11.06	20.58 26.58	26.58	5.14 5.17	5.16
250	22.03	94.93 94.98	94.96	14.83 14.79	14.81	3.16 3.16	3.16	6.37 6.34	6.36
251	22.99	89.98 89.97	89.98	15.33 15.34	15.34	2.38 2.34	2.36	6.82 6.77	6.80
252	22.67	91.67 91.72	91.70	14.55 14.58	14.57	4.52 4.54	4.53	5.66 5.70	5.68
253	15.97	98.00 98.00	98.00	14.88 14.84	14.86	2.86 2.84	2.85	7.70 7.65	7.68
254	20.67	97.55 97.57	97.56	14.93 14.91	14.92	3.71 3.73	3.72	4.77 4.73	4.75
255	35.42	86.10 86.13	86.12	10.21 10.16	10.19	33.45 33.49	33.47	3.84 3.86	3.85
256	24.51	98.82 98.83	98.83	13.40 13.42	13.41	12.14 12.14	12.14	5.06 5.10	5.08
257	19.51	98.12 98.15	98.14	14.96 14.92	14.94	3.94 3.96	3.95	5.86 5.94	5.90
258	21.79	98.33 98.33	98.33	13.42 13.43	13.43	10.98 10.98	10.98	5.57 5.54	5.56
259	18.61	97.40 97.43	97.42	15.29 15.25	15.27	1.95 1.91	1.93	5.70 5.72	5.71
260	23.67	98.68 98.65	98.67	12.33 12.30	12.32	19.75 19.75	19.75	3.92 3.91	3.92
261	26.05	94.28 94.28	94.28	12.66 12.67	12.66	17.14 17.12	17.13	5.25 5.20	5.23
262	20.33	91.00 91.00	91.00	11.64 11.65	11.65	22.53 22.55	22.54	5.24 5.19	5.22
263	24.91	87.55 87.60	87.58	14.18 14.14	14.16	7.49 7.53	7.51	4.71 4.67	4.69
269	26.48	81.38 81.46	81.42	14.08 14.06	14.07	6.73 6.65	6.69	6.32 6.28	6.30
270	19.12	96.40 96.45	96.43	14.63 14.67	14.65	2.86 2.92	2.89	6.65 6.69	6.67
271	24.08	87.37 87.45	87.41	15.07 15.04	15.06	3.52 3.59	3.55	5.39 5.45	5.42
273	21.59	97.40 97.41	97.41	13.54 13.53	13.54	11.40 11.34	11.37	5.58 5.70	5.64
275	31.73	98.59 98.52	98.56	11.39 11.41	11.40	7.22 7.14	7.18	23.16 23.11	23.14
279	41.21	93.74 93.76	93.75	10.24 10.24	10.24	33.80 33.72	33.76	3.49 3.52	3.51
280	44.61	87.38 87.36	87.37	10.17 10.17	10.17	33.50 33.56	33.53	3.70 3.75	3.73

Details of analyses of flesh of specimens of fish.

[Determinations of phosphorus, sulphur, and chlorine, recovered in water-free substances.]

Laboratory number of specimen.	Phosphorus, as P_2O_5.		Sulphur, as SO_3.		Chlorine, Cl.	
	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	2.10 2.11	2.11	2.09 2.13	2.11		
2	1.88 1.83	1.86	2.23 2.23	2.23		
3	2.21 2.16	2.19				
4	1.66 1.74	1.70				
5	2.06 2.06	2.06				
7	2.36 2.66	2.51				
8	2.25 2.27	2.26				
9	1.51 1.51	1.51				
10	1.93 1.95	1.94				
11	3.19 3.17	3.18				
12	2.87 2.98	2.93				
13	2.46 2.39	2.43				
14	1.79 1.78	1.79				
15	3.04 3.03	3.04				
16	2.34 2.52	2.43				
17	1.84 1.76	1.80	1.95 1.93	1.94		
18	2.31 2.38	2.35	1.35 1.37	1.36		
19	2.15 2.16	2.16	2.28 2.27	2.28		
20	2.13 2.17	2.15	2.15 2.22	2.19		
21	2.52 2.56	2.54	2.23 2.29	2.26		
22	2.74 2.65	2.70	3.12 3.07	3.10		
23	4.05 4.15	4.10	2.78 2.79	2.79		
24	2.70 2.70	2.70	2.10 2.16	2.13		
25	0.79 0.79	0.79	1.50 1.47	1.48	24.53 24.50	24.51
26	2.02 2.18	2.10	2.06 2.07	2.07		
27	1.82 1.90	1.86	1.14	1.14		
28	0.98 0.91	0.95	0.90 0.87	0.89	17.64 17.75	17.69
29	1.77 1.77	1.77	1.27 1.27	1.27		
30	2.15 2.16	2.16	1.66 1.69	1.68		
31	1.99 1.97	1.98	1.84	1.84		
32	1.74 1.77	1.76	1.79 1.78	1.78	0.75 0.73	0.74
33	1.27 1.29	1.28	1.88 1.89	1.89	11.10 10.92	11.01
34	0.61 0.61	0.61	1.56 1.56	1.56	25.71 25.61	25.66
35	1.89 1.88	1.89	1.56 1.59	1.58	0.73 0.75	0.74
36	2.20 2.20	2.20	1.46 1.44	1.45	0.84 0.85	0.85
37	0.49 0.46	0.48	1.61 1.01	1.61	25.68 25.74	25.71
38	2.25 2.22	2.24	1.95 1.98	1.97	1.02 1.04	1.03

Details of analyses of flesh of specimens of fish—Continued.

[Determinations of phosphorus, sulphur, and chlorine, recovered in water-free substances.]

Laboratory number of specimen.	Phosphorus, as P_2O_5.		Sulphur, as SO_3.		Chlorine, Cl.	
	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
39	1.60 1.60	1.60	1.42 1.42	1.42	0.68 0.68	0.68
40	2.40 2.21	2.31	1.73 1.81	1.77	0.94 0.96	0.95
41	2.38 2.48	2.43	1.99 1.96	1.98	0.93 0.93	0.93
42	0.61 0.61	0.61	1.07 1.03	1.05	....	....
43	1.91 1.85	1.88	1.80 1.81	1.81	....	....
44	1.41 1.51	1.46	2.50 2.57	2.54	....	....
45	2.19 2.23	2.21	1.50 1.59	1.55	....	....
46	2.13 2.12	2.13	2.83 2.76	2.80	....	....
47	1.77 1.76	1.77	1.75 1.78	1.77	....	....
48	1.64 1.59	1.62	1.71 1.70	1.71	....	....
49	1.67 1.65	1.66	1.12 1.11	1.12	....	....
52	2.26 2.21	2.24	4.38 4.48	4.43	....	....
53	2.02 2.05	2.04	4.08 4.20	4.14	....	....

4. TABULAR STATEMENTS SHOWING THE RESULTS OF THE ANALYSES OF AMERICAN FISHES.

EXPLANATION OF TABLES.

Tables 1 to 9 recapitulate the results of the analyses of American fishes.

Table 1 gives the localities of the specimens as stated by the parties from whom they were received, the portions received for analysis, results of weighings in preparing for analysis, etc. The "loss in preparing for analysis" I suppose to have consisted chiefly of water which evaporated during the process, and of material which adhered to the hands and the instruments with which the separations were made. The specimens are here arranged, for convenience, in numerical order. The full descriptions and details regarding the specimens were given in the previous chapter.

Table 2 gives results of analyses of flesh calculated on water-free substance. It will be observed that the percentages of protein as estimated by multiplying the nitrogen by the factor 6.25, and those of "albuminoids, etc.," (actual nitrogenous substances) as estimated by difference [100−(ether extract+ash) = albuminoids, etc.], are both given. The former (protein = N × 6.25) has the sanction of common usage, but the latter comes nearer to the truth. We certainly can not go far away in assuming that the flesh of fish contains ordinarily but very little of non-nitrogenous compounds other than fats and mineral compounds, though a more thorough study of the carbohydrates and complex nitrogenous and phosphorized fats is much needed. Accordingly it seems to me that in these analyses the most accurate measure of the nitrogenous compounds is to be found by subtracting the sum of the ether extract and ash from the whole.

Table 3 gives analyses of flesh calculated on fresh substance, and includes both protein as estimated by multiplying N by 6.25, and "albuminoids, etc.," by difference [100−(water+ether extract+ash)=albuminoids, etc.] The figures of this table are computed from those of Table 2, the percentages of water and water-free substance in the flesh and of ingredients in water-free substance serving as the basis of the calculations. In the subsequent tables, deduced from these and taken as representing the actual composition of the flesh, the latter figures rather than those obtained by multiplying N by 6.25 are taken as representing the nitrogenous matters.

Table 4 gives the proportions of proximate ingredients in the water-free (dry) substance of specimens of American preserved fish. It corresponds to Table 2, which gives the same ingredients in water-free substance of fresh fish.

Table 5 gives the proportions of proximate ingredients in the flesh of American preserved fish, corresponding to Table 3 of fresh fish.

Table 6 gives the proportions of proximate ingredients in the water-free substance of the flesh of American fishes as directly determined; that is to say, it recapitulates the determinations of extractive matters, albumen, gelatin, insoluble protein, etc., as made in accordance with the statements in the chapter on Methods of Analysis. The figures for ether extract and ash are those of the previous tables. As there stated, I do not consider the determinations of the nitrogenous constituents entirely accurate. The methods are not yet well enough worked up to give satisfactory results. The figures will, nevertheless, serve for comparison with those obtained by Almén,* and, I presume, with those of Kostytschef.* It is to be noted, however, that the figures here given refer simply to the flesh, while those of Almén I understand to include the skin with the flesh, and I presume that the same may be the case with Kostytschef's, though as to the latter point I am not definitely informed. The last column of Table 6 gives the sums of the several constituents. These vary more or less from 100 per cent., and they thus indicate errors in the determination. Where these footings have varied by more than 5 per cent. from 100 per cent. in the water-free substance (which would correspond to from 1 per cent. to 2 per cent. in the fresh flesh), the insoluble protein for each specimen has been omitted from the table. The methods of estimating the extractive matters, gelatin, and insoluble protein differ in the different specimens with respect to the determinations of ash and fat, as indicated in the table and stated in full in the details of the analyses.

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* See beyond, Section B, Division 2, Recapitulation of Analyses of European Fishes.

I have deemed it proper to state the precise facts with reference to these analyses, so that they may be taken exactly for what they are worth. The analytical details will help in judging properly of their value. As stated in the description of the method of analysis, the methods were those laid down by other analysts. We followed those methods and did the work as faithfully as we were able. If the results have no other value, they at least show the need of working up the methods more thoroughly.

Table 7 gives the proximate ingredients of the flesh as directly determined. The analyses are those of Table 6 calculated on fresh substance, the figures for water being those stated in previous tables.

Table 8 states the percentages of phosphorus calculated as P_2O_5 and as PO_4, of sulphur as SO_3 and as SO_4, and of chlorine, in both water-free substance and fresh substance of flesh. The determinations were made as described in the chapter on Methods of Analysis, and I believe them to be reasonably accurate.

The composition of the specimens of fresh and preserved fish as received for analysis, including both flesh and other parts, is stated in Table 9.

OTHER ANALYSES OF AMERICAN FISHES.

Prof. R. H. Chittenden has reported an analysis of the flesh of halibut, "a fresh sample obtained in the market."* The source of the specimen, the season in which it was taken, and the portion of the body used for analysis are not stated. It appears, however, to have been rather lean in comparison with the specimens of halibut above reported. To facilitate such comparison, I give the result in the forms followed in the tables here, basing the calculations on the averages of Professor Chittenden's analyses, which from their close agreement, as well as from the context, I take to be duplicate determinations of the same specimen of flesh.

Composition of flesh of halibut.

[In water-free substance, "flesh dried at 100° C."]

	P. ct.
Nitrogen	11.68
Protein, N × 6.25	73.00
Fats	7.12
Ash	6.35
Protein (N × 6.25) + fats + ash	86.47
Albuminoids, etc., by difference	86.53

Prof. G. H. Cook has reported an analysis of menhaden, *Brevoortia tyrannus*,† which was, however, made for the purpose of learning the value of the fish for fertilizing the soil, and yielded no data that could well be utilized here. No other analyses of flesh of American food-fishes have come to my attention.

* Am. Jour. Sci. [3], 13, 123. † Geology of New Jersey, p. 498.

TABLE 1.—*List of specimens of American fishes analyzed, names, localities, and proportions of flesh, etc.*

Kinds of fish, localities, and portion taken for analysis.	Laboratory No. of specimen.	When received.	Number of fish in specimen.	Proportion of flesh, etc., in specimen as taken for analysis. Total weight of specimen.			Flesh, edible portion.	Refuse, bones, skin, entrails, etc.	Loss in preparation for analysis.
				Lbs.	*Oz.*	*Grams.*	*Per ct.*	*Per ct*	*Per ct.*
Halibut (Hippoglossus hippoglossus), posterior part of body, lean	1	Spring, 1879		4	2.7	1894.0	75.92	23.12	0.96
Common flounder (Paralichthys dentatus), entrails removed	2	....do	2	5	1.2	2308.0	41.33	57.02	1.65
Cod (Gadus morrhua), head and entrails removed	3	....do	1	6	1.9	2780.0	64.57	33.70	1.73
Eel, salt water (Anguilla rostrata), skin, head, and entrails removed	4	....do	11	3	0.1	1368.0	76.24	21.42	2.34
Alewife (Clupea vernalis), whole, Connecticut River	5	....do	12	1	14.2	859.0	49.48	50.52	0.00
Shad (Clupea sapidissima), whole, Hudson River, first of season	6	....do	2	4	3.8	1925.0	48.31	49.35	2.34
Striped bass (Roccus lineatus), whole, Connecticut River	7	....do	1	4	8.4	2055.0	42.09	56.69	1.22
Mackerel (Scomber scombrus), whole	8	....do	4	2	13.0	1280.0	60.55	38.28	1.17
Halibut (Hippoglossus hippoglossus), section of body, fatter than No. 1	9	....do		2	6.0	1075.0	88.28	11.16	0.56
Shad (Clupea sapidissima), whole, Connecticut River, early in season	10	....do	1	3	8.2	1595.0	52.35	46.40	1.25
Cod (Gadus morrhua), head and entrails removed	11	....do	1	5	9.2	2532.0	68.13	30.57	1.30
Bluefish (Pomatomus saltatrix), entrails removed	12	....do	1	3	1.3	1400.0	50.14	48.57	1.29
Mackerel (Scomber scombrus), whole	13	....do	2	1	15.7	893.2	45.76	51.77	2.47
Salmon (Salmo salar), entrails removed, Maine	14	....do	1	10	8.0	4764.3	76.16	23.84	0.00
Porgy (Diplodus argyrops), whole	15	....do	4	2	9.9	1190.5	33.16	65.17	1.67
Haddock (Gadus æglefinus), entrails removed	16	..do	1	4	2.9	1900.0	46.84	51.42	1.74
Lake trout, "Mackinaw trout" (Salvelinus namaycush), whole, Lake Ontario	17	November, 1879	1	7	14.8	3600.4	43.31	56.32	0.37
Whitefish (Coregonus clupeiformis), whole, Lake Champlain	18	....do	1	2	14.3	1313.0	45.76	53.47	0.77
Striped bass (Roccus lineatus), whole, Bridgehampton, Long Island	19	....do	1	2	6.7	1098.5	42.51	56.90	0.59
Red snapper (Lutjanus blackfordi), whole, Fernandina, Florida	20	....do	1	7	11.7	3507.5	60.00	39.60	0.40
Haddock (Gadus æglefinus), entrails removed, Rockaway, Long Island	21	....do	1	5	4.7	2402.2	47.50	51.62	0.88
Common flounder (Paralichthys dentatus), whole, Amagansett, Long Island	22	March, 1880	1	2	12.3	1257.5	31.97	66.80	1.23
Smelt (Osmerus mordax), whole, Hackensack River, New Jersey	23	....do	73	2	4.0	1023.0	61.78	34.82	3.40
Brook trout (Salvelinus fontinalis), whole, cultivated, Long Island	24	....do	6	2	13.6	1295.0	46.95	50.11	2.94
Red snapper (Lutjanus blackfordi), entrails removed, Florida, east coast	26	April, 1880	1	12	1.6	5498.7	47.36	52.45	0.19
Mackerel (Scomber scombrus), whole, Cape May, New Jersey	30	May, 1880	4	5	11.3	2594.0	50.29	48.85	0.86
Porgy (Diplodus argyrops), whole, Rhode Island	31	....do	4	6	4.6	2857.0	41.65	57.33	1.02
Shad (Clupea sapidissima), whole, Connecticut River	32	....do	1	3	13.7	1752.0	52.80	45.89	1.31
Blackfish (Hiatula onitis), whole, Stonington, Connecticut	38	December, 1880	2	4	8.6	2060.0	42.16	56.15	1.69
Mackerel (Scomber scombrus), whole, Cape Cod, Massachusetts	39	..do	1	1	2.4	522.1	64.60	33.78	1.62
Spanish mackerel (Cybium maculatum), whole	43	March, 1881	1	3	5.2	1512.4	64.02	34.61	1.37
White perch (Roccus americanus), whole	44	....do	2	1	11.1	770.1	35.24	63.24	1.52
Muskellunge (Esox nobilior), whole, St. Lawrence River	45	....do	1	9	1.0	4118.0	50.57	49.23	0.20
White perch (Roccus americanus), whole	46	....do	4	2	0.9	935.9	36.24	61.80	1.96
Herring (Clupea harengus), whole	47	....do	4	2	6.0	1080.8	51.13	46.00	2.87
Sheepshead (Diplodus probatocephalus), entrails removed, Florida	48	....do	1	4	5.5	1974.2	42.07	56.59	1.34
Turbot, or Greenland halibut (Platysomatichthys hippoglossoides), whole, Newfoundland	49	....do	1	5	8.0	2496.5	52.27	46.04	1.69
Pike perch, or wall-eyed pike (Stizostedion vitreum), whole	52	....do	2	2	7.5	1122.7	41.21	57.25	1.54
Large-mouthed black bass (Micropterus salmoides), whole, North Carolina	53	....do	1	3	11.1	1676.5	43.16	56.05	0.79

Salmon (*Salmo salar*), whole, *Penobscot River*	77	July, 1881	1	13	1.8	5948.0	66.54	32.98	0.48
Salmon (*Salmo salar*), whole, *Penobscot River*	78	....do	1	11	3.3	5082.0	69.22	30.56	0.22
Pollock (Gadus virens), head and entrails, removed, Massachusetts coast	81	October, 1881	1	5	13.1	2638.0	69.64	28.50	1.86
Butter-fish (Stromateus triacanthus), whole, east end of Long Island	90	November, 1881	4	1	9.6	724.0	55.86	42.76	1.38
Small-mouthed black bass (Micropterus dolomieu), whole, Seneca Lake, New York	91	....do	2	1	11.2	772.8	45.36	53.66	0.98
Pike or pickerel (Esox lucius), entrails removed, Lake Ontario	98	....do	1	3	9.0	1617.0	55.69	42.67	1.64
Tomcod (Gadus tomcod), whole, south side of Long Island	99	....do	4	2	7.6	1131.6	39.06	59.88	1.06
Pickerel (Esox reticulatus), whole, Seneca Lake, New York	100	....do	3	2	2.5	960.6	53.14	45.44	1.42
Cusk (Brosmius brosme), entrails removed, Massachusetts coast	110	December, 1881	1	3	2.7	1436.5	58.40	40.28	1.32
Cisco (Coregonus sp. tullibee or artedi?), whole, Lake Erie	111	....do	4	2	12.4	1256.0	55.95	42.70	1.35
Hake (Phycis chuss), entrails removed, off Coney Island, New York	113	....do	1	14	6.5	6534.5	47.54	52.46	0.00
Grouper (Epinephelus morio), entrails removed, Pensacola, Florida	114	....do	1	3	7.0	1559.0	43.55	55.77	0.68
Mullet (Mugil albula), whole, Virginia	126	....do	1	1	8.9	707.5	40.99	57.88	1.13
Yellow perch (Perca fluviatilis), whole, Lake Champlain	127	....do	4	2	8.8	1152.0	36.56	62.64	0.80
Black fish (Hiatula onitis), whole	205	March, 1882	1	3	3.0	1446.5	33.95	64.08	1.97
Cod, "rock cod" (Gadus morrhua), whole, near Block Island	206	....do	1	4	2.3	1881.0	42.85	56.51	0.64
Smelt (Osmerus mordax), whole, Maine coast	207	....do	14	0	14.0	398.0	47.99	48.99	3.02
Yellow perch (Perca fluviatilis), head, entrails, fins, and tail removed, Connecticut River	208	....do	6	0	10.7	302.0	60.60	35.10	4.30
Halibut (Hippoglossus hippoglossus), sections of different parts of body, George's Banks	211	....do		8	2.7	3705.0	79.52	18.70	1.78
Shad (Clupea sapidissima), whole, Delaware River	212	....do	1	2	10.2	1196.0	53.77	44.39	1.84
Eel (salt water) (Anguilla rostrata), head, skin, and entrails removed, north coast of Long Island	217	April, 1882	6	0	15.4	436.0	76.14	19.04	4.82
Alewife (Clupea vernalis), whole, Connecticut River	220	....do	4	1	14.8	879.2	47.90	49.42	2.68
Shad (Clupea sapidissima), whole, Connecticut River	221	....do	1	3	3.5	1461.0	45.18	53.25	1.57
Pickerel (Esox reticulatus), whole, Connecticut River	224	....do	2	1	5.2	600.0	48.16	48.67	3.17
Striped bass (Roccus lineatus), whole, Long Island Sound	225	....do	1	2	7.9	1132.0	49.63	48.59	1.78
Cod (Gadus morrhua), head and entrails removed	228	....do	1	7	7.4	3387.0	72.90	25.54	1.56
Haddock (Gadus æglefinus), entrails removed	229	....do	1	3	4.2	1480.0	49.73	47.97	2.30
Mackerel (Scomber scombrus), entrails removed	230	....do	2	1	6.6	640.0	57.35	40.65	2.00
California salmon (Oncorhynchus chouicha), section of anterior part of body	233	....do		1	14.7	870.5	88.70	10.34	0.96
Pompano (Trachynotus carolinus), whole, Pensacola, Florida	234	....do	1	1	8.1	683.5	56.24	42.37	1.39
Lamprey eel (Petromyzon marinus?), whole, Hackensack River	236	....do	2	2	13.6	1295.0	50.40	45.79	3.81
Striped bass (Roccus lineatus), whole, North Carolina	237	....do	1	2	12.8	1270.0	41.37	57.08	1.55
Sturgeon (Acipenser sturio), section of anterior part of body, Delaware River	238	....do		1	10.6	753.0	84.72	14.41	0.87
Red snapper (Lutjanus blackfordi), entrails and gills removed, Pensacola, Florida	242	....do	1	4	1.2	1848.0	54.33	45.29	0.38
Cod (Gadus morrhua), whole, Long Island	243	....do	1	5	7.5	2481.0	49.78	48.53	1.69
Blackfish (Hiatula onitis), entrails removed, Massachusetts	244	....do	1	2	8.5	1147.0	40.80	57.81	1.39
Shad (Clupea sapidissima), whole, Hudson River	245	....do	1	3	7.7	1579.0	45.92	52.69	1.39
Skate (Raia sp.), left lobe of body	247	....do		4	11.9	2150.0	46.32	51.03	2.65
Striped bass (Roccus lineatus), whole, Long Island	248	....do	1	2	0.0	906.0	42.93	55.41	1.66
Shad (Clupea sapidissima), whole, North Carolina	249	....do	1	3	15.6	1801.0	39.75	58.75	1.50
Sheepshead (Diplodus probatocephalus), whole, North Carolina	250	....do	1	1	15.3	886.5	32.61	65.98	1.41
Sea bass (Centropristis atrarius), whole, Pensacola, Florida	251	....do	1	6	9.3	2985.0	43.84	56.09	0.07
Kingfish (Menticirrus nebulosus), whole, North Carolina	252	....do	1	1	8.2	685.5	42.16	56.60	1.24
Winter flounder (Pleuronectes americanus), whole, Rhode Island	253	....do	1	1	10.5	751.0	41.16	56.20	2.64
Brook trout (Salvelinus fontinalis), whole, cultivated, Long Island	254	....do	3	0	12.3	353.1	51.15	45.20	3.65
Lake trout "Mackinaw trout" (Salvelinus namaycush), entrails removed, Lake Ontario	255	....do	1	5	7.4	2477.0	63.58	35.21	1.21
Brook trout (Salvelinus fontinalis), whole, Montreal, Canada	256	....do	1	0	12.2	346.0	48.86	49.12	2.02
Pike perch or gray pike (Stizostedion canadense), whole, Cleveland, Ohio	257	....do	1	0	12.3	349.5	35.20	63.23	1.57
Small-mouthed red-horse (Moxostoma velatum), entrails removed, Cleveland, Ohio	258	....do	1	3	5.0	1500.0	46.20	52.47	1.33
Haddock (Gadus æglefinus), entrails removed, Long Island	259	....do	1	7	2.1	3235.0	46.09	52.89	1.02
Striped bass (Roccus lineatus), entrails removed, Long Island	260	....do	1	2	2.2	969.5	47.96	51.16	0.88
Mackerel (Scomber scombrus), whole, Virginia capes	261	....do	1	1	4.4	576.0	48.48	50.35	1.22

TABLE 1.—*List of specimens of American fishes analyzed, names, localities, and proportions of flesh, etc.*—Continued.

Kinds of fish, localities, and portion taken for analysis.	Laboratory No. of specimen.	When received.	Number of fish in specimen.	Proportion of flesh, etc., in specimen as taken for analysis. Total weight of specimen.					
							Flesh, edible portion.	Refuse, bones, skin, entrails, etc.	Loss in preparation for analysis.
				Lbs.	*Oz.*	*Grams.*	*Per ct.*	*Per ct.*	*Per ct.*
Porgy (Diplodus argyrops), whole, Gravesend Bay, Long Island	262	April, 1882	1	1	15.6	896.0	41.70	57.58	0.72
Pompano (Trachynotus carolinus), whole, Pensacola, Florida	263	....do	1	2	1.5	949.0	50.39	48.56	1.05
Blackfish (Hiatula onitis), entrails removed, Rhode Island	269	May, 1882	1	2	10.0	1189.0	45.30	53.57	1.13
Red bass (Sciæna ocellata), whole, North Carolina	270	....do	1	6	11.1	3033.0	36.47	63.53	0.00
Red grouper (Epinephelus morio), entrails removed, Pensacola, Florida	271	....do	1	11	12.5	5344.0	44.05	55.95	0.00
Weakfish (Cynoscion regale), whole, Long Island	273	....do	2	2	0.0	909.4	47.01	51.89	1.10
Salmon (Salmo salar), female, whole, Penobscot River, Maine	279	June, 1882	1	11	3.5	5107.0	64.27	35.73	0.00
Salmon (Salmo salar), male, whole, Penobscot River, Maine	280	....do	1	12	10.0	5826.0	60.45	39.55	0.00
ROE.									
Shad roe, from shad No. 245	246	April, 1882	..	0	9.0	257.0	100.00	....	....
SPENT FISH.									
Salmon (Salmo salar), male, whole, Penobscot River, Maine	35	November, 1880	2	18	11.3	8482.7	55.72	43.78	0.50
Salmon (Salmo salar), female, whole, Penobscot River, Maine	36	....do	2	22	8.0	10204.9	56.19	43.54	0.27
Land locked salmon (Salmo salar, subsp. sebago), male, whole, Grand Lake Stream, Maine	40	December, 1880	4	12	8.2	5686.3	50.74	48.41	0.85
Land-locked salmon (Salmo salar, subsp. sebago), female, whole, Grand Lake Stream, Maine	41	... do	4	7	15.6	3622.3	52.50	46.20	1.30
PRESERVED FISH.									
Boned cod (Gadus morrhua)	25	April, 1880	....	....	....	....	100.00	....	....
Smoked halibut (Hippoglossus hippoglossus)	28	....do	....	3	8.9	1616.0	91.34	8.04	0.62
Canned salmon (Oncorhynchus chouicha), California (Oregon)	29	...do		1	14.7	870.0	87.99	11.66	0.35
Smoked herring (Clupea harengus)	33	May, 1880	6	1	0.0	451.7	54.98	44.42	0.60
Salt cod (Gadus morrhua), "Channel fish," George's Banks	34	November, 1880	1	9	2.2	4145.7	74.02	25.47	0.51
Salt cod (Gadus morrhua), "Boat fish," vicinity of Nantucket, Mass	37	....do	1	6	3.1	2813.4	74.25	24.34	1.41
Salt mackerel (Scomber scombrus), No. 1 mackerel	42	February, 1881	3	1	11.5	781.4	72.28	22.91	4.81
"Alden's dried fresh cod" (Gadus sp.?), boned, dried, and ground	79	October, 1881	....	....	....	....	100.00	....	....
"Alden's dried salt cod" (Gadus sp.?), boned, dried, and ground	80	....do	....	....	....	....	100.00	....	....
Canned sardines (Clupea pilchardus?), Mediterranean Sea (?)*	87	November, 1881	....	0	10.9	309.2	94.15	5.04	0.81
"Findon haddie" (Smoked haddock), (Gadus æglefinus)	88	.. do	1	3	3.5	1460.0	65.07	33.22	1.71
Canned fresh mackerel (Scomber scombrus)	94	...do	....	1	0.5	468.5	100.00	....	....
Canned salt mackerel (Scomber scombrus), No. 2 mackerel	95	...do	2	1	0.2	460.0	82.17	16.96	0.87
Canned salmon (Oncorhynchus chouicha), Columbia River, Oregon	96	....do		1	0.7	474.0	100.00	....	....
Smoked halibut (Hippoglossus hippoglossus)	218	April, 1882	....	0	11.4	323.5	93.05	5.87	1.08
Canned salt mackerel (Scomber scombrus)	219	November, 1881	2	0	14.5	410.0	74.63	22.44	2.93
Canned tunny, "Horse mackerel" (Orcynus secundi-dorsalis?)	240	...do	....	0	12.8	361.5	100.00	....	....
Canned salmon (Oncorhynchus chouicha), Columbia River, Oregon	241	...do	....	1	0.6	470.0	100.00	....	....
Canned "findon haddie" (Smoked haddock), (Gadus æglefinus)	275	April, 1882	....	1	1.0	480.0	100.00	....	....

* This belongs more properly with European fishes, but is included here because it was analyzed with the American specimens.

TABLE 2.—*Composition of water-free substance of flesh of American fishes.*

Name of fish.	Laboratory No. of specimen.	Nitrogen.	Protein, N×6.25.	Fats, Ether extract.	Ash.	Protein+fats+ash.	Albuminoids, etc. (by difference).
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Sturgeon (Acipenser sturio)	238	13.63	85.19	8.90	6.72	100.81	84.38
Small-mouthed red-horse (Moxostoma velatum)	258	13.43	83.94	10.98	5.56	100.48	83.46
Herring (Clupea harengus)	47	9.87	61.69	35.55	4.83	102.07	59.62
Alewife (Clupea vernalis)	5	12.61	78.81	15.88	6.08	100.77	78.04
Do	220	11.67	72.94	22.28	5.48	100.70	72.24
Do (average of 2 specimens)		12.14	75.87	19.08	5.78	100.73	75.14
Shad (Clupea sapidissima)	6	9.83	61.44	35.67	4.26	101.37	60.07
Do	10	9.19	57.38	39.10	4.26	100.74	56.64
Do	32	9.90	61.88	34.50	4.58	100.96	60.92
Do	212	10.06	62.87	35.32	3.09	101.28	61.69
Do	221	11.48	71.75	23.24	5.46	100.45	71.30
Do	245	10.57	66.06	29.10	5.52	100.68	65.38
Do	240	11.06	69.13	26.58	5.16	100.87	68.26
Do (average of 7 specimens)		10.30	64.36	31.93	4.62	100.91	63.47
Smelt (Osmerus mordax)	23	13.32	83.25	9.76	10.08	103.09	80.16
Do	207	13.66	85.38	7.55	6.24	99.17	86.21
Do (average of 2 specimens)		13.49	84.31	8.65	8.16	101.13	83.19
Whitefish (Coregonus clupeiformis)	18	12.16	76.00	21.51	5.36	102.87	73.13
Cisco (Coregonus, sp. tullibee or artedi)	111	12.92	80.75	14.59	5.25	100.59	80.16
California salmon (Oncorhynchus chouicha)	27			51.50	2.98		45.43
Do	233	8.37	52.31	46.51	2.85	101.67	50.64
Do (average of 2 specimens)				49.05	2.92		48.03
Salmon (Salmo salar)	14	9.57	59.81	37.94	3.35	101.10	58.71
Do (female)	77	9.47	59.19	40.98	4.26	104.43	54.76
Do do	78	9.71	60.69	38.20	4.19	103.08	57.61
Do do	279	10.24	64.00	33.76	3.51	101.27	62.73
Do (male)	280	10.17	63.56	33.53	3.73	100.82	62.74
Do (average of 5 specimens)		9.83	61.45	36.88	3.81	102.14	59.31
Spent salmon (Salmo salar) (male)	35	12.39	77.44	17.66	4.51	99.61	77.83
Do (female)	36	12.93	80.81	12.98	5.36	99.15	81.66
Do (average of 2 specimens)		12.66	79.13	15.32	4.93	99.38	79.75
Spent land-locked salmon (Salmo salar, subsp. sebago) (male)	40	11.70	73.13	18.12	5.76	97.01	76.12
Do (female)	41	13.26	82.88	9.36	5.76	98.00	84.88
Do (average of 2 specimens)		12.48	78.00	13.74	5.76	97.50	80.50
Lake trout (Salvelinus namaycush)	17	9.04	56.50	40.14	4.33	100.97	55.53
Do	255	10.19	63.69	33.47	3.85	101.01	62.68
Do (average of 2 specimens)		9.62	60.10	36.80	4.09	100.99	59.11
Brook trout (Salvelinus fontinalis)	24	13.25	82.81	11.61	6.33	100.75	82.06
Do	254	14.92	93.25	3.72	4.75	101.72	91.53
Do	256	13.41	83.81	12.14	5.08	101.03	82.78
Do (average of 3 specimens)		13.86	86.62	9.16	5.39	101.17	85.46
Pickerel (Esox reticulatus)	100	14.63	91.43	2.58	6.14	100.15	91.28
Do	224	14.86	92.88	2.38	5.46	100.72	92.16
Do (average of 2 specimens)		14.74	92.15	2.48	5.80	100.43	91.72
Pike (Esox lucius)	98	14.78	92.38	2.87	5.07	100.32	92.06
Muskellunge (Esox nobilior)	45	13.58	84.87	10.70	6.63	102.20	82.67
Eel, salt-water (Anguilla rostrata)	4	10.20	63.75	34.23	3.04	101.02	62.73
Do	217	10.68	66.75	29.62	4.16	100.53	66.22
Do (average of 2 specimens)		10.44	65.25	31.92	3.60	100.77	64.48
Mullet (Mugil albula)	126	12.40	77.50	18.45	4.66	100.61	76.89
Mackerel (Scomber scombrus)	8	13.72	85.75	10.31	4.67	100.73	85.02
Do	13	10.89	68.06	27.26	4.83	100.15	67.91
Do	30	11.25	70.31	27.04	5.02	102.37	67.94
Do	39	8.48	53.00	45.28	4.11	102.39	50.61
Do	230	11.85	74.06	22.28	4.60	100.94	73.12
Do	261	12.66	79.10	17.13	5.23	101.46	77.64
Do (average of 6 specimens)		11.47	71.71	24.88	4.75	101.34	70.38
Spanish mackerel (Cybium maculatum)	43	10.76	67.25	29.56	4.71	101.52	65.73
Pompano (Trachynotus carolinus)	234	9.00	56.25	41.40	2.95	100.60	55.65
Do	263	14.16	88.50	7.51	4.69	100.70	87.80
Do (average of 2 specimens)		11.58	72.37	24.46	3.82	100.65	71.72
Bluefish (Pomatomus saltatrix)	12	14.42	90.13	5.79	5.91	101.83	88.30
Butter-fish (Stromateus triacanthus)	90	9.60	60.00	36.80	3.82	100.62	59.38
Large-mouthed black bass (Micropterus salmoides)	53	14.54	90.88	4.47	5.57	100.92	89.96
Small-mouthed black bass (Micropterus dolomieu)	91	13.79	86.19	9.69	4.93	100.81	85.38
Yellow perch (Perca fluviatilis)	127	14.54	90.88	2.81	5.86	99.55	91.33
Do	208	14.37	89.81	5.11	6.12	101.04	88.77
Do (average of 2 specimens)		14.46	90.34	2.96	5.99	100.29	90.05
Pike perch, Wall-eyed pike (Stizostedion vitreum)	52	14.67	91.69	2.31	6.75	100.75	90.94
Pike perch, Gray pike (Stizostedion canadense)	257	14.94	93.38	3.95	5.90	103.23	90.15

TABLE 2.—*Composition of water-free substance of flesh of American fishes*—Continued.

Name of fish.	Laboratory No. of specimen.	Nitrogen.	Protein, N × 6.25.	Fats. Ether extract.	Ash.	Protein + fats + ash.	Albuminoids, etc. (by difference.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Striped bass (Roccus lineatus)	7	14.25	89.05	7.47	5.51	102.03	87.02
Do	19	13.40	83.78	10.49	6.69	100.96	82.82
Do	225	13.36	83.50	12.35	4.92	100.77	82.73
Do	237	12.90	80.63	15.02	5.23	100.88	79.75
Do	248	13.72	85.75	9.93	5.05	100.73	85.02
Do	260	12.32	77.00	19.75	3.92	100.67	76.33
Do (average of 6 specimens)	......	13.32	83.28	12.50	5.22	101.00	82.28
White perch (Roccus americanus)	44	11.79	73.69	23.07	4.56	101.32	72.37
Do	46	13.59	84.94	10.42	5.27	100.63	84.31
Do (average of 2 specimens)	......	12.69	79.31	16.74	4.92	100.97	78.34
Sea bass (Centropristis atrarius)	251	15.34	95.88	2.36	6.80	105.04	90.84
Grouper (Epinephelus morio)	114	14.88	93.00	2.39	5.79	101.18	91.82
Do	271	15.06	94.13	3.39	5.42	102.94	91.19
Do (average of 2 specimens)	......	14.97	93.57	2.89	5.60	102.06	91.51
Red snapper (Lutjanus blackfordi)	20	14.82	92.63	2.85	5.82	101.30	91.33
Do	26	13.96	87.25	8.58	5.86	101.69	85.50
Do	242	15.26	95.38	2.67	6.48	104.53	90.85
Do (average of 3 specimens)	......	14.68	91.75	4.70	6.05	102.50	89.25
Porgy (Diplodus argyrops)	15	13.74	85.88	7.18	6.88	99.94	85.94
Do	31	10.77	67.31	28.04	4.81	100.16	67.15
Do	262	11.65	72.81	22.54	5.22	100.57	72.24
Do (average of 3 specimens)	......	12.05	75.33	19.25	5.64	100.22	75.11
Sheepshead (Diplodus probatocephalus)	48	11.90	74.38	24.02	3.93	102.33	72.05
Do	250	14.81	92.56	3.16	6.36	102.08	90.48
Do (average of 2 specimens)	......	13.36	83.47	13.59	5.14	102.20	81.27
Red bass (Sciæna ocellata)	270	14.65	91.56	2.89	6.67	101.12	90.44
Kingfish (Menticirrus nebulosus)	252	14.57	91.08	4.53	5.68	101.29	89.79
Weakfish (Cynoscion regale)	273	13.54	84.63	11.37	5.64	101.64	82.99
Blackfish (Hiatula onitis)	38	13.42	83.88	12.20	5.54	101.62	82.26
Do	205	15.12	94.52	2.95	3.48	100.95	93.57
Do	244	14.86	92.88	3.05	5.05	100.98	91.90
Do	269	14.07	87.94	6.60	6.30	100.93	87.01
Do (average of 4 specimens)	......	14.37	89.81	6.22	5.09	101.12	88.69
Hake (Phycis chuss)	113	14.56	91.00	3.97	5.77	100.74	90.26
Cusk (Brosmius brosme)	110	15.10	94.38	0.94	4.98	100.30	94.08
Haddock (Gadus æglefinus)	16	15.08	94.25	0.85	5.82	100.92	93.33
Do	21	14.77	92.31	0.78	8.72	101.81	90.50
Do	229	14.97	93.56	1.82	6.78	102.16	91.40
Do	259	15.27	95.44	1.93	5.71	103.08	92.36
Do (average of 4 specimens)	......	15.02	93.89	1.34	6.76	101.99	91.90
Cod (Gadus morrhua)	3	15.00	93.75	1.66	7.62	103.03	90.72
Do	11	15.50	96.88	2.30	7.60	106.87	90.01
Do	206	15.20	95.00	1.54	7.22	103.76	91.24
Do	228	15.30	95.63	1.89	6.03	103.55	92.08
Do	243	15.10	94.38	2.80	6.95	104.22	90.16
Do (average of 5 specimens)	......	15.22	95.13	2.07	7.08	104.28	90.84
Tomcod (Gadus tomcod)	99	14.95	93.44	2.08	5.32	100.84	92.60
Pollock (Gadus virens)	81	14.41	90.06	3.23	6.45	99.74	90.32
Halibut (Hippoglossus hippoglossus)	1	13.46	84.06	10.59	5.53	100.18	83.88
Do	9	9.93	62.06	35.41	3.83	101.80	60.76
Do	211	13.67	85.43	11.95	3.81	101.19	84.24
Do (average of 3 specimens)	......	12.35	77.18	19.32	4.39	100.89	76.29
Turbot (Platysomatichthys hippoglossoides)	49	8.25	51.56	50.36	4.47	106.39	45.17
Common flounder (Paralichthys dentatus)	2	14.35	89.69	3.73	7.67	101.09	88.60
Do	22	14.14	88.38	5.18	8.63	102.19	86.19
Do (average of 2 specimens)	......	14.24	89.03	4.46	8.15	101.64	87.39
Winter flounder (Pleuronectes americanus)	253	14.86	92.88	2.85	7.08	103.41	89.47
Lamprey eel (Petromyzon marinus)	236	8.30	51.88	46.03	2.27	100.18	51.70
Skate (Raia)	247	16.29	101.82	7.81	6.38	116.01	85.81

TABLE 3.—*Composition of flesh of American fishes.*

Kind of fish.	Laboratory No. of specimen.	Water.	Water-free substance.	Albuminoids, etc. (by difference).	Fats, Ether extract.	Ash.	Nitrogen.	Protein, N × 6.25	Water + protein + fats + ash.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Sturgeon (Acipenser sturio)	238	78.71	21.29	17.96	1.90	1.43	2.90	18.11	100.15
Small-mouthed red-horse (Moxostoma velatum)	258	78.56	21.44	17.90	2.35	1.19	2.88	17.99	100.09
Herring (Clupea harengus)	47	69.03	30.97	18.46	11.01	1.50	3.06	19.12	100.06
Alewife (Clupea vernalis)	5	75.92	24.08	18.80	3.82	1.46	3.04	19.00	100.20
Do	220	72.96	27.04	19.54	6.02	1.48	3.16	19.72	100.18
Do ..... (average of 2 specimens)	....	74.44	25.56	19.17	4.92	1.47	3.10	19.36	100.19
Shad (Clupea sapidissima)	6	69.65	30.35	18.25	10.80	1.30	2.98	18.64	100.39
Do	10	65.25	34.75	19.68	13.59	1.48	3.18	19.89	100.21
Do	32	70.75	29.25	17.83	10.08	1.34	2.89	18.08	100.25
Do	212	71.04	28.96	17.83	10.23	.90	2.92	18.19	100.36
Do	221	71.98	28.02	19.98	6.51	1.53	3.21	20.10	100.12
Do	245	72.14	27.86	18.24	8.08	1.54	2.95	18.40	100.16
Do	249	73.56	26.44	18.05	7.03	1.36	2.92	18.27	100.22
Do ...... (average of 7 specimens)	....	70.62	29.38	18.56	9.47	1.35	3.01	18.83	100.27
Smelt (Osmerus mordax)	23	80.16	19.84	15.90	1.94	2.00	2.64	16.52	100.62
Do	207	78.16	21.84	18.83	1.65	1.36	2.98	18.65	99.82
Do ..... (average of 2 specimens)	....	79.16	20.84	17.37	1.79	1.68	2.81	17.59	100.22
Whitefish (Coregonus clupeiformis)	18	69.83	30.17	22.06	6.49	1.62	3.67	22.93	100.87
Cisco (Coregonus, sp. tullibee or artedi?)	111	76.15	23.85	19.12	3.48	1.25	3.08	19.26	100.14
California salmon (Oncorhynchus chouicha)	27	62.68	37.32	16.96	19.25	1.11	3.26	......	......
Do	233	64.53	35.47	17.96	16.50	1.01	2.97	18.56	100.60
Do ..... (average of 2 specimens)	....	63.61	36.39	17.46	17.87	1.06	3.12	......	......
Salmon (Salmo salar)	14	67.15	32.85	19.17	12.47	1.21	3.15	19.63	100.46
Do ..... (female)	77	63.41	36.59	20.04	14.99	1.56	3.46	21.66	101.62
Do ..... do	78	65.08	34.92	20.12	13.34	1.46	3.39	21.19	101.07
Do ..... do	279	61.37	38.63	24.23	13.04	1.36	3.95	24.72	100.49
Do ..... (male)	280	61.03	38.97	24.45	13.07	1.45	3.96	24.77	100.32
Do ...... (average of 5 specimens)	....	63.61	36.39	21.60	13.38	1.41	3.59	22.39	100.79
Spent salmon (Salmo salar) .... (male)	35	75.27	24.73	19.24	4.37	1.12	3.06	19.15	99.91
Do ...... (female)	36	78.20	21.80	17.80	2.83	1.17	2.82	17.62	99.82
Do .... (average of 2 specimens)	...	76.74	23.26	18.52	3.60	1.14	2.94	18.39	99.87
Spent land-locked salmon (Salmo salar, subsp. sebago) ...... (male)	40	77.88	22.12	16.84	4.01	1.27	2.59	16.18	99.34
Do ...... (female)	41	79.20	20.80	17.65	1.95	1.20	2.76	17.24	99.59
Do .... (average of 2 specimens)	...	78.54	21.46	17.24	2.98	1.24	2.68	16.71	99.47
Lake trout (Salvelinus namaycush)	17	68.78	31.22	17.32	12.55	1.35	2.82	17.62	100.30
Do	255	69.50	30.50	19.12	10.21	1.17	3.11	19.42	100.30
Do ...... (average of 2 specimens)	....	69.14	30.86	18.22	11.38	1.26	2.97	18.52	100.30
Brook trout (Salvelinus fontinalis)	24	77.54	22.46	18.45	2.61	1.42	2.98	18.60	100.17
Do	254	79.84	20.16	18.45	0.75	0.96	3.01	18.80	100.35
Do	256	75.78	24.22	20.03	2.94	1.25	3.25	20.30	100.27
Do ...... (average of 3 specimens)	....	77.72	22.28	18.97	2.10	1.21	3.08	19.23	100.26
Pike (Esox lucius)	98	79.79	20.21	18.60	0.58	1.03	2.99	18.67	100.07
Pickerel (Esox reticulatus)	100	79.84	20.16	18.46	0.52	1.24	2.96	18.43	100.03
Do	224	79.52	20.48	18.88	0.49	1.11	3.04	19.02	100.14
Do ...... (average of 2 specimens)	....	79.68	20.32	18.64	0.50	1.18	3.00	18.73	100.09
Muskellunge (Esox nobilior)	45	76.26	23.74	19.63	2.54	1.57	3.22	20.15	100.52
Eel, salt-water (Anguilla rostrata)	4	69.80	30.20	18.95	10.34	0.91	3.08	19.25	100.30
Do	217	73.40	26.60	17.61	7.88	1.11	2.84	17.75	100.14
Do .... (average of 2 specimens)	....	71.60	28.40	18.28	9.11	1.01	2.96	18.50	100.22
Mullet (Mugil albula)	126	74.87	25.13	19.32	4.64	1.17	3.12	19.48	100.16
Mackerel (Scomber scombrus)	8	78.67	21.33	18.13	2.20	1.00	2.92	18.29	100.16
Do	13	74.26	25.74	17.48	7.02	1.24	2.80	17.51	100.03
Do	30	74.14	25.86	17.57	6.99	1.30	2.91	18.18	100.61
Do	39	64.01	35.99	18.21	16.30	1.48	3.05	19.08	100.87
Do	230	73.68	26.32	19.25	5.86	1.21	3.12	19.50	100.25
Do	261	75.44	24.56	19.07	4.21	1.28	3.11	19.43	100.36
Do .... (average of 6 specimens)	....	73.37	26.63	18.26	7.09	1.28	2.90	18.66	100.38
Spanish mackerel (Cybium maculatum)	43	68.10	31.90	20.97	9.43	1.50	3.43	21.45	100.48
Pompano (Trachynotus carolinus)	234	67.38	32.62	18.15	13.51	0.96	2.94	18.35	100.20
Do	263	78.18	21.82	19.15	1.64	1.03	3.09	19.30	100.15
Do ...... (average of 2 specimens)	....	72.78	27.22	18.65	7.57	1.00	3.02	18.83	100.18
Bluefish (Pomatomus saltatrix)	12	78.46	21.54	19.02	1.26	1.27	3.11	19.41	100.39
Butter-fish (Stromateus triacanthus)	90	70.02	29.98	17.81	11.03	1.14	2.88	17.99	100.18
Large-mouthed black bass (Micropterus salmoides)	53	78.61	21.39	19.24	0.96	1.19	3.11	19.44	100.20
Small-mouthed black bass (Micropterus dolomieu)	91	74.82	25.18	21.50	2.44	1.24	3.47	21.71	100.21
Yellow perch (Perca fluviatilis)	127	80.43	19.57	17.88	0.55	1.14	2.85	17.79	99.91
Do	208	78.07	21.93	19.47	1.12	1.34	3.15	19.69	100.22
Do .... (average of 2 specimens)	....	79.25	20.75	18.68	0.83	1.24	3.00	18.74	100.06

TABLE 3.—*Composition of flesh of American fishes*—Continued.

Kind of fish.	Laboratory No. of specimen.	Water.	Water-free substance.	Albuminoids, etc. (by difference).	Fats. Ether extract.	Ash.	Nitrogen.	Protein, N × 6.25	Water + protein + fats + ash.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Wall-eyed pike (Stizostedion vitreum)	52	79.74	20.26	18.42	0.47	1.37	2.97	18.58	100.16
Gray pike (Stizostedion canadense)	257	80.85	19.15	17.26	0.76	1.13	2.86	17.88	100.62
Striped bass (Roccus lineatus)	7	79.02	20.98	18.26	1.56	1.16	2.99	18.69	100.43
Do	19	79.63	20.37	16.87	2.14	1.36	2.73	17.06	100.19
Do	225	77.27	22.73	18.81	2.81	1.11	3.04	18.97	100.10
Do	237	75.76	24.24	19.33	3.64	1.27	3.13	19.54	100.21
Do	248	77.87	22.13	18.81	2.20	1.12	3.04	18.97	100.16
Do	260	76.65	23.35	17.82	4.61	0.92	2.88	17.98	100.16
Do (average of 6 specimens)	....	77.70	22.30	18.31	2.83	1.16	2.97	18.54	100.22
White perch (*Roccus americanus*)	44	75.64	24.36	17.63	5.62	1.11	2.87	17.95	100.32
Do	46	75.77	24.23	20.43	2.52	1.28	3.29	20.58	100.15
Do (average of 2 specimens)	....	75.71	24.29	19.03	4.07	1.19	3.08	19.27	100.24
Sea bass (Centropristis atrarius)	251	79.32	20.68	18.75	0.49	1.44	3.17	19.84	101.09
Grouper (Epinephelus morio)	114	79.95	20.05	18.41	0.48	1.16	2.98	18.63	100.22
Do	271	78.96	21.04	19.15	0.75	1.14	3.17	19.81	100.66
Do (average of 2 specimens)	....	79.45	20.55	18 80	0.60	1.15	3.04	19.25	100.40
Red snapper (Lutjanus blackfordi)	20	78.22	21.78	19.89	0.62	1.27	3.23	20.17	100.28
Do	26	77.34	22.66	19.39	1.94	1.33	3.16	19.75	100.36
Do	242	79.81	20.19	18.31	0.54	1.34	3.08	19.26	100 95
Do (average of 3 specimens)	....	78.46	21.54	19.20	1.03	1.31	3.16	19.73	100.53
Porgy (Diplodus argyrops)	15	79.68	20.32	17.46	1.46	1.40	2.79	17.44	99.98
Do	31	71.98	28.02	18.81	7.86	1.35	3.02	18.80	100.05
Do	262	73.31	26.69	19.29	6.01	1.39	3.11	19.43	100.14
Do (average of 3 specimens)	....	74.99	25.01	18.52	5.11	1.38	2.97	18.58	100.06
Sheepshead (Diplodus probatocephalus)	48	72.01	27.99	20.17	6.72	1.10	3.33	20.82	100.65
Do	250	79.08	20.92	18.93	0.66	1.33	3.10	19.38	100.43
Do (average of 2 specimens)	....	75.55	24.45	19.54	3.60	1.22	3.22	20.08	100.54
Red bass (*Sciæna ocellata*)	270	81.56	18.44	16.68	0.53	1.23	2.70	16.88	100.20
Kingfish (Menticirrus nebulosus)	252	79.21	20.79	18.66	0.95	1.18	3.03	18.94	100.28
Weakfish (Cynoscion regale)	273	78.97	21.03	17.45	2.39	1.19	2.85	17.80	100.35
Blackfish (Hiatula onitis)	38	76.95	23.05	18.96	2.81	1.28	3.09	19.33	100.37
Do	205	81.36	18.64	17.44	0.55	0.65	2.82	17.61	100.17
Do	244	79.64	20.36	18.71	0.62	1.03	3.03	18.91	100.20
Do	269	78.44	21.56	18.76	1.44	1.36	3.03	18.96	100.20
Do (average of 4 specimens)	....	79.10	20.90	18.47	1.35	1.08	2.99	18.71	100.24
Hake (Phycis chuss)	113	83.11	16.89	15.24	0.67	0.98	2.46	15.37	100.13
Cusk (*Brosmius brosme*)	110	82.01	17.99	16.92	0.17	0.90	2.72	17.00	100.08
Haddock (Gadus æglefinus)	16	80.30	19.70	18.38	0.17	1.15	2.97	18.58	100.20
Do	21	82.03	17.97	16.26	0.14	1.57	2.65	16.55	100.29
Do	229	82.56	17.44	15.94	0.32	1.18	2.61	16.32	100.38
Do	259	81.87	18.13	16.75	0.35	1.03	2.77	17.31	100.56
Do (average of 5 specimens)	....	81.69	18.31	16.83	0.25	1.23	2.75	17.19	100.36
Cod (Gadus morrhua)	3	83.48	16.52	14.97	0.28	1.27	2.48	15.49	100.52
Do	11	83.39	16.61	14.95	0.40	1.26	2.58	16.09	101.14
Do	206	80.71	19.29	17.59	0.30	1.40	2.93	18.32	100.73
Do	228	83.43	16.57	15.26	0.31	1.00	2.54	15.84	100.58
Do	243	82.20	17.80	16.08	0.51	1.21	2.69	16.80	100.72
Do (average of 5 specimens)	....	82.64	17.36	15.77	0.36	1.23	2.54	16.51	100.74
Tomcod (Gadus tomcod)	99	81.55	18.45	17.08	0.38	0.99	2.76	17.24	100.16
Pollock (Gadus virens)	81	76.02	23.98	21.65	0.78	1.55	3.46	21.60	99.95
Halibut (Hippoglossus hippoglossus)	1	79.15	20.85	17.49	2.21	1.15	2.80	17.53	100.04
Do	9	70.13	29.87	18.16	10.57	1.14	2.97	18.54	100.38
Do	211	76.97	23.03	19.40	2.75	0.88	3.15	19.68	100.28
Do (average of 3 specimens)	....	75.42	24.58	18.35	5.17	1.06	2.97	18.58	100.23
Turbot (Platysomatichthys hippoglossoides)	49	71.39	28.61	12.92	14.41	1.28	2.36	14.75	101.83
Common flounder (Paralichthys dentatus)	2	83.37	16.63	14.73	0.62	1.28	2.39	14.91	100.18
Do	22	85.04	14.96	12.90	0.77	1.29	2.12	13.22	100.32
Do (average of 2 specimens)	....	84.21	15.79	13.82	0.69	1.28	2.26	14.07	100.25
Winter flounder (Pleuronectes americanus)	253	84.35	15.65	14.01	0.44	1.20	2.33	14.53	100.52
Lamprey eel (*Petromyzon marinus*) ?	236	71.12	28.88	14.93	13.29	0.66	2.40	14.98	100.05
Skate (Raia sp. ?)	247	82.15	17.85	15.22	1.39	1.14	2.91	18.17	102.85

TABLE 4.—*Composition of water-free substance of flesh of American specimens of preserved fish.*

Kind of fish.	Laboratory No. of specimen.	Nitrogen.	Protein, N. × 6.25.	Fats. Ether extract.	Crude ash (including salt).	Protein (N × 6.25) + fats + ash.	Albuminoids, etc. (by difference).
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
DRIED.							
Desiccated cod, "evaporated fish" (Gadus morrhua)	79	14.72	92.00	2.24	9.78	101.02	87.98
SALTED.							
Mackerel (Scomber scombrus)	42	5.85	36.56	39.08	22.76	98.40	38.16
SALTED AND DRIED.							
Cod (Gadus morrhua)	34	8.58	53.63	0.53	53.82	107.98	45.65
Do	37	8.91	55.69	0.94	52.43	109.06	46.63
Cod, boned (Gadus morrhua)	25	9.20	57.50	0.71	50.72	108.93	48.57
Desiccated cod, boned and ground (Gadus morrhua)	80	13.04	81.50	5.54	13.40	100.44	81.06
SALTED, SMOKED, AND DRIED.							
Haddock (Gadus æglefinus)	88	13.58	84.88	0.62	13.10	98.60	86.28
Halibut (Hippoglossus hoppoglossus)	28	6.04	37.75	31.90	31.01	100.66	37.09
Do	218	7.04	44.00	27.61	28.42	100.03	43.97
Herring (Clupea harengus)	33	9.03	56.44	24.18	20.15	100.77	55.67
CANNED.							
Mackerel (Scomber scombrus)	94	9.87	61.68	27.28	10.17	99.13	62.55
Salmon (Oncorhynchus chouicha)	29	9.87	61.69	32.40	5.24	99.33	62.36
Do	96	8.48	53.00	38.55	9.34	100.89	52.11
Do	241	7.34	45.88	50.62	4.15	100.65	45.23
Sardines (Clupea pilchardus)*	87	9.12	57.00	29.14	12.85	98.99	58.01
Tunny, "horse mackerel" (Orcynus secundi-dorsalis)	240	12.72	79.50	14.84	6.19	100.53	78.97
Salt mackerel (Scomber scombrus)	95	4.68	29.25	49.22	21.09	99.56	29.69
Do	219	5.08	31.75	44.05	24.53	100.33	31.42
Smoked haddock (Gadus æglefinus)	275	11.40	71.25	7.18	23.14	101.57	69.68

* This specimen was said to be from France, and properly belongs with the European specimens beyond, but was analyzed and is inserted with the American specimens.

TABLE 5.—*Composition of flesh of American specimens of preserved fish.*

Kind of fish.	Laboratory No. of specimen.	Water.	Water-free substance.	Albuminoids, etc. (by difference).	Fats. Ether extract.	Ash.†	Salt.†	Nitrogen.	Protein N × 6.25.	Water+protein (N × 6.25)+fats+ash+salt.
DRIED.		*Per ct*	*Per ct.*	*Per ct.*	*Per ct.*	*P. ct.*	*Per ct.*	*P. ct.*	*Per ct.*	*P. ct.*
Desiccated cod, "evaporated fish" (Gadus morrhua)	79	15.25	81.87	74.56	1.90	5.41	2.88	12.48	77.97	103.41
SALTED.										
Mackerel (Scomber scombrus)	42	42.19	47.21	22.06	22.59	2.56	10.60	3.38	21.14	99.08
SALTED AND DRIED.										
Cod (Gadus morrhua.)	34	53.62	23.01	21.17	0.25	1.59	23.37	3.98	24.87	103.70
Do	37	53.54	23.75	21.67	0.44	1.64	22.71	4.14	25.86	104.19
Do. (average of 2 specimens)	....	53.58	23.38	21.42	0.34	1.62	23.04	4.06	25.37	103.95
Cod, boned, "boneless codfish" (Gadus morrhua)	25	54.35	24.17	22.18	0.32	1.67	21.48	4.20	26.25	104.07
Desiccated cod, boned and ground (Gadus morrhua)	80	11.65	81.75	71.62	4.89	5.24	6.60	11.52	72.02	100.40
SALTED, SMOKED, AND DRIED.										
Haddock (Gadus æglefinus)	88	72.56	25.38	23.68	0.17	1.53	2.06	3.73	23.29	99.61
Halibut (H. hippoglossus)	28	51.06	35.89	18.15	15.61	2.13	13.05	2.90	18.49	100.34
Do	218	47.70	39.43	23.00	14.44	1.99	12.87	3.68	23.01	100.01
Do. (average of 2 specimens)	...	49.38	37.66	20.57	15.03	2.06	12.96	3.32	20.75	100.18
Herring (Clupea harengus)	33	34.55	53.79	36.44	15.82	1.53	11.66	5.91	36.94	100.50
CANNED.										
Mackerel (Scomber scombrus)	94	68.18	20.89	19.91	8.68	1.30	1.93	3.14	19.63	99.72
Salmon (Oncorhynchus chouicha)	29	65.86	33.61	21.29	11.06	1.26	0.53	3.37	21.06	99.77
Do	96	62.23	35.58	19.69	14.55	1.34	2.19	3.20	20.02	100.33
Do	241	57.55	42.04	19.20	21.49	1.35	0.41	3.12	19.47	100.27
Do (average of 3 specimens)	...	61.88	37.08	20.06	15.70	1.32	1.04	3.23	20.18	100.12
Sardines (Clupea pilchardus)*	87	56.37	43.63	25.31	12.71	5.61	....	3.98	24.87	99.56
Tunny, "horse mackerel" (Orcynus secundi-dorsalis)	240	72.74	27.26	21.52	4.05	1.69	....	3.47	21.67	100.15
Salt mackerel (Scomber scombrus)	95	43.23	47.33	16.86	27.94	2.53	9.44	2.66	16.60	99.74
Do	219	43.62	45.22	17.71	24.84	2.67	11.16	2.80	17.90	100.19
Do. (average of 2 specimens)	....	43.43	46.27	17.28	26.39	2.60	10.30	2.76	17.35	99.97
Smoked haddock (Gadus æglefinus)	275	68.73	25.08	21.78	2.25	1.65	5.59	3.58	22.29	100.51

* French, but analyzed with American specimens.

† Computed by assuming the ash to bear the same ratio to albuminoids, etc. Fat as in the fresh fish, the excess of mineral matter being taken as salt.

TABLE 6.—*Composition of water-free substance of flesh of specimens of American fishes. Proximate ingredients as directly determined.*

Kind of fish.	Laboratory No. of specimen.	Extractive matters. Cold-water extract, not coagulated.	Albumen, coagulated from cold-water extract.	Gelatin. Hot-water extract.	Insoluble protein.	Fats. Ether extract.	Ash.	Total.
FRESH FISH.		*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Black bass (Micropterus salmoides)	53	10.49*	9.54	14.48*	......	4.47	5.57	......
Blackfish (Hiatula onitis)	38	7.46*	11.32	15.79*	51.00*	12.20	5.54	103.31
Common flounder (Paralichthys dentatus)	22	12.77†	6.51	24.07†	......	5.18	8.63	......
Haddock (Gadus æglefinus)	21	6.18†	7.89	16.36†	65.06	0.78	8.72	104.99
Herring (Clupea harengus)	47	4.51*	5.23	9.46*	......	35.55	4.83	......
Muskellunge (Esox nobilior,	45	9.55*	6.95	10.20*	56.71*	10.70	6.63	100.74
Mackerel (Scomber scombrus)	30	8.61*	7.27	5.74*	47.37†	27.04	5.02	101.05
Spanish mackerel (Cybium maculatum)	43	6.06*	3.92	9.22*	......	29.56	4.71	......
White perch (Roccus americanus)	44	6.76*	7.35	13.39*	......	23.07	4.56	......
Do	46	8.88*	9.78	11.04*	51.47*	10.42	5.27	96.86
Do (average of 2 specimens)	....	7.82*	8.57	12.22*	......	16.75	4.92	......
Pike perch (Stizostedion vitreum)	52	13.14*	5.87	16.98*	52.15*	2.31	6.75	97.20
Porgy (Diplodus argyrops)	31	6.35*	10.64	7.41*	44.40†	28.04	4.81	101.65
Red snapper (Lutjanus blackfordi)	20	8.38†	7.30	16.83†	60.84	2.85	5.82	102.02
Do	26	8.16†	8.12	12.75†	56.09	8.58	5.86	99.56
Do (average of 2 specimens)	....	8.27†	7.71	14.79†	58.46	5.72	5.84	100.79
California salmon (Oncorhynchus chouicha)	27	4.85†	4.21	4.74†	32.02	51.59	2.98	100.39
Shad (Clupea sapidissima)	32	6.68*	6.57	6.63*	43.60†	34.50	4.58	102.56
Sheepshead (Diplodus probatocephalus)	48	5.11*	7.11	11.98*	......	24.02	3.93	......
Smelt (Osmerus mordax)	23	10.23†	3.02	25.07†	37.50	9.76	10.08	101.66
Brook trout (Salvelinus fontinalis)	24	11.44†	8.01	9.88†	55.74	11.61	6.33	103.01
Turbot (Platysomatichthys hippoglosoides)	49	7.04*	0.42	12.89*	28.14*	50.36	4.47	103.32
SPENT FISH.								
Salmon (Salmo salar) (male)	35	9.18*	4.69	9.66*	53.09*	17.66	4.51	98.79
Do (female)	36	6.27*	4.59	13.92*	......	12.98	5.36	......
Do (average of 2 specimens)	....	7.73*	4.64	11.79	......	15.32	4.94	......
Land-locked salmon (Salmo salar, subsp. sebago) (male)	40	9.18†	2.94	8.88*	......	18.12	5.76	......
Land-locked salmon (Salmo salar, subsp. sebago) (female)	41	10.56†	5.14	10.58*	......	9.36	5.76	......
Do (average of 2 specimens)	....	9.87†	4.04	9.73*	......	13.74	5.76	......
PRESERVED FISH.								
Salt mackerel (Scomber scombrus)	42	6.17*	0.50	2.91*	26.81*	30.08	22.76	98.23
Salt cod (Gadus morrhua)	34	3.26*	1.07	10.38*	32.67*	0.53	53.82	101.73
Do	37	2.50*	2.07	7.28*	36.92*	0.94	52.43	102.14
Do (average of 2 specimens)	....	2.88	1.57	8.83	34.80	0.73	53.12	101.94
Boned cod (Gadus morrhua)	25	7.01†	1.84	6.02†	32.81	0.71	50.72	99.71
Smoked halibut (Hippoglossus hippoglossus)	28	5.60†	1.51	3.23*	26.57†	31.90	31.01	†99.82
Smoked herring (Clupea harengus)	33	13.04*	0.48	7.84*	33.14†	24.18	20.15	†98.83
Canned salmon (Oncorhynchus chouicha)	29	14.21†	......	5.27†	42.44†	32.40	5.24	†99.56

* Ash and fat free. † Ash-free.

TABLE 7.—*Composition of flesh of specimens of American fishes. Proximate ingredients as directly determined.*

Kind of fish.	Laboratory No. of specimen.	Water.	Extractive matters. Cold water extract. not coagulated.	Albumen, coagulated from cold-water extract.	Gelatin. Hot-water extract.	Insoluble protein.	Fats. Ether extract.	Ash.	Total.
FRESH FISH.									
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Black bass (Micropterus salmoides)	53	78.61	2.24*	2.04	3.10*	......	0.96	1.19	......
Blackfish (Hiatula onitis)	38	76.95	1.72*	2.61	3.64*	11.76*	2.81	1.28	100.77
Common flounder (Paralichthys dentatus)	22	85.04	1.91†	0.98	3.60†	......	0.77	1.29	......
Haddock (Gadus æglefinus)	21	82.03	1.11†	1.42	2.94†	11.70	0.14	1.57	100.91
Herring (Clupea harengus)	47	69.03	1.40*	1.62	2.93*	......	11.01	1.50	......
Muskellunge (Esox nobilior)	45	76.26	2.27*	1.65	2.40*	13.46*	2.54	1.57	100.15
Mackerel (Scomber scombrus)	30	74.14	2.22*	1.88	1.48*	12.25†	6.09	1.30	100.26
Spanish mackerel (Cybium maculatum)	43	68.10	2.22*	1.25	2.94*	......	9.43	1.50	......
White perch (Roccus americanus)	44	75.64	1.65*	1.79	3.27*	......	5.62	1.11	......
Do	46	75.77	2.22*	2.37	2.68*	12.47*	2.52	1.28	99.31
Do (average of 2 specimens)	....	75.71	1.94*	2.08	2.98*	......	4.07	1.20	......
Pike perch (Stizostedion vitreum)	52	79.74	2.66*	1.19	3.44*	10.57*	0.47	1.37	99.44
Porgy (Diplodus argyrops)	31	71.98	1.78*	2.98	2.07*	12.44†	7.86	1.35	100.46
Red snapper (Lutjanus blackfordi)	20	78.22	1.81†	1.59	3.65†	13.25	0.62	1.27	100.41
Do	26	77.34	1.85†	1.84	2.89†	12.71	1.94	1.33	99.90
Do (average of 2 specimens)	....	77.78	1.83†	1.72	3.27†	12.98	1.28	1.30	100.15
California salmon (Oncorhynchus chouicha)	27	62.68	1.81†	1.57	1.77†	11.95	19.25	1.11	100.14
Shad (Clupea sapidissima)	32	70.75	1.92*	1.92	1.93*	12.74†	10.08	1.34	100.68
Sheepshead (Diplodus probatocephalus)	48	72.01	1.44*	1.99	3.36*	......	6.72	1.10	......
Smelt (Osmerus mordax)	23	80.16	3.22†	0.60	4.07†	7.44	1.94	2.00	100.33
Brook trout (Salvelinus fontinalis)	24	77.54	2.57†	1.80	2.22†	12.52	2.61	1.42	100.68
Turbot (Platysomatichthys hippoglossoides)	49	71.39	2.01*	0.12	3.69*	8.05*	14.41	1.28	100.95
SPENT FISH.									
Salmon (Salmo salar) (male)	35	75.27	2.27*	1.16	2.39*	13.13*	4.57	1.12	99.71
Do (female)	36	78.20	1.37*	1.00	3.03*	......	2.83	1.17	......
Do (average of 2 specimens)	....	76.74	1.82	1.08	2.71	......	3.60	1.15	......
Land-locked salmon (salmo salar, subsp. sebago) (male)	40	77.88	2.03†	0.65	1.97*	......	4.01	1.27	......
Do (female)	41	79.20	2.20†	1.07	2.20*	......	1.95	1.20	......
Do (average of 2 specimens)	....	78.54	2.11†	0.86	2.09*	......	2.98	1.24	......
PRESERVED FISH									
Salt mackerel (Scomber scombrus)	42	42.19	3.57*	0.29	1.68*	15.49*	22.59	13.16	98.97
Salt cod (Gadus morrhua)	34	53.62	1.51*	0.50	4.79*	15.15*	0.25	24.96	100.78
Do	37	53.54	1.16*	0.96	3.38*	17.17*	0.44	24.35	101.00
Do (average of 2 specimens)	....	53.58	1.34	0.73	4.08	16.16	0.35	24.65	100.89
Boned cod (Gadus morrhua)	25	54.35	3.20†	0.84	3.02†	14.98	0.32	23.15	99.86
Smoked halibut (Hippoglossus hippoglossus)	28	57.06	2.74†	0.74	1.58*	13.01†	15.61	15.18	99.92
Smoked herring (Clupea harengus)	33	34.55	8.53*	0.32	5.13*	21.09†	15.82	13.19	99.23
Canned salmon (Oncorhynchus chouicha)	29	65.86	4.85†	......	1.80†	14.49†	11.06	1.79	99.85

* Ash and fat free. † Ash free.

TABLE 8.—*Percentages of phosphoric acid, sulphuric acid, and chlorine in flesh of specimens of American fishes.*

Kind of fish.	Laboratory No. of specimen.	In water-free substance. Phosphoric acid. Total phosphorus calculated as P_2O_5.	Total phosphorus calculated as PO_4.	Sulphuric acid. Total sulphur calculated as SO_3.	Total sulphur calculated as SO_4.	Chlorine.	In fresh substance. Phosphoric acid. Total phosphorus calculated as P_2O_5.	Total phosphorus calculated as PO_4.	Sulphuric acid. Total sulphur calculated as SO_3.	Total sulphur calculated as SO_4.	Chlorine.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
FRESH FISH.											
Alewife (Clupea vernalis)	5	2.06	2.76	....	....	....	0.50	0.67	....	....	....
Black bass (Micropterus salmoides)	53	2.04	2.73	4.14	4.97	....	0.44	0.59	0.89	1.07	....
Striped bass (Roccus lineatus)	7	2.51	3.36	....	....	....	0.53	0.71	....	....	....
Do	19	2.16	2.89	2.28	2.73	....	0.44	0.59	0.46	0.55	....
Do (average of 2 specimens)	....	2.34	3.13	....	....	....	0.48	0.64	....	....	....
Blackfish (Hiatula onitis)	38	2.24	3.01	1.97	2.36	1.03	0.52	0.70	0.46	0.55	0.23
Bluefish (Pomatomus saltatrix)	12	2.93	3.92	....	....	....	0.63	0.84	....	....	....
Cod (Gadus morrhua)	3	2.19	2.93	....	....	....	0.36	0.48	....	....	....
Do	11	3.18	4.26	....	....	....	0.53	0.71	....	....	....
Do (average of 2 specimens)	....	2.69	3.60	....	....	....	0.45	0.60	....	....	....
Eel, salt-water (Anguilla rostrata)	4	1.70	2.28	....	....	....	0.51	0.68	....	....	....
Flounder (Paralichthys dentatus)	2	1.86	2.49	2.23	2.68	....	0.31	0.41	0.38	0.46	....
Do	22	2.70	3.62	3.10	3.72	....	0.40	0.54	0.46	0.55	....
Do (average of 2 specimens)	....	2.28	3.06	2.67	3.20	....	0.36	0.48	0.42	0.50	....
Haddock (Gadus æglefinus)	16	2.43	3.26	....	....	....	0.48	0.64	....	....	....
Do	21	2.54	3.40	2.26	2.71	....	0.45	0.60	0.40	0.48	....
Do (average of 2 specimens)	....	2.49	3.34	....	....	....	0.47	0.63	....	....	....
Halibut (Hippoglossus hippoglossus)	1	2.11	2.83	2.11	2.53	....	0.44	0.59	0.44	0.53	....
Do	9	1.51	2.02	....	....	....	0.43	0.58	....	....	....
Do (average of 2 specimens)	....	1.81	2.43	....	....	....	0.44	0.59	....	....	....
Herring (Clupea harengus)	47	1.77	2.37	1.77	2.12	....	0.55	0.74	0.55	0.66	....
Muskellunge (Esox nobilior)	45	2.21	2.96	1.55	1.86	....	0.52	0.70	0.37	0.44	....
Mackerel (Scomber scombrus)	8	2.26	3.03	....	....	....	0.47	0.63	....	....	....
Do	13	2.43	3.26	....	....	....	0.63	0.84	....	....	....
Do	30	2.16	2.89	1.68	2.02	....	0.56	0.75	0.43	0.52	....
Do	39	1.60	2.14	1.42	1.70	0.68	0.58	0.78	0.51	0.61	0.24
Do (average of 4 specimens)	....	2.11	2.83	1.55	1.86	....	0.56	0.75	0.47	0.56	....
Spanish mackerel (Cybium maculatum)	43	1.88	2.52	1.81	2.17	....	0.60	0.80	0.58	0.70	....
White perch (Roccus americanus)	44	1.46	1.96	2.54	3.05	....	0.36	0.48	0.62	0.74	....
Do	46	2.13	2.85	2.80	3.36	....	0.52	0.70	0.68	0.82	....
Do (average of 2 specimens)	....	1.79	2.40	2.67	3.20	....	0.44	0.59	0.65	0.78	....
Pike perch (Stizostedion vitreum)	52	2.24	3.00	4.43	5.32	....	0.45	0.60	0.90	1.08	....
Porgy (Diplodus argyrops)	15	3.04	4.07	....	....	....	0.62	0.83	....	....	....
Do	31	1.98	2.65	1.84	2.21	....	0.56	0.76	0.52	0.62	....
Do (average of 2 specimens)	....	2.51	3.36	....	....	....	0.59	0.79	....	....	....
Red-snapper (Lutjanus blackfordi)	20	2.15	2.88	2.19	2.63	....	0.47	0.63	0.47	0.56	....
Do	26	2.10	2.81	2.06	2.47	....	0.48	0.64	0.46	0.55	....
Do (average of 2 specimens)	....	2.13	2.85	2.13	2.56	....	0.47	0.63	0.47	0.56	....
Salmon (Salmo salar)	14	1.79	2.40	....	....	....	0.59	0.79	....	....	....
California salmon (Oncorhynchus chouicha)	27	1.86	2.49	1.14	1.37	....	0.69	0.92	0.43	0.52	....
Spent salmon (Salmo salar) (male)	35	1.89	2.53	1.58	1.90	0.74	0.47	0.63	0.39	0.47	0.18
Do (female)	36	2.20	2.95	1.45	1.74	0.85	0.48	0.64	0.32	0.38	0.18
Do (average of 2 specimens)	....	2.05	2.75	1.52	1.82	0.80	0.48	0.64	0.36	0.43	0.18
Spent salmon, land-locked (Salmo salar, subsp. sebago.) (male)	40	2.31	3.10	1.77	2.12	0.95	0.51	0.68	0.39	0.47	0.21
Do (female)	41	2.43	3.26	1.98	2.38	0.93	0.51	0.68	0.41	0.49	0.19
Do (average of 2 specimens)	....	2.37	3.18	1.88	2.26	0.94	0.51	0.68	0.40	0.48	0.20
Shad (Clupea sapidissima)	10	1.94	2.60	....	....	....	0.67	0.90	....	....	....
Do	32	1.76	2.36	1.78	2.14	0.74	0.52	0.70	0.52	0.62	0.22
Do (average of 2 specimens)	....	1.85	2.48	....	....	....	0.60	0.80	....	....	....
Sheepshead (Diplodus probatocephalus)	48	1.62	2.17	1.71	2.05	....	0.45	0.60	0.48	0.58	....
Smelt (Osmerus mordax)	23	4.10	5.49	2.79	2.35	....	0.81	1.08	0.55	0.66	....
Turbot (Platysomatichthys hippoglossoides)	49	1.66	2.22	1.12	1.34	....	0.48	0.64	0.32	0.38	....
Lake trout (Salvelinus namaycush)	17	1.80	2.41	1.94	2.33	....	0.56	0.75	0.62	0.74	....
Brook trout (Salvelinus fontinalis)	24	2.72	3.64	2.13	2.56	....	0.61	0.82	0.48	0.58	....
Whitefish (Coregonus clupeiformis)	18	2.35	3.15	1.36	1.63	....	0.71	0.95	0.41	0.49	....
PRESERVED FISH.											
Salt mackerel (Scomber scombrus)	42	0.61	0.82	1.06	1.27	....	0.35	0.47	0.61	0.73	....
Salt cod (Gadus morrhua)	34	0.61	0.82	1.56	1.87	25.66	0.28	0.37	0.72	0.86	11.90
Do	37	0.48	0.64	1.61	1.93	25.71	0.22	0.29	0.75	0.90	11.94
Do (average of 2 specimens)	....	0.55	0.74	1.59	1.91	25.69	0.25	0.34	0.74	0.89	11.92
Boned cod (Gadus morrhua)	25	0.79	1.06	1.48	1.78	24.51	0.36	0.48	0.68	0.82	11.19
Smoked halibut (H. hippoglossus)	28	0.95	1.27	0.89	1.07	17.69	0.46	0.62	0.44	0.53	8.66
Smoked herring (Clupea harengus)	33	1.28	1.72	1.89	2.27	11.01	0.84	1.12	1.24	1.49	7.21
Canned salmon (Oncorhynchus chouicha)	29	1.77	2.37	1.27	1.52	....	0.60	0.80	0.43	0.52	....

TABLE 9.—*Composition of American fishes. Specimens as received for analysis, including both flesh (edible portion) and refuse.*

Names of fish and portions analyzed.	Laboratory No. of specimen.	In whole or dressed fish as taken for analysis.						
		Refuse: Entrails, bones, skin, etc.	Edible portion (flesh).	Edible portion.				
				Water.	Water-free substance (nutrients).	Nutrients.		
						Albuminoids (by difference).	Fats.	Mineral matters.
FRESH FISH.								
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. c.*
Sturgeon (Acipenser sturio), section of anterior part of body	238	14.4	85.6	67.4	18.2	15.4	1.6	1.2
Small-mouthed red-horse (Moxostoma velatum), entrails removed	258	52.5	47.5	37.3	10.2	8.5	1.1	0.6
Herring (Clupea harengus), whole	47	46.0	54.0	37.3	16.7	10.0	5.9	0.8
Alewife (Clupea vernalis), whole	5	49.5	50.5	38.3	12.2	9.5	1.9	0.8
Do	220	49.4	50.6	36.9	13.7	9.9	3.0	0.8
Do (average of 2 specimens)	....	49.5	50.5	37.5	13.0	9.7	2.5	0.8
Shad (Clupea sapidissima), whole	6	49.3	50.7	35.3	15.4	9.2	5.5	0.7
Do	10	46.4	53.6	35.0	18.6	10.5	7.3	0.8
Do	32	45.9	54.1	38.3	15.8	9.6	5.5	0.7
Do	212	44.4	55.6	39.5	16.1	9.9	5.7	0.5
Do	221	53.2	46.8	33.7	13.1	9.3	3.1	0.7
Do	245	52.7	47.3	34.1	13.2	8.6	3.8	0.8
Do	249	58.8	41.2	30.3	10.9	7.4	2.9	0.6
Do (maximum of 7 specimens)	....	58.8	55.6	39.5	18.6	10.5	7.3	0.8
Do (minimum of 7 specimens)	...	44.4	41.2	30.3	10.9	7.4	2.9	0.6
Do (average of 7 specimens)	....	50.1	49.9	35.2	14.7	9.2	4.8	0.7
Smelt (Osmerus mordax), whole	23	34.8	65.2	52.3	12.9	10.4	1.2	1.3
Do	207	49.0	51.0	39.9	11.1	9.6	0.8	0.7
Do (average of 2 specimens)	....	41.9	58.1	46.1	12.0	10.0	1.0	1.0
Whitefish (Coregonus clupeiformis), whole	18	53.5	46.5	32.5	14.0	10.3	3.0	0.7
Cisco (Coregonus, sp. tullibee or artedi?), whole	111	42.7	57.3	43.6	13.7	11.0	2.0	0.7
California salmon (Oncorhynchus chouicha), sections of anterior part of body	27	0.0	100.0	62.7	37.3	17.0	19.2	1.1
Do	233	10.3	89.7	57.9	31.8	16.1	14.8	0.9
Do (average of 2 specimens)	....	5.2	94.8	60.3	34.5	16.5	17.0	1.0
Salmon (Salmo salar), female, whole	77	33.5	66.5	42.2	24.3	13.3	10.0	1.0
Do	78	30.8	69.2	45.0	24.2	13.9	9.3	1.0
Do	279	37.5	62.5	38.3	24.2	15.2	8.1	0.9
Salmon (Salmo salar), male, whole	280	39.5	60.5	36.9	23.6	14.8	7.9	0.9
Do (maximum of 4 specimens)	....	39.5	69.2	45.0	24.3	15.2	10.0	1.0
Do (minimum of 4 specimens)	....	30.8	60.2	36.9	23.6	13.3	7.9	0.9
Do (average of 4 specimens)	....	35.3	64.7	40.6	24.1	14.3	8.8	1.0
Salmon (Salmo salar), entrails removed	14	23.8	76.2	51.2	25.0	14.6	9.5	0.9
Lake trout, "Mackinaw trout" (Salvelinus namaycush), whole	17	56.3	43.7	30.0	13.7	7.7	5.4	0.6
Lake trout, "Mackinaw trout" (Salvelinus namaycush), entrails removed	255	35.2	64.8	45.0	19.8	12.4	6.6	0.8
Brook trout (Salvelinus fontinalis), whole, cultivated	24	50.1	49.9	38.7	11.2	9.2	1.3	0.7
Do	254	45.2	54.8	43.8	11.0	10.1	0.4	0.5
Do	256	49.1	50.9	38.6	12.3	10.2	1.5	0.6
Do (average of 3 specimens)	....	48.1	51.9	40.4	11.5	9.8	1.1	0.6
Pickerel (Esox reticulatus), whole	100	45.4	54.6	43.6	11.0	10.0	0.3	0.7
Do	224	48.7	51.3	40.8	10.5	9.7	0.2	0.6
Do (average of 2 specimens)	....	47.1	52.9	42.2	10.7	9.8	0.2	0.7
Pike (Esox lucius), whole	98	42.7	57.3	45.7	11.6	10.7	0.3	0.6
Muskellunge (Esox nobilior), whole	45	49.2	50.8	38.7	12.1	10.0	1.3	0.8
Eel, salt-water (Anguilla rostrata), skin, head, and entrails removed	4	21.4	78.6	54.9	23.7	14.9	8.1	0.7
Do	217	19.0	81.0	59.4	21.6	14.3	6.4	0.9
Do (average of 2 specimens)	....	20.2	79.8	57.2	22.6	14.6	7.2	0.8
Mullet (Mugil albula), whole	126	57.9	42.1	31.5	10.6	8.1	2.0	0.5
Mackerel (Scomber scombrus), whole	8	38.3	61.7	48.5	13.2	11.2	1.4	0.6
Do	13	51.8	48.2	35.8	12.4	8.4	3.4	0.6
Do	30	48.9	51.1	37.9	13.2	8.0	3.6	0.7
Do	39	33.8	66.2	42.4	23.8	12.1	10.7	1.0
Do	261	50.4	49.6	37.4	12.2	9.5	2.1	0.6
Do (maximum of 5 specimens)	....	57.9	66.2	48.5	23.8	12.1	10.7	1.0
Do (minimum of 5 specimens)	....	33.8	48.2	35.8	12.2	8.4	1.4	0.6
Do (average of 5 specimens)	....	44.6	55.4	40.4	15.0	10.0	4.3	0.7
Mackerel (Scomber scombrus), entrails removed	230	40.7	59.3	43.7	15.6	11.4	3.5	0.7
Spanish mackerel (Cybium maculatum), whole	43	34.6	65.4	44.5	20.9	13.7	6.2	1.0

TABLE 9.—*Composition of American fishes. Specimens as received for analysis, including both flesh (edible portion) and refuse*—Continued.

Names of fish and portions analyzed.	Laboratory No. of specimen.	In whole or dressed fish as taken for analysis.						
		Refuse: Entrails, bones, skin, etc.	Edible portion.					
			Edible portion (flesh).	Water.	Water-free substance (nutrients).	Nutrients.		
						Albuminoids (by difference).	Fats.	Mineral matters.
FRESH FISH—Continued.		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. c.
Pompano (Trachynotus carolinus), whole	234	42.4	57.6	38.8	18.8	10.5	7.8	0.5
Do	263	48.6	51.4	40.2	11.2	9.9	0.8	0.5
Do (average of 2 specimens)	...	45.5	54.5	39.5	15.0	10.2	4.3	0.5
Bluefish (Pomatomus saltatrix), entrails removed	12	48.6	51.4	40.3	11.1	9.8	0.6	0.7
Butter-fish (Stromateus triacanthus), whole	90	42.8	57.2	40.1	17.1	10.2	6.3	0.6
Large-mouthed black bass (Micropterus salmoides), whole	53	56.0	44.0	34.6	9.4	8.5	0.4	0.5
Small-mouthed black bass (Micropterus dolomieu), whole	91	53.6	46.4	34.7	11.7	10.0	1.1	0.6
Yellow perch (Perca fluviatilis), whole	127	62.7	37.3	30.0	7.3	6.7	0.2	0.4
Yellow perch (Perca fluviatilis), head, entrails, fins, and tail removed	208	35.1	64.9	50.7	14.2	12.6	0.7	0.9
Wall-eyed pike (Stizostedion vitreum), whole	52	57.2	42.8	34.1	8.7	7.9	0.2	0.6
Gray pike (Stizostedion canadense), whole	257	63.2	36.8	29.7	7.1	6.4	0.3	0.4
Striped bass (Roccus lineatus), whole	7	56.7	43.3	34.2	9.1	7.9	0.7	0.5
Do	19	56.9	43.1	34.4	8.7	7.2	0.9	0.6
Do	225	48.6	51.4	39.7	11.7	9.7	1.4	0.6
Do	237	57.1	42.9	32.5	10.4	8.3	1.6	0.5
Do	248	55.4	44.6	34.7	9.9	8.4	1.0	0.5
Do (maximum of 5 specimens)	..	57.1	51.4	39.7	11.7	9.7	1.6	0.6
Do (minimum of 5 specimens)	..	48.6	42.9	32.5	8.7	7.2	0.7	0.5
Do (average of 5 specimens)		54.9	45.1	35.1	10.0	8.3	1.1	0.6
Striped bass (Roccus lineatus), entrails removed	260	51.2	48.8	37.4	11.4	8.7	2.2	0.5
White perch (Roccus americanus), whole	44	63.2	36.8	27.8	9.0	6.5	2.1	0.4
Do	46	61.8	38.2	28.9	9.3	7.8	1.0	0.5
Do (average of 2 specimens)	..	62.5	37.5	28.4	9.1	7.2	1.5	0.4
Sea bass (Centropristris atrarius), whole	251	56.1	43.9	34.8	9.1	8.3	0.2	0.6
Red grouper (Epinephelus morio), entrails removed		55.8	44.2	35.3	8.9	8.2	0.2	0.5
Do	271	55.9	44.1	34.8	9.3	8.5	0.3	0.5
Do (average of 2 specimens)	...	55.9	44.1	35.0	9.1	8.4	0.2	0.5
Red snapper (Lutjanus blackfordi):								
Whole	20	40.0	60.0	46.9	13.1	11.9	0.4	0.8
Entrails removed	26	52.5	47.5	36.8	10.7	9.2	0.9	0.6
Entrails and gills removed	242	45.3	54.7	43.7	11.0	10.0	0.3	0.7
Dressed (average of 2 specimens)	..	48.9	51.1	40.3	10.8	9.6	0.6	0.6
Porgy (Diplodus argyrops), whole	15	65.1	34.9	27.8	7.1	6.1	0.5	0.5
Do	31	57.3	42.7	30.7	12.0	8.0	3.4	0.6
Do	262	57.6	42.4	31.1	11.3	8.2	2.5	0.6
Do (maximum of 3 specimens)	....	65.1	42.7	31.1	12.0	8.2	3.4	0.6
Do (minimum of 3 specimens)	....	57.3	34.9	27.8	7.1	6.1	0.5	0.5
Do (average of 3 specimens)	....	60.0	40.0	29.9	10.1	7.4	2.1	0.6
Sheepshead (Diplodus probatocephalus), entrails removed	48	56.5	43.5	31.3	12.2	8.8	2.9	0.5
Do	250	66.0	34.0	26.9	7.1	6.4	0.2	0.5
Red bass (Sciæna ocellata), whole	270	63.5	36.5	29.8	6.7	6.1	0.2	0.4
Kingfish (Menticirrus nebulosus), whole	252	56.6	43.4	34.4	9.0	8.1	0.4	0.5
Weakfish (Cynoscion regalis), whole	273	51.9	48.1	38.0	10.1	8.4	1.1	0.6
Blackfish (Hiatula onitis):								
Whole	38	56.2	43.8	33.7	10.1	8.3	1.2	0.6
Do	205	64.1	35.9	29.2	6.7	6.3	0.2	0.2
Entrails removed	244	57.8	42.2	33.5	8.7	7.9	0.4	0.4
Do	269	53.6	46.4	36.4	10.0	8.7	0.7	0.6
Whole (average of 2 specimens)	....	60.1	39.9	31.5	8.4	7.3	0.7	0.4
Dressed (average of 2 specimens)	....	55.7	44.3	35.0	9.3	8.3	0.5	0.5
Hake (Phycis chuss), entrails removed	113	52.5	47.5	39.5	8.0	7.2	0.3	0.5
Cusk (Brosmius brosme), entrails removed	110	40.3	59.7	49.0	10.7	10.1	0.1	0.5
Haddock (Gadus æglefinus) entrails removed	16	51.4	48.6	39.0	9.3	8.9	0.1	0.6
Do	21	51.6	48.4	39.7	8.7	7.8	0.1	0.8
Do	229	48.0	52.0	42.9	9.1	8.3	0.2	0.6
Do	259	52.9	47.1	38.5	8.6	7.9	0.2	0.5
Do (maximum of 4 specimens)	....	52.9	52.0	42.9	9.6	8.9	0.2	0.8
Do (minimum of 4 specimens)	....	48.0	47.1	38.5	8.6	7.8	0.1	0.5
Do (average of 4 specimens)	....	51.0	49.0	40.0	9.0	8.2	0.2	0.6
Cod (Gadus morrhua), head and entrails removed	3	33.7	66.3	55.3	11.0	9.9	0.2	0.9

TABLE 9.—*Composition of American fishes. Specimens as received for analysis, including both flesh (edible portion) and refuse*—Continued.

Names of fish and portions analyzed.	Salt.	Laboratory No. of specimen.	In whole or dressed fish as taken for analysis. Refuse: Entrails, bones, skin, etc.	Edible portion (flesh).	Edible portion. Water.	Water-free substance (nutrients).	Nutrients. Albuminoids (by difference).	Fats.	Mineral matters.
FRESH FISH—Continued.			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. c.
Cod (Gadus morrhua), head and entrails removed		11	30.6	69.4	57.9	11.5	10.4	0.3	0.8
Do		228	25.5	74.5	62.1	12.4	11.4	0.2	0.8
Cod (Gadus morrhua), whole		206	56.5	43.5	35.1	8.4	7.7	0.1	0.6
Do		243	48.5	51.5	42.3	9.2	8.3	0.3	0.6
Cod (Gadus morrhua), dressed (average of 3 specimens)		....	29.9	70.1	58.5	11.6	10.6	0.2	0.8
Cod (Gadus morrhua), whole (average of 2 specimens)		...	52.5	47.5	38.7	8.8	8.0	0.2	0.6
Tomcod (Gadus tomcod), whole		99	59.9	40.1	32.7	7.4	6.8	0.2	0.4
Pollock (Gadus virens), head and entrails removed		81	28.5	71.5	54.3	17.2	15.5	0.6	1.1
Halibut (Hippoglossus hippoglossus):									
Posterior part of body, lean		1	23.1	76.9	60.9	16.0	13.4	1.7	0.9
Section of body fatter than No. 1		9	11.2	88.8	62.3	26.5	16.1	9.4	1.0
Sections from different parts of body		211	18.7	81.3	62.6	18.7	15.8	2.2	0.7
Average of 3 specimens		....	17.7	82.3	61.9	20.4	15.1	4.4	0.9
Turbot (Platysomatichthys hippoglossoides), whole		49	47.7	52.3	37.3	15.0	6.8	7.5	0.7
Common flounder (Paralichthys dentatus), entrails removed		2	57.0	43.0	35.8	7.2	6.3	0.3	0.6
Common flounder (Paralichthys dentatus), whole		22	66.8	33.2	27.2	6.0	5.2	0.3	0.5
Winter flounder (Pleuronectes americanus), whole		253	56.2	43.8	37.0	6.8	6.1	0.2	0.5
Lamprey eel (Petromyzon marinus), whole		236	45.8	54.2	38.5	15.7	8.1	7.2	0.4
Skate (Raia sp.), left lobe of body		247	51.0	49.0	40.2	8.8	7.5	0.7	0.6
SPENT FISH.									
Salmon (Salmo salar), male, whole		35	43.8	56.2	42.3	13.9	10.8	2.5	0.6
Salmon (Salmo salar), female, whole		36	43.5	56.5	44.2	12.3	10.0	1.6	0.7
Do (average of 2 specimens)		....	43.6	56.4	43.3	13.1	10.4	2.1	0.6
Salmon, land-locked (Salmo salar, subsp. sebago), male, whole		....	48.4	51.6	40.2	11.4	8.7	2.1	0.6
Salmon, land-locked (Salmo salar, subsp. sebago), female, whole		41	46.2	53.8	42.6	11.2	9.5	1.0	0.7
Do (average of 2 specimens)		....	47.3	52.7	41.4	11.3	9.1	1.6	0.6
ROE.									
Shad roe, from shad No. 245		246	0.0	100.0	71.2	28.8	23.4	3.8	1.6
PRESERVED FISH.	Salt.								
DRIED.									
Cod (Gadus morrhua,) flesh desiccated and ground	Pr. ct. 2.9	79	0.0	97.1	15.2	81.9	74.6	1.9	5.4
SALTED.									
Mackerel (Scomber scombrus), "No. 1 mackerel"	7.1	42	33.3	59.6	28.1	31.5	14.7	15.1	1.7
SALTED AND DRIED.									
Salt cod (Gadus morrhua), "channel fish"	17.3	34	25.5	57.2	40.0	17.2	15.7	0.3	1.2
Salt cod (Gadus morrhua), "boat fish"	17.2	37	24.3	58.5	40.5	18.0	16.4	0.4	1.2
Do (average of 2 specimens)	17.2	....	24.9	57.9	40.3	17.6	16.0	0.4	1.2
Salt cod (Gadus morrhua), boned "boneless codfish"	19.1	25	0.0	80.9	54.4	26.5	22.1	0.3	4.1
Salt cod (Gadus morrhua), flesh desiccated and ground)	6.6	80	0.0	93.4	11.7	81.7	71.6	4.9	5.2
SALTED, SMOKED AND DRIED.									
Smoked herring (Clupea harengus)	6.5	33	44.4	49.1	19.2	29.9	20.2	8.8	0.9
Smoked haddock, "Findon haddie" (Gadus æglefinus)	1.4	88	32.2	66.4	49.2	17.2	16.1	0.1	1.0
Smoked halibut (Hippoglossus hippoglossus)	12.0	28	8.0	80.0	47.0	33.0	16.7	14.4	1.9
Do	12.1	218	5.9	82.0	44.9	37.1	21.6	13.6	1.9
Do (average of 2 specimens)	12.1	....	6.9	81.0	46.0	35.0	19.1	14.0	1.9
CANNED									
Sardines (Clupea pilchardus)	0.0	87	5.0	95.0	53.6	41.4	24.0	12.1	5.3
Salmon (Oncorhynchus chouicha)	0.4	29	11.7	87.9	58.2	29.7	18.8	9.8	1.1

TABLE 9.—*Composition of American fishes. Specimens as received for analysis, including both flesh (edible portion) and refuse*—Continued.

Names of fish and portions analyzed.	Salt.	Laboratory No. of specimen.	In whole or dressed fish as taken for analysis. Refuse: Entrails, bones, skin, etc.	Edible portion (flesh).	Edible portion. Water.	Water-free substance (nutrients).	Nutrients. Albuminoids (by difference).	Fats.	Mineral matters.
PRESERVED FISH—Continued.			*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. c.*
Salmon (Oncorhynchus chouicha)	2.2	96	0.0	97.8	62.2	35.6	19.7	14.6	1.3
Do	0.4	241	0.0	99.6	56.6	42.0	19.2	21.5	1.3
Do (average of 3 specimens)	1.0	....	3.9	95.1	59.3	35.8	19.3	15.3	1.2
Mackerel (Scomber scombrus)	1.9	94	0.0	98.1	68.2	29.9	19.9	8.7	1.3
Salt mackerel (Scomber scombrus), "No. 2 mackerel"	7.9	95	17.0	75.1	35.8	39.3	14.0	23.2	2.1
Do	8.7	219	22.4	68.9	33.8	35.1	13.7	19.3	2.1
Do (average of 2 specimens)	8.3	....	19.7	72.0	34.8	37.2	13.8	21.3	2.1
Tunny, "Horse mackerel" (Orcynus secundi-dorsalis)	0.0	240	0.0	100.0	72.7	27.3	21.5	4.1	1.7
Smoked haddock (Gadus æglefinus)	5.6	275	0.0	94.4	68.7	25.7	21.8	2.3	1.6

5. PROTEIN IN THE FLESH OF FISHES.

ERRORS INVOLVED IN THE COMMON METHOD OF ESTIMATION.

In the tables in division 3 of this section, which give the results of analyses of specimens of the flesh of fishes, the percentages of protein as estimated by multiplying the nitrogen by the factor 6.25, and those of "albuminoids, etc." (actual nitrogenous substances), as estimated by difference [100—(ether extract + ash) = "albuminoids, etc."], are both given. In the tables which recapitulate the analyses these figures for "albuminoids by difference" are taken for the nitrogenous matters.

It will be interesting to observe the differences between results obtained by estimating the nitrogenous substance by these two methods (see remarks on "Nitrogen, Protein, etc.," under Methods of Analysis, above). If we leave the carbohydrates out of account, assume the ash to represent the mineral matters, and take ether extract as representing the fats, but as including no nitrogenized fats, then the figures for "albuminoids, etc., by difference" will represent exactly the amount of nitrogenous substance (albuminoids, gelatinoids, nitrogenous extractives, and nitrogenized fats). Of course, these assumptions are not absolutely correct. The flesh contains a minute quantity of carbohydrates (including all non-nitrogenous organic substances other than fats); the ash is not the exact measure of the mineral matters, and the ether extract does not exactly represent the neutral fats. But the errors involved are small, and until better methods of analysis are devised and brought into current use, "albuminoids, etc., by difference" will be the closest approach to the actual nitrogenous substance.

The current method of estimating the nitrogenous material is by multiplying the nitrogen by 6.25. To this product, various terms, as albuminoids, proteids, and protein, are applied. If the figures for "albuminoids, etc., by difference" were the exact measure of the nitrogenous substance, the difference between them and the product of N × 6.25 would be the error in computing protein in this latter way. In Table 2 the ash+ether extract+"albuminoids by difference" = 100; and the ash + ether extract+protein (N×6.25)=a quantity varying more or less from 100. On the assumption that the "albuminoids by difference" represent the actual nitrogenous substance, the variations from 100 in the latter figures represent the error in calculating protein by multiplying N by 6.25.

Of course, the correct determination of actual nitrogenous substance involves numerous other questions in addition to those here suggested, and first of all the chemical and physiological distinctions between the different nitrogenous compounds. But for the present purpose it will suffice to take the "albuminoids, etc., by difference" as the measure of the nitrogenous material.

The tabular statements which follow give the sum of ash+fat+protein (N×6.25) in water-free substance, and of water+ash+fat+protein (N×6.25) in flesh, of the specimens of fishes in Tables 2 and 3, and of prepared fish in Tables 4 and 5. For the water-free substance the range of the figures is from 97.01 to 116.01, but in the flesh (leaving the preserved fish out of account) the range is only from 99.34 to 102.85, or, omitting the skate, to 101.14.* The only cases in which the sum is below 99 in the water-free substance of the fresh flesh are those of the spent salmon. In these, both nitrogenous substance and fat had been reduced during the spawning season. The only ones above 101 in the flesh are two specimens of fat salmon, one each of sea bass and turbot, several of cod, and one of skate. It is clear that the use of either of the figures for protein, N×6.25, or "albuminoids, etc., by difference," for the total nitrogenous substance in the flesh, will involve no very serious error except in the last named cases.

The figures for protein in sea bass, turbot, cod, and especially skate, are a little surprising. The question naturally suggests itself whether there may not be errors in the analyses. The analytical details show that this explanation is extremely improbable. All the nitrogenous determinations in the specimens of cod gave large figures. Two determinations in the specimens of skate gave respectively 16.28 and 16.29 per cent. in the water-free substance. These figures are so large that a third determination was made, with 16.30 as the result.

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* In our analyses of the flesh of fishes or other animals, when this sum has varied much from 100, we have repeated the work to make sure of its correctness.

In brief, while the error involved in estimating the total nitrogenous substance by multiplying the nitrogen by the factor 6.25 in the usual way, is, when viewed from the exact scientific standpoint, very considerable in many cases, it is seldom large enough to be of great practical importance. The exceptional cases, however, demand further study.

Sum of protein ($N \times 6.25$), ether extract, ash, and water in the flesh of specimens of American fishes.

Lab. No.	Name.	Protein + ether extract + ash in water-free substance.	Protein + ether extract + ash + water in flesh.	Averages. Protein + ether extract + ash in water-free substance.	Averages. Protein + ether extract + ash + water in flesh.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
40	Spent land-locked salmon	97.01	99.34	97.50	99.47
41	....do	98.00	99.59		
36	Spent salmon	99.15	99.82	99.38	99.87
35	....do	99.61	99.91		
81	Pollock	99.74	99.95		
236	Lamprey eel	100.18	100.05		
15	Porgy	99.94	99.98	100.22	100.06
31	....do	100.16	100.05		
262	....do	100.57	100.14		
127	Yellow perch	99.55	99.91	100.29	100.13
208	....do	101.04	100.22		
110	Cusk	100.30	100.08		
98	Pike pickerel	100.32	100.07		
100	Pickerel	100.15	100.03	100.43	100.09
224	....do	100.72	100.14		
258	Small-mouthed red-horse	100.48	100.09		
111	Cisco	100.59	100.14		
126	Mullet	100.61	100.16		
90	Butter-fish	100.62	100.18		
234	Pompano	100.60	100.20	100.65	100.18
263	....do	100.70	100.15		
220	Alewife	100.70	100.18	100.73	100.19
5	....do	100.77	100.20		
113	Hake	100.74	100.13		
52	Pike perch, wall-eyed pike	100.75	100.16		
217	Salt-water eel	100.53	100.14	100.77	100.22
4	....do	101.02	100.30		
91	Small-mouthed black bass	100.81	100.21		
238	Sturgeon	100.81	100.15		
99	Tomcod	100.84	100.16		
1	Halibut	100.18	100.04	100.89	100.23
211	....do	101.19	100.28		
9	....do	101.30	100.38		
221	Shad	100.45	100.12	100.91	100.27
245	....do	100.68	100.16		
10	....do	100.74	100.21		
249	....do	100.87	100.22		
32	....do	100.96	100.25		
212	....do	101.28	100.36		
6	....do	101.37	100.39		
53	Large-mouthed black bass	100.92	100.20		
40	White perch	100.63	100.15	100.97	100.24
44	....do	101.32	100.32		
17	Lake trout	100.97	100.30	100.99	100.30
255	....do	101.01	100.30		
260	Striped bass	100.67	100.16	101.00	100.23
248	....do	100.73	100.16		
225	....do	100.77	100.16		
237	....do	100.88	100.21		
19	....do	100.96	100.24		
7	....do	102.03	100.43		
269	Blackfish	100.93	100.20	101.12	100.24
205	....do	100.95	100.17		
244	....do	100.98	100.20		
38	....do	101.62	100.37		
270	Red bass	101.12	100.20		
207	Smelt	99.17	99.82	101.13	100.22
23	....do	103.09	100.62		
24	Brook trout	100.75	100.17	101.17	100.26
256	....do	101.03	100.27		
254	....do	101.72	100.35		
252	Kingfish	101.29	100.28		

Sum of protein (N × 6.25), ether extract, ash, and water in the flesh of specimens of American fishes—Continued.

Lab. No.	Name.	Protein + ether extract + ash in water-free substance.	Protein + ether extract + ash + water in flesh.	Averages. Protein + ether extract + ash in water-free substance.	Averages. Protein + ether extract + ash + water in flesh.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
13	Mackerel	100.15	100.03	101.34	100.37
8	....do	100.73	100.16		
230	....do	100.94	100.21		
261	....do	101.46	100.36		
30	....do	102.37	100.61		
39	....do	102.39	100.87		
43	Spanish mackerel	101.52	100.48		
273	Weakfish	101.64	100.35		
2	Common flounder	101.09	100.18	101.64	100.25
22	....do	102.19	100.32		
233	California salmon	101.67	100.60		
12	Bluefish	101.83	100.39		
16	Haddock	100.92	100.20	101.99	100.37
21	....do	101.81	100.32		
229	....do	102.16	100.38		
259	....do	103.08	100.56		
114	Grouper	101.18	100.17	102.06	100.40
271	....do	102.94	100.62		
47	Herring	102.07	100.06		
280	Salmon	100.82	100.32		
14	....do	101.10	100.46	102.14	100.79
279	....do	101.27	100.49		
78	....do	103.08	101.07		
77	....do	104.43	101.62		
45	Muskellunge	102.20	100.52		
250	Sheepshead	102.08	100.43	102.20	100.54
48	....do	102.33	100.65		
20	Red snapper	101.30	100.28	102.50	100.53
26	....do	101.69	100.36		
242	....do	104.53	100.95		
18	Whitefish	102.87	100.87		
257	Pike perch, Gray pike	103.23	100.62		
253	Winter flounder	103.41	100.52		
3	Cod	103.03	100.52	104.28	100.74
228	....do	103.55	100.58		
206	....do	103.76	100.73		
243	....do	104.22	100.72		
11	....do	106.87	101.14		
251	Sea bass	105.04	101.09		
49	Turbot	106.39	101.83		
247	Skate	116.01	102.85		
	PRESERVED FISH.				
79	Desiccated cod, flesh desiccated and ground, dried.	104.02	103.41		
42	Mackerel, salted	98.40	99.08		
34	Cod, salted and dried	107.98	103.70	108.57	103.95
37	....do	100.06	104.19		
88	Haddock, salted, smoked, and dried	98.60	99.61		
218	Halibut, salted, smoked, and dried	100.03	100.01	100.35	100.18
28	....do	109.66	100.34		
33	Herring	100.77	100.50		
87	Sardines, canned	98.99	99.56		
94	Mackerel, canned	99.13	99.72		
95	Salt mackerel, canned	99.56	99.74	99.95	99.97
219	....do	100.33	100.19		
29	Salmon, canned	99.33	99.77	100.29	100.12
241	....do	100.65	100.27		
96	....do	100.89	100.33		
240	Tunny, "Horse mackerel," canned	100.53	100.15		
275	Smoked haddock, canned	101.57	100.51		

6. CLASSIFICATION OF SPECIMENS OF AMERICAN FISHES BY THEIR CHEMICAL COMPOSITION.

On the basis of the figures of Tables 1, 3, and 9 I have attempted a classification of the specimens of American fishes analyzed, by their content of (1) flesh, (2) water-free substance in flesh, and (3) water and fats. With the following figures the classifications will need no further explanation. Where more than one specimen was analyzed the averages of the analyses are used. Of course, a satisfactory classification would require many more analyses. Nevertheless, these figures may be assumed to give a tolerably fair idea of the relative composition of the fish, or at least an approximation that may serve until more complete data are obtained. Accordingly, the exact order of the species in each of the groups in the tabular arrangements which follow must be regarded as by no means fixed, since further analyses would very likely give averages varying more or less from the results here tabulated.

In the following table the species of which entire specimens of fish were received for analysis, *i. e.*, specimens from which no portion had been removed before weighing and preparing for analysis, are arranged in order from those with the largest to those with the smallest proportions of flesh. The data are from Tables 1 and 9.

Classification of fishes by percentages of flesh, chiefly muscular tissue, in entire body.

Kind of fish.	No. of specimens analyzed.	Flesh.
Containing 60 per cent. or over of flesh.		*Per ct.*
Spanish mackerel	1	65.4
Salmon	4	64.7
Red snapper	1	60.0
Containing between 60 and 50 per cent. of flesh.		
Smelt	2	58.1
Pike (pickerel)	1	57.3
Cisco	1	57.3
Butter-fish	1	57.2
Spent salmon	2	56.4
Mackerel	5	55.4
Pompano	2	54.5
Lamprey eel	1	54.2
Herring	1	54.0
Pickerel	2	52.9
Spent land-locked salmon	2	52.7
Turbot	1	52.3
Brook trout	3	51.9
Muskellunge	1	50.8
Alewife	2	50.5
Containing between 50 and 40 per cent. of flesh.		*Per ct.*
Shad	7	49.9
Weakfish	1	48.1
Cod	2	47.5
Whitefish	1	46.5
Small-mouthed black bass	1	46.4
Striped bass	5	45.1
Large-mouthed black bass	1	44.0
Sea bass	1	43.9
Winter flounder	1	43.8
Lake trout, "Mackinaw trout"	1	43.7
Kingfish	1	43.4
Pike perch, "wall-eyed pike"	1	42.8
Mullet	1	42.1
Tomcod	1	40.1
Porgy	3	40.0
Containing between 40 and 30 per cent. of flesh.		
Blackfish	2	39.9
White perch	2	37.5
Yellow perch	1	37.3
Pike perch, "gray pike"	1	36.8
Red bass	1	36.5
Sheepshead	1	34.0
Common flounder	1	33.2

In the next tabular arrangement, compiled from Table 3, the species are grouped by the percentages of water-free substance in the flesh, from those with the most to those with the least water-free substance. Of course, those with the most water-free substance have the least water, and *vice versa*; hence the first in the list have the lowest percentages of water, and the last are the most watery.

Classification of fishes by proportions of water-free substance in the flesh of specimens analyzed.

Kinds of fish.	No. of specimens analyzed.	Water-free substance.
Containing over 30 per cent. of water-free substance.		Per ct.
California salmon	2	36.4
Salmon	5	36.4
Spanish mackerel	1	31.9
Herring	1	31.0
Lake trout	2	30.9
Whitefish	1	30.2
Containing from 30 to 25 per cent. of water-free substance.		
Butter-fish	1	30.0
Shad	7	29.4
Lamprey eel	1	28.9
Turbot	1	28.6
Salt-water eel	2	28.4
Pompano	2	27.2
Mackerel	6	26.6
Alewife	2	25.6
Small-mouthed black bass	1	25.2
Mullet	1	25.1
Porgy	3	25.0
Containing between 25 and 20 per cent. of water-free substance.		
Halibut	3	24.6
Sheepshead	2	24.5
White perch	2	24.3
Pollock	1	24.0
Cisco	1	23.9
Muskellunge	1	23.7
Spent salmon	2	23.3
Striped bass	6	22.3
Containing between 25 and 30 p. ct. of water-free substance—Cont'd.		Per ct.
Brook trout	3	22.3
Bluefish	1	21.5
Red snapper	3	21.5
Spent land-locked salmon	2	21.5
Small-mouthed red-horse	1	21.4
Large-mouthed black bass	1	21.4
Sturgeon	1	21.3
Weakfish	1	21.0
Blackfish	4	20.9
Smelt	2	20.8
Kingfish	1	20.8
Yellow perch	2	20.8
Sea bass	1	20.7
Grouper	2	20.6
Pickerel	2	20.3
Pike perch, "wall-eyed pike"	1	20.3
Pike (pickerel?)	1	20.2
Containing between 20 and 15 per cent. of water-free substance.		
Pike perch, gray pike	1	19.2
Tomcod	1	18.5
Red bass	1	18.4
Haddock	4	18.3
Cusk	1	18.0
Skate	1	17.9
Cod	5	17.4
Hake	1	16.9
Common flounder	2	15.8
Winter flounder	1	15.7

The next tabular arrangement, likewise from Table 3, gives a grouping of the species by the proportions of fat (ether extract) in the specimens analyzed. They are arranged in order from those with the most to those with the least fats in the flesh. The proportions of water are also given to illustrate the principle, to be discussed in another place, that as a rule the percentage of water in the muscular tissue diminishes as that of fat increases, and *vice versa*. In general the fattest species have the most water-free substance.

Classification of fishes by proportions of fat in the flesh of specimens analyzed.

Kinds of fish.	No. of specimens analyzed.	Water.	Fats.
Containing over 5 per cent. of fats.		*Per ct.*	*P. ct.*
California salmon	2	63.6	17.9
Turbot	1	71.4	14.4
Salmon	5	63.6	13.4
Lamprey eel	1	71.1	13.3
Lake trout	2	69.1	11.4
Butter-fish	1	70.0	11.0
Herring	1	69.0	11.0
Shad	7	70.6	9.5
Spanish mackerel	1	68.1	9.4
Salt-water eel	2	71.6	9.1
Pompano	2	72.8	7.6
Mackerel	6	73.4	7.1
Whitefish	1	69.8	6.5
Halibut	3	75.4	5.2
Porgy	3	75.0	5.1
Containing between 5 and 2 per cent. of fats.			
Alewife	2	74.4	4.9
Mullet	1	74.9	4.6
White perch	2	75.7	4.1
Sheepshead	2	75.6	3.7
Spent salmon	2	76.7	3.6
Cisco	1	76.2	3.5
Spent land-locked salmon	2	78.5	3.0
Striped bass	6	77.7	2.8
Muskellunge	1	76.3	2.5
Small-mouthed black bass	1	74.8	2.4
Weakfish	1	79.0	2.4
Small-mouthed red-horse	1	78.6	2.4
Brook trout	3	77.7	2.1
Containing less than 2, the majority less than 1 per cent. of fats.		*Per ct.*	*P. ct.*
Sturgeon	1	78.7	1.9
Smelt	2	79.2	1.8
Skate	1	82.2	1.4
Blackfish	4	79.1	1.4
Bluefish	1	78.5	1.3
Red snapper	3	78.5	1.0
Large-mouthed black bass	1	78.6	1.0
Kingfish	1	79.2	1.0
Pollock	1	76.0	0.8
Yellow perch	2	79.3	0.8
Pike perch, Gray pike	1	80.9	0.8
Hake	1	83.1	0.7
Common flounder	2	84.2	0.7
Grouper	2	79.4	0.6
Pike (pickerel?)	1	79.8	0.6
Sea bass	1	79.3	0.5
Pike perch, Wall-eyed pike	1	79.7	0.5
Pickerel	2	79.7	0.5
Red bass	1	81.6	0.5
Tomcod	1	81.6	0.4
Cod	5	82.6	0.4
Winter flounder	1	84.4	0.4
Haddock	4	81.7	0.3
Cusk	1	82.0	0.2

Comparison of the above groupings with the classification by families as practiced by ichthyologists shows no very definite connection between the two. For that matter there is perhaps no reason to expect any such connection.

SECTION B.—EUROPEAN FISHES.

1.—LIST OF NAMES OF EUROPEAN FISHES, OF WHICH ANALYSES ARE HERE COLLATED.

In attempting to collate such European analyses of the flesh of fish as have been performed by methods now in vogue and are consequently capable of fair comparison with the analyses of American fishes reported, I have found the following:

(1) *Fishes analyzed by Payen.*—These include analyses of 18 specimens of 17 species and are especially worthy of note as being the first series of analyses of any considerable importance made by modern methods.

(2) *Analyses by König.*—Professor König and his assistants have likewise published a series of analyses, 9 specimens of 8 or 9 species.

(3) *Analyses by Buckland.*—These are only 2 in number, of 2 species.

(4) *Analyses by Almén.*—These include 18 specimens of 10 or 11 species, and constituted at the time of their publication the largest

contribution made to the knowledge of the chemical composition of the flesh of fish.

(5) *Analyses by Kostytscheff.*—These include 31 specimens of some 24 species. A considerable number of these, however, are of the prepared flesh or other parts of fish, so that, although their practical importance is very considerable, they contribute less to our knowledge of the actual composition of the tissues in their natural conditions than the number would indicate. The same remarks apply, though in less degree, to the analyses of Almén, König, and Payen.

(6) I also append the results of analyses of 2 specimens of European haddock made by myself in connection with the investigation on the digestibility of the flesh of fish reported beyond.

The above include all the analyses of the flesh of fish made by methods now current, which I had succeeded in finding when the present report was prepared. The following have since come to hand, but too late to be included in the tabular recapitulations.

(7) *Analyses by Popoff.*—These are reported by Kostytscheff and include 8 specimens of fresh and salt fish and 2 of roe of apparently 4 species.

(8) *Analyses by Sempolowski.*—Ten specimens were analyzed including 1 each of 7 species of fish, 1 of a crab, 1 of starfish, and 1 of oysters. They were chiefly for the purpose of learning the value of the materials for fertilizers and are of less interest here. The main results, however, are quoted beyond.

In the reports of Almén and of Kostytscheff Latin names are given. In the other reports, some of the names are those of species so common and well known as to leave little or no doubt, while other names are local or such as are applied to two or more species. Where the Latin names are not given by the analyst and are inserted by myself they are inclosed in brackets. In some cases the Latin names were kindly furnished by Prof. D. S. Jordan. These are indicated by "J" outside the brackets. Especially doubtful cases are indicated in the list of names by omission of the specific names or by an interrogation point.

The numbers prefixed to the names in the subjoined lists are those employed to designate the specimens in the tabular statements and discussions beyond.

NAMES OF EUROPEAN FISHES.

Fishes analyzed by Payen.—The French names herewith are those given by Payen, *Précis des Substances Alimentaires*, 4th ed., 1865, pp. 45 and 488. The German names are taken from a report of Payen's analyses in Dingler, *Polyt. Journal*, 134 (1854), 385. The analyses to follow are from the same sources.

No. I. Raie, Rochem, Skate, [*Raia*, sp.].
No. II. Anguille de mer (Congre), Meeraal, Conger eel, Conger [*vulgaris* ?].
No. III. Morue salée, Gesalzener Stockfisch, Stockfish, Salt codfish (?).
No. IV. Sardines à l'huile, Sardines, [*Clupea*, sp.].

No. V. Harengs salés, Gesalzenér Häring, Salt herring, [*Clupea harengus*].
No. VI. Harengs frais, Frischer Häring, Herring, [*Clupea harengus*].
No. VII. Merlan, Merlan, Whiting, [*Gadus harengus**].
No. VIII. Maquereau, Makrele, Mackerel, [*Scomber scombrus*].
No. IX. Sole, Meerzunge, Sole, *Pleuronectes solea*, [*Solea vulgaris*]
No. X. Limande, Glahrke, Dab, *Pleuronectes limanda*.
No. XI. Saumon, Lachs, Salmon, *Salmo salar*.
No. XII. Brochet, Hecht, Pike, *Esox lucius*.
No. XIII. Carpe, Karpfen, Carp, [*Cyprinus carpio*], J.
No. XIV. Barbillon, Bartfischen, Barbel (?), [*Barbus vulgaris* (?)].
No. XV. Gardon, Plotze (?), Roach (?), [*Leuciscus* sp.].
No. XVI. Goujons, Grundling, Gudgeon, *Gobio* sp.†
No. XVII. Ablettes, Uklei, (Kleiner) Weissfisch Bleak, [*Alburnus lucidus* ?].
No. XVIII. Anguille, Aal, Eel, [*Anguilla* sp.].

Fishes analyzed by König.—The following list of fishes analyzed by König and assistants, and the analyses beyond, are taken from König *Nahrungsmittel*, 2d ed., I, 16–18. The German names are König's.

No. XIX. Hecht, Pike, [*Esox lucius*].
No. XX. Shellfisch, Haddock (?), [*Gadus* sp.].
No. XXI. Häring, Salt Herring, [*Clupea harengus* (?)].
No. XXII. Lachs, Salmon, [*Salmo salar*].
No. XXIII. Sardellen, Anchovies (?), [*Engraulis encrasicholus* (?)].
No. XXIV. Stockfisch (Getrockneter Schellfisch), Cod or Ling (?), [*Gadus* sp.].
No. XXV. Bücklinge, Smoked herring (?), [*Clupea harengus* (?)].
No. XXVI. Sprotten, Sprat, [*Clupea sprattus*]. J.
No. XXVII. Neunaugen, Lamprey eel, [*Petromyzon* sp.].

I have marked haddock (Schellfisch), No. XVIII, as doubtful, though it may be less so than some of the others. Schellfisch is given in the books which I have consulted as the name for haddock (*M. aeglefinus*) in distinction from Dorsch, cod (*G. morrhua*), and is so used in common parlance, as I have observed, in different parts of Germany. But the plural is used generically for edible fishes of the genus, and in No. XXII of König's list it seems to me probable that it is intended to apply to cod or some other species of the same genus. The herring I suppose to be *C. harengus*.

Fishes analyzed by Buckland.—The following German names are, like the analyses, given by Konig,‡ for fishes reported§ as analyzed by F. Buckland. I have not seen Buckland's original account of the analyses, but there would seem to be little doubt that the ordinary salmon and herring are intended.

No. XXVIII. Lachs, Salmon, [*Salmo salar* (?)].
No. XXIX. Häring, Herring, [*Clupea harengus* (?)].

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* *Gadus aeglefinus* ? Payen, loc. cit., p. 45.

† Payen, loc. cit., speaks of the goujon as *Gobio cyprinus*, a species which I do not find in Günther's catalogue.

‡ In the Archiv f. Pharmacie, 1874, 203.

§ Nahrungsmittel, I, 16.

Fishes analyzed by Almén.—The subjoined list, with the analyses which follow, is copied from a monograph by Almén.* The English names, it will be noticed, are the last. The names in brackets are inserted by myself.

No. XXX. Aal, *Muræna anguilla* Lin., Al, Anguille, Eel.
No. XXXI. Makrele, *Scomber scombrus*, Lin., Makrill, Macquereau vulgaire.
No. XXXII. Lachs, *Salmo salar* Lin. Lax, Saumon, Salmon.
No. XXXIII. Stromling, *Clupea harengus* var. *membras* Lin., Stromming, Hareng commun petit, Little Herring, [Whitebait (?)].
No. XXXIV. Scholle, *Pleuronectes platessa* Lin., Flundra, Plie commune, Plaice.
No. XXXV. Barsch, *Perca fluviatilis* Lin., Aborre, Perche, Perch.
No. XXXVI. Dorsch, *Gadus callarias* Lin., [*Gadus morrhua*, Günther], Torsk, Morue proprement dite, Common cod.
No. XXXVII. Hecht, *Esox lucius* Lin., Gädda, Brochet commun, Pike.
No. XXXVIII. Gesalzener Häring, *Clupea harengus* Lin., Salt sill, Hareng commun, Herring.
No. XXXIX. Gesalzener fette Makrele, *Scomber scombrus* Lin., Salt Fet-Makrill, Maquereau vulgaire, Mackerel.
No. XL. Gesalzener Lachs, *Salmo salar* Lin., Salt Lax, Saumon, Salmon.
No. XLI. Kabeljau oder gesalzener Leng, *Gadus molva* Lin., Kabeljo eller salted Langa, Lingue, Ling.
No. XLII. Gesalzener Strömling, *Clupea harengus* var. *membras* Lin., Salt Stromming, Hareng commun petit, Little Herring, [Whitebait (?)].
No. XLIII. Stockfisch. *Gadus virens* Lin., Grasej, Stockfisk, Merlan noir, Codfish. [The *Gadus virens* is Pollock or Coalfish.]
No. XLIV. Fischmehl, *Gadus*, Fiskmjol, Morue, Cod.
No. XLV. Leng, *Gadus molva*, Lin., Spillanga eller torkad Langa Molva, Ling.

Fishes analyzed by Kostytscheff.—The following list of names and the accompanying analyses of Russian fishes analyzed by Professor Kostytscheff, are taken (with the analyses which follow) from a tabular statement (in English) exhibited at the International Fisheries Exhibition in London, in 1883. The explanatory names in brackets were kindly supplied by Professor Jordan. The names and analyses have also been compared with an English translation, made at the instance of the U. S. Fish Commission, of an article by Professor Kostytscheff in the Russian "Journal of Rural Economy and Forestry," vol. CXLIV, part II.

No. XLVI. Sigg, *Coregonus baerii*. [A kind of whitefish or lavaret].
No. XLVII. Pike perch, *Lucioperca sandra*, [Sandre, Stizostedion sandra].
No. XLVIII. Codfish, *Gadus morrhua*.
No. XLIX. Carp, *Cyprinus carpio*.
No. L. Pike, *Esox lucius*.
No. LI. Crucian carp, *Carassius vulgaris*.
No. LII. *Gadus navaga*, Russian cod, [*Pleurogadus navaga*].
No. LIII. Smelt, *Osmerus eperlanus*.
No. LIV. Salmon, *Salmo salar*.
No. LV. Salmon-trout, *Salmo trutta*.
No. LVI. *Clupea harengus* var. *membras*, [Common herring].
No. LVII. Sturgeon, *Acipenser güldenstaedtii*.
No. LVIII. Sterlet, *Acipenser ruthenus*.
No. LIX. Burbot, eel-pout, *Lota vulgaris*.

* Anales des Fleisches einiger Fische, Kgl. Ges. d. Wiss., Upsala, 1877.

No. LX. *Osmerus spirinchus.* [A kind of smelt].
No. LXI. *Meletta vulgaris.* [A kind of shad. *Clupea meletta*].
No. LXII. Salmon, *Salmo salar.*
No. LXIII. Halibut, *Hippoglossus maximus.*
No. LXIV. Great sturgeon, *Acipenser huso.*
No. LXV. River lamprey, *Petromyzon fluviatilis.*
No. LXVI. *Pelecus vulgaris.* [A kind of minnow.]
No. LXVII. *Alburnus chalcoides,* [Bleak].
No. LXVIII. *Leuciscus rutilus* var. *caspica,* [Roach].
No. LXIX. Cod, *Gadus morrhua.*
No. LXX. Caspian shad, *Alosa caspica, Clupea caspica.*
No. LXXI. Caviar of *Coregonus* species.
No. LXXII. Caviar of sturgeon.
No. LXXIII. *Coregonus leucichthys,* (Balyk.)
No. LXXIV. Sturgeon, (Balyk).
No. LXXV. Dorsal chords (Vezeega). [Back bones of sturgeon (?)].

Fishes analyzed by the writer.—Two specimens of European haddock, *Gadus æglefinus,* used in an investigation on the digestibility of fish (which was conducted in Munich, Germany, and is reported beyond) were analyzed with results as shown in Nos. LXXVI and LXXVII in the tables.

Fishes analyzed by Popoff.—The following list of names of Russian fishes and fish roe, analyzed by Popoff, is taken from the article by Professor Kostytscheff, referred to above, in which they are said to be quoted from a "dissertation for the degree of doctor of medicine," St. Petersburg, 1882. The names are from the translation above mentioned:

No. LXXVIII. Salt smelt (?)
No. LXXIX. Fresh smelt.
No. LXXX. Fresh vobla.
No. LXXXI. Smoked bream.
No. LXXII. Salt dried pike perch.
No. LXXXIII. Salt dried smelt.
No. LXXXIV. Roe of fresh vobla.
No. LXXXV. Roe of smoked bream.

The Russian names of Nos. LXXVIII and LXXXIII are different. That of LXXXIII is the same as No. LIII, which Prof. Kostytscheff translates into English as "Smelt, *Osmerus eperlanus.*"

Analyses by Sempolowski.—For reasons stated beyond, in connection with the quoted results, these analyses are not considered in detail in the present report, and hence the names of the species need not be given here.

2. RECAPITULATIONS OF ANALYSES OF EUROPEAN FISHES.

ANALYSES BY PAYEN.

Tables 10, 11, and 12 give the results of analyses by Payen. Table 10 gives the analyses of flesh in the form given by the analyst. Table 11 gives the proportion of refuse and flesh in the same specimens. In Table 12 the results are given in the forms used in this report.

Payen's analyses and statements were made before the methods now current had come into vogue, and a few changes of form of statement are necessary to make the results comparable with later ones. Thus (Table 10) instead of giving the percentages of nitrogenous substance, Payen gives the percentages of nitrogen and adds that the nitrogeneous substance can be estimated by multiplying the nitrogen by the factor 6.5. We have used the factor 6.25. In making the recalculations for Table 12 we here follow Payen's figures, but have also noted the adaptations of the same made by König.*

Regarding the figures in Table 10 the following remarks may be made: In the analysis of sardines † the percentage of nitrogen is given by Payen in round numbers as 6, and in a way that seems to imply that this was not intended as an exact statement of the percentage. Accordingly we have not figured out the percentage of protein. In the analysis of Roach,† No. XV, the percentage of nitrogen is stated at 2.33. The protein calculated from this by multiplying by 6.25 would be 14.56. The percentage of ash is not stated, but even if it were as high as 2 per cent. it would make the protein (N × 6.25) only 14.56 per cent., while the albuminoids, etc., as estimated by difference would amount to 17.72. There is probably an error in the figures. Presuming that this error may be in the nitrogen I have omitted the percentage of protein from the table. In the specimen of salmon, No. XI, the percentage of nitrogen is given as 2.10, which would make 13.1 per cent. of protein, while the percentage of albuminoids by difference is 18.17. The probability of error here is such that the protein is omitted. The figures for fresh herring are calculated by Payen from the analysis of salt herring, and I therefore omit the protein in this case also. In the other analyses the footings of water + protein + fat + ash are pretty near 100.

TABLE 10.—*Analyses of the flesh of fishes by Payen.*

Names of fishes.	Reference No. of specimen.	Water.	Dry substance.	Fat.	Mineral matters.	Nitrogen.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Skate (Raie)	I	75.489	24.511	0.472	1.706	3.846
Conger eel (Anguille de mer, Congre)	II	70.909	20.091	5.021	1.106	2.172
Stockfish (Morue salée)	III	47.029	52.071	0.383	[2]21.320	5.023
Sardines (Sardines à l'huile)	IV	46.04	53.96	9.36	7.9	6.
Salt herring (Harengs salés)	V	48.998	51.002	12.718	[3]16.433	3.112
Herring (Harengs frais)[1]	VI	70.000	30.000	10.300	1.900	2.450
Whiting (Merlan)	VII	82.950	17.050	0.383	1.083	2.416
Mackerel (Maquerau)	VIII	68.275	31.725	6.758	1.846	3.747
Sole (Sole)	IX	86.144	13.856	0.248	1.229	1.911
Dab (Limande)	X	79.412	20.588	2.058	1.936	2.898
Salmon (Saumon)	XI	75.704	24.296	4.849	1.279	2.095
Pike (Brochet)	XII	77.530	22.470	0.602	1.293	3.258
Carp (Carpe)	XIII	76.968	23.032	1.092	1.335	3.498
Barbel (Barbillon)	XIV	89.349	10.651	0.212	0.900	1.571
Roach (Gardon)	XV	67.030	32.970	13.250	....	2.329
Gudgeon (Goujons)	XVI	76.889	23.111	2.676	[6]3.443	[4]2.779
Bleak (Ablettes)	XVII	72.869	27.111	[5]8.134	[6]3.253	2.689
Eel (Anguille)	XVIII	62.076	37.924	23.861	0.773	2.000

[1] The analysis of fresh herring is calculated from that of salt herring, and the figures are therefore only approximate.
[2] Including 19.544 per cent. salt.
[3] Including 14.623 per cent. salt.
[4] 2.77 in Payen, Subs. Alimentaires, 488.
[5] 8.03 in loc. cit.
[6] These specimens included the small bones with the flesh "since they are eaten entire;" hence the large percentages of mineral matters.

* Nahrungsmittel. 3te Aufl., 1, 201-207.

† In *Subst. Aliment.*, p. 488. The analysis is not given in the other report referred to. See remarks on analysis by König beyond.

TABLE 11.—*Proportions of refuse and flesh in fishes analyzed by Payen.*

Kind of fish.	Reference No. of specimen.	Refuse.	Flesh.	Kind of fish.	Reference No. of specimen.	Refuse.	Flesh.
		P. ct.	*P. ct.*			*P. ct.*	*P. ct.*
Skate	I	19.28	80.72	Dab	X	24.66	75.34
Conger eel	II	14.92	85.08	Salmon	XI	9.04	90.52
Stockfish	III	11.34	88.66	Pike	XII	31.88	68.12
Sardines	IV	19.54	80.46	Carp	XIII	37.15	62.85
Salt herring	V	12.00	88.00	Barbel	XIV	46.95	53.05
Whiting	VII	40.88	59.12	Gudgeon	XVI	....	100.00
Mackerel	VIII	22.13	77.87	Bleak	XVII	24.11	75.89
Sole	IX	13.86	86.14	Eel	XVIII	....	100.00

TABLE 12.—*Analyses of fishes by Payen, stated in the form used in the present report.*

Kind of fish	Reference No. of specimen.	Water.	Water-free substance.	Albuminoids (by difference).	Fats.	Ash.	Nitrogen.	Protein (N × 6.25.)	Water+protein+fats+ash.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Skate	I	75.50	24.50	22.32	0.47	1.71	3.85	24.04	101.72
Conger eel	II	79.91	20.09	13.96	5.02	1.11	2.17	13.58	99.62
Stockfish	III	47.03	52.97	31.27	0.38	*21.32	5.02	31.39	100.12
Sardines (in oil)	IV	46.04	53.96	30.70	9.36	7.90	6.00	......	......
Salt herring	V	49.00	51.00	21.85	12.72	†16.43	3.11	19.45	97.60
Herring	VI	70.00	30.00	17.80	10.30	1.90	......	......	......
Whiting	VII	82.95	17.05	15.59	0.38	1.08	2.42	15.10	99.51
Mackerel	VIII	68.28	31.72	23.11	6.76	1.85	3.75	23.42	100.31
Sole	IX	86.14	13.86	12.38	0.25	1.23	1.91	11.94	99.56
Dab	X	79.41	20.59	16.59	2.06	1.94	2.90	18.11	101.52
Salmon	XI	75.70	24.30	18.17	4.85	1.28	......	......	......
Pike	XII	77.53	22.47	20.58	0.60	1.29	3.26	20.36	99.78
Carp	XIII	76.97	23.03	20.60	1.09	1.34	3.50	21.86	101.26
Barbel	XIV	89.35	10.65	9.54	0.21	0.90	1.57	9.82	100.28
Roach	XV	67.03	32.97	......	13.25	......	2.33	14.56	......
Gudgeon	XVI	76.89	23.11	16.99	2.68	‡3.44	2.78	17.37	100.38
Bleak	XVII	72.89	27.11	15.73	8.13	‡3.25	2.69	16.81	101.08
Eel	XVIII	62.08	37.92	13.29	23.86	0.77	2.00	12.50	99.21

* Including 19.54 per cent. salt. † Including 14.62 per cent. salt. ‡ Including small bones.

ANALYSES BY KÖNIG.

The analyses in Table 13, by Professor König and his assistants, Messrs. Brimmer, Farwick, and Krauch, are taken from König, *Nahrungsmittel*, as above stated. Some of the analyses are given in the *Zeitschrift für Biologie*, 1876, p. 507, others in the *Chem. u. tech. Untersuchungen an der Versuchstation, Münster*, 1878, *S.* 106.

In König's tables the protein (Stickstoff-Substanz) is estimated by multiplying the nitrogen by 6.25, the nitrogen having been determined by soda-lime. Where the sum of percentages, protein + fat (ether extract) + ash + water, is less than 100, the difference is taken as, "Non-nitrogenous extractives" (*N-freie Extractstoffe*). We have altered the form of statement into that adopted for the tables of this report; that is to say, the amounts of "albuminoids by difference" are computed by subtracting the sum of the water, fats, and ash from water-free substance, and put in the place of the protein (N × 6.25) of König's table.

The protein is given, however, in another column, as in the previous table, and the sum of water, protein, fat, and ash are also stated. This permits the same comparisons as in the tables of analyses of American fishes. In the salt herring, the footing of water + protein + fats + ash is exactly 100 per cent. and in the smoked salmon it is exactly 99 per cent. Although these are round numbers I see no justification for assuming that they are other than accidental.

TABLE 13.—*Analyses of fishes by König and assistants.*

Kind of fish.	Reference No. of specimen.	Water.	Water-free substance.	Albuminoids (by difference).	Fats.	Ash.	Nitrogen.	Protein (N × 6.25).	Water + protein + fats + ash.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct*	*P. ct.*	*P. ct.*	*P. ct.*
Pike (Hecht)	XIX	77.37	22.63	21.46	0.79	0.38	3.18	19.86	98.40
Haddock (Schellfisch)	XX	80.97	19.03	17.05	0.34	*1.64	2.73	17.09	100.04
Salt herring (Häring)	XXI	47.12	52.88	18.97	16.67	17.24	3.04	18.97	100.00
Smoked and salted salmon (Lachs)	XXII	51.89	48.11	27.00	11.72	9.39	4.16	26.00	99.00
Anchovies (Sardellen)	XXIII	51.77	48.23	22.75	2.21	23.27	3.57	22.30	99.55
Cod or ling (Stockfisch, getrockneter Schellfisch)	XXIV	18.60	81.40	79.52	0.36	1.52	12.46	77.90	98.38
Smoked herring (Bücklinge)	XXV	69.49	30.51	20.76	8.51	*1.24	3.38	21.12	100.36
Spratt	XXVI	59.89	40.11	23.71	15.94	*0.46	3.64	22.73	99.02
Lamprey eel pickled (Neunaugen, marinirt)	XXVII	51.21	48.79	21.79	25.59	1.41	3.23	20.18	98.39

*After the extraction of calcium phosphate from bones and scales.

ANALYSES BY BUCKLAND.

The *Central-Blatt für Agrikulturchemie*, 1874, II, 75, contains reports of analyses of salmon and herring by F. Buckland, which are said to have been published in the *Circular des deutschen Fischereivereins*, 1875, *No.* 6, and republished in the *Archiv für Pharmacie*, 1874, *Bd.* 203, *Heft* 2, *S.* 178, from which latter the very brief account in the *Central-Blatt* is taken. The percentages are stated to have been calculated by the compiler of the article in the last-named journal from the English figures, which were given in absolute weights. Not having the original data at hand, I give in Table 14 the composition as stated by König (loc. cit.), who, as I infer from his statement, had the original figures. The fact that the footings are both exactly 100 suggest that one of the estimations may have been made by difference. The ash in the salmon is abnormally large.

TABLE 14.—*Analyses by Buckland.*

Kind of fish.	Reference No. of specimen.	Date of analysis.	Water.	Protein (nitrogen compounds).	Fat.	Ash.	Water + protein + fat + ash.	In water-free substance.	
								Nitrogen.	Fat.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Salmon, fresh	XXVIII	1874	77.06	13.11	4.30	5.53	100.00	9.23	18.74
Herring	XXIX	1874	80.71	10.11	7.11	2.07	100.00	8.39	36.86

ANALYSES BY ALMÉN.

As the original report* of Almén's investigations seems to have had a somewhat limited circulation, and only brief abstracts have appeared in the journals, it will not be amiss to cite some of the details. They may be best introduced by his tabular statement of results, which is translated as Table 15. The succeeding statements are freely translated or condensed from Almén's report.

TABLE 15.—*Analyses of fishes and of beef by Almén.*

Name of specimen.		A. Fresh fish and beef.								
		1	2	3	4	5	6	7	8	9
		Eel (Muræna anguilla).	Mackerel (Scomber scombrus).	Salmon (Salmo salar).	Little herring (Clupea harengus v. membras).	Beef (Bos taurus).	Plaice (Pleuronectes platessa).	Perch (Perca fluviatilis).	Common cod (Gadus callarias).	Pike (Esox lucius).
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Soluble albumen	*a*	1.46	2.74	3.39	2.64	2.13	1.72	3.61	1.78	2.52
Insoluble protein compounds	*b*	8.14	11.84	11.02	11.76	14.29	12.31	9.01	9.33	7.64
Gelatin formers	*c*	2.04	1.01	1.50	2.53	1.46	3.17	3.74	2.69	2.82
Protein compounds	*d*	11.64	15.59	15.91	16.93	17.88	17.20	16.36	13.80	12.98
Extractive matters	*e*	1.78	1.87	2.15	2.30	1.95	2.15	1.76	1.58	1.85
Fat	*f*	32.88	16.41	10.12	5.87	2.28	1.80	0.44	0.20	0.15
Salts	*g*	0.92	1.70	1.49	1.65	1.13	1.46	1.38	1.44	1.13
Water	*h*	52.78	64.43	70.33	73.25	76.76	77.39	80.06	82.98	83.89
Water-free substance	*i*	47.22	35.57	29.67	26.75	23.24	22.61	19.94	17.02	16.11
Nitrogen	*k*	2.105	3.225	3.103	3.013	3.328	3.198	2.898	2.674	2.370
Protein compounds calculated from nitrogen	*l*	11.24	17.22	16.57	16.09	17.77	17.08	15.48	14.28	12.66
Insoluble salts	*m*	0.26	0.25	0.32	0.89	0.65	0.44	0.57	0.75	0.22
Soluble salts	*n*	0.66	1.45	1.17	0.76	0.48	1.02	0.81	0.69	0.91
Chlorine	*o*	0.013	0.173	0.043	0.079	0.059	0.140	0.061	0.097	0.186
Calculated on water-free substance. — Protein compounds	*p*	24.65	43.83	53.62	63.29	76.94	76.07	82.04	81.08	80.57
Calculated on water-free substance. — Extractive matters	*q*	3.77	5.26	7.25	8.60	8.39	9.51	8.83	9.28	11.48
Calculated on water-free substance. — Fat	*r*	69.63	46.14	34.11	21.94	9.81	7.96	2.21	1.18	0.93
Calculated on water-free substance. — Salts	*s*	1.95	4.77	5.02	6.17	4.86	6.46	6.92	8.46	7.02
Calculated on water-free substance. — Nitrogen percentage	*t*	4.46	9.07	10.46	11.26	14.32	14.14	14.53	15.71	14.71

*Analyse des Fleisches einiger Fische, von Aug. Almén (Mitgetheilt der Königl. Gesellschaft der Wissenschaften zu Upsala am 7 April, 1877.) Upsala, 1877, 4to, 59 pp.

TABLE 15.—*Analyses of fishes and of beef by Almén*—Continued.

Name of specimen.		B. Salted fish.					C. Dried fish.		
		10	11	12	13	14	15	16	17
		Herring (Clupea harengus).	Mackerel (Scomber scombrus).	Salmon (Salmo salar).	Ling (Gadus molva vel morrhua).	Little herring (Clupea harengus v. membras).	Codfish (Gadus virens).	Codfish powder (Gadus).	Ling (Gadus molva).
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Soluble albumen	*a*	1.71	1.28	2.73	0.60	1.00	5.36	3.38	1.86
Insoluble protein compounds	*b*	11.31	15.68	15.10	16.07	13.82	54.01	50.56	38.60
Gelatin formers	*c*	1.93	1.50	1.41	7.06	1.76	12.35	10.47	13.72
Protein compounds	*d*	14.95	18.46	19.24	23.73	16.58	71.72	64.41	54.18
Extractive matters	*e*	5.52	2.74	3.02	3.70	2.82	6.48	9.14	4.00
Fat	*f*	21.30	14.10	12.00	0.40	7.05	1.20	0.70	0.57
Salts	*g*	15.66	16.27	14.70	19.75	17.93	6.89	8.73	11.82
Water	*h*	42.57	48.43	51.04	52.42	55.62	13.71	17.02	28.53
Water-free substance	*i*	57.43	51.57	48.96	47.58	44.38	86.29	82.98	71.47
Nitrogen	*k*	2.925	3.331	3.581	4.575	3.100	12.79	12.17	9.46
Protein compounds calculated from nitrogen	*l*	15.62	17.79	19.12	24.43	16.55	68.30	65.00	50.51
Insoluble salts	*m*	1.43	1.13	0.72	1.42	0.83	3.83	7.00	2.29
Soluble salts	*n*	14.23	15.14	13.98	18.33	17.10	3.06	1.73	9.53
Chlorine	*o*	13.65	14.50	13.81	18.00	16.24	0.19	0.60	9.08
Calculated on water-free substance. Protein compounds	*p*	26.03	35.80	39.30	49.88	37.36	83.11	77.62	75.81
Calculated on water-free substance. Extractive matters	*q*	9.61	5.31	6.17	7.77	6.35	7.51	11.02	6.86
Calculated on water-free substance. Fat	*r*	37.09	27.34	24.51	0.84	15.89	1.39	0.84	0.79
Calculated on water-free substance. Salts	*s*	27.27	31.55	30.02	41.51	40.40	7.99	10.52	16.54
Calculated on water-free substance. Nitrogen percentage	*t*	5.093	6.459	7.314	9.62	6.985	14.82	14.67	13.23

METHODS OF ANALYSIS.

The execution of the analyses seems to have been in some respects less detailed than might have been the case. Thus many, if not most, of the more important determinations are not duplicated but made only once in each experiment. I would not, however, be understood to question the reliability of the results except in so far as single determinations are always uncertain. Agreement of duplicates by no means proves the correctness of an analysis but their failure to agree often calls attention to errors which might otherwise escape notice.

As regards the preparation of the material for the analysis, Almén, after speaking of the ease with which bones, tendons, and fat can be separated from the other tissues in meats, remarks as follows:

In investigating the colorless and almost white meat of fish the foreign ingredients can not be separated with the same facility and thoroughness as is done in the analysis of beef. In fish there are a great number of bones disseminated throughout the meat and which have the same color. These are very difficult to separate and portions remain in the flesh during the analysis, and through their richness in phosphate of lime and gelatin-formers increase the quantity of salts, especially the insoluble salts, and of gelatin. As it is, however, not intended in these investigations to make a comparison between the muscular tissues of fish and mammals, but a comparison between the different kinds of fish and beef as articles of food, the flesh of fish for investigation has been no more carefully prepared than is usual in the preparation of food for the table.

The scales were thoroughly removed from the fresh fish, their heads cut off, and the entrails taken out. The meat and skin were then separated as well as possible from the backbone, tail, and bony fins. The whole flesh thus obtained was cut fine, and carefully rubbed in a mortar until it formed a homogeneous mass, which was used for the analyses.

The water was determined in the flesh by heating 15 or 20 grammes, first at a lower temperature in a water bath and then at 110° C., to a constant weight. As the flesh grew horny and hard in drying it was from time to time stirred and pulverized with a glass rod or pestle, and thus ground fine so as to allow the escape of all of the water. Almén insists upon the necessity of thorough and complete drying, and believes that it was accomplished by this means.

The ash was determined by burning the dried substance in air. When necessary to avoid fusion of the alkaline salts and consequent imperfect ignition, the mass was first charred and then extracted with water. Where the ignition was practicable without this previous charring and extraction the ash was treated with water, and the soluble and insoluble salts weighed separately. Where the material was first charred the soluble salts were then extracted and weighed and the insoluble salts afterwards determined.

The chlorine was determined in the salts by a titration with a decinormal solution of silver nitrate. Almén remarks that—

In the fresh fish the chlorine occurs principally as potassium chloride; in the salt fish almost exclusively as sodium chloride. In the former the content of chlorine as shown by the analyses must be regarded as correct, while for the latter the amount of sodium chloride must be taken into account in order to determine the amount of salt used in salting the fish. A small portion of the chlorides may have been volatilized in the ignition, and the results of the determinations of ash and of chlorine thus rendered somewhat incorrect. Since, however, the method was the same in all of the cases, the figures that are given may be accepted as fair indications of the relative amounts actually present.

The amount of fat was determined by extracting the dried and pulverized flesh with ether to which a small quantity of 97 per cent. alcohol had been added. The ethereal solution was dried in a water-bath to constant weight. The extraction was always complete and the errors can not be important.

The nitrogen determinations were made by burning with soda lime. For this purpose 3 or 4 grammes of the finely divided and homogeneously mixed flesh were dried in a water bath. It was then very finely pulverized and carefully mixed with the soda lime.

The combustions were conducted first in glass tubes and afterwards in porcelain tubes, in which latter the operation went on more quietly. The ammonia was caught in a standard solution of sulphuric acid of normal strength and titrated against soda solution of one-third normal strength. In the first combustions, colored decomposition products appeared, imparting to the sulphuric acid a light-reddish color which made the titration somewhat uncertain. The litmus color was, nevertheless, predominant and the limits of error in the titration could not have exceeded 0.2 per cent. or at most 0.4 per cent. of the soda solution, which would correspond to from 1 to 2 milligrammes of nitrogen, which was of no importance for these investigations in view of their practical purpose. I succeeded, however, in avoiding these colored combustion products by filling the anterior part of the tube with coarse soda lime, through which the products of the combustion were obliged to pass. When, however, only the fine soda lime was used the colored products passed over without being decomposed.

Almén insists upon the finest practicable pulverization and careful mixing of the substance with soda lime, which latter had been carefully tested by combustion with sugar to prove its purity:

As an indication that the nitrogen determinations were reliable and correct, within the limits required for their purpose, I may state that two determinations with fish meal gave, respectively, 12.17 per cent. and 12.21 per cent. of nitrogen, and two others with fresh flesh of cod gave, respectively, 2.63 per cent. and 2.72 per cent. of nitrogen. The disagreement of duplicates thus did not exceed 0.1 per cent. of nitrogen or 0.5 per cent. of protein.

In speaking of our own attempts at determining the nitrogenous ingredients directly, Section A, Division 2, I referred to the fact that these determinations were made as much for the purpose of testing the methods, and for comparing the results with those obtained by other investigators, as for the sake of the results themselves. I had especially in mind the work of Almén, who has made a considerable number of estimations of albumen, other substances soluble in water, gelatin-formers, and the extractive matters. The descriptions of his methods as well as his results seem worthy of somewhat detailed statement here, since this work with that of Kostytschef, which I presume to have been conducted by similar methods, constitutes the most extensive contribution we have to the knowledge of this particular subject.

Almén lays especial stress upon the comparison between the composition of beef and that of the several kinds of fishes which he analyzed, the analyses of the beef and fish being made by the same methods. The albumen soluble in water, the gelatin-forming substances (gelatinoids as they are sometimes called), and the extractive matters were estimated as follows:

The determination of these several constituents were made in each case in a single portion of the flesh, generally about 33.3 grammes, which had been finely divided and well mixed as previously stated. The flesh was placed in about 250 grammes of distilled water, stirred and allowed to stand from 8 to 12 hours, with frequent stirring, and then filtered through paper by means of a Bunsen filter pump. The undissolved portion was then extracted in like manner a second time, with the same quantity of distilled water, and washed once on the filter. The filtrates and the washings, which together made about 600 cubic centimeters, were then boiled down in a porcelain dish to about 70 to 100 cubic centimeters. In this process the albumen separated out in coarse flocculent masses which were easily filtered. They were placed upon the filter, washed with hot water, completely dried at 110° C., and weighed between two watch-glasses. In working with some kinds of fish, it happens that in the second extraction with cold water the insoluble portion assumes a gelatinous form similar to syntonin, and is difficult to filter. By use of the Bunsen pump and a goodly amount of patience, the filtration always succeeded.

The longer the extraction was protracted with new portions of water, the more gelatinous the residue became, without, however, any considerable quantity of soluble albuminous matter passing into the solution. This was particularly the case with perch. Whether this peculiarity of the flesh of some of the fishes depended upon lack of acid in the muscle, upon the way they were killed, or upon the fact that the fishes in question had been frozen and that the flesh had thereby suffered some alteration, or whether it was due to other causes, I can not say. In the boiling of the extract, complete coagulation was not obtained until a small quantity, 5 to 10 drops, of acetic acid had been added. The flesh of some fishes gives a second filtrate of so slight acidity that boiling alone, without addition of acetic acid, does not cause a complete separation of the albuminoids. On this account the filtration proceeds very slowly, and there is formed on the surface of the filtrate during the subsequent evaporation a casein-like film. This occurs when a little acetic acid had been added during the boiling for precipitating the albumen. When the amount of the precipitated albumen is considerable, from 0.5 gramme to 1.0 gramme, a complete drying upon the filter is tedious and difficult. But if the partly dried and reasonably solid mass which sticks to the filter is separated in thin layers by means of a sharp penknife and placed upon a watch-glass, the drying is rapid and complete.

The filtrate from the precipitated albumen was evaporated in a platinum capsule over a water bath and then completely dried at 110° C. and weighed. Thereafter it was ignited at a low heat, generally in the same platinum capsule, which, during the incineration, was covered with a larger capsule, the latter thus serving as a loosely fitting cover. The light-colored ash thus produced was weighed and its weight subtracted from the total weight of the dried substance, the loss being taken as the amount of the extractive matters. If, however, the direct ignition was not satisfactory, the amounts of the soluble and insoluble salts were determined separately and their sum subtracted from the total weight of the dried substance.

The portion of the flesh which did not dissolve in water was carefully removed from the filter and boiled for about 12 hours in a porcelain dish with a larger amount, 500 to 600 cubic centimeters of water. The porcelain dish was covered with a large funnel and as the water boiled away it was replaced by distilled water. During the boiling, thin yellow films formed on the sides of the evaporating dish. These had the appearance of gelatin but were not soluble in boiling water. Boiling in a glass flask was not successful on account of the heavy bumping, by which the contents were at times projected out of the flask. This occurred once or twice in the boiling in the porcelain evaporating dish. The solution of gelatin was filtered boiling hot, the insoluble portion boiled again with a larger amount of water, filtered, and washed with boiling hot water. The gelatin solution, which was usually light yellow in color, was concentrated by evaporation in a porcelain dish to a small volume, then transferred to a platinum capsule and dried, first over a water bath and then in the drying oven. The residue had the appearance of a fine jelly, but did not become hard on cooling.

This gelatin is not entirely pure. It contains especially, besides other matters, some salts insoluble in cold water. The gelatin from the plaice, for instance, contained 3 per cent. of ash corresponding to 0.1 per cent. of the total flesh. The parallel determinations from the same flesh gave results which agreed well with one another. The perch, for instance, yielded in two determinations 3.71 per cent. and 3.77 per cent. of gelatin. The amount of gelatin obtained in the second 12 hours' boiling, though appreciable, is very small in comparison with that yielded by the first 12 hours' boiling. In my opinion, the determinations of the gelatinoids are the least reliable of all. They are, nevertheless, sufficiently accurate for comparison, since they were all conducted by the same method.

In regard to the remaining nitrogenous material, Almén remarks:

The insoluble protein, for reasons easily seen, can not be directly determined. On this account, it is usual to determine by differences. The total water-free substance minus the sum of the salts, fat, extractives, gelatinoids, and soluble albumen, gives the insoluble protein. All the errors which may be made, in the determinations of the other substances named, thus appear in the estimation of the insoluble protein.

In other words, the insoluble protein was not directly determined, but was estimated by difference.

Since this is one of the most important constituents of the flesh, Almén had recourse to direct determination of nitrogen and the computation of the amount of total protein matters from the percentage thus obtained.

PERCENTAGE OF NITROGEN IN PROTEIN COMPOUNDS.

The subject of the percentages of nitrogen in the flesh of fish is treated at some length by Almén. I quote his language:

The percentage of nitrogen, without doubt, demands special consideration, because it is a measure of the amount of protein compounds. When we consider the varying percentage of fat, we might expect wide variations. The amounts of nitrogen in the flesh of fish, however, range between 2.1 per cent. and 3.2 per cent., while beef contains 3.33 per cent. The plaice comes next to beef, with 3.20 per cent. Consequently it contains more protein matters than any other fish studied. By comparing the series (*d*) and (*e*) (of table 15 above) it will be seen that the percentages of nitrogen are a correct measure of the relative amounts of protein.

The amount of protein computed from the determined percentages of nitrogen depends, of course, upon the number by which the latter percentages are multiplied or, in other words, upon the nitrogen percentage-coefficient [nitrogen factor] of the flesh. The percentage of nitrogen in the true protein compounds [albuminoids and gelatinoids] varies from 15.4 to 16.5 per cent., and averages 16 per cent., from which it follows that, to obtain the percentage of actual protein compounds, we have to multiply the nitrogen in the latter by 6.25, or, in other words, 6.25 is the nitrogen percentage-coefficient (nitrogen factor) for pure protein compounds in general. This coefficient is often used in calculating the amount of protein in vegetable as well as in animal food materials.

Referring now to the amount of protein compounds in the flesh of fish, it may be noted that Payen gives the nitrogen percentages of different fish and adds (in a footnote) that the amount of protein may be obtained by multiplying the percentage of nitrogen by 6.5. Letheby, in like manner, in a table of the composition of various food materials, gives their contents of nitrogen and protein compounds, the latter being 6.5 times as large as the former. Pavy employs the same coefficient, following the figures in Letheby's table.

This method of calculating the amount of protein compounds in meat and other food materials in the same way as for pure protein compounds, namely, by multiplying the nitrogen percentages by 6.25, leads to gross errors, because flesh is in no way pure protein, but contains a number of other ingredients, namely the extractive matters, some of which are non-nitrogenous (inosite), while others which are rich in nitrogen (kreatin, hypoxanthin, etc.) might, with as good reason, be counted as worthless as ranked with protein. The common "Liebig's meat extract" is said to contain 9 to 10 per cent. of nitrogen and 33 to 40 per cent. of salts and water. Taking these out, the remainder corresponds to the water-free extractive matters, which are said to contain about 15 per cent. of nitrogen or nearly the same proportion as the pure protein compounds. Now, since flesh contains about 2 per cent. of extractive matters with about the same content of nitrogen as the protein compounds, it is clear that the amount of protein compounds obtained by multiplying the nitrogen by 6.25 must be too large, and in no way corresponds to the actual quantity of pure protein compounds present but, rather, very closely to the sum of these and the extractive matters.

Almén's point, that multiplying the total nitrogen, including that which belongs to the extractives as well as that in the protein compounds, albuminoids, and gelatinoids, by 6.25 would give a product larger than the actual amount of protein compounds, is too evident to require argument. He adduces, however, figures from Payen's and Pettenkofer and Voit's analyses, as well as his own, from which he computes that in the water-free substance of lean beef the actual amounts of protein compounds could hardly be more than 77 per cent., while the ordinary computation would make them as high as 88 to 92 per cent.

In view of the labor involved in direct determinations of the actual amount of protein compounds, exclusive of extractive matters, Almén has attempted to find what proportion of the nitrogen actually belongs to these compounds, or, to speak more properly, by what factor the total nitrogen should be multiplied in order to yield figures corresponding with the actual amounts of protein compounds. For this purpose he takes the sums of the soluble albumen, the gelatinoids, and the other protein compounds in eight different specimens of flesh of fish and one of beef (which numbers are found in the line designated by (*d*) in Part A of Table 15), and adding them together finds their sum to be 138.29 per cent. The sum of the corresponding percentages of nitrogen, line (*k*) in the same table, is 25.914 per cent. Dividing the former of these two sums by the latter he obtains the quotient 5.34, which he designates as the coefficient by which the percentage of nitrogen in the flesh should be multiplied in order to give the actual amount of protein compounds in the flesh. He then assumes that the multiplication of the percentage of nitrogen in any one of the specimens of fish analyzed, fresh, salt, or dried,. will give the actual amount of protein. These calculated amounts he gives in line (*e*) of his table. The amounts of protein as directly determined then compare with the amounts thus calculated, as shown in Table 16.

TABLE 16.—*Comparison between percentages of protein compounds as directly determined and as computed by multiplying the total nitrogen by 5.34.*

Fresh fish and lean beef.			Dried and salted fish.		
In flesh of—	Protein compounds. Directly determined.	Protein compounds. Computed from nitrogen.	In flesh of—	Protein compounds. Directly determined.	Protein compounds. Computed from nitrogen.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Eel	11.64	11.24	Salted herring	14.95	15.62
Mackerel	15.59	17.22	Salted mackerel	18.46	17.79
Salmon	15.91	16.57	Salted salmon	19.24	19.12
Little herring	16.93	16.09	Salted ling	23.73	24.43
Plaice	17.20	17.08	Salted little herring	16.58	16.55
Perch	16.36	15.48	Dried pollock	71.72	68.30
Cod	13.80	14.28	Dried cod (powdered)	64.41	65.00
Pike	12.98	12.66	Dried ling	54.18	50.51
Lean beef	17.88	17.77			

It will be borne in mind that the direct determination of protein was more properly a determination by difference, since it was made by subtracting the sum of the extractive matters, fat, and ash from the total water-free substance. Any errors, therefore, which might have occurred in the determinations of either ash, fat, or albumen would enter into this estimation of the protein. The fact that the majority of the determinations of these substances were made not in duplicate but singly would, unless unusual care was exercised in the work, leave grounds for fear that errors might have entered into them. That Almén was himself persuaded that his determinations might not have been free from mistakes, he takes pains to state in his references to the differences which occur between the amounts of protein as estimated by the two methods. Thus, the quite wide differences between the two estimations in the fresh mackerel (1.6 per cent.) and in the perch (0.9 per cent.) he attributes to probable errors in the nitrogen determination. While I would wish to refrain from criticism of the labor of a fellow-investigator, it is not easy to avoid the feeling that greater care in the analytical work would have yielded less uncertain results. At the same time, my own analyses,* already given, show variations between the amounts of protein as directly determined (albuminoids by difference of the tables) and the amounts obtained by multiplying the nitrogen by 6.25 as large as, or nearly as large as, those here stated, though of course in my own analyses the protein refers to the whole nitrogenous material, while in this case Almén includes only the true protein compounds, the albuminoids and the gelatinoids, the extractive matters being excluded.

SOLUBLE AND INSOLUBLE SALTS, CHLORINE, ETC.

Some of Almén's other conclusions are of decided interest. The insoluble salts he regards as including, in some cases, the phosphates of the small bones which are not separated from the flesh. The soluble salts vary between 0.5 per cent. and 1.5 per cent. in the flesh. The smallest portion was in the lean beef; the percentage in the different kinds of flesh of fishes being considerably larger.

The amount of chlorine is very insignificant. No difference is observable, either between the chlorine in the fresh-water and sea-water fishes or between the flesh of fishes and lean beef; but, as Almén observes, it is to be remembered that the chlorine was determined in the ash, from which a portion may have escaped in the ignition.

STATEMENTS REGARDING INDIVIDUAL SPECIMENS.

As stated above, in the descriptions of the methods of analysis, Almén analyzed the flesh and skin of the fish together, regarding these as constituting the edible portion and the remainder as refuse. Reference to the details of his memoir, however, shows that in some cases the flesh alone was used, the skin being rejected. The following statements in Almén's description of the individual specimens are also worthy of especial record:

No. XXX. The first specimen in the table was, "An ordinary fresh-water eel weighing 328 grammes. The skin was removed and weighed 35 grammes or 11 per cent. of the whole. The flesh freed from bones and other refuse weighed 209 grammes, or 64 per cent. of the whole eel. The head and other parts not used for food amounted to 36 per cent." In this very fat fish, therefore, the refuse, as Almén remarks, made up a

* See Section A, Divisions 4 (Tables 2 and 3) and 5, above.

much smaller proportion of the whole weight than is usually the case with fishes. The specimen thus analyzed consisted of flesh without skin.

No. XXXI. "The specimen of fresh mackerel was of the kind which occur in late autumn in the bays on the Swedish coast and are very fat. This specimen was quite small."

No. XXXII. "This specimen was taken from a salmon estimated to weigh about 6½ kilos. It consisted of a slice across the middle of the fish intended to include the leaner flesh of the back and the fatter flesh of the belly." The attempt was evidently made to secure a slice that would fairly represent the composition of the whole of the flesh. The flesh freed from skin was used for the analysis.

No. XXXIII. The specimen of "little herring" (whitebait"?) included 7 fish, weighing together 198 grammes. The head, bones, scales, and entrails weighed 66 grammes, or 33 per cent., the milt and spawn 22 grammes, or 11 per cent., the flesh and skin which were taken for analysis, 110 grammes, or 55 per cent. of the whole weight.

No. XXXV. The specimen of perch consisted of one entire fish weighing 403 grammes, of which the roe constituted 10 per cent., the head 20 per cent., and these, with the entrails, bones, and other refuse, 59 per cent. of the whole weight, the edible portion, flesh, and skin making 41 per cent.

No. XXXVII. The specimen of pike consisted of one very small fish, weighing only 260 grammes, of which the edible portion, flesh, and skin, freed from scales, made 53 per cent.

No. XXXVIII. The salt herring was "one of the ordinary Norwegian *Tonnen härringe*," which I understand to be herring salted in brine. The specimen was smaller and leaner than usual. The edible portion, flesh, and skin of a large herring was found to constitute 69 per cent. and that of a small one 63 per cent. of the total weight of the fish, from which Almén takes 66 per cent. as the average amount of edible portion in these fish.

No. XXXIX. The salted mackerel are the so-called fat mackerel taken in late autumn on the Swedish coast. These are cleaned, heavily salted and packed in small kegs. On account of their fatness they are highly prized, bringing higher prices than the Norwegian herring. The specimen analyzed consisted of flesh and skin.

No. XL. The next specimen is described as "one of the ordinary salted salmon, as it is commonly found in large flat pieces." The specimen consisted of the flesh and skin, freed from scales.

No. XLI. The ling is described as "the ordinary Kabeljau as it occurs in the markets, dried and salted in tubs without brine." The flesh, with the skin freed from scales, was analyzed.

No. XLII. This consisted of 9 salt herring ("Little herring," Germ. Strömling) a kind very common in the Swedish market, salted in brine in tubs. The specimen was of inferior quality. The 9 fish, after the brine had been wiped off with a cloth, weighed only 217 grammes, of which the edible portion (both flesh and skin?) made 61 per cent.

No. XLIII. This is designated by Almén as "Stockfish, *Gadus virens*, codfish." The *Gadus virens*, however, is not what we ordinarily call in English codfish, but rather the pollock or coal fish. Almén describes the specimen as ordinary stockfish, dried, unsalted, and with a brownish yellow flesh, and so hard and tough and horny that it was impossible to cut it with a knife. "I was obliged to pound the knife with a hammer, and thus succeeded in dividing the fish into small pieces which were pounded up in a mortar to a coarse homogeneous powder."

No. XLIV. This fish-meal (fischmehl) is described as a "light-yellow, loose powder which has lately come into our markets, and consists of short elastic fibers (muscle fibers). It has a slight odor similar to that of dried fish, and is nearly tasteless." According to this description, the specimen must be very similar in appearance, odor, and taste to the dessicated cod, No. 80, described in the analyses of American preserved fishes.

No. XLV. Of the ling, Almén speaks as follows: "In the preparation of this fish, it is customary to cut off the head and remove the entrails and backbone. The two sides, which remain together, are spread out, and thus dried. In this form it comes into the market. The ling is not salted before drying. I believe, however, that after it has been cleaned, it is allowed to lie for a short time in sea water to remove the blood and coloring matter and give the fish a white and attractive appearance. The specimen analyzed had the ordinary appearance, and was so dry, tough, and hard that it was only with the help of a hammer and knife that I succeeded in cutting it up into small pieces. The flesh and skin were then pulverized and used for the analysis."

Tables 17 and 18 give the results of Almén's analyses in the form used in this report. The percentage of "albuminoids, etc., by difference" and for protein (N × 6.25) are computed from Almén's figures. As shown in the last column of Table 18, the sum of the water, protein (N×6.25), fats, and ash in the flesh came very near to 100 in most of the cases. In our analyses of American fishes the sums of these ingredients in the cod and other species of *Gadus* exceeded 100. Almén's results are very similar. One of the specimens of mackerel comes up quite high, 102.7 per cent. The correctness of this analysis is, however, called in question by Almén. The data of Table 18 are not exactly comparable with those of the corresponding table of analyses of American fishes, since, in most cases, the specimens include, with the flesh, the skin, which is richer in gelatinoids, while our analyses were made with the flesh alone. In our analyses, the insoluble albuminoids (insoluble protein) were determined directly, while the estimates in Almén's are by difference. Rather more pains were taken, in our analyses, to determine the ash and fat in the albuminoids, etc. The methods of analysis were otherwise essentially the same.

TABLE 17.—*Analyses of fish, etc., by Almén (figures recalculated to the forms used in this report).*

Names of fishes.	Reference No. of specimen.	Water.	Water-free substance.	Albuminoids (by difference).*	Fats.	Ash.†	Nitrogen.	Protein, N×6.25.	Water protein + fats + ash.
FRESH FISH.		P. ct.	P. ct.	P. ct	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Eel‡	XXX	52.78	47.22	13.42	32.88	0.92	2.11	13.16	99.74
Mackerel	XXXI	64.43	35.57	17.46	16.41	1.70	3.23	20.16	102.70
Salmon‡	XXXII	70.33	20.67	18.06	10.12	1.49	3.10	19.39	101.33
Little herring	XXXIII	73.25	26.75	19.23	5.87	1.65	3.01	18.83	99.60
Plaice	XXXIV	77.39	22.61	19.35	1.80	1.46	3.20	19.99	100.64
Perch	XXXV	80.06	19.94	18.12	0.44	1.38	2.90	18.11	99.99
Common cod	XXXVI	82.98	17.02	15.38	0.20	1.44	2.67	16.71	101.33
Pike	XXXVII	83.89	16.11	14.83	0.15	1.13	2.37	14.81	99.98
SALTED FISH.									
Herring	XXXVIII	42.57	57.43	20.47	21.30	15.66	2.93	18.28	97.81
Mackerel	XXXIX	48.43	51.57	21.20	14.10	16.27	3.33	20.82	99.62
Salmon (smoked?)	XL	51.04	48.96	22.26	12.00	14.70	3.58	22.38	100.12
Ling	XLI	52.42	47.58	27.43	0.40	19.75	4.58	28.60	101.17
Little herring	XLII	55.62	44.38	19.40	7.05	17.93	3.10	19.38	99.98
DRIED FISH.									
Stockfish (pollock?)	XLIII	13.71	86.29	78.20	1.20	6.89	12.70	79.94	101.74
Codfish (?) powder (Fischmehl)	XLIV	17.02	82.98	73.55	0.70	8.73	12.17	76.06	102.51
Ling	XLV	28.53	71.47	59.08	0.57	11.82	9.46	59.12	100.04

† Including salt of salted fish.
* Water-free substance—fats and ash.
‡ These specimens consisted of the flesh alone; the others included the skin with the flesh.

TABLE 18.—*Analyses of fish by Almén. Proximate ingredients directly determined.*

Names of fish.	Reference No. of specimen.	Water.	Extractives.	Gelatinoids.	Albuminoids. Soluble.	Albuminoids. Insoluble (by difference).	Fat.	Ash.
FRESH FISH.		*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Eel	XXX	52.78	1.78	2.04	1.46	8.14	32.88	0.92
Mackerel	XXXI	64.43	1.87	1.01	2.74	11.81	16.41	1.70
Salmon	XXXII	70.33	2.15	1.50	3.39	11.02	10.12	1.49
Little herring	XXXIII	73.25	2.30	2.53	2.61	11.76	5.87	1.05
Plaice	XXXIV	77.39	2.15	3.17	1.72	12.31	1.80	1.46
Perch	XXXV	80.06	1.76	3.74	3.61	9.01	0.44	1.38
Common cod	XXXVI	82.98	1.58	2.69	1.78	9.33	0.20	1.44
Pike	XXXVII	83.89	1.85	2.82	2.52	7.64	0.15	1.13
SALTED FISH.								
Herring	XXXVIII	42.57	5.52	1.93	1.71	11.31	21.30	15.66
Mackerel	XXXIX	48.43	2.74	1.50	1.28	15.68	14.10	16.27
Smoked salmon	XL	51.04	3.02	1.41	2.73	15.10	12.00	14.70
Ling	XLI	52.42	3.70	7.06	0.60	16.07	0.40	19.75
Little herring	XLII	55.62	2.82	1.76	1.00	13.82	7.05	17.93
DRIED FISH.								
Stockfish	XLIII	13.71	6.48	12.35	5.30	54.01	1.20	6.89
Codfish powder	XLIV	17.02	9.14	10.47	3.38	50.56	0.70	8.73
Ling	XLV	28.53	4.90	13.72	1.86	38.60	0.57	11.82

TABLE 19.—*Estimated proportions of refuse, water, and nutrients in specimens of European fishes analyzed by Almén.*

Kind of fish and portion analyzed.	Reference No.	Refuse.	Edible portion.	In edible portion. Water.	In edible portion. Water-free substance.	Water-free substance. Albuminoids, etc.†	Water-free substance. Fats.	Water-free substance. Ash.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Eel, whole	XXX	36	*64	33.8	30.2	8.6	21.0	0.6
Little herring, whole	XXXIII	45	55	40.3	14.7	10.6	3.2	0.9
Perch, whole	XXXV	59	41	32.8	8.2	7.4	0.2	0.6
Pike, whole	XXXVII	47	53	44.5	8.5	7.8	0.1	0.6
Salted herring, whole?	XXXVIII	34	66	28.1	37.9	13.5	14.1	‡10.3
Salted little herring, whole?	XLII	39	61	33.9	27.1	11.9	4.3	§10.9

* The "edible portion" in this case consisted of flesh only; in the other specimens in this table it included flesh and skin.
† Estimated "by difference." See foot note, Table XVI.
‡ Including 5.2 per cent. salt; in XXXVIII, 13.7.
§ Including 4.4 per cent. salt.

ANALYSES BY KOSTYTSCHEFF.

In the Russian exhibit at the International Fisheries Exhibition in London, in 1883, were shown some copies of reports of analyses of Russian fishes by Professor Kostytscheff, of the Agricultural Station at St. Petersburg. These were simply charts giving the name and figures without explanations. From copies, which I owe to the courtesy of Professor Goode, United States Commissioner to the Exhibition, Table 26 is transcribed. The only alterations are the insertion of reference numbers, the addition of names in brackets (see list of names above), and corrections of a few typographical errors. These changes were made after comparison with the detailed account by Professor Kostytscheff, which was received after this report had been prepared for the printer. Kostytscheff's account,* a translation of part of which is given beyond, includes a discussion of the analyses of Payen, Konig, and Almén as well as his own. The statements imply that his analyses were made by methods similar to those used by Almén, both following Hoppe-Seyler.

In Table 21 the results are calculated into the forms used for this report. The figures for water-free substance represent the difference between the percentages of water and 100 per cent. Those for "albuminoids by difference" are found by subtracting the sum of the percentages of fats and ash from that of water-free substances. I have added the percentages of water, extractive matters, gelatinous principles, albuminous principles, fat, and ash, in Table 21, and find the footings to be 100 per cent. in all cases but three. In the pike, No. L, it amounts to 99.90 per cent; in the salmon, No. LIV, to 98.90 per cent; and in the *Coregonus leucichthys*, No. LXXIII, to 99.99 per cent. (In table [20] in Professor Kostytscheff's article the ash in LXXIII is 13.17 per cent., which would make a total of 99.89 per cent.) I infer that these variations from 100 per cent. are due simply to typographical errors. Those in Nos. L and LXXIII are so small that they may be left out of account. That of LIV, though larger, amounts to only 1.1 per cent., hardly enough to make it necessary to discard the analysis.

Almén estimated the amount of insoluble protein by difference; if the percentage of "albuminous matters" in these analyses are estimated in the same way, as would appear from Kostytscheff's statements, we should infer that direct determinations had been made of the water, extractive matters, gelatinous principles, fat, and ash. The calculations in Table 20 are made on the supposition that the percentages of water, fats, and ash were directly determined. If this assumption be correct, the only cases in which this table is in error would be the three above mentioned, L, LIV, and LXXIII, the only considerable error being that of 1.1 per cent. in the salmon, LIV. I regret that I have no data for either verifying the assumptions or correcting the minor errors named.

The portions of fish analyzed by Kostytscheff, when not otherwise stated, included only the flesh. The "balyk" (the Russian term for the flesh of fish dried in the sun), No. LXXIII, is said by Kostytscheff to be "too dry; the fresh balyk ought to contain at least 48 to 50 per cent. of water, with corresponding amounts of other constituent parts."

One of the specimens, No. LIX, is that of liver of burbot, in which

* The Chemical Composition of Fish Products, with some remarks on their nutritive value. By Prof. P. Kostytscheff, from the Russian "Journal of Rural Economy and Forestry," vol. CXLIV, part II. The translation was furnished through the kindness of Prof. S. F. Baird, U. S. Commissioner of Fish and Fisheries.

non-nitrogenous "extractive matters" would be expected to occur in some quantity. Thus von Bibra (see analyses of liver of fish beyond) reports from 0.4 to 13.5 per cent. of these substances in livers of pike, trout, and carp. As Professor Kostytscheff's analyses are reported, no account is made of these constituents. If they were actually present, the percentage of "albuminous matters" (protein) must have been less than stated by an amount equivalent to that of the non-nitrogenous matters.

TABLE 20.—*Analyses of fishes of Russia by P. Kostytscheff, professor at the Agricultural Station in St. Petersburg.*

Names of fishes.	Reference No. of specimen.	Water.	Extractive matter.	Gelatinous principles.	Albuminous matter.	Fat.	Ash.	Common salt ($NaCl$).	Phosphoric acid (P_2O_5).	Iron oxide (Fe_2O_3).
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
FRESH FISH.										
Sigg	XLVI	79.13	2.93	3.70	11.69	1.53	1.22	......	0.4711	0.0031
Pike perch (Lucioperca sandra)	XLVII	79.87	3.28	3.55	12.10	0.20	1.00	......	0.2602	0.0023
Codfish	XLVIII	81.02	3.45	4.24	10.11	0.07	1.11	......	0.3731	0.0018
Carp	XLIX	79.89	3.92	2.84	10.79	1.42	1.14	......	......	......
Pike	L	80.70	3.14	3.32	11.23	0.33	1.18	......	0.3989	0.0034
Crucian carp	LI	80.82	4.56	3.63	9.41	0.48	1.07	......	......	......
Gadus navaga	LII	81.35	4.09	2.46	9.03	0.59	1.58	......	0.4833	0.0041
Smolt (Osmerus eporlanus)	LIII	78.38	4.14	2.83	10.00	3.08	1.57	......	......	......
Salmon	LIV	62.02	2.70	5.08	12.98	14.82	1.30	......	0.3822	0.0035
Salmon trout	LV	75.35	3.11	1.71	16.01	2.49	1.33	......	0.3998	0.0040
Herring (whitebait?)	LVI	76.11	2.54	1.29	13.46	4.89	1.71	......	......	......
Sturgeon (Acipenser güldenstædtii)	LVII	76.02	3.05	1.58	13.04	5.15	1.16	......	0.2093	0.0027
Sterlet	LVIII	76.81	1.69	1.74	13.21	5.59	0.96	......	0.3104	0.0023
Liver of burbot (eel-pout)	LIX	45.58	2.55	1.01	6.36	44.89	0.61	......	......	......
PRESERVED FISH.										
Salted and dried entire Osmerus spirinchus	LX	47.12	3.56	2.27	20.55	8.03	18.47	13.14	1.3701	0.1341
Marinated and entire Melotta vulgaris	LXI	60.72	3.73	3.06	3.79	17.14	11.56	9.90	......	......
Salted flesh of salmon (Somga)	LXII	53.48	3.96	5.08	13.64	12.19	11.05	11.21	......	......
Salted flesh of the halibut (Hippoglossus maximus)	LXIII	54.65	5.57	1.09	16.83	6.82	15.04	13.77	0.4007	0.0041
Salted flesh of the great sturgeon (Acipenser huso)	LXIV	61.85	1.83	2.05	14.82	8.93	10.52	10.03	......	......
Marinated entire river lamprey	LXV	44.62	2.70	4.05	27.57	16.57	4.49	3.33	......	......
Salted and smoked flesh of Pelecus vulgaris	LXVI	54.89	5.42	6.14	18.48	5.87	9.20	7.99	......	......
Salted and smoked flesh of Alburnus chalcoides	LXVII	43.53	6.37	3.47	18.99	16.21	11.43	9.86	......	......
Salted and dried flesh of roach (Leuciscus rutilus, var. caspica)	LXVIII	27.96	9.44	8.23	30.18	9.88	14.31	8.92	......	......
Dried flesh of codfish	LXIX	25.23	5.21	13.23	50.44	0.69	5.20	1.20	......	......
Salted flesh of Caspian shad	LXX	59.56	3.78	4.87	13.41	8.86	9.52	8.98	0.2733	0.0020
Salted caviar of Coregonus species	LXXI	66.05	2.16	1.19	14.37	8.97	7.26	6.16	......	......
Fresh caviar of sturgeon	LXXII	56.97	1.62	0.78	25.47	12.85	2.31	0.35	1.0340	0.0047
Salted and dried backs of Coregonus leucichthys (Balyk)	LXXIII	57.55	3.99	4.59	14.91	13.17	5.78	4.13	......	......
Salted and dried backs of sturgeon (Balyk	LXXIV	36.07	8.34	2.63	31.08	14.35	0.93	3.53	......	......
Dried cartilaginous dorsal cords (Vezeega)	LXV	50.99	5.21	40.04	0.18	0.00	3.52	......	......	......

TABLE 21.—*Analyses of Russian fishes by Kostytscheff, recalculated to forms used in this report.*

Names of fishes.	Reference No. of specimen.	Water.	Water-free substance.	Albuminoids, etc. (by difference.)	Fats.	Ash.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Sigg	XLVI	79.13	20.87	18.12	1.53	1.22
Pike perch (L. sandra)	XLVII	79.87	20.13	18.93	0.20	1.00
Codfish	XLVIII	81.02	18.98	17.80	0.07	1.11
Carp	XLIX	79.89	20.11	17.55	1.42	1.14
Pike	L	80.70	19.30	17.79	0.33	1.18
Crucian carp	LI	80.82	19.18	17.63	0.48	1.07
Gadus navaga	LII	81.35	18.65	16.48	0.59	1.58
Smelt (O. eperlanus)	LIII	78.38	21.02	16.97	3.08	1.57
Salmon	LIV	62.02	37.98	21.86	14.82	1.30
Salmon trout	LV	75.35	24.65	20.83	2.49	1.33
Herring (white bait?)	LVI	76.11	23.89	17.29	4.89	1.71
Sturgeon (A. güldenstædtii)	LVII	76.02	23.98	17.67	5.15	1.16
Sterlet	LVIII	76.81	23.19	16.04	5.59	0.96
Liver of burbot	LIX	45.58	54.42	8.92	44.89	0.61
PRESERVED FISH.						
Salted and dried Osmerus spirinchus	LX	47.12	52.88	26.38	8.03	18.47
Marinated Meletta vulgaris	LXI	60.72	39.28	10.58	17.14	11.56
Salted salmon	LXII	53.48	46.52	22.68	12.19	11.65
Salted halibut (H. maximus)	LXIII	54.65	45.35	23.49	6.82	15.04
Salted great sturgeon (A. huso)	LXIV	61.85	38.15	18.70	8.93	10.52
Marinated river lamprey	LXV	44.62	55.38	34.32	16.57	4.49
Salted and smoked Pelecus vulgaris	LXVI	54.89	45.11	30.04	5.87	9.20
Salted and smoked Alburnus chalcoides	LXVII	43.53	56.47	28.83	16.21	11.43
Salted and dried roach (Leuciscus rutilus, var. caspica)	LXVIII	27.96	72.04	47.85	9.88	14.31
Dried cod	LXIX	25.23	74.77	68.88	0.69	5.20
Salted Caspian shad	LXX	59.56	40.44	22.06	8.86	9.52
Salted caviar of Coregonus species	LXXI	66.05	33.95	17.72	8.97	7.26
Fresh caviar of sturgeon	LXXII	56.97	43.03	27.87	12.85	2.31
Salted and dried Coregonus leucichthys	LXXIII	57.55	42.45	23.50	13.17	5.78
Salted and dried sturgeon	LXXIV	36.67	63.33	42.05	14.35	6.93
Dried "dorsal cords" (Vezeega)	LXXV	50.99	49.01	45.43	0.06	3.52

The following translation of part of Prof. Kostytscheff's article above referred to is interesting in its bearing upon the economic importance of fish as food and of fish-culture in Russia.

It is well known that in general our waters are comparatively rich in fish, and that a very large quantity of fish is caught there every year. In a recently published pamphlet by O. A. Grimm* the amount of fresh fish caught annually in Russia is estimated at 40,000,000 puds.†

Whoever will take the trouble to closely examine the statistical data presented in this work will find that these data are very incomplete, and that this figure of 40,000,000 puds is far below the actual number. But even this incomplete estimate will allow us to deduce some very instructive conclusions concerning the importance of fish as food in our national life. To do this, let us determine the quantity of nutritive matter derived from the fish caught and prepared in various ways in Russia. In doing this we may restrict ourselves to the consideration of the albuminous matter as the most important constituent of animal food.

*Fishing and hunting in Russian waters. (International Fisheries Exhibition.) St. Petersburg, 1883. (English).

† 1 pud = 40 Russian pounds = about 36 English pounds.

Let us first select for our calculation those more important species of fish about which Mr. Grimm's pamphlet gives definite data, and for which we also have analysis:

	Puds.
1. Pike-perch, amount sent out from Astrakhan, not less than	2,000,000
2. Salmon caught in various places, not less than	60,000
3. Smelt and spirling	1,000,000
4. Salt-dried "vòbla"	3,000,000
5. Bream, shield-fish, etc	3,500,000
6. Astrakhan herring	7,000,000
7. Sturgeon, sturgeon caviar, and balyk	1,500,000

It will be seen from Mr. Grimm's figures that this whole amount of fish (which is mostly in a preserved condition) corresponds to 25,000,000 puds of fresh fish. Consequently, the quantity of all other kinds of fish caught every year amounts to not less than 15,000,000 puds.

Assuming that in the fishes mentioned above two-thirds of the weight is flesh and one-third makes up the weight of bones, skin, etc., it will be found with the aid of the analyses given before that the amount of dry albumen obtained from these fishes is not less than 2,330,000 puds.

Assuming, further, that in the remaining 15,000,000 puds of fish the skin, scales, bones, etc., amount to one-third and the flesh to two-thirds of the total weight, and supposing all these fishes to be such as contain the least amount, 10 per cent., of albuminous matter, the amount of dry albumen obtained will be at least 1,000,000 puds.

We thus find that we annually derive from our fisheries 3,330,000 puds of albuminous matter. This estimate is certainly below the actual amount: first, because many fishes contain more than two-thirds of flesh; second, because the annual yield of the fisheries in Russia is no doubt greater than 40,000,000 puds.

At first sight this figure of 3,330,000 puds of albuminous matter may not appear very great. To better realize its true signification, let us try to calculate what resources would be required to obtain the same amount of animal albuminous substance from cattle. Let us suppose that, to replace fish as food, we keep black cattle of such kind that on an average every head when fully grown weighs 20 puds. Such an animal will contain 45.9 per cent. of flesh without bones, or 9.18 puds; and this flesh will contain 1.61 puds of albuminous matter. Now, to obtain from such black cattle 3,330,000 puds of albuminous matter annually, it will be necessary to kill not less than 2,000,000 head of cattle a year. Let us further assume that our cattle will be ready for slaughter when four years old; it will be seen that the supply of cattle in Russia would have to be increased by 8,000,000 head of cattle for slaughter and not less than 2,500,000 cows for breeding. Consequently, even under the most fortunate but impossible circumstances, such as the absence of special cattle diseases, sterility of cows, etc., the number of black cattle in Russia would have to be increased by at least 10,500,000 in order to supply these 3,500,000 puds of albumen. It would require not less than 25,000,000 *desiatin** of meadows and pastures of good quality to keep and feed these cattle. How enormous these figures are will be seen from the fact that the number of milch cows in European Russia (not including Poland and Finland) is estimated by various authors at from 5,000,000 to 10,000,000, and the area of pasturage at 55,000,000 *desiatin*.

We have however, neglected in our calculation to take into account the milk provided by the cows. Supposing that, on an average, every cow gives 60 pails or 180 pounds of milk, this milk represents 1.44 puds of albuminous matter (the average proportion of albumen in milk being 3.2 per cent.). Every cow thus furnishes nearly as much albuminous matter per year as is contained in the flesh of the full-grown animal. Taking the milk into account, our figures will therefore have to be reduced by one-half. But even then they are exceedingly high, amounting to 6,000,000 head of cattle that would require over 12,000,000 *desiatin* of meadows and pastures. Approximately, we may adopt as our final result that, in order to substi-

* One *desiatin* = about 2.7 acres.

tute the albuminous matter of the milk and flesh of our domestic animals for that obtained from our fisheries, we would have to raise the productivity of our cattle-breeding industry 10 per cent., and the supply of food for the same.

These figures define (with the degree of approximation attainable with the available statistical data) the position and rank the fisheries take in the animal food-supply of the population of Russia. It would of course be possible to replace it by the products of cattle breeding, but only with the same prices for food. But the prices for the products derived from cattle are far higher than those for the corresponding nutritive products of fish (taken on an average); 1 pud of albuminous matter of fish is worth less than 20 roubles, whereas the same amount derived from the flesh of cattle will be worth not less than 40 to 50 roubles; the latter food is therefore accessible to a smaller number of people.

It is true, however, that to replace fish by vegetable food would require very much smaller resources. To produce 3½ million puds of albuminous matter requires, for instance, only 600,000 *desiatin* of rye, assuming a yield of 55 puds per *desiatin* exclusive of seed, or not over 900,000 *desiatin* in the case of farming by triennial rotation, and neglecting the meadows necessary for obtaining manure.

ANALYSES OF EUROPEAN HADDOCK BY THE WRITER.

The haddock, of which analyses by myself are given in Tables 22 and 23, were purchased in Munich and were stated to have come from the Baltic. The methods of analysis were the same as followed in the analyses of American fishes previously described, except that the determinations of water were made in air instead of hydrogen.* The specimens consisted of flesh, nearly pure muscular tissue, freed from skin, bones, and other refuse.

TABLE 22.—*Analyses of flesh of European haddock (water free substance).*

Specimen No.	Nitrogen.	Protein (N×6.25).	Fats (ether extract).	Ash.	Protein+fats+ash.	Albuminoids, etc., (by difference).
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
LXXVI...	14.91	93.19	0.61	6.37	100.17	93.02
LXXVII..	15.36	96.00	1.83	6.12	103.95	92.05

TABLE 23.—*Analyses of flesh of European haddock (fresh substance).*

Specimen No.	Water.	Water-free substance.	Albuminoids, etc., (by difference).	Fats.	Ash.	Nitrogen.	Protein (N×6.25).	Water+protein+fat+ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
LXXVI...	81.91	18.09	16.83	0.11	1.15	2.73	17.06	100.23
LXXVII..	80.58	19.42	17.87	0.36	1.19	2.98	18.63	100.76

ANALYSES BY POPOFF.

Table 24 gives the analyses of Russian fishes by Dr. Popoff, quoted by Kostytscheff. The analyses are said to have been made by the same method as those of König in which "the proportion of albuminous matter is computed from the amount of nitrogen found by simply multiplying the latter by the coefficient 6.25." The determinations include

* Zeitschrift für Biologie, XXIV, 1887, 16.

only water, protein ("albuminous matters"), fat, and ash. The figures in the other columns of Table 24 are computed to the forms used in this report, as was done with the analyses of Payen, König, and others above. As already explained, these data were received after the present report had been prepared for the printer and hence can not be treated as fully as would otherwise be done.

TABLE 24.—*Analyses of Russian fishes and fish roe by Dr. Popoff (recalculated to forms used in this report).*

Names of fishes.	Reference No. of specimen.	Water.	Water-free substance.	Water-free substance.				
				Albuminoids (by difference).	Fats.	Ash.	Protein, N × 6.25.	Water + protein + fats + ash.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Smelt (Osmerus eperlanus ?)	LXXVIII	79.01	20.99	13.71	4.31	2.97	13.86	100.15
"Vobla"*	LXXIX	75.76	24.24	16.76	5.88	1.60	17.29	100.53
Roe of fresh "vobla"	LXXX	72.18	27.82	20.06	6.85	0.91	19.78	99.62
PRESERVED FISH.								
Salted smelt (Osmerus eperlanus ?)	LXXXI	42.58	57.42	30.21	8.28	18.93	29.98	99.77
Smoked bream	LXXXII	37.25	62.75	36.71	15.22	10.82	36.92	100.21
Salted and dried pike perch	LXXXIII	20.55	79.45	59.91	1.92	17.62	60.33	100.42
Salted and dried spirling (smelts)	LXXXIV	72.45	27.55	17.26	6.78	3.51	16.14	98.88
Roe of smoked bream	LXXXV	33.17	66.83	42.95	16.30	7.58	42.80	99.85

* Said to be "a fish found in the Volga, the size of a crucian."

ANALYSES BY SEMPOLOWSKI.

In a paper entitled "*Untersuchungen von Seetieren auf ihren Gehalt an agrikultur-chemisch wichtigen Stoffen*,"* L. Sempolowski gives the results of analyses of fishes with a view to learning their fertilizing value. The specimens analyzed included the whole fish, except in the cases of No. 1, from which fat had been extracted, and No 5, in which separate analyses were made of the flesh and of the head and bones. The following tables are translated from the original. As no further reference is to be made to the results in the present report the numbers are not made consecutive with the previous ones.

TABLE 25.—*Analyses of fishes and fish refuse, by L. Sempolowski.* (*Fresh material.*)

Names of fishes.	Water.	Water-free substance.	Fat.	Ash.	Phosphoric acid.	Potash.	Lime.	Nitrogen.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1. Plaice (Pleuronectes platessa)	79.12	20.88	1.39	3.58	1.24	0.63	0.62	2.73
2. Plaice (Pleuronectes limanda)	78.32	21.68	1.75	3.45	1.25	0.47	1.25	2.79
3. Star-ray or skate (Raja radiata)	80.67	19.33	1.79	2.61	0.91	0.34	0.61	2.68
4. Haddock (Gadus aeglefinus)	78.90	21.10	1.14	3.59	1.22	0.40	1.16	2.76
5. Cod (Gadus morrhua):								
(a) Flesh	80.61	19.39	0.37	1.57	0.61	0.60	0.11	3.00
(b) Head and bones	78.25	21.75	0.67	7.42	2.91	0.43	3.65	2.29
6. Gray gurnet (Trigla gurnardus)	74.59	25.41	5.31	4.47	1.78	0.70	0.97	2.70
7. Common thornhound (Acanthias vulgaris)	59.08	40.92	10.45	2.75	0.98	0.52	0.07	5.33

* Die Landw. Vers.-Stat., XXXVI, S. 61.

TABLE 26.—*Analyses of fishes and fish refuse by L. Sempolowski. (Air-dry material.)*

Names of fishes.	Water.	Water-free substance.	Fat.	Ash.	Phosphoric acid.	Potash.*	Lime.	Nitrogen.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1. Plaice (Pleuronectes platessa)	8.76	91.24	6.07	15.65	5.42	2.75	2.71	11.90
2. Plaice (Pleuronectes limanda)	7.93	92.07	7.43	14.64	5.32	1.98	5.31	11.85
3. Star-ray or skate (Raja radiata)	8.57	91.43	8.45	12.32	4.31	1.61	2.89	12.66
4. Haddock (Gadus æglefinus)	7.68	92.32	5.00	15.70	5.32	1.75	5.09	12.06
5. Cod (Gadus morrhua):								
(*a*) Flesh	9.52	90.48	1.73	7.30	2.86	2.85	0.53	14.00
(*b*) Head and bones	8.83	91.17	2.80	31.09	12.18	1.81	15.29	9.58
6. Gray gurnet (Trigla gurnardus)	6.04	93.96	19.63	16.94	6.60	2.59	3.58	9.94
7. Common thornhound (Acanthias vulgaris)	18.91	81.09	20.71	5.46	1.95	1.03	0.14	10.56

TABLE 27.—*Analyses of fishes and fish-refuse by L. Sempolowski. (Water-free material.)*

Names of fishes.	Fat.	Ash.	Phosphoric acid.	Potash.	Lime.	Nitrogen.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1. Plaice (Pleuronectes platessa)	6.64	17.16	5.94	3.01	2.98	13.10
2. Plaice (Pleuronectes limanda)	8.07	15.90	5.78	2.16	5.77	12.87
3. Star-ray or skate (Raja radiata)	9.24	13.48	4.72	1.76	3.17	13.85
4. Haddock (Gadus æglefinus)	5.42	17.00	5.76	1.89	5.51	13.06
5. Cod (Gadus morrhua):						
(*a*) Flesh	1.91	8.07	3.16	3.15	0.58	15.47
(*b*) Head and bones	3.07	34.10	13.36	1.99	16.77	10.51
6. Gray gurnet (Trigla gurnardus)	20.89	17.61	7.02	2.76	3.81	10.58
7. Common thornhound (Acanthias vulgaris)	25.55	6.73	2.40	1.27	0.18	13.02

Besides the analyses above mentioned, others have been reported, but none with which I am familiar have been executed by methods making them comparable with these, or to give definite information as to the amounts of the constituents now recognized as making up the tissues of the fish. I may, however, refer to a number of earlier analyses.

One of these is *Examen Chimique de L'eperlan, Salmo eperlanus*, Morin. This is a qualitative investigation of some of the constituents of the flesh of the smelt, of which a résumé may be found in Pereira (Food and Diet, New York, 1851, p. 132).

Brande's Manual of Chemistry, quoted by Pereira (loc. cit., p. 111), gives the composition of the muscles of various animals, including cod, haddock, and sole, but regards the nutritive matter (water-free substance) as made up of albumen or fibrin and gelatin, exclusively, and takes no account of the fat or other ingredients.

Schlossberger † gives the composition of the muscular flesh of carp and trout, with that of other animals. His table is quoted by Pereira along with that of Brande just named. No account is taken of the fats.

The analysis of *Leuciscus rutilus* by Limpricht ‡ will be referred to

* Journal de Pharmacie VIII, 1822, p. 61.

† Valentine's Report, 1841, 294, and Pharmaceutisches Central-blatt 1842, 41.

‡ Liebig's Annaler, CXXVII, 1863, 185.

in the discussion of the constitution of the flesh of fishes in another place, as will Christison's statement regarding the composition of clean and foul salmon.*

Various other chemists have studied the composition of the flesh and other organs of fishes, but the purposes and methods have been such that the results need not be referred to in detail here. I should, however, call attention to an article by Dr. Davy,† in which the attempt is made to compare the nutritive values of different fishes by their percentages of dry substance.

PROPORTIONS OF PROTEIN IN THE FLESH OF FISHES.

In the recapitulations of European analyses of the flesh of fishes the percentage of protein as estimated by multiplying the percentages of nitrogen by the factors 6.25, the percentages of "albuminoids" as estimated by difference, and the footings, water+protein+fats+ash, are given where the data permit. One object in this has been to obtain a crude test of the correctness of the analyses, it being assumed that a wide divergence between the figures for nitrogenous material by the two methods or, what is the same thing, a wide divergence between the sums named and 100, would indicate error of analysis. Doubtless some of the wider divergences in the analyses here cited are due to typographical errors. But considering the fact that even the directions for determining nitrogen by the soda-lime method as found in standard works on quantitative analysis are such as to involve danger of serious error, and that numerous analysts in following them have been unable to obtain reliable results, it would not be strange if errors in the nitrogen determinations had crept into some of the earlier analyses. My experience has also warned me that the dangers of error in the determinations of water and fats are greater than is sometimes supposed.

The object of these remarks is not to criticise the most valuable work of the investigators whose results are quoted, but rather to enforce the need of improvement of the analytical methods. Meanwhile the figures for albuminoids by difference perhaps represent the actual quantities of nitrogenous material more nearly than those obtained by multiplying the nitrogen by 6.25. They are used in the tables beyond, in which the analyses are summarized.

* Cited by Smith, Foods, p. 108.

† Edinburgh New Philosophical Journal, Oct. 1853, p. 225; Dingler's Polyt. Journal, 131, 1854, p. 390.

3. ANALYSES OF ROE, CAVIAR, AND THE LIVER OF FISHES.

ANALYSES OF ROE, CAVIAR, ETC.

Payen gives an analysis of caviar;* König and Brimmer one of caviar;† Lidow one of "fresh granular caviar" and one of "paionsnaja," a strongly salted and pressed caviar;‡ von Kletzinski one of "fischrogenkase," prepared by fishermen of the Dardanelles by drying the roe of certain fish in air and pressing;§ and Stutzer one of Russian caviar.¶ The analyses by Kostytscheff (Tables 20 and 21) above include one of "salted caviar of *Coregonus*, sp., No. LXXI, and one of "fresh caviar (roe?) of sturgeon, No. LXXII. Those of Popoff (Table 24) include one of "roe of vobla," No. LXXX, and one of "roe of smoked bream," No. LXXXV. With the analyses of the flesh of American fishes, previously given, a specimen of fresh roe of shad was made. It was from shad No. 245 and is numbered 246. These analyses are collated in Table 31, in which the results are, in so far as the data permit, calculated to the forms used here.

The analyses of eggs of carp by Gobley‖ were made by different methods and for a different purpose from these, and would hardly be in place here.

TABLE 28.—*Analyses of roe, caviar, etc.*

[The roe of shad is American, the rest are European.]

Kinds of fish, etc.	Reference No. of specimen.	Water.	Water-free substance.	Albuminoids, etc., by difference.	Fats.	Ash.	Non-nitrogenous extractive matters.	Protein, N × 6.25.	Water + protein + fats + ash.
Roe of shad, fresh	246	71.25	28.75	23.44	3.78	1.53	(2.56)	20.88	97.44
Fresh caviar (roe?) of sturgeon.	LXXII	56.97	43.03	27.87	12.85	2.31			
Roe of fresh vobla (Popoff)	LXXXIV	72.18	27.82	20.06	6.85	0.91			
Salted caviar of *Coregonus*, sp.	LXXI	66.05	33.95	17.72	8.97	7.26			
Caviar (Payen)	LXXXVI	37.50	62.50	36.96	16.26	9.28	(7.82)	28.04	91.08
Caviar (König and Brimmer)	LXXXVII	45.04	54.96	31.91	14.14	8.91	......	31.90	90.99
Caviar, fresh, granular (Lidow)	LXXXVIII	53.84	46.16	25.18	13.12	7.80	......	25.18	100.00
Caviar, Russian (Stutzer)	LXXXIX	52.16	47.84	27.86	15.45	4.53	......	28.02	100.16
Average 5 specimens caviar		50.92	49.08	27.92	13.59	7.57			
"Roe of smoked bream"	XC	33.17	66.83	42.95	16.30	7.58	......	42.80	99.85
"Paionsnaja" (Lidow)	XCI	30.89	69.11	40.33	18.90	9.88	......	40.33	100.00
"Fischroggenkäse" (Kletzinski)	XCII	19.38	80.62	41.14	28.87	10.61	(6.33)	34.81	93.67

* Compt. rend., 39, 318, quoted by König, Nahrungsmittel, 3te, Aufl. I, 217. † König, loc. cit. ‡ Chem. Zeit'g., 1880, 818, quoted by König. § Jbt. d. Chem., 1865, 836. ¶ Repertorium der Anal. Chem., II, 1882, 168. ‖ Jour. d. Pharm. (3), 17, 401, and 18, 411.

THE LIVER OF FISHES.

König (Nahrungsmittel, 1, 18) cites from Moleschott (Physiologie, der Nahrungsmittel, 1859), analyses by von Bibra of liver of pike, trout, and carp. The percentage of protein, as given in each case, is 6¼ times that of nitrogen, and the percentages of water, protein, fat, ash, and "non-nitrogenous extractives," together make 100; hence I infer that the last are estimated by the difference. The figure for the amount of these substances in No. XCVI is noticeably large. These analyses, with one of liver of burbot by Kostytscheff, taken from Table 21, are put together in Table 32. As above explained, non-nitrogenous extractives are given in the analysis of the liver of burbot.

Analyses of oil in fish of different species may be found in König, Nahrungsmittel, 3te Aufl., p. 218.

TABLE 29.—*Analyses of the liver of fishes.*

Liver of—	Reference No. of specimen.	Water.	Water-free substance.	Protein.	Fat.	"Non-nitrogenous extractives.	Ash.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Pike, (v. Bibra)	XCIII	79.34	20.66	6.66	4.73	7.61	1.64
Trout, (v. Bibra)	XCIV XCV	73.64	21.36	16.05	3.00	6.42	1.89
Carp, (v. Bibra)	XCVI	68.06	31.94	14.37	2.93	13.49	1.15
Burbot, (Kostytscheff)	LIX	45.58	54.42	8.92	44.89	(?)	0.61

SECTION C.—COMPOSITION OF AMERICAN AND EUROPEAN FISHES COMPARED.

1. RECAPITULATION OF ANALYSES OF AMERICAN AND EUROPEAN FISHES.

GENERAL STATEMENT.

The analyses recounted in the previous chapters include all that I am familiar with of American and European fishes made in accordance with the methods now current. They are summarized in the forms adopted in the present report, in Tables 30, 31, and 32. Of these, not much need be said by way of explanation, except that the analyses of a few of the European specimens, particularly of preserved fish, have been omitted, either because they were of so unusual occurrence that a repetition of the statements of the analyses is hardly necessary, or because of apparent errors in the reports to which I have had access. I believe that these tables contain all the analyses that are most important for our present purpose.

Table 30 recapitulates the analyses of the flesh of specimens of fresh fish. It will be observed that the albuminoids, etc., are estimated by difference, but that the percentages of protein (N × 6.25) are also given. When a number of analyses of the same species were made the maximum and minimum percentages of each constituent and the averages of all the analyses are given.

Table 31 gives corresponding analyses of the flesh of preserved fish. The percentage of salt, sodium chloride, is usually given separately, though in some cases the analyst reported the two together, and in consequence no distinction is made here.

Table 32 gives the percentages of proximate ingredients as directly determined. I have regarded it as worth while to put these analyses together, though, as was stated in discussing the subject in the previous chapters, the methods of analysis are incomplete and the results not entirely satisfactory. It is to be further noted that the American analyses were all made of the flesh freed from skin, while part, and I presume nearly all, of the specimens of the European analyses included both flesh and skin. In some if not all of the European analyses the insoluble albuminoids were determined by difference.

So few of the reports of European analyses include statements of the composition of the fish as found in the markets, including both flesh and refuse matters, that a table summarizing the European and American analyses on this basis, as was done with the American analyses in Table 9, seems hardly necessary here, especially as such a compilation is to be given in one of the chapters beyond (Part II) on the economic application of the analyses.

TABLE 30.—*Recapitulation of analyses of flesh of specimens of American and European fishes.*

["Albuminoids," etc., estimated by difference. "Protein" estimated by multiplying nitrogen by 6.25. By "maximum" and "minimum" are to be understood, in each case, the largest and smallest percentages of each ingredient found in any of the specimens of the species.]

Names of fishes. (A, American; E European.)	No. of specimens analyzed.	Water.	Water-free substance.	Albuminoids, etc. (by difference).	Fats.	Ash.	Protein (N×6.25).
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Sturgeon (Acipenser sturio), A	1	78.71	21.29	17.96	1.90	1.43	18.11
Sturgeon (Acipenser güldenstædtii), E	1	76.02	23.98	17.67	5.15	1.16	.....
Sterlet (Acipenser ruthenus), E	1	76.81	23.19	16.64	5.59	0.96	.....
Small-mouthed red-horse (Moxostoma velatum), A	1	78.56	21.44	17.90	2.35	1.19	17.99
Carp (Cyprinus carpio), E:							
Maximum	....	79.89	23.03	20.60	1.42	1.34	.....
Minimum	....	76.97	20.11	17.55	1.09	1.14	.....
Average	2	78.43	21.57	19.07	1.26	1.24	*21.86
Crucian carp (Carassius vulgaris), E	1	80.82	19.18	17.63	0.48	1.07	.....
Barbel? (Barbus vulgaris?), E	1	80.35	10.65	9.54	0.21	0.90	9.82
Gudgeon (Gobio fluviatilis), E	1	76.89	23.11	16.99	2.68	3.44	17.37
Bleak (Alburnus lucidus), E	1	72.89	27.11	15.73	8.13	3.25	16.81
Herring (Clupea harengus), A and E:							
Maximum	....	76.11	30.97	19.23	11.01	1.90	19.12
Minimum	....	69.03	23.89	17.29	4.89	1.50	15.31
Average	4	72.10	27.90	18.19	8.02	1.69	*17.75
Alewife (Clupea vernalis), A:							
Maximum	....	75.92	27.04	19.54	6.02	1.48	19.72
Minimum	....	72.96	24.08	18.80	3.82	1.40	19.00
Average	2	74.44	25.56	19.17	4.92	1.47	19.36
Shad (Clupea sapidissima), A:							
Maximum	....	73.56	34.75	19.98	13.59	1.54	20.10
Minimum	....	65.25	26.44	17.83	6.51	0.90	18.08
Average	7	70.62	29.38	18.55	9.48	1.35	18.80

* Of less than all the analyses.

TABLE 30.—*Recapitulation of analyses of flesh of specimens of American and European fishes*—Continued.

Names of fishes. (A, American; E, European.)	No. of specimens analyzed.	Water.	Water-free substance.	Albuminoids, etc. (by difference).	Fats.	Ash.	Protein (N×6.25).
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Smelt (Osmerus mordax), A:							
Maximum		80.16	21.84	18.83	1.94	2.00	18.65
Minimum		78.16	19.84	15.90	1.65	1.36	16.52
Average	2	79.16	20.84	17.36	1.80	1.68	17.58
Smelt (Osmerus eperlanus), E	1	78.38	21.62	16.97	3.08	1.57	......
Whitefish (Coregonus clupeiformis), A	1	69.83	30.17	22.06	6.49	1.62	22.93
Whitefish (Coregonus barii), E	1	79.13	20.87	18.12	1.53	1.22	......
Cisco, Coregonus sp. (tullibee or artedi?), A	1	76.15	22.85	19.12	3.48	1.25	19.26
California salmon (Oncorhynchus chouicha), A:							
Maximum		64.53	37.32	17.96	19.25	1.11	......
Minimum		62.68	35.47	16.96	16.50	1.01	......
Average	2	63.61	36.39	17.46	17.87	1.06	*18.56
Salmon (Salmo salar), A and E:							
Maximum		75.70	38.97	24.45	14.99	1.56	24.77
Minimum		61.03	24.30	18.06	4.85	1.10	13.09
Average	8	65.76	34.24	20.77	12.09	1.38	20.51
Spent salmon (Salmo salar), A:							
Maximum		78.20	24.73	19.24	4.37	1.17	19.15
Minimum		75.27	21.80	17.80	2.83	1.12	17.62
Average	2	76.74	23.26	18.52	3.60	1.14	18.38
Spent landlocked salmon (Salmo salar, subsp. sebago), A:							
Maximum		79.20	22.12	17.65	4.01	1.27	17.24
Minimum		77.88	20.80	16.84	1.95	1.20	16.18
Average	2	78.54	21.46	17.24	2.98	1.24	16.71
Lake trout (Salvelinus namaycush), A:							
Maximum		75.35	31.22	19.12	12.55	1.35	19.42
Minimum		68.78	24.65	17.32	10.21	1.17	17.62
Average	2	69.14	30.86	18.22	11.38	1.26	18.52
Salmon trout (Salmo trutta), E	1	75.35	24.65	20.83	2.49	1.33	......
Brook trout (Salvelinus fontinalis), A:							
Maximum		79.84	24.22	20.03	2.94	1.42	20.30
Minimum		75.78	20.16	18.43	0.75	0.98	18.60
Average	3	77.72	22.28	18.97	2.10	1.21	19.23
Pickerel (Esox reticulatus), A:							
Maximum		79.84	20.48	18.88	0.52	1.24	19.02
Minimum		79.52	20.16	18.40	0.49	1.11	18.43
Average	2	79.68	20.32	18.64	0.50	1.18	18.73
Pike (Esox lucius), A and E:							
Maximum		83.89	22.47	20.58	0.60	1.29	*20.36
Minimum		77.53	16.11	14.83	0.15	1.03	*14.81
Average	4	80.48	19.52	17.95	0.41	1.16	*17.95
Muskellunge (Esox nobilior), A	1	76.26	23.74	19.63	2.54	1.57	20.15
Eel (Anguilla rostrata), A and E:							
Maximum		73.40	47.22	18.95	32.88	1.11	19.25
Minimum		52.78	26.60	13.29	7.88	0.77	12.50
Average	4	64.51	35.49	15.82	18.74	0.93	15.67
Conger eel (Conger vulgaris), E	1	79.91	20.09	13.96	5.02	1.11	13.58
Mullet (Mugil albula), A	1	74.87	25.13	19.32	4.64	1.17	19.48
Mackerel (Scomber scombrus), A and E:							
Maximum		78.67	35.99	23.11	16.41	1.85	23.42
Minimum		64.01	21.33	17.42	2.20	1.00	17.51
Average	8	71.62	28.38	18.77	8.21	1.40	19.45
Spanish mackerel (Cybium maculatum), A	1	68.10	31.90	20.97	9.43	1.50	21.45
Pompano (Trachynotus carolinus), A:							
Maximum		78.18	32.62	19.15	13.51	1.03	19.30
Minimum		67.38	21.82	18.15	1.64	0.96	18.35
Average	2	72.78	27.22	18.65	7.57	1.00	18.83
Bluefish (Pomatomus saltatrix), A	1	78.46	21.54	19.02	1.25	1.27	19.41
Butterfish (Stromateus triacanthus), A	1	70.02	29.98	17.81	11.03	1.14	17.99
Large-mouthed black bass (Micropterus salmoides), A	1	78.61	21.39	19.24	0.96	1.19	19.44
Small-mouthed black bass (Micropterus dolomieu), A	1	74.82	25.18	21.50	2.44	1.24	21.71
Yellow perch (Perca fluviatilis), A and E:							
Maximum		80.43	21.93	19.47	1.12	1.38	19.60
Minimum		78.07	19.57	17.88	0.44	1.14	17.79
Average	3	79.52	20.48	18.49	0.70	1.29	18.53
Wall-eyed pike (Stizostedion vitreum), A	1	79.74	20.26	18.42	0.47	1.37	18.58
Gray pike (Stizostedion canadense), A	1	80.85	19.15	17.26	0.76	1.13	17.88
Pike perch (Stizostedion sandra), E	1	79.87	20.13	18.93	0.20	1.00	......
Striped bass (Roccus lineatus), A:							
Maximum		79.63	24.24	19.33	4.61	1.36	19.54
Minimum		75.76	20.37	16.87	1.56	0.92	17.06
Average	6	77.70	22.30	18.31	2.83	1.16	18.54

* Of less than all the analyses.

TABLE 30—*Recapitulation of analyses of flesh of specimens of American and European fishes*—Continued.

Names of fishes. (A, American; E, European.)	No. of specimens analyzed.	Water.	Water-free substance.	Albuminoids, etc. (by difference).	Fats.	Ash.	Protein (N ×6.25).
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
White perch (Roccus americanus), A:							
Maximum	....	75.77	24.36	20.43	5.62	1.28	20.58
Minimum	...	75.64	24.23	17.63	2.52	1.11	17.95
Average	2	75.71	24.29	19.63	4.07	1.19	19.27
Sea bass (Centropristris atrarius), A	1	79.32	20.68	18.75	0.49	1.44	19.84
Grouper (Epinephelus morio), A:							
Maximum	....	79.95	21.04	19.19	0.71	1.16	19.81
Minimum	....	78.96	20.05	18.41	0.48	1.14	18.63
Average	2	79.45	20.55	18.80	0.60	1.15	19.22
Red Snapper (Lutjanus blackfordi), A:							
Maximum	....	79.81	22.66	19.89	1.94	1.34	20.17
Minimum	....	77.34	20.19	18.34	0.54	1.27	19.26
Average	3	78.46	21.54	19.20	1.03	1.31	19.72
Porgy (Diplodus argyrops), A:							
Maximum	....	79.68	28.02	19.29	7.86	1.40	19.43
Minimum	....	71.98	20.32	17.46	1.46	1.35	17.44
Average	3	74.99	25.01	18.52	5.11	1.38	18.58
Sheepshead (Diplodus probatocephalus), A:							
Maximum	....	79.08	27.99	20.17	6.72	1.33	20.82
Minimum	....	72.01	20.92	18.93	0.66	1.10	19.36
Average	2	75.55	24.45	19.54	3.69	1.22	20.08
Red bass (Sciæna ocellata), A	1	81.56	18.44	16.68	0.53	1.23	16.88
Kingfish (Menticirrus nebulosus), A	1	79.21	20.79	18.66	0.95	1.18	18.94
Weakfish (Cynoscion regale), A	1	78.97	21.03	17.45	2.39	1.19	17.80
Blackfish (Hiatula onitis), A:							
Maximum	....	81.36	23.05	18.96	2.81	1.36	19.33
Minimum	....	76.95	18.64	17.44	0.55	0.65	17.61
Average	4	79.10	20.90	18.47	1.35	1.08	18.70
Hake (Phycis chuss), A	1	83.11	16.89	15.24	0.67	0.98	15.37
Cusk (Brosmius brosme), A	1	82.01	17.99	16.92	0.17	0.90	17.00
Haddock (Gadus æglefinus), A and E:							
Maximum	....	82.56	19.70	18.38	0.36	1.64	18.63
Minimum	....	80.30	17.44	15.94	0.11	1.03	16.32
Average	8	81.39	18.61	17.10	0.26	1.25	17.36
Cod (Gadus morrhua), A and E:							
Maximum	....	83.48	19.29	17.80	0.51	1.44	*18.32
Minimum	....	80.71	16.52	14.95	0.07	1.00	*15.49
Average	7	82.46	17.54	16.00	0.30	1.24	*16.54
Russian cod (Gadus navaga), E	1	81.35	18.65	16.48	0.59	1.58	.....
Whiting (Gadus merlangus), E	1	82.95	17.05	15.59	0.38	1.08	15.10
Tomcod (Gadus tomcod), A	1	81.55	18.45	17.08	0.38	0.99	17.24
Pollock (Gadus virens), A	1	76.02	23.98	21.65	0.78	1.55	21.00
Halibut (Hippoglossus vulgaris), A:							
Maximum	....	79.15	29.87	19.40	10.57	1.15	19.68
Minimum	....	70.13	20.85	17.49	2.21	0.88	17.53
Average	3	75.42	24.58	18.35	5.18	1.05	18.58
Turbot (Platysomatichthys hippoglossoides), A	1	71.39	28.61	12.92	14.41	1.28	14.75
Common flounder (Paralichthys dentatus), A:							
Maximum	....	85.04	16.63	14.73	0.77	1.29	14.91
Minimum	....	83.37	14.96	12.90	0.62	1.28	13.22
Average	2	84.21	15.79	13.82	0.60	1.28	14.07
Winter flounder (Pleuronectes americanus), A	1	84.35	15.65	14.01	0.44	1.20	14.53
Plaice (Pleuronectes platessa), E	1	77.39	22.61	19.35	1.80	1.46	19.99
Dab (Pleuronectes limanda), E	1	79.41	20.59	16.59	2.06	1.94	18.11
Sole (Solea vulgaris), E	1	86.14	13.86	12.38	0.25	1.23	11.94
Lamprey eel (Petromyzon marinus?), A	1	71.12	28.88	14.93	13.29	0.66	14.98
Skate (Raia sp.), A and E:							
Maximum	....	82.15	24.50	22.32	1.39	1.71	24.04
Minimum	....	75.50	17.85	15.32	0.47	1.14	18.17
Average	2	78.82	21.18	18.82	0.93	1.43	21.10

* Of less than all the analyses.

TABLE 31.—*Recapitulation of analyses of flesh of preserved fish, American and European specimens.*

[By "Maximum" and "Minimum" are to be understood in each case the largest and smallest percentages of each ingredient found in any of the specimens of the same species.]

Kinds of preserved fish. (A, American; E, European.)	No. of specimens analyzed.	Water.	Water-free substance.	Albuminoids, etc., by difference.	Fats.	Ash.	Salt (sodium chloride).	Protein (N×6.25).
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Salt sturgeon (Acipenser huso), E	1	61.85	38.15	18.70	8.93	0.49	10.03	.....
Salted and smoked Poleeus vulgaris, E	1	54.89	45.11	30.04	5.87	1.21	7.99	.....
Salted and smoked bleak (Alburnus chalcoides), E	1	43.53	56.47	28.83	16.21	1.57	9.86	.....
Salted and dried roach (Leuciscus rutilus var. caspica), E	1	27.96	72.04	18.26	9.88	5.39	8.92	.....
Smoked herring, salted (Clupea harengus), A	1	34.55	65.45	36.44	15.82	1.53	11.66	36.94
Smoked and pickled (?) herring (Bücklinge) (Clupea harengus), E	1	69.49	30.51	20.76	8.51	1.24	......	21.12
Salt herring (Clupea harengus), E:								
Maximum	...	55.62	57.43	21.85	21.36	2.10	16.24	19.45
Minimum	..	42.57	44.38	18.97	7.05	1.69	13.65	18.28
Average	4	48.58	51.42	20.17	14.44	1.90	14.91	19.02
Smoked sprat (Clupea sprattus), E	1	59.89	40.11	23.71	15.94	0.46	......	22.73
Smoked anchovy (Engraulis encrasicholus), E	1	51.77	48.23	22.75	2.21	2.68	20.59	22.30
Salted Caspian shad (Clupea caspica), E	1	59.56	40.44	22.06	8.86	0.54	8.98	.....
Marinated shad (Clupea meletta), E	1	60.72	39.28	10.58	17.14	1.66	9.90	.....
Salted and dried smelt (Osmerus spirinchus), E	1	47.12	52.88	26.38	8.03	5.33	13.14	.....
Salted and dried backs of Stenodus (Coregonus) leucichthys, E	1	57.55	42.45	23.50	13.17	1.65	4.13	.....
Salted salmon (Salmo salar), E	1	53.48	46.52	22.68	12.19	0.44	11.21	.....
Smoked and salted salmon (Salmo salar), E:								
Maximum	....	51.89	48.96	27.00	12.00	1.45	13.81	26.00
Minimum	....	51.04	48.11	22.26	11.72	0.89	7.94	22.38
Average	2	51.47	48.53	24.63	11.86	1.17	10.87	24.19
Salt mackerel (Scomber scombrus), A:								
Maximum	....	43.62	57.81	22.06	27.94	2.67	11.16	21.14
Minimum	...	42.19	56.38	16.86	22.50	2.53	9.44	16.60
Average	3	43.01	56.99	18.88	25.12	2.59	10 40	18.55
Salt mackerel (Scomber scombrus), E	1	48.43	51.57	21.20	14.10	1.77	14.50	20.82
Smoked haddock (Gadus æglefinus), A	1	72.56	27.44	23.68	0.17	1.53	2.06	23.29
Do (canned)	1	68.73	31.27	21.78	2.25	1.65	5.69	22.29
Desiccated cod (Gadus, sp.?), A	1	15.25	84.75	74.66	1.90	5.41	2.88	77.97
Salt desiccated cod (Gadus, sp.?), A	1	11.65	88.35	71.62	4.89	5 24	6.60	72.02
Salt cod (Gadus, sp.?), A:								
Maximum	....	53.62	46.46	22.18	0 44	1.64	23.37	26.25
Minimum	....	53.54	46.38	21.17	0.25	1.59	22.71	24.87
Average	2	53.58	46.42	21.67	0.34	1.62	23.04	25.66
Dried cod, "Fischmehl" (Gadus morrhua?), E	1	17.02	82.98	73.55	0.70	8.73		76.06
Stockfish (Pollock?), E	1	13.71	86.29	78.20	1.20	6.80		79.94
Dried cod (Gadus morrhua?), E	1	25.23	74.77	68.88	0.69	4.00	1.20	.....
Stockfish (Dried cod) (Gadus morrhua?), E	1	18.60	81.40	79.52	0.36	1.52	......	77.90
Salt stockfish (Gadus morrhua?), E	1	47.03	52.97	31.27	0.38	1.77	19.55	31.39
Dried ling (Gadus molva?), E	1	28.53	71.47	59.08	0.57	2.74	9.08	59.12
Salt ling (Gadus molva?), E	1	52.42	47.58	27.43	0.40	1.75	18.00	28.60
Salted, smoked, and dried halibut (Hippoglossus hippoglossus), A:								
Maximum	....	51.06	52.30	23.00	15.61	2.13	13.05	23.01
Minimum	....	47.70	48.94	18.15	14.44	1.99	12.87	18.49
Average	2	49.38	50.62	20.57	15.03	2.06	12.96	20.75
Salt halibut (Hippoglossus maximus), E	1	54.65	45.35	23.49	6.82	1.27	13.77	.....
Marinated Lamprey eel (Petromyzon, sp. ?), E:								
Maximum	....	51.21	55.38	34.32	25.59	1.16	3.33	.....
Minimum	....	44.62	48.79	21.79	16.57	1.41	......	.....
Average	2	47.92	52.08	28.05	21.08	1.29	1.66	20.18
Canned sardines (Clupea pilchardus?), E	1	56.37	43.63	25.31	12.71	5.61		24.87
Canned salmon (Oncorhynchus chouicha), A:								
Maximum	....	65.86	42.45	21.29	21.49	1.35	2.19	21.06
Minimum	....	57.55	34.14	19.20	11.06	1.26	0.41	19.47
Average	3	61.88	38.12	20.06	15.70	1.32	1.04	20.18
Canned mackerel (Scomber scombrus), A	1	68.18	31.82	19.91	8.68	1.30	1.93	19.63
Canned tunny, "Horse mackerel" (Orcynus secundidorsalis?), A	1	72.74	27.26	21.52	4.05	1.69	......	21.67

TABLE 32.—*Recapitulation of analyses of specimens of flesh of American and European fishes.*

[Proximate ingredients as directly determined.]

Names of fishes. (A, American; E, European.)	No. of specimens analyzed.	Water.	Extractive matters.	Gelatin.	Soluble albuminoids.	Insoluble albuminoids.	Fats.	Ash.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Sturgeon (Acipenser güldenstædtii), E	1	76.02	3.05	1.58	13.04		5.16	1.16
Sterlet (Acipenser ruthenus), E	1	76.81	1.69	1.74	13.21		5.59	0.95
Carp (Cytorinus carpio), E	1	79.89	3.92	2.84	10.79		1.42	1.14
Crucian carp (Carassius vulgaris), E	1	80.82	4.56	3.63	9.44		0.48	1.07
Herring (Clupea harengus), A	1	69.03	1.40	2.93	1.62	......	11.01	1.50
Herring (Clupea harengus), E (average)	2	74.68	2.42	1.91	13.93		5.38	1.68
Shad (Clupea sapidissima), A	1	70.75	1.92	1.93	1.92	12.74	10.08	1.34
Smelt (Osmerus mordax), A	1	80.16	3.22	4.97	0.60	7.44	1.94	2.00
Smelt (Osmerus eperlanus), E	1	78.38	4.14	2.83	10.00		3.08	1.57
Sigg (Coregonus baerii), E	1	79.13	2.93	3.70	11.69		1.53	1.22
Salmon (Salmo salar), A (average)	1	62.68	1.81	1.77	1.57	11.95	19.25	1.11
Salmon (Salmo salar), E	2	66.18	2.42	3.29	13.69		12.47	1.40
Salmon (Salmo salar), spent, A (average)	2	76.74	1.82	2.71	1.08	......	3.60	1.15
Spent land-locked salmon (Salmo salar, subsp. sebago), A (average)	2	78.54	2.11	2.09	0.86	......	2.98	1.24
Salmon trout (Salmo trutta) E	1	75.35	3.11	1.71	16.01		2.49	1.33
Brook trout (Salvelinus fontinalis) A	1	77.54	2.57	2.22	1.80	12.52	2.61	1.42
Pike (Esox lucius), E (average)	2	82.29	2.50	3.07	10.69		0.24	1.16
Muskellunge (Esox nobilior), A	1	76.26	2.27	2.40	1.65	13.46	2.54	1.57
Eel (Muræna anguilla), E	1	52.78	1.78	2.04	1.46	8.14	32.88	0.92
Mackerel (Scomber scombrus), A	1	74.14	2.22	1.48	1.88	12.25	6.99	1.30
Mackerel (Scomber scombrus), E	1	64.43	1.87	1.01	2.74	11.84	16.41	1.70
Spanish mackerel (Cybium maculatum), A	1	68.10	2.22	2.04	1.25	......	9.43	1.50
Black bass (Micropterus salmoides), A	1	78.61	2.24	3.10	2.04	......	0.96	1.19
Yellow perch (Perca fluviatilis), E	1	80.06	1.76	3.74	3.61	9.01	0.44	1.39
Wall-eyed pike (Stizostedion vitreum), A	1	79.74	2.66	3.44	1.19	10.57	0.47	1.37
Pike perch (Stizostedion sandra), E	1	79.87	3.28	3.55	12.10		0.20	1.00
White perch (Roccus americanus), A (average)	2	75.71	1.94	2.98	2.08	......	4.07	1.20
Red snapper (Lutjanus blackfordi), A (average)	2	77.78	1.83	3.27	1.72	12.98	1.28	1.30
Porgy (Diplodus argyrops), A	1	71.98	1.78	2.07	2.98	12.44	7.86	1.35
Sheepshead (Diplodus probatocephalus), A	1	72.01	1.44	3.36	1.90	11.76	6.72	1.10
Blackfish (Hiatula onitis), A	1	76.95	1.72	3.64	2.61	11.76	2.81	1.28
Haddock (Gadus æglefinus), A	1	82.03	1.11	2.94	1.42	11.70	0.14	1.57
Cod (Gadus morrhua), E (average)	2	82.00	2.52	3.46	10.61		0.14	1.27
Russian cod (Gadus navaga), E	1	81.35	4.99	2.46	9.03		0.59	1.58
Turbot (Platysomatichthys hippoglossoides), A	1	71.39	2.01	3.69	0.12	8.05	14.41	1.28
Flounder (Paralichthys dentatus), A	1	85.04	1.91	3.60	0.98	......	0.77	1.29
Plaice (Pleuronectes platessa), E	1	77.39	2.15	3.17	1.72	12.31	1.80	1.46
PRESERVED FISH.								
Salt sturgeon (Acipenser huso), E	1	61.85	1.83	2.05	14.82		8.93	10.52
Sturgeon, salted and dried backs, E	1	36.67	8.84	2.63	31.08		14.35	6.93
Dried dorsal cords, E	1	50.99	5.21	40.04	0.18		0.06	3.52
Salted and smoked Pelecus vulgaris, E	1	54.89	5.42	6.14	18.48		5.87	9.20
Salted and smoked bleak (Alburnus chalcoides), E	1	43.53	6.37	3.47	18.99		16.21	11.43
Salted and dried roach (Leuciscus rutilus, var. caspica), E	1	27.96	9.44	8.23	30.18		9.88	14.31
Salt herring (Clupea harengus), E (average)	2	49.59	4.17	1.84	1.36	12.56	14.18	16.79
Smoked herring (Clupea harengus), A	1	34.55	8.53	5.13	0.32	21.69	15.82	13.19
Marinated shad (Meletta vulgaris), E	1	60.72	3.73	3.06	3.79		17.14	11.56
Salted Caspian shad (Clupea caspica), E	1	59.56	3.78	4.87	13.41		8.86	9.52
Salted and dried smelt (Osmerus spirinchus), E	1	41.12	8.56	2.27	20.55		8.03	18.47
Salted and dried backs of Coregonus leucichthys, E	1	57.55	3.99	4.59	14.91		13.17	5.78
Canned salmon (Oncorhynchus chouicha), A	1	65.86	4.85	1.80	.....	14.49	11.06	1.79
Salted salmon (Salmo salar), E (average)	2	52.26	3.49	3.25	15.73		12.09	13.18
Salt mackerel (Scomber scombrus), A	1	42.19	3.57	1.68	0.29	15.49	22.59	13.16
Salt mackerel (Scomber scombrus), E	1	48.43	2.74	1.50	1.28	15.68	14.10	16.27
Desiccated cod (Gadus morrhua), E	1	17.02	9.14	10.47	3.38	50.56	0.70	8.73
Dried cod (Gadus morrhua), E	1	25.23	5.21	13.23	50.44		0.69	5.20
Salt cod (Gadus morrhua), A (average)	3	53.84	1.96	8.73	0.77	15.76	0.34	24.15
Dried pollock (Gadus virens), E	1	13.71	6.48	12.35	5.36	54.01	1.20	6.89
Salted ling (Gadus molva), E	1	52.42	3.70	7.06	0.60	16.07	0.40	19.75
Dried ling (Gadus molva), E	1	28.53	4.90	13.72	1.86	38.60	0.57	11.82
Smoked halibut (Hippoglossus hippoglossus), A	1	51.06	2.74	1.58	0.74	13.01	15.61	15.18
Salt halibut (Hippoglossus maximus), E	1	54.65	5.57	1.09	16.83		6.82	15.04
Marinated Lamprey eel (Petromyzon fluviatilis)	1	44.62	2.70	4.05	27.57		16.57	4.40

2. CLASSIFICATION OF SPECIMENS OF AMERICAN AND EUROPEAN FISHES ANALYZED BY THEIR CHEMICAL COMPOSITION.

In the following tabular statements the specimens of American and European fishes are classified by the composition of the flesh in the same manner as was done with the American specimens in a preceding chapter. A repetition of the explanations there made seems unnecessary.

Classification of American and European fishes by proportions of water-free substances in flesh of specimens analyzed.

[A, American; E, European.]

Kinds of fish.	No. of specimens analyzed.	Water-free substance.
Containing over 30 per cent. of water-free substance.		
California salmon, A	2	36.4
Eel, A and E	4	35.5
Salmon, A and E	8	34.2
Spanish mackerel, A	1	31.9
Lake trout, A	2	30.9
Whitefish, A	1	30.2
Containing between 30 and 25 per cent., inclusive, of water-free substance.		
Butter-fish, A	1	29.9
Shad, A	7	29.4
Lamprey eel, A	1	28.9
Turbot, A	1	28.6
Mackerel, A and E	8	28.4
Herring, A and E	4	27.9
Pompano, A	2	27.2
Bleak, E	1	27.1
Alewife, A	2	25.6
Small-mouthed black bass, A	1	25.2
Mullet, A	1	25.1
Porgy, A	3	25.0
Containing between 25 and 20 per cent. of water-free substance.		
Salmon trout, E	1	24.7
Halibut, A	3	24.6
Sheepshead, A	2	24.5
White perch, A	2	24.3
Pollock, A	1	23.9
Sturgeon, E	1	23.9
Cisco, A	1	23.8
Muskellunge, A	1	23.7
Sterlet, E	1	23.2
Gudgeon, E	1	23.1
Plaice, E	1	22.6
Striped bass, A	6	22.3
Brook trout, A	3	22.3
Smelt, E	1	21.6
Carp, E	2	21.6
Containing between 25 and 20 per cent. of water-free substance—Cont'd.		
Red snapper, A	3	21.5
Bluefish, A	1	21.5
Large-mouthed black bass, A	1	21.4
Small-mouthed red-horse, A	1	21.4
Sturgeon, A	1	21.3
Skate, A and E	2	21.2
Weakfish, A	1	21.0
Blackfish, A	4	20.9
Whitefish, E	1	20.9
Smelt, A	2	20.8
Kingfish, A	1	20.8
Sea bass, A	1	20.7
Dab, E	1	20.6
Grouper, A	2	20.5
Yellow perch, A and E	3	20.4
Pike-perch, wall-eyed pike, A	1	20.3
Pickerel, A	2	20.3
Pike-perch, E	1	20.2
Conger eel, E	1	20.0
Containing between 20 and 15 per cent. of water-free substance.		
Pike, A and E	4	19.5
Pike-perch, gray pike, A	1	19.2
Crucian carp, E	1	19.2
Russian cod, E	1	18.7
Haddock, A and E	8	18.6
Tomcod, A	1	18.5
Red bass, A	1	18.4
Cusk, A	1	18.0
Cod, A and E	7	17.5
Whiting, E	1	17.0
Hake, A	1	16.9
Common flounder, A	2	15.8
Winter flounder, A	1	15.7
Containing between 15 and 10 per cent. of water-free substance.		
Sole, E	1	13.9
Barbel, E	1	10.7

Classification of American and European fish by proportions of fat in flesh of specimens analyzed.

[A, American; E, European.]

Kinds of fish.	No. of specimens analyzed.	Water.	Fats.	Kinds of fish.	No. of specimens analyzed.	Water.	Fats.
Containing over 5 per cent. of fats.				*Containing less than 2 per cent. of fats.*			
Eel, A and E	4	64.5	18.7	Sturgeon, A	1	78.7	1.9
California salmon, A	2	63.6	17.9	Plaice, E	1	77.4	1.8
Turbot, A	1	71.4	14.4	Smelt, A	2	79.2	1.8
Lamprey eel, A	1	71.1	13.3	Whitefish, E	1	79.1	1.5
Salmon, A and E	8	65.8	12.1	Blackfish, A	4	79.1	1.4
Lake trout, A	2	69.1	11.4	Carp, E	2	78.4	1.3
Butter-fish, A	1	70.0	11.1	Bluefish, A	1	78.5	1.3
Shad, A	7	70.6	9.5	Red snapper, A	3	78.5	1.0
Spanish mackerel, A	1	68.1	9.4	Large-mouthed black bass, A	1	78.6	1.0
Mackerel, A and E	8	71.6	8.2	Skate, A and E	2	78.8	1.0
Bleak, E	1	72.9	8.2	Kingfish, A	1	79.2	1.0
Herring, A and E	4	72.1	8.0	Pike perch, Gray pike, A	1	80.9	0.8
Pompano, A	2	72.8	7.6	Pollock, A	1	76.0	0.8
Whitefish, A	1	69.9	6.5	Yellow perch, A and E	3	79.5	0.7
Sterlet, E	1	76.8	5.6	Hake, A	1	83.1	0.7
Halibut, A	3	75.4	5.2	Common flounder, A	2	84.2	0.7
Conger eel, E	1	79.9	5.1	Grouper, A	2	79.5	0.6
Sturgeon, A	1	76.0	5.1	Russian cod, E	1	81.4	0.6
Porgy, A	3	74.9	5.1	Red bass, A	1	81.6	0.6
Containing between 5 and 2 per cent. of fats.				Sea bass, A	1	79.3	0.5
				Pickerel, A	2	79.7	0.5
Alewife, A	2	74.5	4.9	Crucian carp, E	1	80.8	0.5
Mullet, A	1	74.9	4.6	Pike perch, wall-eyed pike, A	1	79.7	0.5
White perch, A	2	75.7	4.1	Winter flounder, A	1	84.4	0.5
Sheepshead, A	2	75.6	3.7	Whiting, E	1	82.9	0.4
Cisco, A	1	76.1	3.5	Pike, A and E	4	80.5	0.4
Smelt, E	1	78.4	3.1	Tomcod, A	1	81.6	0.4
Striped bass, A	6	77.8	2.9	Haddock, A and E	8	81.4	0.3
Gudgeon, E	1	76.9	2.7	Cod, A and E	7	82.5	0.3
Muskellunge, A	1	76.2	2.5	Barbel, E	1	89.4	0.2
Dab, E	1	79.4	2.5	Pike perch, E	1	79.9	0.2
Small-mouthed black bass, A	1	74.8	2.5	Cusk, A	1	82.0	0.2
Salmon trout, E	1	75.3	2.5	Sole, E	1	86.1	0.2
Small-mouthed red-horse, A	1	78.6	2.4				
Weakfish, A	1	78.9	2.4				
Brook trout, A	3	77.7	2.1				

SECTION D.—MOLLUSKS, CRUSTACEANS, ETC.

1. LIST OF AMERICAN SPECIES ANALYZED.

	No. of specimens.
Mollusks:	
Oysters, *Ostrea virginica*	41
Scallops, *Pecten irradians*	2
Long clams, *Mya arenaria*	4
Round clams, or quahogs, *Venus mercenaria*	2
Mussels, *Mytilus edulis*	1
	50
Crustaceans.	
Lobsters, *Homarus americanus*	6
Crayfish, *Cambarus*, sp	1
Crabs, *Callinectes hastatus*	2
Shrimp	1
	10
Vertebrates:	
Terrapin, *Ptychemys?*	1
Green turtle, *Chelonia mydas*	1
	2

There were in all 62 specimens of 11 species of mollusks, crustaceans, and vertebrates.

2. METHODS OF ANALYSIS AND ANALYTICAL DETAILS.

METHODS OF ANALYSIS.

The methods of analysis employed were practically those used in the analysis of fish, and described in a previous part of this report. A few notes on special details of methods used for the invertebrates, especially the mollusks, will be in place here.

Many of the specimens examined, as oysters, clams, etc., are liable to have foreign matters, mud, sea-weed, hydroids, gastropods, etc., adhering to their shells. These foreign materials were removed by washing, after which the specimens were drained and wiped dry.

After the cleaning of their shells, the weighed oysters were opened, the liquid thus escaping being caught in a large evaporating dish. They were then put upon a porcelain colander ("crystal drainer") and the liquid contents allowed to drain into a beaker. In this way some very small particles of solid matter would probably be added to the filtrate. For the purpose of analysis the part remaining upon the dish was called "flesh," while that passing through was designated as "liquids." The flesh and liquids in canned oysters and those that were opened before they were received were separated in the same way. After this separation the flesh was chopped in a wooden tray until the sample was quite fine, and evenly and thoroughly mixed, as was done with the samples of fish above reported.

The specimens of clams and mussels were prepared in the same way as oysters. In the case of scallops only the part usually eaten, the muscle that holds the shell together (adductor muscle), was analyzed. This was analyzed as received, the flesh being chopped and sampled in the same way as that of the oyster.

In the case of lobsters, crabs, crayfish, and turtles the flesh was carefully separated from the shell and prepared as above. For the parts taken for analysis, see description of samples in the analytical details which follow.

In all of the samples a portion, usually about 100 grammes, of the chopped flesh was dried in hydrogen and prepared for analysis in the same manner as the hydrogen-dried samples of fish already described. The liquids were evaporated over a water bath, and then dried in air. After drying they were ground, sampled, and used for the determinations made in "liquids," the methods for which were in the main like that for the flesh.

DESCRIPTIONS OF SPECIMENS AND ANALYTICAL DETAILS.

The details of the analysis which follow contain the description of the samples and the details of the determinations. They are arranged in the order previously named, the specimens of each species being in the order of the laboratory numbers.

The description of the specimens of oysters and clams do not say, except in a very few cases, whether they were or were not "floated," *i. e.*, placed for a time in brackish or fresh water after removal from the beds. As the practice of floating is so universal, and as the specimens were received in the condition in which they are usually sold, it is probable that the majority, if not all, of the specimens, with the exception of those in cases specially referred to, had been floated.

The following data have been compiled from our laboratory note-books, as was done with the analyses of fishes:

DESCRIPTIVE LIST OF THE MOLLUSKS, CRUSTACEA, ETC., ANALYZED.

54. Oysters. Fair Haven, Connecticut. Long Island Sound. Purchased in Middletown. The sample consisted of 33 oysters, one-half peck.

55. Oysters. Stony Creek, Connecticut. "Natives." Purchased in Middletown. Dredged April 4, 1881. Thirty-nine oysters, one peck. Length, from 4 to 6 inches; mostly 4½ to 5½ inches.

56. Oysters. "Blue Points." Patchogue, Long Island. Furnished by Mr. Blackford. Length, 2½ to 4½ inches; breadth, 1¼ to 2½ inches.

57. Oysters. "East Rivers." Cow Bay, Long Island Sound, New York. Furnished by Mr. Blackford. Length, 2½ to 5¼ inches; breadth, 1¾ to 3½ inches.

58. Oysters. "Rockaways." Presumably from Rockaway, Long Island. Furnished by Mr. Blackford. Length, 3¼ to 4½ inches; breadth, 2 to 3¼ inches.

59. Oysters. "Virginias." Presumably from Virginia. Furnished by Mr. Blackford. Length, 2½ to 4½ inches; breadth, 1⅞ to 3½ inches.

60. Oysters. "Sounds." Staten Island, New York. Furnished by Mr. Blackford.

61. Oysters. "Shrewsbury." Presumably from Shrewsbury, New Jersey. Furnished by Mr. Blackford. The specimen consisted of 28 oysters in the shell.

68. Oysters. Buzzard's Bay, Massachusetts. Furnished by Mr. Blackford. The specimen consisted of 29 oysters in the shell.

70. Oysters. Providence River, Rhode Island. Purchased in Newton, Massachusetts. The specimen consisted of 28 oysters in the shell.

71. Oysters. James River, Virginia. Furnished by Mr. F. T. Lane, New Haven. Transplanted to New Haven, Connecticut. The specimen consisted of 30 oysters in the shell. An accompanying letter says: "From James River, Va., * * * are what we consider the best stock to plant; * * * have been planted here five weeks." Though not distinctly stated, the probable inference seems to be that the oysters were floated, like No. 72. Specimens taken from the same bed were analyzed five and one-half months later, October 31, as Nos. 82 and 83.

72. Oysters. Rappahannock River, Virginia. Furnished by Mr. Lane, New Haven. In an accompanying letter Mr. Lane says: "* * * From Rappahannock River; * * * are what we use mostly for winter and spring; * * * have been planted here three weeks, then taken up into a river where the water is quite fresh and put into floats for forty-eight hours to fatten them."

73. Oysters. Potomac River, Virginia. Furnished by Mr. Lane, New Haven. Transplanted to New Haven, Connecticut. The specimen consisted of 55 oysters in

the shell. In an accompanying letter Mr. Lane says: "These are from the Potomac River and the cheapest of anything we get from the South; * * * have been transplanted three weeks." Though not distinctly stated, the probable inference seems to be that the oysters are "floated," like No. 72. Specimens taken nearly six months later from the same bed were analyzed as Nos. 84 and 85.

74. Canned oysters, sometimes called "Cove Oysters." Chesapeake Bay. Furnished by Mr. J. F. Ely, Baltimore, Maryland. The samples consisted of a one-half pound can containing 30 oysters and a one-pound can containing 77 oysters. In an accompanying letter Mr. Ely states: "The oysters we 'steamers' use are gathered from all points in the Chesapeake Bay and mouth of the Potomac River. There is no agency but heat applied in the preparation."

75. Oysters. Stony Creek, Connecticut. Purchased in Middletown. The specimen consisted of 30 oysters in the shell.

82. Oysters. James River, Virginia. Furnished by Mr. F. T. Lane, New Haven. Transplanted to New Haven, Connecticut, April, 1881. Thirty-one oysters in the shell. Mr. Lane says: "These samples, 82 and 83, are from the James River, Virginia, planted here last April. No. 1 (this sample) is as they came from the bed. This is some of the same James River stock I sent you last spring." (No. 71.)

83. Oysters. James River, transplanted as 82. Furnished by Mr. F. T. Lane, New Haven. Thirty-four oysters in the shell. Mr. Lane says: "No. 2 (this sample) has been in the float 48 hours." Both 82 and 83 were taken from the same bed at the same time.

84. Oysters. Potomac River, transplanted to New Haven, Connecticut. Furnished by Mr. F. T. Lane, New Haven. Forty-one oysters in shell. Mr. Lane says: "Stock planted here last April. This sample has been in the float 48 hours. This is some of the same stock I sent you last spring." (No. 73.)

85. Oysters. Potomac River, Virginia. Furnished by Mr. F. T. Lane, New Haven. Transplanted as 84. Mr. Lane says: "This sample came direct from the beds." Both 84 and 85 were taken from the same bed at the same time. Thirty-five oysters in the shell.

89. Oysters. Fair Haven, Connecticut. New Haven Bay. Natives. Purchased in Middletown. The specimen consisted of one pint of the so-called "solids," *i. e.*, the shell contents as ordinarily sold, and contained the "flesh" or "meats" with part of the "liquids" or "liquor" of 36 oysters. The laboratory record contains the following entry: "The specimen, one pint, did not furnish enough liquids for analysis."

92. Oysters. Long Island Sound. Furnished by Mr. F. T. Lane, New Haven. Thirty-four oysters in shell. In accompanying letter Mr. Lane describes them as "outside" or "Sound" oysters, which we understand to mean that they were taken in Long Island Sound, outside of New Haven Harbor.

93. Oysters. Fair Haven, Connecticut. New Haven Bay. Furnished by Mr. F. T. Lane, New Haven. Thirty-six oysters in the shell. In accompanying letter Mr. Lane describes them as "inside" or "harbor" natives, which we understand to mean that they grew in New Haven Bay near Fair Haven.

97. Canned oysters. Purchased in Middletown. One "one-pound" can containing 78 oysters.

103. Oysters. Clinton, Connecticut. Long Island Sound. Natives. Purchased in Middletown. Thirty-one oysters in the shell, one-half peck. Price, 50 cents per peck.

104. Oysters. "Solids." Virginias transplanted to New Haven, Connecticut. Purchased in Middletown. Price 50 cents per quart. One quart of oysters, shell contents, as commonly sold. They were said to have come from Mr. F. T. Lane, of New Haven, and were very likely from the same beds as some of the specimens previously reported as received directly from Mr. Lane.

105. Oysters. Stony Creek, Connecticut. Long Island Sound. Purchased in Middletown. Thirty oysters in the shell, one peck. Price, 50 cents per peck.

106. Oysters. North Shrewsbury River, Shrewsbury, New Jersey. Furnished by Dorlon & Shaffer, New York. Twenty-five oysters in the shell.

107. Oysters. "Blue Points." Great South Bay, Long Island. Furnished by Dorlon & Shaffer, New York. Thirty oysters in shell.

108. Oysters. "East Rivers." Oyster Bay, Long Island. Furnished by Dorlon & Shaffer, New York. Twenty-five oysters in the shell.

109. Oysters. "Sounds." Princess Bay, Staten Island, New York. Furnished by Dorlon & Shaffer, New York. Thirty oysters in the shell.

112. Oysters. "Rockaways." Far Rockaway, Long Island. Furnished by Dorlon & Shaffer, New York. Thirty oysters in the shell.

118. Oysters. Norwalk, Connecticut. Furnished by Dorlon & Shaffer, New York. Thirty oysters in the shell.

120. Canned oysters. Furnished by Thurber & Co., New York. One "one pound" can containing fifty oysters.

151. Oysters. Norwalk, Connecticut. Long Island Sound. Furnished by Dorlon & Shaffer, New York. Thirty oysters in the shell.

180. Oysters. Oyster Bay, New York. Furnished by Dorlon & Shaffer, New York. Thirty-two oysters in the shell.

181. Oysters. Shrewsbury, New Jersey. Furnished by Dorlon & Shaffer, New York. Thirty oysters in the shell.

182. Oysters. Furnished by Dorlon & Shaffer, New York. Thirty oysters in the shell. The so-called "Blue Points," a favorite kind of oyster stated to come from sundry places on the coast of Long Island.

202. Oysters. "Solids." Virginia. Purchased in Middletown. The specimen consisted of one quart of the shell contents as ordinarily sold, containing 118 oysters and weighing 970.5 grammes. The dealer from whom they were purchased stated that they were received from F. T. Lane, of New Haven, where they "were taken from a vessel just in from Virginia." The amount of liquid was so small that no attempt was made to separate it from the flesh.

203. Oysters. Stony Creek, Connecticut. Long Island Sound. Purchased in Middletown. The specimen consisted of one peck of oysters in the shell, containing 90 oysters, weighing 6,585 grammes. Price, 50 cents per peck. Said to be from the Stony Creek Oyster Company, Connecticut, and called "Offshore oysters."

204. Oysters. "Solids." Fair Haven, Connecticut. Long Island Sound. Purchased in Middletown. The specimen consisted of one pint of the shell contents, the portion ordinarily sold, and contained 61 oysters, weighing 522.5 grammes. Price, 35 cents per quart. The amount of liquid was so small that no attempt was made to separate it from the flesh.

210. Oysters. Fair Haven, Connecticut. Long Island Sound. Purchased in Middletown. The specimen consisted of one-half peck of Fair Haven natives in the shell and contained 20 oysters weighing 3,371 grammes. Price, 50 cents per peck.

51 and 63. Scallops. Furnished by Mr. Blackford. The specimens consisted of the adductor muscle only, the portion commonly eaten, and were in the form usually found for sale in the market.

65. "Long" Clams. Napaug, Long Island. Purchased in Middletown. The specimen consisted of 20 clams in the shell.

67. "Long" Clams. Boston Harbor, Massachusetts. Purchased in Newton, Massachusetts. The specimen consisted of 20 clams in the shell.

102. "Long" Clams. Clinton, Connecticut. Long Island Sound. Purchased in Middletown. Twenty-five clams in the shell. Price, 50 cents per peck.

122. Canned clams. "Long Clams." Penobscot Bay, Maine. Furnished by Thurber & Company, New York. One "one pound" can. The can bore the brand "Penobscot Bay, Little Neck Clams, Castine Packing Company, Maine."

201. Long Clams. Clinton, Connecticut. Long Island Sound. Purchased in Middletown. The specimen consisted of one peck, containing 145 clams. Price per peck, 45 cents. Forty-five clams were taken for analysis.

66. "Round" Clams. Little Neck, New York. Purchased in Middletown. The specimen consisted of 20 clams in the shell.

139. Mussels. Stony Creek, Connecticut. Long Island Sound. Purchased in Middletown. The specimen consisted of one peck containing 208 mussels in the shell. Price, 30 cents per peck. Fifty mussels were taken for analysis.

50. Lobster. Furnished by Mr. Blackford. Two lobsters entire and evidently lately caught.

Weighings in preparation for analysis.

Parts.	*a.*	*b.*	Average.
	Grms.	*Grms.*	*Grms.*
Edible portion:			
Body	118.5	127.5	123.0
Claws	152.5	219.5	186.0
Tail	138.0	131.0	134.5
Liquid portion	54.4	94.8	74.6
Total	463.4	572.8	518.1
Refuse	367.8	499.5	433.7
Loss	38.8	30.7	34.7
Total weight	870.0	1,103.0	986.5

62. Lobster. Furnished by Mr. Blackford. Locality unknown.

69. Lobster. Purchased in Newton, Massachusetts.

239. Lobster. Maine. Furnished by Mr. Blackford.

64. Crayfish, *Cambarus*. Species not determined. Furnished by Mr. Blackford. The specimen consisted of 21 crayfish, weighing 684.6 grammes, of which the abdomens ("tails") weighed 176.6 grams.

Weighings in preparation for analysis.

		Grms.
Cephalothorax		508.0
Abdomen:		
Edible portion, flesh	85.5	176.6
Refuse	83.8	
Loss	7.3	
Total		684.6

101. Crabs. ("Hard Crabs.") Coast of New Jersey. Furnished by Mr. Blackford. The specimen consisted of three entire crabs. They were boiled before the flesh was separated from the shells.

Weighings in preparation for analysis.

Parts.	*a.*	*b.*	*c.*	Average.
	Grms.	*Grms.*	*Grms.*	*Grms.*
Flesh	103.0	77.0	105.0	95.0
Refuse	120.5	103.5	114.5	112.8
Loss	11.5	5.7	4.7	7.3
Total	235.0	186.2	224.2	215.1

125. Canned round clams. Furnished by Thurber & Co., New York. One "one-pound" can, containing 25 clams. The can was labeled "Little Neck Clams."

76. Canned lobster. Purchased in Middletown. The contents weighed 469.5 grammes.

121. Canned lobster. Furnished by Thurber & Co., New York. One "one-pound" can, labeled "Thurber's Egmont Bay Fresh Lobster."

124. Canned crab. Hampton, Virginia. Furnished by Thurber & Co., New York. One "one-pound" can, labeled "Bryce's Fresh Crab Meat." It contained no seasoning except a little salt. The contents of the can weighed 607 grammes.

274. Canned crab. Hampton, Va. Furnished by Thurber & Co., New York. One "one-pound" can, bearing label "Bryce's Fresh Crab Meat." The can contents weighed 600 grammes.

123. Canned shrimps. Furnished by Thurber & Co., New York. Gulf of Mexico. One "half-pound" can, labeled "Barataria Shrimp."

235. Terrapin. Savannah, Georgia. Furnished by Mr. Blackford, the specimen consisting of two whole terrapin. The species was not determined.

Weighings in preparation for analysis.

Parts.	*a.*	*b.*	Average.
Flesh:	*Grms.*	*Grms.*	*Grms.*
Edible portion	183.0	45.0	114.0
Refuse	562.0	258.0	410.0
Loss	28.0	11.0	19.5
Total	773.0	314.0	543.5

272. Green turtle. Key West, Florida. Furnished by Mr. Blackford. One whole turtle. The larger portion of the muscle was taken for analysis.

DETAILS OF ANALYSES OF FLESH (AND "LIQUIDS") OF MOLLUSKS, CRUSTACEANS, ETC.

The following figures are transcribed from our laboratory books. Full details of analyses are given of a few specimens, showing what determinations were made, how they were recorded, and the calculations made from them. Following these statements are tabulated summaries of the determinations of all the specimens. The details of determinations of proximate ingredients are, however, omitted from the tabular statement, as in the details of analyses of the flesh of fishes, and for the same reason:

LABORATORY NUMBER 57.

Name: Oysters ("East Rivers").
Locality: Cow Bay, Long Island Sound, New York.
Received: April 8, 1881, from E. G. Blackford.
Description: Length, 2½ to 5½ inches; breadth, 1¾ to 3½ inches.

Weighings in preparation for analysis.

	Grms.	*Lb.*	*Oz.*	*P. ct.*
Flesh	558.0	= 1	3.6	10.27
Liquid	543.7	1	3.1	10.01
Refuse (shells, etc.)	4284.7	9	7.2	78.86
Loss	47.3	....	1.7	.86
Total, 51 oysters	5433.7	11	15.6	100.00

Analysis of flesh.

Water (dried in hydrogen).	Partial drying.—100.00 grm. fresh substance, "Fr." = 21.30 grm. partially dried, "Pd." = 21.30% Pd. in Fr.	
	Complete drying.—1.0815 grm. Pd. = 1.0190 grm. Water-free "Wfr." = 94.22% Wfr. in Pd.	Av'ge 94.25% Wfr. in Pd.
	Complete drying.—1.1015 grm. Pd. = 1.0385 grm. Water-free "Wfr." = 94.28% Wfr. in Pd.	
	21.30% Pd. in Fr. × 94.25% Wfr. in Pd. = 20.08% Wfr. in Fr., or 79.92% Water in Fr.	
Nitrogen.	.601 grm. Pd. = .5664 grm. Wfr., gave .4717 grm. N. = 8.33% N.	Av'ge 8.32% N. in Wfr., or 1.67% N. in Fr.
	.600 = .5655 .4699 = 8.31	

Ether Ext. { 1.0815 grm. Pd. = 1.0190 grm. Wfr., gave .1095 grm. Ext. = 10.75% Ext. } Av'ge 10.79% Ext. in Wfr., or 2.16% Ext. in Fr.
{ 1.1015 = 1.0385 .1150 = 10.82 }

Ash. 2.276 grm. Pd. = 2.145 grm. Wfr., gave .1865 grm. Ash. = 8.69% Ash. in Wfr., or 1.74% Ash. in Fr.

P_2O_5 0.9030 grm. Pd. = 0.8511 grm. Wfr., gave 0.0138 grm. P_2O_5 = 1.62% P_2O_5 } Av'ge 1.62% P_2O_5 in Wfr., or 0.32% P_2O_5 in Fr.
0.9055 = 0.8535 0.0138 = 1.61 }

SO_3 0.9050 grm. Pd. = 0.8530 grm. Wfr., gave 0.0431 grm. SO_3 = 5.06% SO_3 } Av'ge 5.01% SO_3 in Wfr., or 1.00% SO_3 in Fr.
0.9020 = 0.8501 0.0422 = 4.96 }

Albumen in cold-water ext. { 33.3 grm. Fr. = 6.6933 grm. Wfr., gave 0.2455 grm. Alb. = 0.74% Alb. } Av'ge 0.75% Alb. in Fr., or 3.73% Alb. in Wfr.
{ 33.3 = 6.6933 0.2490 = 0.75 }

Analysis of liquids.

Water (dried in air). {
Partial drying.—543.7 grm. fresh substance, "Fr." = 24.8 grm. partially dried, "Pd." = 4.56% Pd. in Fr.
Complete drying.—1.000 grm. Pd. = 1.000 grm. Water-free, "Wfr." = 100.00% Wfr. in Pd. } Av'ge 100.00% Wfr. in Pd.
Complete drying.—1.000 grm. Pd. = 1.000 grm. Water-free, "Wfr." = 100.00% Wfr. in Pd. }
4.56% Pd. in Fr. × 100.00% Wfr. in Pd. = 4.56% Wfr. in Fr., or 95.44% Water in Fr.

Nitrogen. { .6000 grm. Pd. = .6000 grm. Wfr., gave 0.03492 grm. N. = 5.82% N. } Av'ge 5.85% N. in Wfr. or 0.26% N. in Fr.
{ .6015 = .6015 0.03529 = 5.88 }

Ether ext. { 1.1385 grm. Pd. = 1.1385 grm. Wfr., gave .005 grm. Ext. = 0.44% Ext. } Av'ge 0.45% Ext. in Wfr., or 0.02% Ext. in Fr.
{ 1.1115 = 1.1115 .005 = 0.45 }

Ash. 3.000 grm. Pd. = 3.0000 grm. Wfr., gave 1.0335 grm. Ash. = 34.45% Ash. in Wfr., or 1.57% Ash in Fr.

Recapitulation of analysis.

[Protein = N × 6.25.]

Constituents.	In water-free substance.			In fresh substance.		
	Flesh.	Liquid.	Flesh + liquid.	Flesh.	Liquid.	Flesh + liquid.
	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Water	......	....	....	79.92	95.44	87.57
Protein	52.00	36.57	49.20	10.44	1.67	6.11
Fat (ether extract)	10.79	0.45	8.92	2.16	0.02	1.11
Carbohydrates, etc., (by difference)	28.52	28.53	28.52	5.74	1.30	3.55
Ash	8.69	34.45	13.36	1.74	1.57	1.66
	100.00	100.00	100.00	100.00	100.00	100.00

Proximate ingredients of flesh directly determined.

Constituents.	In water-free substance.	In fresh substance.
	P. ct.	P. ct.
Water	....	79.92
Albumen, coagulated from cold-water extract	3.73	0.75
Extractives, etc., not coagulated in cold-water ext.	26.88	5.40
Gelatin in hot-water extract	18.67	3.75
Insoluble protein	33.15	6.65
Ether extract	10.79	2.16
Ash	8.69	1.74
Total	101.91	100.37

LABORATORY NUMBER 109.

Name: Oysters, "Sounds."
Locality: Princess Bay, Staten Island, New York.
Received: November 30, 1881, from Dorlon & Shaffer, New York City.
Description: Thirty oysters in shell.

Weighings in preparation for analysis.

	Grms.	Lbs.	Oz.	P. ct.
Flesh	384.0	....	13.5	8.24
Liquid	436.0	....	15.4	9.35
Refuse	3,816.0	8	6.6	81.87
Loss	25.0	....	0.9	0.54
Total, 30 oysters	4,661.0	10	4.4	100.00

Analysis of flesh.

Water (dried in hydrogen).
Partial drying.—100.10 grm. fresh substance, "Fr." = 17.54 grm. partially dried, "Pd." = 17.52% Pd. in Fr.
Complete drying.—1,000 grm. Pd. = 0.9830 grm. Water-free, "Wfr." = 98.30% Wfr. in Pd.
Complete drying.—1,000 grm. Pd. = 0.9823 grm. Water-free, "Wfr." = 98.23% Wfr. in Pd.
} Av'ge 98.27% Wfr. in Pd.
17.52% Pd. in Fr. × 98.27% Wfr. in Pd. = 17.21% Wfr. in Fr., or 82.79% Water in Fr.

Water (dried in air).
Partial drying.—100.19 grm. fresh substance, "Fr." = 17.28 grm. partially dried, "Pd." = 17.24% Pd. in Fr.
Complete drying.—1,000 grm. Pd. = 0.9815 grm. Water-free, "Wfr." = 98.15% Wfr. in Pd.
Complete drying.—1,000 grm. Pd. = 0.9817 grm. Water-free, "Wfr." = 98.17 Wfr. in Pd.
} Av'ge 98.16% Wfr. in Pd.
17.24% Pd. in Fr. × 98.16% Wfr. in Pd. = 16.96% Wfr. in Fr., or 83.04% Water in Fr.

Nitrogen. 0.500 grm. Pd. = 0.4914 grm. Wfr., gave 0.38344 grm. N. = 7.80% N.
0.500 = 0.4914 0.38534 7.84
} Av'ge 7.82% N. in Wfr. or 1.35% N. in Fr.

Ether Ext. 1.500 grm. Pd. = 0.9827 grm. Wfr., gave 0.09975 grm. Ext. = 10.15% Ext.
1.000 = 0.9827 0.09950 = 10.12%
} Av'ge 10.14% Ext. in Wfr. or 1.74% Ext. in Fr.

Ash. 3.000 grm. Pd. = 2.9481 grm. Wfr., gave 0.2940 grm. Ash. = 9.99% Ash.
3.000 = 2.9481 0.2925 = 9.92
} Av'ge 9.96% Ash. in Wfr. or 1.71% Ash. in Fr.

LABORATORY NUMBER 102.

Name: "Long clams."
Locality: Clinton, Connecticut, Long Island Sound.
Purchased November 26, 1881, in Middletown.
Description: Twenty-five clams, in shell. Price 50 cts. per peck.

Weighings in preparation for analysis.

	Grms.	*Lb.*	*Oz.*	*P. ct.*
Flesh	485.5 =	1	1.2	32.89
Liquid	369.5 =	..	13.0	25.03
Refuse	601.0 =	1	5.2	40.72
Loss	20.0 =	..	0.7	1.36
Total, 25 clams	1,476.0	3	4.1	100.00

Analysis of flesh.

Water (dried in hydrogen).
Partial drying.—100.50 grm. fresh substance, "Fr." = 22.60 grm. partially dried, "Pd." = 22.40% Pd. in Fr.
Complete drying.—1.000 grm. Pd. = 0.9530 grm. Water-free, "Wfr." = 95.30% Wfr. in Pd.
Complete drying.—1.000 grm. Pd. = 0.9527 grm. Water-free, "Wfr." = 95.27% Wfr. in Pd.
} Av'ge 95.27% Wfr. in Pd.
22.40% Pd. in Fr. × 95.29% Wfr. in Pd. = 21.43% Wfr. in Fr., or 78.57% Water in Fr.

Water (dried in air).
Partial drying.—99.93 grm. fresh substance, "Fr." = 21.95 grm. partially dried, "Pd." = 21.97% Pd. in Fr.
Complete drying.—1.000 grm. Pd. = 0.974 grm. Water-free, "Wfr." = 97.40% Wfr. in Pd.
Complete drying.—1.000 grm. Pd. = 0.974 grm. Waterfree, "Wfr." = 97.40% Wfr. in Pd.
} Av'ge 97.40% Wfr. in Pd.
21.97% Pd. in Fr. + 97.40% Wfr. in Pd. = 21.39% Wfr. in Fr., or 78.61% Water in Fr.

Nitrogen. 0.500 grm. Pd. = 0.4765 grm. Wfr., gave 0.052815 grm. N. = 11.08% N.
0.500 = 0.4765 0.052983 = 11.12
} Av'ge 11.10% N. in Wfr., or 2.38% N. in Fr.

Ether Ext. 1.000 grm. Pd. = 1.9529 grm. Wfr., gave 0.0790 grm. Ext. = 8.29% Ext.
1.000 = 0,9529 0.0795 = 8.34
} Av'ge 8.32% Ext. in Wfr., or 1.78% Ext. in Fr.

Ash. 2.000 grm. Pd. = 1.9058 grm. Wfr., gave 0.2185 grm. Ash = 11.47% Ash
2.000 = 1.9058 0.2252 = 11.80
} Av'ge 11.64% Ash in Wfr., or 2.49% Ash. in Fr.

Analysis of liquids.

Water (dried in air).
Partial drying.—369.5 grm. fresh substance, "Fr." = 14.85 grm. partially dried, "Pd. = 4.02% Pd. in Fr.
Complete drying.—1,000 grm. Pd. = 0.991 grm. Water-free, "Wfr." = 99.10% Wfr. in Pd.
Complete drying.—1.000 grm. Pd. = 0.990 grm. Water-free, "Wfr." = 99.00% Wfr. in Pd.
} Av'ge 99.05% Wfr. in Pd.
4.02% Pd. in Fr. × 99.10% Wfr. in Pd. = 3.98% Wfr. in Fr., or 96.02% Water in Fr.

Nitrogen. 0.500 grm. Pd. = 0.4953 grm. Wfr., gave 0.013065 grm. N. = 2.64% N.
0.500 = 0.4953 0.012875 = 2.60
} Av'ge 2.62% N. in Wfr., or 0.11% N. in Fr.

Ether Ext.	1.000 grm. Pd. = 0.9905 grm. Wfr., gave 0.001 grm. Ext. = 0.10% Ext. 1.000 = 0.9905 0.001 = 0.10	Av'ge 0.10% Ext. in Wfr., or 0.00% Ext. in Fr.
Ash.	2.000 grm. Pd. = 1.981 grm. Wfr., gave 1.3950 grm. Ash. = 70.38% Ash. 2.000 = 1.981 1.4115 = 71.21 2.000 = 1.981 1.380 = 69.63	Av'ge 70.41% Ash. in Wfr., or 2.81% Ash. in Fr.

Recapitulation of analysis.

[Protein = N × 6.25.]

Constituents.	In water-free substance.			In fresh substance.		
	Flesh.	Liquid.	Flesh + liquid.	Flesh.	Liquid.	Flesh + liquid.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Water				78.57	96.02	86.11
Protein	69.37	16.37	62.81	14.86	0.65	8.71
Fat (ether ext.)	8.32	0.10	7.30	1.78	0.00	1.01
Carbohydrates, etc. (by difference)	10.67	13.12	10.97	2.30	0.52	1.54
Ash	11.64	70.41	18.92	2.49	2.81	2.63
	100.00	100.00	100.00	100.00	100.00	100.00

LABORATORY NUMBER 50.

Name: Lobster.
Received: March 15, 1881, from E. G. Blackford, fish commissioner of the State of New York.
Description: Two lobsters, entire, and evidently lately caught.

Weighings in preparation for analysis.

Parts.	a.	b.	Average.	Average.		Per cent.
Edible portions:	*Grms.*	*Grms.*	*Grms.*	*Lbs.*	*Oz.*	
Body	118.5	127.5	123.0	....	4.3	12.46
Claws	152.5	219.5	186.0	....	6.5	18.86
Tail	138.0	131.0	134.5	....	4.8	13.64
Liquid	54.4	94.8	74.6	....	2.6	7.56
Total edible	463.4	572.8	518.1	1	2.2	52.52
Refuse	367.8	499.5	433.7	....	15.3	43.96
Loss	38.8	30.7	34.7	....	1.3	3.52
Total weight	870.0	1,103.0	986.5	2	2.8	100.00

Analysis of flesh (edible portion).

Water, (dried in hydrogen).	Partial drying.—113.0 grm. fresh substance, "Fr." = 18.3 grm. partially dried, "Pd.," = 16.19 % Pd. in Fr. Complete drying.—1.6815 grm. Pd. = 1.6305 grm. Water free, "Wfr." = 96.97 % Wfr. in Pd. Complete drying.—1.6220 grm. Pd. = 1.5725 grm. Water free, "Wfr." = 96.95 % Wfr. in Pd. 16.19 % Pd. in Fr. × 96.96 % Wfr. in Pd. = 15.70 % Wfr. in Fr., or 84.30 % Water in Fr.	Av'ge 96.96 % Wfr. in Pd.
Nitrogen.	0.5995 grm. Pd. = 0.5812 grm. Wfr., gave 0.06890 grm. N. = 11.85 % N. 0.6015 = 0.5832 0.06909 = 11.85	Av'ge 11.85 % N. in Wfr. or 1.86 % N. in Fr.
Ether Ext.	0.6257 grm. Pd. = 0.6067 grm. Wfr., gave 0.0708 grm. Ext. = 11.67 % Ext. 0.6345 0.6154 0.0715 = 11.55	Av'ge 11.62 % Ext. in Wfr. or 1.82 % Ext. in Fr.
Ash.	2.0535 grm. Pd. = 1.927 grm. Wfr., gave 0.200 grm. Ash = 10.38 % Ash.	Av'ge 10.38 % Ash in Wfr. or 1.63 % Ash in Fr.
P_2O_5.	0.9115 grm. Pd. = 0.8553 grm. Wfr., gave 0.0182 grm. P_2O_5 = 2.13 % P_2O_5 0.9130 = 0.8567 0.0182 = 2.13	Av'ge 2.13 % P_2O_5 in Wfr. or 0.33 % P_2O_5 in Fr.
SO_3.	0.9050 grm. Pd. = 0.8510 grm. Wfr., gave 0.0203 grm. SO_3 = 2.39 % SO_3 0.9085 = 0.8525 0.0203 = 2.38	Av'ge 2.39 % SO_3 in Wfr. or 0.38 % SO_3 in Fr.
Albumen in cold-water Ext.	33.3 grm. Fr. = 5.2333 grm. Wfr., gave 0.1775 grm. Alb. = 0.53 % Alb. 33.3 = 5.2333 0.2065 = 0.62	Av'ge 0.58 % Alb. in Fr. or 3.69 % Alb. in Wfr.

Extractives, etc., in cold-water Ext.
33.3 grm. Fr. = 5.2333 grm. Wfr., gave 1.9795 grm. crude Ext. = 5.94 % crude Ext.
33.3 grm. Fr. = 5.2333 grm. Wfr., gave 1.9320 grm. crude Ext. = 5.80 % crude Ext.
} Av'ge 5.87 % crude Ext. in Fr. or 37.38 % crude Ext. in Wfr.
0.6545 grm. crude Ext. gave 0.0270 grm. water = 4.12 % water
0.6545 0.0150 fat = 2.39 fat
1.1430 0.2160 ash = 19.72 ash
} 26.23 % = 73.77 % pure Ext. in crude Ext.
37.38 % crude Ext. = 27.58 % pure Ext. in Wfr. = 4.33 % pure Ext. in Fr.

Gelatin in hot-water Ext.
33.3 grm. Fr. = 5.2333 grm. Wfr., gave 0.9600 grm. crude gel. = 2.88 % crude gel.
33.3 grm. Fr. = 5.2333 grm. Wfr., gave 0.9400 grm. crude gel. = 2.82 % crude gel.
} Av'ge 2.85 % crude gel. in Fr. or 18.15 % crude gel. in Wfr.
0.5360 grm. crude gel. gave 0.0115 grm. water = 2.15 % water
0.5360 0.0035 fat = 0.67 fat
0.9600 0.0670 ash = 7.15 ash
} 9.97 % = 90.03 % pure gel. in crude gel.
18.15 % crude gel. = 16.34 % pure gel. in Wfr. = 2.57 % pure gel. in Fr.

Insoluble protein.
33.3 grm. Fr. = 5.2333 grm. Wfr., gave 1.531 grm. crude Ins. = 4.59 % crude Ins.
33.3 grm. Fr. = 5.2333 grm. Wfr., gave 1.652 grm. crude Ins. = 4.95 % crude Ins.
} Av'ge 4.77 % crude Ins. in Fr. or 30.38 % crude Ins. in Wfr.
0.8515 grm. crude Ins. gave 0.0245 grm. water = 2.88 % water
0.8515 0.0050 fat = 0.60 fat
1.8170 0.0395 ash = 2.24 ash
} 5.72 % = 94.28 % pure Ins. in crude Ins.
30.38 % crude Ins. = 28.64 % pure Ins. in Wfr. = 4.48 % pure Ins. in Fr.

Recapitulation of analysis of flesh.

Constituents.	Protein = N × 6.25.		Albuminoids estimated by difference.	
	In water-free substance.	In fresh substance.	In water-free substance.	In fresh substance.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Water	....	84.30	....	84.30
Protein	74.06	11.63	78.00	12.25
Ether extract	11.62	1.82	11.62	1.82
Ash	10.38	1.63	10.38	1.63
Total	96.06	99.38	100.00	100.00

Proximate ingredients of flesh directly determined.

Constituents.	In water-free substance.	In fresh substance	In fresh substance, calculated to 100 per cent.
Water	....	84.30	84.54
Albumen, coagulated in cold-water, ext	3.69	0.58	0.58
Extractives, etc., not coagulated in cold-water ext	27.58	4.33	4.34
Gelatin in hot-water extract	16.34	2.57	2.58
Insoluble protein	28.64	4.48	4.49
Ether extract	11.62	1.82	1.83
Ash	10.38	1.63	1.64
Total	98.25	99.71	100.00

Details of analyses of flesh (and liquids) of specimens of mollusks, crustaceans, etc.

[Determinations of water, nitrogen, ether extract (fat), and ash.]

Laboratory No. of specimen. F=flesh, L=liquid.	Water and water-free substance.			In water-free substance.					
	Partly dried substance "Pd." in fresh substance.	Water-free substance "Wfr." in partly dried substance.		Nitrogen.		Ether extract.		Ash.	
		Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*
F. 54	19.22	97.28 97.30	97.29	8.44 8.48	8.46	10.84 11.00	10.92	11.77	11.77
L. 54	6.11	98.15 98.09	98.12	5.54 5.58	5.56	0.26 0.28	0.27	53.13	53.13
F. 55	19.50	97.35 97.31	97.33	8.79 8.84	8.82	8.33 8.49	8.41	14.58	14.58
L. 55	6.51	59.61 59.51	59.56	3.42 3.41	3.42	0.35 0.34	0.35	70.91	70.91
F. 56	23.88	97.22 97.26	97.24	7.05 7.10	7.08	9.90 9.87	9.80	8.29	8.29
L. 56	5.67	100.00 100.00	100.00	6.49 6.51	6.50	1.57 1.50	1.54	33.74	33.74
F. 57	21.30	94.22 94.28	94.25	8.33 8.31	8.32	10.75 10.82	10.79	8.69	8.69
L. 57	4.56	100.00 100.00	100.00	5.82 5.88	5.85	0.44 0.45	0.45	34.45	34.45
F. 58	19.50	96.08 96.06	96.07	7.83 7.85	7.84	11.31 11.37	11.34	8.94	8.94
L. 58	4.97	99.38 99.41	99.39	5.34 5.30	5.32	0.71 0.70	0.71	45.75	45.75
F. 59	16.80	96.05 96.07	96.06	9.22 9.26	9.24	9.10 8.93	9.01	11.27	11.27
L. 59	3.19	99.12 99.15	99.14	5.23 5.21	5.22	0.19 0.16	0.18	52.03	52.03
F. 60	15.90	97.71 97.65	97.68	8.39 8.38	8.39	10.85 10.82	10.84	9.10	9.10
L. 60	3.69	98.99 98.87	98.93	5.69 5.73	5.71	2.52 2.58	2.55	23.15	23.15
F. 61	10.00	96.51 96.60	96.56	7.15 7.15	7.15	12.06 11.94	12.00	7.24	7.24
L. 61	4.96	99.51 99.61	99.56	6.60 6.60	6.60	0.88 0.88	0.88	37.18	37.18
F. 68	17.30	91.40 91.19	91.30	7.87 7.82	7.85	9.97 9.93	9.95	9.39	9.39
L. 68	3.62	99.52 99.52	99.52	5.54 5.61	5.58	0.07 0.07	0.07	45.27	45.27
F. 70	23.20	90.44 90.53	90.49	7.89 7.80	7.85	12.12 12.37	12.25	10.15	10.15
L. 70	4.95	99.86 99.86	99.86	4.79 4.76	4.78	0.04 0.04	0.04	48.79	48.79
F. 71	17.70	93.30 93.20	93.30	8.02 8.00	8.01	10.86 10.66	10.76	10.48	10.48
L. 71	4.13	98.84 99.07	98.96	4.63 4.65	4.64	0.24 0.29	0.27	62.37	62.37
F. 72	18.40	94.44 94.31	94.37	7.86 7.83	7.85	10.92 10.99	10.96	9.12	9.12
L. 72	2.78	99.14 99.21	99.18	5.89 5.89	5.89	0.24 0.24	0.24	49.87	49.87
F. 73	22.70	93.09 93.08	93.09	7.43 7.42	7.43	10.69 10.85	10.77	12.02	12.02
L. 73	4.52	99.54 99.37	99.45	5.17 5.14	5.16	0.25 0.25	0.25	54.96	54.96
F. 74	22.80	94.15 94.12	94.14	10.50 10.50	10.50	17.82 17.69	17.76	7.51	7.51
L. 74	6.87	93.66 93.64	93.65	4.41 4.40	4.41	4.14 4.14	4.14	18.88	18.88
F. 75	19.40	92.26 92.33	92.30	8.82 8.83	8.83	8.21 8.37	8.29	14.30	14.30
L. 75	3.71	98.95 98.92	98.94	2.77 2.88	2.83	1.31 1.30	1.31	70.46	70.46
F. 82	24.00	93.40 93.45	93.43	7.71 7.73	7.72	11.87 11.76	11.82	10.00 10.02	10.01
L. 82	5.51	95.40 95.49	95.45	5.96 5.91	5.94	0.80 0.74	0.77	48.40	48.40
F. 83	17.80	96.35 96.35	96.35	8.17 8.15	8.16	11.05 11.10	11.08	8.94 9.00	8.97
L. 83	4.98	96.10 96.10	96.10	6.99 7.03	7.01	2.81 2.81	2.81	29.60 29.61	29.61
F. 84	10.25	91.20 91.10	91.15	8.13 8.09	8.11	10.83 10.75	10.79	8.78 8.77	8.78

Details of analyses of flesh (and liquids) of specimens of mollusks, etc.—Continued

Laboratory No. of specimen. F=flesh, L=liquid.	Water and water-free substance.			In water-free substance.					
	Partly dried substance "Pd." in fresh substance.	Water-free substance "Wfr." in partly dried substance.		Nitrogen.		Ether extract.		Ash.	
		Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*
L. 84	4.36	98.80 98.78	98.79	7.66 7.74	7.70	0.30 0.27	0.29	27.83 27.62	27.71
F. 85	22.55	96.15 96.20	96.18	7.49 7.43	7.46	10.55 10.55	10.55	9.78 9.87	9.83
L. 85	5.11	98.00 98.05	98.03	5.81 5.76	5.79	0.35 0.30	0.33	40.30	49.30
F. 89	16.80	95.45 95.40	95.43	7.15 7.13	7.14	12.26 12.31	12.29	5.32 5.36	5.34
L. 89	3.93	96.88 96.92	96.90	6.89 6.85	6.87	0.50 0.48	0.49	14.55 14.50	14.53
F. 92	22.00	97.70 97.70	97.70	8.62 8.66	8.64	8.62 8.55	8.59	11.68 11.80	11.74
L. 92	6.45	95.90 95.95	95.93	5.92 5.94	5.93	0.26 0.26	0.26	51.41 50.82	51.12
F. 93	25.50	92.40 92.40	92.40	7.37 7.39	7.38	10.39 10.34	10.37	8.42 8.47	8.45
L. 93	5.72	97.38 97.40	97.39	6.14 6.14	6.14	0.31 0.31	0.31	44.10 43.34	43.73
F. 97	28.20	83.50 83.60	83.55	9.12 9.16	9.14	18.68 18.73	18.71	7.03 6.97	7.00
L. 97	6.90	96.15 96.23	96.19	3.48 3.46	3.47	1.51 1.56	1.54	14.16 14.11	14.14
F. 103	19.69	96.95 97.00	96.98	8.11 8.09	8.10	9.72 9.70	9.76	12.04 11.91	11.98
L. 103	4.07	97.80 97.85	97.83	4.44 4.44	4.44	0.41 0.36	0.39	55.97 54.90	55.44
F. 104	14.87	97.50 97.55	97.53	8.31 8.27	8.29	12.61 12.56	12.59	7.79 7.67	7.73
L. 104	3.58	99.75 99.72	99.74	6.41 6.41	6.41	0.55 0.60	0.58	21.45 21.36	21.41
F. 105	22.87	96.95 97.00	96.98	7.67 7.63	7.65	10.39 10.46	10.43	11.31 11.29	11.30
L. 105	4.65	99.05 99.00	99.03	4.75 4.70	4.73	0.20 0.20	0.20	50.54 50.59	50.57
F. 106	23.51	95.40 95.38	95.39	6.94 6.88	6.91	11.85 11.90	11.88	8.30 8.35	8.33
L. 106	4.82	96.50 96.47	96.49	6.49 6.46	6.48	0.90 0.85	0.88	42.13 42.03	42.08
F. 107	25.17	97.08 97.15	97.12	8.72 8.71	8.71	8.27 8.26	8.27	10.48 10.54	10.51
L. 107	3.25	95.72 95.66	95.69	3.86 3.84	3.85	0.25 0.23	0.24	61.60 61.62	61.61
F. 108	25.29	97.98 98.02	98.00	6.50 6.50	6.50	11.53 11.58	11.56	7.58 7.53	7.56
L. 108	5.33	96.14 96.18	96.16	5.67 5.61	5.64	1.85 1.82	1.84	45.44 45.37	45.41
F. 109	17.52	98.30 98.23	98.27	7.80 7.84	7.82	10.15 10.12	10.14	9.99 9.92	9.96
L. 109	3.53	95.22 95.25	95.24	5.19 5.23	5.21	0.26 0.26	0.26	55.70 55.65	55.68
F. 112	23.33	95.80 95.75	95.78	7.57 7.51	7.54	12.16 12.18	12.17	9.03 9.08	9.06
L. 112	5.33	97.65 97.70	97.68	5.44 5.40	5.42	0.26 0.24	0.25	49.13 49.14	49.14
F. 118	19.64	95.07 95.10	95.09	8.14 8.18	8.16	8.10 8.12	8.11	11.23 11.23	11.23
L. 118	3.60	98.50 98.57	98.54	3.61 3.52	3.57	0.32 0.30	0.31	65.48 65.41	65.45
F. 120	24.12	94.33 94.30	94.32	9.26 9.19	9.23	18.61 18.66	18.64	6.36 6.36	6.36
L. 120	9.62	98.00 98.10	98.05	3.38 3.31	3.35	1.33 1.30	1.32	11.63 11.63	11.63
F. 151	20.57	94.80 94.75	94.78	8.16 8.19	8.18	9.71 9.65	9.68	11.04 11.01	11.03
L. 151	3.74	98.48 98.50	98.49	3.30 3.31	3.31	0.40 0.43	0.42	67.82 67.75	67.79
F. 180	23.99	92.15 92.10	92.13	7.68 7.68	7.68	10.64 10.64	10.64	9.88 9.92	9.90
L. 180	4.73	99.11 99.07	99.09	4.96 4.98	4.97	0.25 0.30	0.28	50.63 50.56	50.60
F. 181	19.60	93.25 93.20	93.23	8.02 8.02	8.02	10.89 10.99	10.94	9.18 9.25	9.22

Details of analyses of flesh (and liquids) of specimens of mollusks, etc.—Continued.

Laboratory No. of specimen. F=flesh. L=liquid.	Water and water-free substance.			In water-free substance.					
	Partly dried substance "Pd." in fresh substance.	Water-free substance "Wfr." in partly dried substance.		Nitrogen.		Ether extract.		Ash.	
		Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*
L. 181	3.54	98.28 98.23	98.26	6.31 6.33	6.32	0.36 0.36	0.36	48.95 48.85	48.90
F. 182	17.55	91.35 91.35	91.35	8.78 8.78	8.78	10.13 10.09	10.11	9.90 9.98	9.94
L. 182	3.17	98.93 98.95	98.94	4.67 4.69	4.68	0.36 0.36	0.36	53.71 53.79	53.75
F. 202	12.63	95.82 95.75	95.78	8.08 8.09	8.09	12.92 13.00	12.96	6.34 6.39	6.37
F. 203	20.07	97.57 97.59	97.58	8.46 8.49	8.48	9.43 9.43	9.43	11.32 11.32	11.32
L. 203	4.83	97.40 97.39	97.40	4.82 4.83	4.83	0.62 0.62	0.62	53.31 53.13	53.22
F. 204	11.88	97.39 97.40	97.39	8.16 8.18	8.17	13.34 13.30	13.32	7.70 7.64	7.67
F. 210	10.65	97.70 97.69	97.70	8.25 8.23	8.24	10.62 10.68	10.66	9.60 9.62	9.61
L. 210	4.77	96.94 97.00	96.98	6.24 6.22	6.23	0.62 0.68	0.65	45.11 45.37	45.24
51	24.01	92.54 92.45	92.50	10.85 10.83	10.84	0.13 0.13	0.13	6.68	6.68
63	18.98	90.32 90.52	90.42	13.46 13.46	13.46	1.76 1.76	1.76	7.51	7.51
F. 65	19.80	95.70 95.76	95.73	10.58 10.55	10.57	8.08 7.98	8.03	8.23	8.23
L. 65	5.25	99.53 99.48	99.51	3.91 3.92	3.92	0.57 0.52	0.55	56.00	56.00
F. 67	23.99	91.88 91.93	91.89	10.56 10.55	10.56	8.10 8.16	8.13	12.51	12.51
L. 67	4.27	99.81 99.81	99.81	1.85 1.86	1.86	0.14 0.14	0.14	77.20	77.20
F. 102	22.49	95.30 95.27	95.29	11.08 11.12	11.10	8.29 8.34	8.32	11.47 11.80	11.64
L. 102	4.02	99.10 99.00	99.05	2.64 2.60	2.62	0.10 0.10	0.10	70.38 71.21 69.63	70.41
F. 122	28.79	88.10 88.05	88.08	11.28 11.17 11.18	11.21	11.39 11.42	11.41	12.43 12.46	12.45
L. 122	8.29	97.42 97.43	97.43	4.95 4.91	4.93	0.46 0.39	0.43	21.29 21.25	21.27
F. 201	20.45	98.06 98.07	98.07	10.07 10.06	10.07	8.41 8.46	8.44	15.56 15.48	15.52
L. 201	3.23	100.00 100.00	100.00	3.28 3.29	3.29	0.40 0.40	0.40	63.50 63.32	63.41
F. 66	23.20	93.86 93.75	93.81	8.52 8.52	8.52	3.44 3.34	3.39	10.19	10.19
L. 66	4.89	99.66 99.66	99.66	2.93 2.99	2.96	0.34 0.34	0.34	64.97	64.97
F. 139	22.16	96.35 96.35	96.35	9.39 9.36	9.38	7.84 7.85	7.85	8.12 8.09	8.11
L. 139	5.91	97.70 97.69	97.70	4.88 4.85	4.87	2.22 2.26	2.24	38.56 38.66	38.61
50	16.19	96.97 96.95	96.96	11.85 11.85	11.85	11.67 11.55	11.62	10.38	10.38
62	19.12	95.34 95.32	95.33	12.33 12.33	12.33	8.43 8.50	8.47	9.36	9.36
69	19.56	91.46 91.46	91.46	13.44 13.43	13.44	14.20 14.17	14.19	10.43	10.43
239	22.27	93.52 93.57	93.55	13.23 13.24	13.24	6.95 6.93	6.94	7.80 7.78	7.79
64	19.81	94.83 94.79	94.81	13.61 13.64	13.63	2.45 2.45	2.45	6.98	6.98
101	23.40	98.00 98.00	98.00	11.63 11.59	11.61	8.57 8.53	8.55	13.61 13.67	13.64
F. 125	27.16	90.00 89.95	89.98	10.93 10.92	10.93	5.17 5.22	5.20	9.56 9.50	9.53
L. 125	10.00	94.73 94.80	94.77	6.87 6.88	6.88	2.71 2.74	2.73	34.42 34.45	34.43
76	23.10	89.39 89.34	89.37	12.99 12.97	12.98	2.33 2.14	2.24	13.44	13.44
121	25.88	92.20 92.17	92.19	13.09 13.10 13.09	13.09	7.05 7.05	7.05	9.03 9.00	9.01

Details of analyses of flesh (and liquids) of specimens of mollusks, etc.—Continued.

Laboratory No. of specimen. F=flesh, L=liquid.	Water and water-free substance.			In water-free substance.					
	Partly dried substance "Pd." in fresh substance.	Water-free substance "Wfr." in partly dried substance.		Nitrogen.		Ether extract.		Ash.	
		Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.	Individual determinations.	Average.
	Per cent.	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per ct.*
124	20.94	90.85 90.80	90.83	13.15 13.12	13.14	4.19 4.13	4.16	9.36 9.39	9.38
274	22.93	91.85 91.87	91.86	12.18 12.16	12.17	10.91 10.97	10.94	9.96 10.00	9.98
123	32.09	91.00 91.00	91.00	13.89 13.91	13.90	3.46 3.41	3.44	8.82 8.85	8.84
235	26.34	96.90 96.89	96.90	13.28 13.31	13.30	13.56 13.61	13.59	4.01 3.97	3.99
272	21.20	95.33 95.39	95.36	15.69 15.70	15.70	2.68 2.60	2.64	6.00 5.92	5.96

Details of analyses of flesh of specimens of mollusks, crustaceans, etc.

[Determinations of phosphorus and sulphur.]

Laboratory number of specimen.	Phosphorus as P_2O_5.			Sulphur as SO_3		
	Individual determinations.		Average.	Individual determinations.		Average.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
54	1.57	1.57	1.57	5.51	5.67	5.59
55	1.46	1.46	1.46	5.36	5.26	5.31
56	1.29	1.26	1.28	3.64	3.77	3.70
57	1.62	1.61	1.62	5.06	4.96	5.01
58	1.59	1.58	1.59	3.91	3.87	3.89
59	1.78	1.80	1.79	2.89	2.87	2.88
60	1.99	1.96	1.98	3.19	3.19	3.19
61	1.61	1.61	1.61	2.25	2.21	2.23
68	1.47	1.48	1.48	4.14	4.16	4.15
70	1.64	1.64	1.64	3.55	3.54	3.55
71	1.82	1.75	1.79	2.76	2.80	2.78
72	1.83	1.76	1.80	2.12	2.14	2.13
73	1.82	1.67	1.75	2.59	2.59	2.59
74	1.61	1.62	1.62	0.95	0.93	0.94
75	1.76	1.77	1.77	3.65	3.64	3.65
51	2.14	2.19	2.17	2.25	2.20	2.23
63	2.75	2.75	2.75	2.76	2.75	2.76
65	2.48	2.48	2.48	2.32	2.37	2.35
67	2.23	2.20	2.21	3.11	3.14	3.14
66	1.77	1.96	1.86	4.09	4.13	4.11
50	2.13	2.13	2.13	2.39	2.38	2.39
62	2.23	2.24	2.24	1.97	1.96	1.97
69	2.30	2.31	2.35	3.12	2.99	3.06
64	2.85	2.84	2.85	1.38	1.40	1.39
76	1.14	1.11	1.13	2.34	2.34	2.34

3. ANALYSES OF AMERICAN MOLLUSKS, CRUSTACEANS, ETC.

DESCRIPTION OF THE TABLES.

Table 33 contains a list of the specimens analyzed. The specimens of oysters, and of other species as well, are arranged in order of the locality from which the specimens were obtained, the more northern coming first. In the second column is given the date of receipt of the samples at the laboratory. In most cases they had been taken from the water two or three days before being received by us. As will be seen in the third column, the number taken for analysis was generally large in order to obtain a fair sample. In the fourth column are given the total weights of the samples taken for analysis, and in the fifth the average weights of the individual specimens. Details as to the proportions of shell, flesh, liquids, total edible portion, etc., in the several samples of oysters and other invertebrates, are given under the heading "Constituents in whole specimen." The figures for "flesh" denote the percentage of solids or "meat;" those under liquids, the liquid portion, "liquor" in the sample. The solids and liquids together are designated "total edible portion," which with refuse and loss in preparation make up the whole sample.

Under the heading "In flesh" are given the percentages of water and dry substance in the flesh. After these follow the same percentages for liquids and for the total edible portion.

Table 34 gives the proximate percentage composition calculated on water free (dry) substance. The percentages of albuminoids were obtained by multiplying the percentages of nitrogen by the factor 6.25.

Table 35 contains the results of the analyses calculated to the water content of the fresh substance. The term, "fresh substance," as here used, refers to the flesh and liquids as they were obtained by the separations described under methods of analysis of invertebrates, etc. The percentages in the column headed "Extractives" are obtained by difference. That is, the albuminoids (as computed by multiplying nitrogen by 6.25), fats, and ash, are added and their sum subtracted from the total dry substance. Though this method of computation is common in the statements of the composition of animal and vegetable materials, it is, of course, only an approximately accurate way of getting over the difficulty of determining and stating the amounts of the several ingredients. It will be noticed that "extractives" as thus determined by difference are not the same as the "extractive matters" of the tables of the fish analyses.

Table 36 gives the percentages of phosphorus, calculated as phosphoric anhydride, and of sulphur calculated as sulphuric anhydride. The percentages are given calculated to dry substance and to fresh substance.

TABLE 33.—*Mollusks, crustaceans, etc.; list of specimens, names, localities, and proportions of flesh, etc.*

Name and locality of specimen.	Lab. No. of specimen.	Specimens received.	Number taken for analysis.	Total weight.	Average weight.	Constituents in whole specimen.					In flesh.		In liquids.		In total edible portion (flesh plus liquids).		In whole specimen.		
						Flesh.	Liquids.	Total edible portion.	Refuse (shells, etc.).	Loss in preparation for analysis.	Water.	Water-free substance.	Water.	Water-free substance.	Water.	Water-free substance.	Water-free substance of flesh.	Water-free substance of liquids.	Water-free substance of edible portion.
				Grms.	*Grms.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Oysters (Ostrea virginica) in shell:																			
Buzzard's Bay, Mass	68	May, 1881	29	2764.0	95.3	12.50	7.51	20.01	79.77	0.22	84.21	15.79	96.40	3.60	88.80	11.20	1.98	0.27	2.25
Providence River, R. I	70	...do	28	3301.0	117.9	10.88	6.12	17.00	82.41	0.59	79.01	20.99	95.05	4.95	84.79	15.21	2.28	0.30	2.58
Clinton, Conn	103	Nov., 1881	31	2573.0	83.0	11.67	13.20	24.87	74.02	1.11	80.91	19.09	96.02	3.98	88.84	11.16	2.23	0.53	2.76
Stony Creek, Conn	55	Apr., 1881	39	6685.0	171.4	7.52	11.38	18.90	79.74	1.36	81.02	18.98	96.12	3.88	90.11	9.89	1.43	0.44	1.87
Do	75	May, 1881	30	3448.0	114.9	7.34	11.81	19.15	79.66	1.19	82.09	17.91	96.33	3.67	90.92	9.08	1.31	0.43	1.74
Do	105	Nov., 1881	30	3253.0	108.4	10.96	7.27	18.23	80.69	1.08	77.82	22.18	95.40	4.60	84.83	15.17	2.43	0.33	2.76
Do	203	Mar., 1882	30	2579.0	86.0	11.17	9.33	20.50	77.82	1.68	80.42	19.58	95.30	4.70	87.19	12.81	2.19	0.44	2.63
Do. (average of 4 specimens)					120.0	9.25	9.95	19.20	79.48	1.32	80.34	19.66	95.79	4.21	88.26	11.74	1.84	0.41	2.24
Fair Haven, Conn	54	Apr., 1881	33	3784.5	114.7	12.63	5.43	18.06	79.92	2.02	81.30	18.70	94.00	6.00	85.12	14.88	2.36	0.33	2.69
Do	93	Nov., 1881	36	2981.0	82.8	12.26	12.05	24.31	74.87	0.82	76.44	23.56	94.43	5.57	85.25	14.75	2.89	0.67	3.56
Do	210	Mar., 1882	20	3371.0	168.5	12.19	4.40	16.59	82.55	0.86	80.80	19.20	95.38	4.62	84.67	15.33	2.34	0.21	2.55
Do. (average of 3 specimens)					122.0	12.36	7.29	19.65	79.12	1.23	79.51	20.49	94.60	5.40	85.00	15.00	2.53	0.40	2.93
Long Island Sound (near New Haven), Conn	92	Nov., 1881	34	3514.0	103.4	9.72	4.90	14.62	84.09	1.29	78.51	21.49	93.81	6.19	83.64	16.36	2.09	0.30	2.39
Norwalk, Conn	118	Dec., 1881	30	6347.0	211.6	7.61	10.24	17.85	81.16	0.99	81.33	18.67	96.46	3.54	90.01	9.99	1.42	0.36	1.78
Do	151	Feb., 1882	30	7547.0	251.6	7.27	9.78	17.05	81.92	1.03	80.50	19.50	96.32	3.68	89.58	10.42	1.42	0.36	1.78
Do. (average of 2 specimens)					231.6	7.44	10.01	17.45	81.54	1.01	80.92	19.08	96.39	3.61	89.80	10.20	1.42	0.36	1.78
Oyster Bay, Long Island Sound, N. Y	108	Nov., 1881	25	4156.0	166.3	11.91	8.40	20.31	78.84	0.85	75.22	24.78	94.87	5.13	83.35	16.65	2.95	0.43	3.38
Do	180	Feb., 1882	32	5228.0	163.4	10.85	6.42	17.27	81.67	1.06	77.90	22.10	95.31	4.69	84.37	15.63	2.39	0.31	2.70
Do. (average of 2 specimens)					164.9	11.38	7.41	18.79	75.26	0.96	76.56	23.44	95.09	4.91	83.86	16.14	2.67	0.37	3.04
Cow Bay, East River, N. Y	57	Apr., 1881	51	5433.7	106.5	10.27	10.01	20.28	78.86	0.86	79.92	20.08	95.44	4.56	87.57	12.43	2.07	0.46	2.53
Rockaway, N. Y	58	..do	50	5058.0	101.2	10.68	7.72	18.40	81.18	0.42	81.27	18.73	95.06	4.94	87.06	12.94	2.00	0.38	2.38
Do	112	Nov., 1881	30	4187.0	139.5	12.11	7.73	19.84	78.53	1.63	77.66	22.34	94.79	5.21	84.33	15.67	2.71	0.40	3.11
Do. (average of 2 specimens)					120.4	11.40	7.72	19.12	79.85	1.03	79.46	20.54	94.92	5.08	85.70	14.30	2.36	0.39	2.75
"Blue Points," Patchogue, Long Island, N. Y	56	Apr., 1881	47	3725.5	79.3	13.39	5.23	18.62	80.16	1.22	76.77	23.23	94.33	5.67	81.70	18.30	3.11	0.30	3.41
"Blue Points," Great South Bay, Long Island, N. Y	107	Nov., 1881	30	3537.0	117.9	6.50	9.67	16.17	83.36	0.47	75.55	24.45	96.89	3.11	88.30	11.70	1.59	0.30	1.89
"Blue Points," (Long Island coast, N. Y.?)	182	Feb., 1882	30	5818.0	193.9	8.01	7.41	15.42	84.10	0.48	83.97	16.03	96.87	3.13	90.17	9.83	1.29	0.23	1.52
Do. (average of 3 specimens)					130.4	9.30	7.44	16.74	82.54	0.72	78.76	21.24	96.03	3.97	86.72	13.26	2.00	0.28	2.28

Staten Island, N. Y	60	Apr., 1881	30	3901.5	130.5	9.13	7.10	16.23	83.16	0.61	84.47	15.53	96.35	3.65	89.67	10.33	1.42	0.26	1.68
Princess Bay, Staten Island, N. Y	109	..do	30	4661.0	155.3	8.24	9.35	17.59	81.87	0.54	82.79	17.21	96.64	3.36	90.15	9.85	1.42	0.31	1.73
Do. (average of 2 specimens)					142.9	8.69	8.23	16.91	82.52	0.58	83.63	16.37	96.50	3.50	89.91	10.09	1.42	0.29	1.71
Shrewsbury, N. J	61	Apr., 1881	28	3904.0	139.4	12.64	4.88	17.52	81.76	0.72	81.65	18.35	95.07	4.93	85.39	14.61	2.31	0.24	2.55
Do	106	Nov., 1881	25	3954.0	158.1	11.27	8.40	19.67	79.69	0.64	77.58	22.42	95.35	4.65	85.17	14.83	2.53	0.39	2.92
Do	181	Feb., 1882	30	5184.0	172.8	9.55	9.68	19.23	79.82	0.95	81.73	18.27	96.52	3.48	89.16	10.84	1.75	0.34	2.09
Do. (average of 3 specimens)					156.8	11.15	7.66	18.81	80.42	0.77	80.32	19.68	95.65	4.35	86.57	13.43	2.20	0.32	2.52
Norfolk, Va	59	Apr., 1881	48	6635.5	138.3	4.66	6.52	11.18	88.31	0.51	83.86	16.14	96.83	3.17	91.42	8.58	0.75	0.21	0.96
Potomac River, Va.:																			
Transplanted*‡	73	May, 1881	55	3501.4	63.7	6.51	5.64	12.15	87.10	0.75	78.87	21.13	95.51	4.49	86.60	13.40	1.38	0.25	1.63
Transplanted)*§¶	84	Nov., 1881	41	4081.0	99.5	10.18	6.48	16.66	82.97	0.37	82.06	17.94	95.69	4.31	87.36	12.64	1.83	0.28	2.11
Transplanted) * § **	85	...do	35	3624.0	103.5	8.35	7.78	16.13	83.25	0.62	77.90	22.10	94.99	5.01	86.14	13.86	1.85	0.39	2.24
Do. (average of 3 specimens)					88.9	8.35	6.63	14.98	84.44	0.58	79.61	20.39	95.40	4.60	86.70	13.30	1.69	0.30	1.99
Rappahannock River, Va. (transplanted) * ‡ ¶	72	May, 1881	28	3309.5	118.2	7.86	7.31	15.17	84.02	0.81	82.64	17.36	97.24	2.76	89.68	10.32	1.36	0.20	1.56
James River, Va.:																			
Transplanted* ‖	71	...do	30	3085.0	102.8	6.50	7.29	13.79	85.30	0.91	83.49	16.51	95.91	4.09	90.05	9.95	1.07	0.30	1.37
Transplanted * § **	82	Nov., 1881	31	3293.0	106.2	9.49	5.51	15.00	84.36	0.64	77.99	22.01	94.74	5.26	84.15	15.85	2.09	0.29	2.38
Transplanted * § ¶	83	...do	34	3614.0	106.3	11.41	5.76	17.17	82.35	0.48	82.77	17.23	95.22	4.78	86.95	13.05	1.96	0.28	2.24
Do. (average of 3 specimens)					105.1	9.13	6.19	15.32	84.00	0.68	81.42	18.58	95.29	4.71	87.05	12.95	1.71	0.29	2.00
Average of 34 specimens					128.6	9.80	7.87	17.67	81.45	0.88	80.31	19.69	95.61	4.39	87.13	12.87	1.92	0.34	2.26
Oysters, "Solids," out of shell †:																			
Fair Haven, Conn	89	Nov., 1881	36	1021.4	28.3	90.39	9.61	100.00	......	......	84.04	15.96	96.19	3.81	85.21	14.79	14.42	0.37	14.79
Do	204	Mar., 1882	61	522.5	8.6	......	......	100.00	......	......	......	......	......	......	88.44	11.56	......	......	11.56
Virginia (transplanted) *	104	Nov., 1881	90	828.4	9.2	84.20	15.80	100.00	......	......	85.50	14.50	96.43	3.57	87.23	12.77	12.21	0.56	12.77
Do *	202	Mar., 1882	118	970.5	8.2	......	......	100.00	......	......	......	......	......	......	87.90	12.10	......	......	12.10
Do. (average of 4 samples)								100.00							87.19	12.81	......	......	12.81
Oysters, "Cove," canned:																			
Chesapeake Bay	74	May, 1881	77	581.7	7.5	49.29	50.71	100.00	......	......	78.53	21.47	93.57	6.43	86.02	13.98	10.58	3.26	13.84
Do	97	Nov., 1881	78	604.1	7.8	49.41	50.59	100.00	......	......	76.75	23.25	93.35	6.65	85.15	14.85	11.49	3.36	14.85
Do	120	...do	50	621.0	12.4	44.60	55.40	100.00	......	......	77.25	22.75	90.57	9.43	84.60	15.40	10.17	5.23	15.40
Do. (average of 3 samples)					9.2	47.77	52.23	100.00	......	......	77.51	22.49	92.50	7.50	85.26	14.74	10.75	3.95	14.70
Scallops (Pecten irradians)††:																			
Shelter Island, New York	51	Mar., 1881	...	......	......	100.00	......	100.00	......	......	77.79	22.21	......	......	77.79	22.21	22.21	......	22.21
Do	63	Apr., 1881	...	......	......	100.00	......	100.00	......	......	82.84	17.16	......	......	82.84	17.16	17.16	......	17.16
Do. (average of 2 specimens)						100.00	......	100.00	......	......	80.32	19.68	......	......	80.32	19.68	19.68	......	19.68
Long clams (Mya arenaria) in shell:																			
Boston, Mass	67	May, 1881	20	1504.0	75.2	29.26	24.64	53.90	45.18	0.92	77.96	22.04	95.74	4.26	86.09	13.91	6.45	1.05	7.50
Clinton, Conn	102	Nov., 1881	25	1476.0	59.1	32.89	25.03	57.92	40.72	1.36	78.57	21.43	96.02	3.98	86.11	13.89	7.05	1.00	8.05
Do	201	Mar., 1882	45	2061.0	45.8	39.37	16.93	56.30	41.71	1.99	79.94	20.06	96.77	3.23	85.00	15.00	7.89	0.55	8.44
Do. (average of 2 specimens)					52.5	36.13	20.98	57.11	41.22	1.67	79.26	20.74	96.40	3.60	85.55	14.45	7.47	0.78	8.25
Long Island, N. Y	65	Apr., 1881	20	1378.5	68.9	36.49	21.15	57.64	39.93	2.43	81.05	18.95	94.76	5.24	86.10	13.90	6.91	1.11	8.02
Average of 4 specimens					62.3	34.50	21.94	56.44	41.88	1.68	79.38	20.62	95.82	4.18	85.82	14.18	7.07	0.93	8.00
Long clams, canned:																			
Penobscot Bay, Me	122	Nov., 1881	37	458.0	12.4	42.70	57.30	100.00	......	......	74.63	25.37	91.92	8.08	84.54	15.46	10.83	4.63	15.46
Round clams (V. mercenaria) in shell:																			
Little Neck, N.Y	66	Apr., 1881	20	1907.5	95.4	16.80	14.91	31.71	67.50	0.79	78.24	21.76	95.12	4.88	86.18	13.82	3.66	0.73	4.39
Round clams, canned:																			
Islip, Long Island, N. Y	125	Nov., 1881	25	409.5	16.4	50.55	49.45	100.00	......	......	75.56	24.44	90.52	9.48	82.96	17.04	12.35	4.69	17.04

* To New Haven, Conn. † Shell contents, including flesh and liquids. ‡ Taken from beds about 3 weeks after transplanting. § About 6 months after transplanting. ‖ About 5 weeks after transplanting. ¶ Floated. ** Not floated. †† The adductor muscle, the portion ordinarily eaten.

TABLE 33.—*Mollusks, crustaceans, etc.; list of specimens, names, localities, and proportions of flesh, etc.*—Continued.

Name and locality of specimen.	Lab. No. of specimen.	Specimens received.	Number taken for analysis.	Total weight.	Average weight.	Constituents in whole specimen. Flesh.	Liquids.	Total edible portion.	Refuse, (shells, etc.).	Loss in preparation for analysis.	In flesh. Water.	Water-free substance.	In liquids. Water.	Water-free substance.	In total edible portion (flesh plus liquids). Water.	Water-free substance.	In whole specimen. Water-free substance of flesh.	Water-free substance of liquids.	Water-free substance of edible portion.
				Grms.	Grms.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Mussels (Mytilus edulis) in shell:																			
Stony Creek, Conn	139	Dec., 1881	50	1378.0	27.6	32.66	18.00	50.66	46.69	2.65	78.67	21.33	91.23	5.77	84.20	15.80	6.97	1.04	8.01
Lobster (H. americanus) in shell:																			
Locality unknown (Maine or Massachusetts?)	60	Mar., 1881	2	1973.0	986.5	......	......	52.52	43.96	3.52	......	......	......	......	84.30	15.70	......	......	8.25
Do	62	Apr., 1881	1	876.5	876.5	......	......	36.24	60.87	2.89	......	......	......	......	81.77	18.23	......	......	6.60
Do	239	Apr., 1882	1	893.0	893.0	......	......	32.24	62.47	5.29	......	......	......	......	79.17	20.83	......	......	6.72
Do	69	May, 1881	1	1335.0	1335.0	......	......	30.56	67.57	1.87	......	......	......	......	82.11	17.89	......	......	5.47
Do. (average of 4 specimens)	......	......	..	......	1022.8	......	......	37.89	58.72	3.39	......	......	......	......	81.84	18.16	......	......	6.76
Lobster, canned:																			
Maine	76	May, 1881	..	469.5	......	......	......	100.00	......	......	......	......	......	......	79.36	20.64	......	......	20.64
Do	121	Nov., 1881	..	......	......	......	......	100.00	......	......	......	......	......	......	76.15	23.85	......	......	23.85
Do. (average of 2 samples)	......	......	......	......	......	......	......	100.00	......	......	......	......	......	......	77.75	22.25	......	......	22.25
Crayfish (Cambarus) in shell:																			
Potomac River, Va	64	Apr., 1881	21	695.0	33.1	......	......	12.30	85.15	2.55	......	......	......	......	81.22	18.78	......	......	2.31
Crab (Callinectes hastatus) in shell:																			
New Jersey	101	Nov., 1881	3	645.4	215.1	......	......	44.16	52.44	3.40	......	......	......	......	77.07	22.93	......	......	10.13
Crabs, canned:																			
Hampton, Va	124	...do	...	607.0	......	......	......	100.00	......	......	......	......	......	......	80.98	19.02	......	......	19.02
Do	274	Apr., 1882	..	600.0	......	......	......	100.00	......	......	......	......	......	......	78.95	21.05	......	......	21.05
Do. (average of 2 samples)	......	......	......	......	......	......	......	100.00	......	......	......	......	......	......	79.97	20.03	......	......	20.03
Shrimp, canned:																			
Gulf of Mexico	123	Nov., 1881	....	291.5	......	......	......	100.00	......	......	......	......	......	......	70.80	29.20	......	......	29.20
Terrapin, in shell:																			
Savannah, Ga	235	Apr., 1882	2	1087.0	543.5	......	......	20.97	75.44	3.59	......	......	......	......	74.47	25.53	......	......	5.35
Green turtle (Chelonia mydas) in shell:																			
Key West, Fla	272	May, 1882	1	5471.0	5471.0	......	......	24.03	75.97	......	......	......	......	......	79.78	20.22	......	......	4.86

TABLE 34.—*Analyses of mollusks, crustaceans, etc., calculated on water-free substance.*

Name and locality of specimen.	Lab. No. of specimen.	Specimen received.	Ingredients. In flesh. Nitrogen.	In flesh. Protein (nitrogen × 6.25).	In flesh. Fat (ether extract).	In flesh. Crude ash.	In liquids. Nitrogen.	In liquids. Protein (nitrogen × 6.25).	In liquids. Fat (ether extract).	In liquids. Crude ash.	In total edible portion (flesh plus liquids). Nitrogen.	In total edible portion. Protein (nitrogen × 6.25).	In total edible portion. Fat (ether extract).	In total edible portion. Crude ash.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Oysters (Ostrea virginica) in shell:														
Buzzard's Bay, Mass	68	May, 1881	7.85	49.06	9.95	9.39	5.58	34.87	0.07	45.27	7.58	47.36	8.75	13.71
Providence River, R. I	70	..do	7.85	49.06	12.25	10.15	4.78	29.87	0.04	48.79	7.49	46.82	10.82	14.67
Clinton, Conn	103	Nov., 1881	8.10	50.62	9.76	11.98	4.44	27.75	0.39	55.44	7.41	46.32	7.99	20.17
Stony Creek, Conn	55	Apr., 1881	8.82	55.13	8.41	14.58	3.42	21.37	0.35	70.91	7.54	47.15	6.50	27.90
Do	75	May, 1881	8.83	55.19	8.29	14.30	2.83	17.69	1.31	70.46	7.37	46.06	6.59	27.98
Do	105	Nov., 1881	7.65	47.81	10.43	11.30	4.73	29.56	0.20	50.57	7.30	45.61	9.19	16.04
Do	203	Mar., 1882	8.48	53.00	9.43	11.32	4.83	30.19	0.62	53.22	7.87	49.19	7.96	18.31
Do. (average of 4 specimens)			8.45	52.78	9.14	12.88	3.95	24.70	0.62	61.29	7.52	47.00	7.56	22.56
Fair Haven, Conn	54	Apr., 1881	8.46	52.88	10.92	11.77	5.56	34.76	0.27	53.13	8.11	50.67	9.63	16.79
Do	93	Nov., 1881	7.38	46.13	10.37	8.45	6.14	38.38	0.31	43.73	7.15	44.68	8.49	15.05
Do	210	Mar., 1882	8.24	51.50	10.66	9.61	6.23	38.94	0.65	45.24	8.08	50.50	9.86	12.45
Do. (average of 3 specimens)			8.03	50.17	10.65	9.94	5.98	37.36	0.41	47.37	7.78	48.62	9.33	13.76
Long Island Sound (near New Haven, Conn.)	92	Nov., 1881	8.64	54.00	8.59	11.74	5.93	37.06	0.26	51.12	8.29	51.85	7.54	16.73
Norwalk, Conn	118	Dec., 1881	8.16	51.00	8.11	11.23	3.57	22.31	0.31	65.45	7.23	45.19	6.52	22.28
Do	151	Feb., 1882	8.18	51.13	9.68	11.03	3.31	20.69	0.42	67.79	7.19	44.97	7.80	22.53
Do. (average of 2 specimens)			8.17	51.07	8.90	11.13	3.44	21.50	0.37	66.62	7.21	45.08	7.16	22.40
Oyster Bay, Long Island Sound, N. Y	108	Nov., 1881	6.50	40.63	11.56	7.56	5.64	35.25	1.84	45.41	6.39	39.94	10.30	12.39
Do	180	Feb, 1882	7.68	48.01	10.64	9.90	4.97	31.06	0.28	50.60	7.38	46.13	9.48	14.44
Do. (average of 2 specimens)			7.14	48.32	11.10	8.73	5.32	33.16	1.06	48.01	6.89	43.04	9.89	13.42
Cow Bay, East River, N. Y	57	Apr, 1881	8.32	52.00	10.79	8.69	5.85	36.57	0.45	34.45	7.87	49.20	8.92	13.36
Rockaway, N. Y	58	..do	7.84	49.00	11.34	8.94	5.32	33.27	0.71	45.75	7.44	46.48	9.64	14.84
Do	112	Nov., 1881	7.54	47.12	12.17	9.06	5.42	33.88	0.25	49.14	7.27	45.41	10.62	14.25
Do. (average of 2 specimens)			7.69	48.06	11.76	9.01	5.37	33.57	0.48	47.45	7.36	45.95	10.13	14.55
"Blue Points," Patchogue, Long Island, N. Y	56	Apr., 1881	7.08	44.25	9.89	8.29	6.50	40.62	1.54	33.74	7.03	43.97	9.16	10.51
"Blue Points," Great South Bay, Long Island, N. Y	107	Nov., 1881	8.71	54.44	8.27	10.51	3.85	24.06	0.24	61.61	7.94	49.60	6.99	18.65
"Blue Points," (Long Island Coast, N. Y. ?)	182	Feb., 1882	8.78	54.87	10.11	9.94	4.68	29.25	0.36	53.75	8.15	50.94	8.62	1[illegible].65
Do. (average of 3 specimens)			8.19	51.19	9.42	9.58	5.01	31.31	0.71	49.70	7.71	48.17	8.26	15.27
Staten Island, N. Y	60	Apr., 1882	8.39	52.45	10.84	9.10	5.71	35.68	2.55	23.15	7.98	49.85	9.56	11.33
Princess Bay, Staten Island, N. Y	109	..do	7.82	48.87	10.14	9.96	5.21	32.56	0.26	55.68	7.35	45.92	8.35	18.24
Do. (average of 2 specimens)			8.11	50.66	10.48	9.53	5.46	34.12	1.41	39.42	7.67	47.89	8.96	14.79
Shrewsbury, N. J	61	Apr., 1882	7.15	44.69	12.00	7.24	6.60	41.25	0.88	37.18	7.10	44.36	10.97	10.05
Do	106	Nov., 1882	6.91	43.19	11.88	8.33	6.48	40.50	0.88	42.08	6.85	42.83	10.40	12.85
Do	181	Feb., 1882	8.02	50.14	10.94	9.22	6.32	39.50	0.30	48.90	7.75	48.41	9.23	15.63
Do. (average of 3 specimens)			7.36	46.00	11.61	8.26	6.47	40.42	0.71	42.72	7.23	45.20	10.20	12.84

TABLE 34.—*Analyses of mollusks, crustaceans, etc., calculated on water-free substance*—Continued.

Name and locality of specimen.	Lab. No. of specimen.	Specimen received.	Ingredients. In flesh. Nitrogen.	In flesh. Protein (nitrogen×6.25).	In flesh. Fat (ether extract).	In flesh. Crude ash.	In liquids. Nitrogen.	In liquids. Protein (nitrogen×6.25).	In liquids. Fat (ether extract).	In liquids. Crude ash	In total edible portion (flesh plus liquids). Nitrogen.	In total edible portion. Protein (nitrogen×6.25).	In total edible portion. Fat (ether extract).	In total edible portion. Crude ash.
Oysters (Ostrea virginica) in shell—Continued.			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Norfolk, Va	59	Apr., 1881	9.24	57.75	9.01	11.27	5.22	32.63	0.18	52.03	8.37	52.31	7.16	26.06
Potomac River, Va. (transplanted) * ‡	73	May, 1881	7.43	46.44	10.77	12.02	5.16	32.24	0.25	54.96	7.07	44.21	9.14	18.70
Do * § ¶	84	Nov., 1881	8.11	50.69	10.79	8.78	7.70	48.14	0.29	27.71	8.06	50.36	9.31	11.29
Do * § ¶	85	..do	7.46	46.63	10.55	9.83	5.79	36.19	0.33	49.30	7.17	44.81	8.76	16.71
Do. (average of 3 specimens)			7.67	47.92	10.70	10.21	6.22	38.86	0.29	43.99	7.43	46.46	9.07	15.57
Rappahannock River, Va. (transplanted) * ‡ ¶	72	May, 1881	7.85	49.06	10.96	9.12	5.89	36.81	0.24	49.87	7.60	47.48	9.58	14.38
James River, Va. (transplanted) * ‖	71	.. do	8.01	50.06	10.76	10.48	4.64	29.00	0.27	62.37	7.28	45.48	8.48	21.76
Do * ‡ **	82	Nov., 1881	7.72	48.25	11.82	10.01	5.94	37.13	0.77	48.40	7.50	46.88	10.48	14.63
Do * ‡ **	83	...do	8.16	51.00	11.08	8.97	7.01	43.81	2.81	29.61	8.02	50.12	10.06	11.51
Do. (average of 3 specimens)			7.96	49.77	11.22	9.82	5.86	36.65	1.28	46.79	7.60	47.49	9.67	15.98
Average of 34 specimens of oysters in shell			7.98	49.88	10.39	10.12	5.33	33.32	0.62	49.32	7.53	47.09	8.78	16.38
Oysters, "Solids," out of shell: †														
Fair Haven, Conn	89	Nov., 1881	7.14	44.63	12.29	5.34	6.87	42.94	0.49	14.53	7.13	44.58	11.99	5.56
Do	204	Mar., 1882									8.17	51.06	13.32	7.67
Virginia (transplanted) *	104	Nov., 1881	8.29	51.81	12.59	7.73	6.41	40.06	0.58	21.41	8.21	51.31	12.06	8.32
Do *	202	Mar., 1882									8.09	50.56	12.96	6.37
Do. (average of 4 samples)											7.90	49.38	12.58	6.98
Oysters, "Cove," canned:														
Chesapeake Bay	74	May, 1881	10.50	65.62	17.76	7.51	4.41	27.56	4.14	18.88	9.11	56.92	14.64	10.11
Do	97	Nov., 1881	9.14	57.13	18.71	7.00	3.47	21.69	1.54	14.14	7.86	49.10	14.82	8.61
Do	120	...do	9.23	57.69	18.64	6.36	3.35	20.93	1.32	11.63	7.24	45.23	12.77	8.15
Do. (average of 3 samples, canned oysters)			9.62	60.15	18.37	6.96	3.74	23.39	2.33	14.88	8.07	50.42	14.07	8.96
Scallops (Pecten irradians): ††														
Shelter Island, N. Y	51	Mar., 1881	10.84	67.75	0.13	6.68					10.84	67.75	0.13	6.68
Do	63	Apr., 1881	13.46	84.13	1.76	7.51					13.46	84.13	1.76	7.51
Do. (average of 2 specimens)			12.15	75.94	0.95	7.10					12.15	75.94	0.95	7.10
Long clams (Mya arenaria), in shell:														
Boston, Mass	67	May, 1881	10.56	66.00	8.13	12.51	1.86	11.62	0.14	77.20	9.34	58.39	7.01	21.57
Clinton, Conn	102	Nov., 1881	11.10	69.37	8.32	11.64	2.62	16.37	0.10	70.41	10.05	62.81	7.30	18.92
Do	201	Mar., 1882	10.07	62.92	8.44	15.52	3.29	20.56	0.40	63.41	9.63	60.19	7.92	18.62
Do. (average of 2 specimens), Clinton			10.59	66.14	8.38	13.58	2.95	18.47	0.25	66.91	9.84	61.50	7.61	18.77
Long Island, New York	65	Apr., 1881	10.57	66.06	8.03	8.23	3.92	24.50	0.55	56.00	9.65	60.32	7.00	14.82
Average of 4 specimens			10.58	66.09	8.23	11.98	2.92	18.26	0.30	66.76	9.67	60.29	7.31	18.48

Long clams, canned:														
Penobscot Bay, Maine	122	Nov., 1881	11.21	70.06	11.41	12.45	4.93	30.81	0.43	21.27	9.33	58.32	8.12	15.09
Round clams (Venus mercenaria), in shell:														
Little Neck, N. Y	66	Apr., 1881	8.52	53.25	3.39	10.19	2.96	18.50	0.34	64.97	7.60	47.49	2.88	19.28
Round clams, canned:														
Islip, Long Island, N. Y	125	Nov., 1881	10.93	68.31	5.20	9.53	6.88	43.00	2.73	34.43	9.81	61.32	4.52	16.38
Mussels (Mytilus edulis), in shell:														
Stony Creek, Conn	139	Dec., 1881	9.38	58.64	7.85	8.11	4.87	30.43	2.24	38.61	8.80	55.00	7.12	12.06
Lobster (Homarus americanus), in shell:														
Locality unknown (Maine or Massachusetts?)	50	Mar., 1881									11.85	74.06	11.62	10.38
Do	62	Apr., 1881									12.33	77.06	8.47	9.36
Do	239	Apr., 1882									13.24	82.75	6.94	7.79
Do	69	May, 1881									13.44	84.00	14.19	10.43
Do. (average of 4 specimens)											12.72	79.47	10.31	9.49
Lobster, canned:														
Maine	76	May, 1881									12.98	81.13	2.24	13.44
Do	121	Nov., 1881									13.09	81.81	7.05	9.01
Do. (average of 2 samples)											13.04	81.46	4.64	11.23
Crayfish (Cambarus), in shell:														
Potomac River, Virginia	64	Apr., 1881									13.63	85.19	2.45	6.98
Crab (Callinectes hastatus), in shell:														
New Jersey	101	Nov., 1881									11.61	72.56	8.55	13.64
Crabs, canned:														
Hampton, Va	124	...do									13.14	82.14	4.16	9.38
Do	274	Apr., 1882									12.17	76.06	10.94	9.98
Do. (average of 2 samples)											12.65	79.10	7.55	9.68
Shrimp, canned:														
Gulf of Mexico	123	Nov., 1881									13.90	86.89	3.44	8.84
Terrapin, in shell:														
Savannah, Ga	235	Apr., 1882									13.30	83.13	13.59	3.99
Green turtle (Chelonia mydas), in shell:														
Key West, Fla	272	May, 1882									15.70	98.13	2.64	5.96

* To New Haven, Conn.
† i. e. shell contents, including flesh and liquids.
‡ Taken from beds about three weeks after transplanting.
§ About six months after transplanting.
‖ About five weeks after transplanting.
¶ Floated.
** Not floated.
†† The adductor muscle, the portion ordinarily eaten.

TABLE 35.—*Analyses of mollusks, crustaceans, etc., calculated on fresh substance.*

Name and locality of specimen.	Laboratory No. of specimen.	Specimen received.	Edible portion.																	In whole sample.	
			In flesh.					In liquids.					In edible portion (flesh plus liquids).								
			Water.	Nitrogen.	Protein (nitrogen × 6.25).	Fat (ether extract).	Crude ash.	Water.	Nitrogen.	Protein (nitrogen × 6.25).	Fat (ether extract).	Crude ash.	Water.	Water-free substance.	Protein (nitrogen × 6.25).	Fat (ether extract).	Crude ash.	Extractives.	Nitrogen.	Total edible portion. (From Table 33.)	Total water-free subst'ce, actual nutrients.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Oysters (Ostrea virginica), in shell:																					
Buzzard's Bay, Mass	68	May, 1881	84.21	1.24	7.75	1.57	1.48	96.40	0.20	1.23	0.00	1.63	88.80	11.20	5.31	0.99	1.53	3.37	0.85	20.01	2.25
Providence River, R. I	70	..do	79.01	1.65	10.30	2.58	2.13	95.05	0.24	1.48	0.00	2.41	84.79	15.21	7.13	1.65	2.23	4.20	1.14	17.00	2.58
Clinton, Conn	103	Nov., 1881	80.91	1.55	9.67	1.86	2.29	96.02	0.18	1.10	0.02	2.21	88.84	11.16	5.17	0.89	2.25	2.85	0.83	24.87	2.76
Stony Creek, Conn	55	Apr., 1881	81.02	1.67	10.46	1.60	2.76	96.12	0.13	0.83	0.01	2.72	90.11	9.89	4.66	0.64	2.76	1.83	0.75	18.90	1.87
Do	75	May, 1881	82.09	1.58	9.88	1.48	2.55	96.33	0.10	0.65	0.05	2.61	90.92	9.08	4.18	0.60	2.54	1.76	0.67	19.15	1.74
Do	105	Nov., 1881	77.82	1.70	10.60	2.32	2.51	95.40	0.22	1.36	0.01	2.33	84.83	15.17	6.94	1.39	2.42	4.42	1.11	18.23	2.76
Do	203	Mar., 1882	80.42	1.66	10.38	1.85	2.22	95.30	0.23	1.42	0.03	2.50	87.19	12.81	6.30	1.03	2.34	3.14	1.01	20.50	2.63
Do. (average of 4 specimens)			80.31	1.65	10.33	1.81	2.51	95.79	0.17	1.06	0.02	2.54	88.26	11.74	5.52	0.92	2.52	2.79	0.89	19.20	2.24
Fair Haven, Conn	54	Apr., 1881	81.30	1.58	9.89	2.05	2.20	94.00	0.33	2.08	0.02	3.19	85.12	14.88	7.54	1.43	2.50	3.41	1.21	18.06	2.69
Do	93	Nov., 1881	76.24	1.75	10.96	2.47	2.01	94.43	0.34	2.14	0.02	2.43	85.25	14.75	6.59	1.25	2.22	4.69	1.05	24.31	3.56
Do	210	Mar., 1882	80.80	1.58	9.89	2.05	1.85	95.38	0.29	1.80	0.03	2.08	84.67	15.33	7.74	1.51	1.91	4.17	1.24	16.59	2.55
Do. (average of 3 specimens)*			79.44	1.64	10.25	2.19	2.02	94.60	0.32	2.01	0.02	2.57	85.01	14.99	7.29	1.40	2.21	4.09	1.17	19.65	2.93
Long Island Sound (near New Haven, Conn.)	92	Nov., 1881	78.51	1.86	11.61	1.84	2.52	93.81	0.37	2.29	0.02	3.16	83.64	16.36	8.48	1.23	2.74	3.91	1.36	14.62	2.39
Norwalk, Conn	118	Dec., 1881	81.33	1.52	9.52	1.51	2.10	96.46	0.13	0.79	0.01	2.32	90.01	9.99	4.51	0.65	2.22	2.61	0.72	17.85	1.78
Do	151	Feb., 1882	80.50	1.60	9.97	1.89	2.15	96.32	0.12	0.76	0.02	2.50	89.58	10.42	4.68	0.81	2.35	2.58	0.75	17.05	1.78
Do. (average of 2 specimens)	...		80.91	1.56	9.75	1.70	2.13	96.39	0.12	0.77	0.02	2.41	89.79	10.21	4.59	0.73	2.29	2.60	0.74	17.45	1.78
Oyster Bay, Long Island Sound, N. Y	108	Nov., 1881	75.22	1.61	10.07	2.87	1.87	94.87	0.29	1.81	0.09	2.33	83.35	16.65	6.65	1.72	2.06	6.22	1.06	20.31	3.38
Do	180	Feb., 1882	77.90	1.70	10.61	2.35	2.19	95.31	0.23	1.46	0.01	2.37	84.37	15.63	7.21	1.48	2.26	4.68	1.15	17.27	2.70
Do. (average of 2 specimens)			76.11	1.66	10.34	2.61	2.03	95.09	0.26	1.64	0.05	2.35	83.86	16.14	6.93	1.60	2.16	5.45	1.11	18.76	3.00
Cow Bay, East River, N. Y	57	Apr., 1881	79.92	1.67	10.44	2.16	1.74	95.44	0.26	1.67	0.02	1.57	87.57	12.43	6.11	1.11	1.66	3.55	0.98	20.28	2.53
Rockaway, N. Y	58	..do	81.27	1.47	9.18	2.13	1.67	95.06	0.26	1.60	0.04	2.26	87.06	12.94	6.02	1.25	1.91	3.76	0.96	18.40	2.38
Do	112	Nov., 1881	77.66	1.68	10.53	2.72	2.02	94.79	0.28	1.76	0.01	2.56	84.33	15.67	7.12	1.67	2.23	4.65	1.14	19.84	3.11
Do. (average of 2 specimens)			79.46	1.58	9.85	2.43	1.85	94.92	0.27	1.68	0.03	2.41	85.69	14.31	6.57	1.46	2.07	4.21	1.05	19.12	2.75
"Blue Points," Patchogue, Long Island, N. Y	56	Apr., 1881	76.77	1.64	10.28	2.30	1.93	94.33	0.37	2.30	0.09	1.91	81.70	18.30	8.04	1.68	1.92	6.66	1.29	18.62	3.41
"Blue Points," Great South Bay, Long Island, N Y	107	Nov., 1881	75.55	2.13	13.31	2.02	2.58	96.89	0.12	0.75	0.01	1.90*	88.30	11.70	5.80	0.82	2.18	2.90	0.93	16.17	1.89

"Blue Points," (Long Island Coast, N. Y.)	182	Feb., 1882	83.97	1.41	8.81	1.62	1.59	96.87	0.16	0.92	0.01	1.70	90.17	9.83	5.01	0.85	1.63	2.34	0.80	15.42	1.52
Do. (average of 3 specimens)			78.76	1.72	10.80	1.98	2.03	96.03	0.21	1.32	0.04	1.84	86.72	13.28	6.28	1.12	1.91	3.97	1.01	16.74	2.28
Staten Island, N. Y	60	Apr., 1881	84.47	1.30	8.14	1.68	1.41	96.35	0.21	1.30	0.09	0.85	89.67	10.33	5.15	0.99	1.16	3.03	0.82	16.23	1.68
Princess Bay, Staten Island, N. Y	109	..do	82.79	1.35	8.41	1.74	1.71	96.64	0.18	1.09	0.01	1.87	90.15	9.85	4.52	0.82	1.80	2.71	0.72	17.59	1.73
Do. (average of 2 specimens)			83.63	1.33	8.28	1.71	1.56	96.49	0.20	1.20	0.05	1.36	89.91	10.09	4.84	0.91	1.48	2.87	0.77	16.91	1.71
Shrewsbury, N. J	61	Apr., 1881	81.65	1.31	8.20	2.20	1.33	95.07	0.33	2.03	0.04	1.83	85.39	14.61	6.48	1.60	1.47	5.06	1.04	17.52	2.55
Do	106	Nov., 1881	77.58	1.55	9.68	2.66	1.88	95.35	0.30	1.88	0.04	1.93	85.17	14.83	6.35	1.54	1.91	5.03	1.02	19.67	2.92
Do	181	Feb., 1882	81.73	1.46	9.15	2.00	1.68	96.52	0.22	1.38	0.01	1.72	89.16	10.84	5.24	1.00	1.69	2.91	0.84	19.23	2.09
Do. (average of 3 specimens)			80.32	1.44	9.01	2.29	1.63	95.65	0.28	1.76	0.03	1.83	86.57	13.43	6.02	1.38	1.69	4.34	0.97	18.81	2.52
Norfolk, Va	59	Apr., 1881	83.86	1.49	9.32	1.45	1.82	96.83	0.17	1.05	0.01	1.64	91.42	8.58	4.49	0.61	1.72	1.76	0.72	11.18	0.96
Potomac River, Va. (transplanted) * †	73	May, 1881	78.87	1.57	9.81	2.27	2.54	95.51	0.23	1.45	0.01	2.47	86.60	13.40	5.93	1.23	2.50	3.74	0.95	12.15	1.63
Potomac River, Va. (transplanted) * ‡ §	84	Nov., 1881	82.06	1.45	9.09	1.93	1.58	95.69	0.33	2.05	0.01	1.19	87.36	12.64	6.37	1.18	1.43	3.66	1.02	16.66	2.11
Potomac River, Va. (transplanted) * ‡ ‖	85	.. do	77.90	1.65	10.31	2.33	2.17	94.99	0.29	1.81	0.02	2.47	86.14	13.86	6.20	1.21	2.32	4.13	0.99	16.13	2.24
Do (average of 3 specimens)			79.61	1.56	9.74	2.18	2.10	95.40	0.28	1.77	0.01	2.04	86.70	13.30	6.17	1.21	2.08	3.84	0.99	14.98	1.99
Rappahannock River, Va. (transpld) * † §	72	May, 1881	82.64	1.36	8.51	1.90	1.58	97.24	0.16	1.01	0.01	1.38	89.68	10.32	4.90	0.99	1.48	2.95	0.78	15.17	1.56
James River, Va. (transplanted) * ¶	71	..do	83.49	1.32	8.26	1.78	1.71	95.91	0.19	1.17	0.01	2.56	90.05	9.95	4.53	0.84	2.15	2.43	0.72	13.79	1.37
James River, Va. (transplanted) * ‡ ‖	82	Nov., 1881	77.99	1.70	10.63	2.61	2.21	94.74	0.31	1.95	0.05	2.54	84.15	15.85	7.44	1.66	2.32	4.43	1.19	15.00	2.38
James River, Va. (transplanted) * ‡ ‖	83	..do	82.77	1.40	8.79	1.91	1.55	95.22	0.34	2.09	0.13	1.42	86.95	13.05	6.54	1.31	1.50	3.70	1.05	17.17	2.24
Do. (average of 3 specimens)			81.42	1.47	9.23	2.10	1.82	95.29	0.28	1.74	0.07	2.17	87.05	12.95	6.17	1.27	1.99	3.52	0.99	15.32	2.00
Do. (average of 34 specimens)			80.30	1.56	9.78	2.05	1.99	95.61	0.23	1.48	0.03	2.13	87.13	12.87	6.04	1.17	2.03	3.36	0.97	17.67	2.26
Oysters, "solids" (out of shell): **																					
Fair Haven, Conn	89	Nov., 1881	84.04	1.14	7.12	1.96	0.86	96.19	0.26	1.60	0.02	0.55	85.21	14.79	6.60	1.77	0.82	5.60	1.05	100.00	14.79
Do	204	Mar., 1882											88.44	11.56	5.91	1.54	0.89	3.22	0.95	100.00	11.56
Virginia (transplanted)*	104	Nov., 1881	85.50	1.28	7.51	1.83	1.12	96.43	0.23	1.43	0.02	0.77	87.23	12.77	6.56	1.54	1.06	3.61	1.05	100.00	12.77
Do *	202	Mar., 1882											87.90	12.10	6.13	1.57	0.77	3.63	9.98	100.00	12.10
Do. (average of 4 samples)													87.20	12.80	6.30	1.60	0.88	4.01	1.01	100.60	12.80
Oysters, "Cove," canned:																					
Chesapeake Bay	74	May, 1881	78.53	2.24	14.08	3.78	1.60	93.57	0.28	1.77	0.27	1.21	86.02	13.98	7.96	2.05	1.41	2.56	1.27	100.00	13.98
Do	97	Nov., 1881	76.75	2.12	13.29	4.35	1.63	93.35	0.22	1.40	0.09	0.91	85.15	14.85	7.29	2.20	1.28	4.08	1.17	100.00	14.85
Do	120	..do	77.25	2.10	13.12	4.24	1.45	90.57	0.31	1.92	0.12	1.10	84.60	15.40	6.97	1.97	1.25	5.21	1.11	100.00	15.40
Do. (average of 3 samples)			77.51	2.15	13.50	4.12	1.56	92.50	0.27	1.70	0.16	1.08	85.26	14.74	7.41	2.07	1.31	3.95	1.18	100.00	14.74
Scallops (Pecten irradians): ††																					
Shelter Island, N. Y	51	Mar., 1881	77.79	2.41	15.05	0.03	1.48						77.79	22.21	15.05	0.03	1.48	5.65	2.41	100.00	22.21
Do	63	Apr., 1881	82.84	2.31	14.44	0.30	1.29						82.84	17.16	14.44	0.30	1.29	1.13	2.31	100.00	17.16
Do. (average of 2 specimens)			80.32	2.36	14.75	0.17	1.38						80.32	19.68	14.75	0.17	1.38	3.38	2.36	100.00	19.86
Long clams (Mya arenaria), in shell:																					
Boston, Mass	67	May, 1881	77.96	2.33	14.55	1.79	2.76	95.74	0.08	0.49	0.01	3.29	86.09	13.91	8.12	0.98	3.00	1.81	1.30	53.90	7.50
Clinton, Conn	102	Nov., 1881	78.57	2.38	14.86	1.78	2.49	96.02	0.11	0.65	0.00	2.81	86.11	13.89	8.71	1.01	2.63	1.54	1.39	57.92	8.05
Do	201	Mar., 1882	79.94	2.02	12.62	1.69	3.11	96.77	0.11	0.67	0.01	2.05	85.00	15.00	9.03	1.19	2.79	1.99	1.44	56.30	8.44
Do (Average of 2 specimens, Clinton)			79.26	2.20	13.74	1.74	2.80	96.40	0.11	0.66	0.01	2.43	85.56	14.44	8.86	1.09	2.71	1.78	1.41	57.11	8.25
Long Island, N. Y	65	Apr., 1881	81.05	2.00	12.52	1.52	1.56	94.76	0.21	1.30	0.03	2.93	86.10	13.90	8.39	0.97	2.06	2.48	1.34	57.64	8.02
Average of 4 specimens			79.38	2.18	13.64	1.69	2.48	95.82	0.17	0.78	0.01	2.77	85.82	14.18	8.56	1.04	2.62	1.96	1.38	56.44	8.00
Long clams, canned:																					
Penobscot Bay, Maine	122	Nov., 1881	74.63	2.84	17.73	2.89	3.16	91.92	0.40	2.49	0.04	1.72	84.54	15.46	9.00	1.26	2.34	2.86	1.44	100.00	15.46

* To New Haven, Conn.
† Taken from beds about three weeks after transplanting.
‡ About six months after transplanting.
§ Floated.
‖ Not floated.
¶ About five weeks after transplanting.
** *i. e.* Shell-contents, including flesh and liquids.
†† The adductor muscle the portion ordinarily eaten.

TABLE 35.—*Analyses of mollusks, crustaceans, etc., calculated on fresh substance*—Continued.

Name and locality of specimen.	Laboratory No. of specimen.	Specimen received.	Edible portion.																	In whole sample.	
			In flesh.					In liquids.					In edible portion (flesh plus liquids).								
			Water.	Nitrogen.	Protein (nitrogen × 6.25).	Fat (ether extract).	Crude ash.	Water.	Nitrogen.	Protein (nitrogen × 6.25).	Fat (ether extract).	Crude ash.	Water.	Water-free substance.	Protein (nitrogen × 6.25).	Fat (ether extract).	Crude ash.	Extractives.	Nitrogen.	Total edible portion. (From Table 33.)	Total water-free subst'ce, actual nutrients.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Round clams (Venus mercenaria), in shell:																					
Little Neck, N. Y.	66	Apr., 1881	78.24	1.86	11.50	0.74	2.22	95.12	0.14	0.90	0.02	3.17	86.18	13.82	6.52	0.40	2.66	4.24	1.05	31.71	4.39
Round clams, canned:																					
Islip, Long Island, N. Y.	125	Nov., 1881	75.56	2.67	16.70	1.27	2.33	90.52	0.65	4.07	0.26	3.26	82.96	17.04	10.45	0.77	2.79	3.03	1.67	100.00	17.04
Mussels (Mytilus edulis), in shell:																					
Stony Creek, Conn.	139	Dec., 1881	78.67	2.00	12.51	1.67	1.73	94.23	0.28	1.77	0.13	2.23	84.20	15.80	8.69	1.12	1.91	4.08	1.39	50.66	8.01
Lobster (Homarus americanus), in shell:																					
Locality unknown (Maine or Massachusetts?)	50	Mar., 1881	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	84.30	15.70	11.63	1.82	1.63	0.62	1.86	52.52	8.25
Do	62	Apr., 1881	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	81.77	18.23	14.05	1.55	1.71	0.92	2.24	36.24	6.60
Do	239	Apr., 1882	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	79.17	20.83	17.24	1.45	1.62	0.52	2.76	32.24	6.72
Do	69	May, 1881	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	82.11	17.89	15.03	2.54	1.87	(*)	2.41	30.56	5.47
Do. (average of 4 specimens, lobsters)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	81.84	18.16	14.49	1.84	1.71	.....	2.32	37.89	6.76
Lobster, canned:																					
Maine	76	May, 1881	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	79.36	20.64	16.75	0.46	2.78	0.65	2.68	100.00	20.64
Do	121	Nov., 1881	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	76.15	23.85	19.52	1.68	2.15	0.50	3.12	100.00	23.85
Do. (average of 2 samples)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	77.75	22.25	18.13	1.07	2.47	0.58	2.90	100.00	22.25
Crayfish (Cambarus), in shell:																					
Potomac River, Virginia	64	Apr., 1881	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	81.22	18.78	16.00	0.46	1.31	1.01	2.56	12.30	2.31
Crab (Callinectes hastatus), in shell:																					
New Jersey	101	Nov., 1881	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	77.07	22.93	16.64	1.96	3.13	1.20	2.66	44.16	10.13
Crabs, canned:																					
Hampton, Va	124	Nov., 1881	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	80.98	19.02	15.62	0.79	1.78	0.83	2.50	100.00	19.02
Do	274	Apr., 1882	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	78.95	21.05	15.98	2.30	2.10	0.67	2.56	100.00	21.05
Do (average of 2 samples of canned crabs)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	79.97	20.03	15.80	1.54	1.94	0.75	2.53	100.00	20.03
Shrimp, canned:																					
Gulf of Mexico	123	Nov., 1881	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	70.80	29.20	25.38	1.00	2.58	0.24	4.06	100.00	29.20
Terrapin, in shell:																					
Savannah, Ga	235	Apr., 1882	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	74.47	25.53	21.23	3.47	1.02	(†)	3.40	20.97	5.35
Green turtle (Chelonia mydas), in shell:																					
Key West, Fla	272	May, 1882	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	79.78	20.22	19.84	0.53	1.20	(‡)	3.17	24.03	4.86

* Water + protein + fat + ash = 101.55. "Extractives" = −1.55. † "Extractives" = −0.19. ‡ "Extractives" = −1.35.

TABLE 36.—*Percentages of phosphoric and sulphuric acids in flesh of mollusks and crustaceans.*

Name and locality of specimen.	Laboratory No. of specimen.	In water-free substance.					In fresh substance.				
		Phosphoric acid.		Sulphuric acid.			Phosphoric acid.		Sulphuric acid.		
		Total phosphorus calculated as (P_2O_5).	Total phosphorus calculated as (PO_4).	Total sulphur calculated as (SO_3).	Total sulphur calculated as (SO_4)	Chlorine.	Total phosphorus calculated as (P_2O_5).	Total phosphorus calculated as (PO_4).	Total sulphur calculated as (SO_3).	Total sulphur calculated as (SO_4).	Chlorine.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*P. ct.*
Oysters (Ostrea virginica):											
Buzzard's Bay, Mass	68	1.48	1.98	4.15	4.98	3.53	0.23	0.31	0.64	0.77	0.56
Providence River, R. I	70	1.64	2.20	3.55	4.26	2.39	0.34	0.46	0.74	0.89	0.50
Stony Creek, Conn	55	1.46	1.96	5.31	6.37	4.30	0.28	0.37	1.01	1.21	0.82
Do	75	1.77	2.37	3.65	4.37	3.70	0.32	0.44	0.81	0.97	0.66
Do ... Average of 2 specimens	....	1.62	2.17	4.48	5.38	4.00	0.30	0.40	0.91	1.09	0.74
Fair Haven, Conn	54	1.57	2.10	5.59	6.71	3.11	0.29	0.39	1.05	1.26	0.58
Blue Point, N. Y	56	1.28	1.71	3.70	4.44	1.96	0.30	0.40	0.86	1.03	0.46
Rockaway, N. Y	58	1.59	2.13	3.89	4.67	2.81	0.30	0.40	0.73	0.88	0.53
Long Island Sound, N. Y	60	1.98	2.65	3.19	3.83	1.98	0.31	0.41	0.49	0.59	0.31
East River, N. Y	57	1.62	2.17	5.01	6.01	2.94	0.32	0.44	1.00	1.20	0.59
Shrewsbury, N. J	61	1.61	2.16	2.23	2.68	1.58	0.30	0.40	0.41	0.49	0.29
Norfolk, Va	59	1.79	2.39	2.28	2.74	2.76	0.29	0.39	0.46	0.55	0.45
Potomac River, Va. Transplanted to New Haven, Conn	73	1.75	2.35	2.59	3.11	3.18	0.37	0.50	0.55	0.66	0.67
Rappahannock River, Va. Transplanted to New Haven, Conn	72	1.80	2.40	2.13	2.56	1.93	0.31	0.41	0.37	0.44	0.34
James River, Va. Transplanted to New Haven, Conn	71	1.79	2.39	2.78	3.34	3.24	0.30	0.40	0.46	0.55	0.54
Oysters, canned:											
Chesapeake Bay	74	1.62	2.17	0.94	1.13	2.56	0.35	0.47	0.20	0.24	0.55
Scallops (Pecten irradians):											
Shelter Island, N. Y	51	2.17	2.91	2.23	2.68	1.76	0.48	0.64	0.50	0.60	0.30
Do	63	2.75	3.68	2.76	3.32	1.87	0.47	0.63	0.47	0.56	0.32
Do ... Average of 2 specimens	....	2.46	3.29	2.49	2.99	1.82	0.48	0.64	0.49	0.59	0.36
Long clams (Mya arenaria):											
Boston, Mass	67	2.21	2.95	3.14	3.77	2.98	0.48	0.64	0.69	0.83	0.66
Long Island, N. Y	65	2.48	3.31	2.35	2.82	1.84	0.47	0.63	0.44	0.53	0.35
Average of 2 specimens	....	2.35	3.14	2.75	3.30	2.41	0.48	0.64	0.56	0.67	0.51
Round clams (Venus mercenaria):											
Little Neck, N. Y	66	1.86	2.48	4.11	4.93	3.22	0.40	0.53	0.89	1.07	0.70
Lobster (Homarus americanus):											
Maine	50	2.13	2.87	2.39	2.87	4.35	0.33	0.45	0.38	0.45	0.68
Do	62	2.24	2.98	1.97	2.36	3.23	0.41	0.54	0.36	0.43	0.59
Massachusetts	69	2.35	3.14	3.06	3.67	2.81	0.40	0.53	0.53	0.64	0.50
Average of 3 specimens	....	2.24	2.98	2.47	2.97	3.46	0.38	0.51	0.42	0.50	0.59
Lobster, canned:											
Maine	76	1.13	1.51	2.34	2.81	5.05	0.23	0.31	0.48	0.58	1.04
Crayfish (Cambarus):											
Potomac River, Va	64	2.85	3.81	1.39	1.67	1.44	0.53	0.71	0.26	0.31	0.27

4. EFFECT OF OSMOSE UPON THE CONSTITUENTS OF OYSTERS. CHANGES IN COMPOSITION IN THE PROCESS OF FLOATING, I. E., REMOVAL FROM SALT TO BRACKISH OR FRESH WATER.

It is a common practice of oyster dealers, instead of selling the oysters in the condition in which they are taken from the beds in salt water, to first place them for a time (forty-eight hours, more or less) in fresh or brackish water, in order, as the oystermen say, to "fatten" them, the operation being called "floating" or "laying out." By this process the body of the oyster acquires such a plumpness and rotundity, and its bulk and weight are so increased, as to materially increase its selling value.

The study of this matter has a scientific as well as practical interest. It is commonly assumed that the passage of the digested materials through the walls of the alimentary canal in the bodies of animals is in large part due to osmose or dialysis and that the operation of this physical law is very common in living organisms. The quantitative study of the chemical changes involved in these processes is generally rendered difficult or impossible by the very fact of their going on in living bodies where the application of chemical analysis is impossible. An opportunity is, however, given in the case of the oyster.

The following experiments were made with oysters supplied by Mr. F. T. Lane, of New Haven, Connecticut, for whose courteous aid, as well in furnishing the specimens as in giving useful information, I take this occasion to express my thanks.

The oysters had been brought from the James and Potomac Rivers and "planted" in the beds in New Haven harbor (Long Island Sound) in April, 1881, and were taken for analysis in the following November.

Two series of experiments were made. The plan of each consisted in analyzing two specimens, both of which had been taken from the same bed at the same time, but one had been "floated" while the other had not. The first specimen was selected from a boat-load as they were taken from the salt water, and the second from the same lot after they had been "floated" in the usual way in brackish water for forty-eight hours. The separations and weighing of shells, flesh, liquor, etc., and the analyses of flesh and liquors, were made as described in the chapter on methods of analysis. It will suffice to say here briefly that the specimens were weighed as received at the laboratory, the shell contents were then taken out and the shells, flesh (body or solid portion), and liquids (liquid portion) weighed separately. The whole weight, less the sum of the weights of shells, flesh, and liquids, gave the amount of loss in the preparation for analysis, which loss was doubtless, for the most part, adhering water, though a part must, of course, have been due to evaporation. The statistics of the weights of the constituents and of the whole specimens are given in Table 37.

TABLE 37.—*Statistics of weights, etc., of specimens of oysters.*

Constituents.	James River.*				Potomac River.*			
	From beds.		From floats.		From beds.		From floats.	
	Lab. No. 82; 31 oysters.		Lab. No. 83: 34 oysters.		Lab. No. 85; 35 oysters.		Lab. No. 84; 41 oysters.	
	Grms.	*Lbs. Oz.*	*Grms.*	*Lbs. Oz.*	*Grms.*	*Lbs. Oz.*	*Grms.*	*Lbs. Oz.*
Shell contents:								
Flesh (body)	312.5	11.0	412.5	14.5	302.5	10.7	415.5	14.7
Liquids (liquor)	181.5	6.4	208.0	7.3	282.0	10.0	264.3	9.3
Total	494.0	1 1.4	620.5	1 5.8	584.5	1 4.7	679.8	1 8.0
Refuse:								
Shells	2778.0	6 2.0	2976.0	6 9.1	3017.0	6 10.4	3386.0	7 7.4
Loss †	21.0	0.8	17.5	0.6	22.5	0.8	15.2	0.5
Total	2799.0	6 2.8	2993.5	6 9.7	3039.5	6 11.2	3401.2	7 7.9
Total weight of specimen	3293.0	7 4.2	3614.0	7 15.5	3624.0	7 15.9	4081.0	8 15.9

* Transplanted to beds in New Haven harbor, Connecticut, in April, and taken for analysis the following November.
† Loss in opening and weighing, chiefly water.

The flesh and liquids were analyzed separately. From the results of the analyses, of which the details with those of the weighings are stated in full under Nos. 82–85, in the chapter on details of analyses of invertebrates, the composition of the several constituents and of the whole specimen were calculated. The results are set forth in Table 38, viz:

TABLE 38.—*Comparative percentage composition of oysters before and after "floating."*

Constituents of oysters.	James River oysters transplanted to New Haven.		Potomac River oysters transplanted to New Haven.	
	As taken from beds.	As taken from floats.	As taken from beds.	As taken from floats.
	No. 82.	No. 83.	No. 85.	No. 84.
In whole specimen:				
Shell contents:	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Flesh	9.49	11.41	8.35	10.18
Liquids	5.51	5.76	7.78	6.48
Total shell contents	15.00	17.17	16.13	16.66
Refuse:				
Shells	84.36	82.35	83.25	82.97
Loss in preparation for analysis	0.64	0.48	0.62	0.37
Total refuse	85.00	82.83	83.87	83.34
Total constituents, shell contents and refuse	100.00	100.00	100.00	100.00
In flesh (body):				
Water	77.99	82.77	77.90	82.06
Water-free substance	22.01	17.23	22.10	17.94
Total flesh	100.00	100.00	100.00	100.00
In water-free substance:				
Nitrogen	1.70	1.40	1.65	1.45
Protein (nitrogen × 6.25)	10.63	8.79	10.31	9.09
Fat (ether extract)	2.61	1.91	2.33	1.93
Ash	2.21	1.55	2.17	1.58
Carbohydrates, etc. (by difference)	6.56	4.98	7.29	5.34
Total water-free substance	22.01	17.23	22.10	17.94

TABLE 38.—*Comparative percentage composition of oysters before and after "floating"*—Continued.

Constituents of oysters.	James River oysters transplanted to New Haven.		Potomac River oysters transplanted to New Haven.	
	As taken from beds.	As taken from floats.	As taken from beds.	As taken from floats.
	No. 82.	No. 83.	No. 85.	No. 84.
In liquids:	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Water	94.74	95.22	94.99	95.69
Water-free substance	5.26	4.78	5.01	4.31
Total liquids	100.00	100.00	100.00	100.00
In water-free substance:				
Nitrogen	0.31	0.34	0.29	0.33
Protein (nitrogen × 6.25)	1.95	2.09	1.81	2.05
Fat (ether extract)	0.04	0.13	0.02	0.01
Ash	2.54	1.42	2.47	1.19
Carbohydrates, etc. (by difference)	0.73	1.14	0.71	1.06
Total water-free substance	5.26	4.78	5.01	4.31
In total shell contents, flesh and liquids:				
Water	84.15	86.95	86.14	87.36
Water-free substance	15.85	13.05	13.86	12.64
Total shell contents	100.00	100.00	100.00	100.00
In water-free substance:				
Nitrogen	1.19	1.05	0.99	1.02
Protein (nitrogen × 6.25)	7.44	6.54	6.20	6.37
Fat (ether extract)	1.66	1.31	1.21	1.18
Ash	2.32	1.50	2.32	1.43
Carbohydrates, etc. (by difference)	4.43	3.70	4.13	3.66
Total water-free substance	15.85	13.05	13.86	12.64
In whole specimen:				
Shell contents:				
Water	12.62	14.93	13.89	14.55
Water-free substance	2.38	2.24	2.24	2.11
Total shell contents	15.00	17.17	16.13	16.66
Refuse	85.00	82.83	83.87	83.34
Total shell contents and refuse	100.00	100.00	100.00	100.00
Shell contents:				
Nitrogen	0.18	0.18	0.16	0.17
Protein (nitrogen × 6.25)	1.12	1.12	1.00	1.06
Fat (ether extract)	0.25	0.22	0.20	0.20
Ash	0.35	0.26	0.37	0.24
Carbohydrates, etc. (by difference)	0.66	0.64	0.67	0.61
Total water-free substance	2.38	2.24	2.24	2.11
Water	12.62	14.93	13.89	14.55
Total shell contents	15.00	17.17	16.13	16.66

Regarding the results of these analyses it should be said that—

1. Of course the figures can not claim absolute accuracy; but for the reasons to be set forth in the discussion of the methods of analysis just referred to, I am persuaded that the errors due to imperfections of method or manipulation can not be very large.

2. The protein is estimated by multiplying the percentage of nitrogen by 6.25. The correctness of this factor for the oyster has not been verified. We know very little about the nitrogenous constituents of the oyster at best, and the uncertainties are here greater than in analyses of

muscular tissue (flesh) of fishes or mammals, not only because of lack of information regarding the nitrogenous compounds in the muscle of the oyster, but also because the other tissues and fluids, including the products of secretion and excretion, and with them the liquids, are analyzed. The liquids consist of the fluids contained within the shells but outside the body, together with whatever blood may have flowed out of the wounds made in separating the body from the shell, or rather of so much of these as drained off from the body and shell in the preparation for analysis. In all of these latter substances we have to do with materials about the composition of which extremely little is known. All that can be said for the figures for protein, therefore, is that they are based upon the amounts of nitrogen as found in the analyses; that the nitrogen determinations were made with soda-lime, but by methods of manipulation which have been tested in this laboratory by numerous comparisons with the absolute and Kjeldahl methods; and that as a measure of the comparative amounts of true protein compounds (albuminoids and gelatinoids) in the body they are, presumably, not very far out of the way.

The determinations of fat represent the amounts of material extracted by warm ether from the residue left after evaporating the flesh and liquids, at a temperature of about 96°, nearly to dryness (so far that the mass was friable and easily pulverized). The flesh was dried in hydrogen, and the liquids in air. I can not vouch for the correctness of the assumption that this ether extract consists entirely of fatty matters, but until the opportunity comes for investigating the subject more closely I see no better way than to simply state the results as we found them.

The determinations of ash and of water I judge to be reasonably accurate. Our experience with the methods employed has given us confidence in their reliability within tolerably narrow limits. I should explain also that all the determinations except water were first computed upon the water-free substance and then calculated over upon fresh substance.

The extractives were estimated by subtracting the sum of the protein, fats, and ether extract from the total water-free substance. It is plain that any errors in the estimates of the other ingredients will, unless they balance each other, affect the estimate of the extractives. The actual substances which the figures for extractives thus approximately represent in the flesh I presume to consist chiefly of the carbohydrates (glycogen) of the liver, which makes up a large portion of the body of the animal.

CHANGES IN COMPOSITION PRODUCED BY FLOATING.

As was to be expected, the sojourn in fresher water resulted in an increase in the percentage of total shell contents. The principal gain was in the flesh, which naturally lost some mineral salts but gained much more water, so that its actual percentage increased. The increase was in one case from 9.49 to 11.41, and in the other from 8.35 to 10.18

per cent. of the total weight. The liquids showed in one case an increase from 5.51 to 5.76 per cent., and in the other a decrease from 7.78 to 6.48 per cent. This disparity, however, is not to be wondered at when we consider that the liquids are very little affected by the dialysis, but are doubtless swept away by the surrounding water to greater or less extent in proportion as the valves are more or less opened and the current is stronger or weaker.

The figures for the composition of the flesh show more exactly how the gain in quantity is brought about by gain of water. The water in the flesh increases in one case from 78.0 to 82.8, and in the other from 77.9 to 82.1 per cent., the percentages of water-free substance decreasing, of course, in corresponding degree during the dialysis. The variations in the several ingredients will appear more clearly if we compute the increase or decrease of each in per cent. of its own percentage in the flesh before the osmose.

For example, flesh of the James River oysters contained before the dialysis 10.63 per cent. of protein (N × 6.25), and after dialysis 8.79 per cent. The difference (10.69—8.79) is 1.84 per cent. This difference, 1.84, is 17.3 per cent. of 10.63, the percentage of protein in the flesh before dialysis. In other words, the protein has fallen off 17.3 per cent. of its amount before dialysis. The proportions of the several ingredients of the flesh thus gained and lost in the two cases may be tabulated as follows:

TABLE 39.—*Gain and loss of ingredients of flesh (body) of oysters during dialysis in "floating."*

Ingredients of flesh	Percentages of ingredients found by analysis.		Gain (+) or loss (—) during dialysis.	
	Before dialysis.	After dialysis.	Expressed in difference of percentages, before and after dialysis.	Expressed in percentages of the percentages in flesh before dialysis.
James River:				
Water	77.99	82.77	+4.78	+ 6.1
Water-free substance	22.01	17.23	—4.78	—21.7
Protein (N × 6.25)	10.63	8.79	—1.84	—17.3
Fats (ether extract)	2.61	1.91	—0.70	—26.8
Carbohydrates, etc	6.56	4.98	—1.58	—24.1
Ash	2.21	1.55	—0.66	—29.9
Potomac River:				
Water	77.90	82.06	+4.16	+ 5.3
Water-free substance	22.10	17.94	—4.16	—18.8
Protein (N × 6.25)	10.31	9.09	—1.22	—11.8
Fats (ether extract)	2.33	1.93	—0.40	—17.8
Carbohydrates, etc	7.29	5.34	—1.95	—26.8
Ash	2.17	1.58	—0.59	—27.2

The gain of water as expressed in the excess of the percentage in the floated over that of the not-floated specimen is 4.78 (which is, of course, the same as the loss of water-free substance). This 4.78 is 6.1 per cent. of the 77.79 per cent. of water in the not-floated specimen. In other words, the percentage of water was increased in the process of osmose by 6.1 per cent. of its amount before the osmose. The corresponding loss of water-free substance, 4.78, is 21.7 per cent. of 22.01, the per cent. of water-free substance before dialysis. That is to say, the water-free substance fell off by 21.7 per cent. of its amount. Among the ingredients of the water-free substance the smallest of these loss percentages is in that of the protein, 17.3; the largest in that of the ash (mineral salts), 29.9. It is interesting to note that not only the extractives but the fats also show larger loss percentages than the protein, that of the fats, 26.8, being almost as great as that of the mineral salts.

In the Potomac oysters the loss percentages are a little smaller and not exactly parallel, since in this case the loss of the extractives is larger than that of the fats. The percentages of fats are, however, so very small that these variations may very likely be due in large part to errors of analysis.

It may not be uninteresting to note how these loss percentages stand in the liquids and in the whole shell contents as well as in the flesh. The calculations in the accompanying table are made in the same way as those in the previous table, except that the averages are also given.

TABLE 40.—*Gain (+) or loss (—) of ingredients of flesh, liquids, and total shell contents of oysters in floating.*

[Estimated by comparing percentages before and after dialysis and expressed in percentages of the percentages of the ingredients before dialysis.]

Constituents.	In flesh.			In liquids.			In shell contents.		
	James River.	Potomac River.	Average.	James River.	Potomac River.	Average.	James River.	Potomac River.	Average.
Water	+ 6.1	+ 5.3	+ 5.7	+ 0.5	+ 0.7	+ 0.6	+ 3.3	+ 1.4	+ 2.9
Water-free substance	—21.7	—18.8	—20.3	— 9.1	—14.0	—11.6	—17.6	— 8.9	—13.2
Protein	—17.3	—11.8	—14.5	+7.1	+13.2	+10.1	—12.1	+ 2.7	— 4.7
Fats	—26.8	—17.8	—22.0	(*)	(*)	(*)	—21.1	— 2.5	—11.8
Carbohydrates, etc	—24.1	—26.8	—25.4	+58.3	+49.3	+53.8	—16.5	—11.3	—13.9
Ash	—29.9	—27.2	—28.6	—44.1	—51.8	—47.9	—35.3	—38.3	—36.8

* The quantities of fats in the liquids were so minute that they are omitted in this computation.

Perhaps the most noticeable change in the composition of the liquids in the floating is the increase in the percentage of protein and extractives. The increase of water and decrease of total water-free substance are what we might anticipate, but the considerable gain of protein and non-nitrogenous extractives which accompanies the gain of water and loss of salts seems, at first sight, rather strange. Although the absolute quantities of protein and carbohydrates involved are small, the differences which represent the increase are far outside the limits of error of analysis. It is, of course, true that the figures above cited represent percentages only, and do not tell whether the total amounts of protein and extractives in the liquids after floating were larger or smaller than before floating. It is, therefore, possible that the absolute content of protein and fats in the liquids may have remained unchanged or even grown smaller, but it seems hardly natural to suppose that such changes as these could occur in the percentages unless the liquids had received protein and extractives from the flesh.

An explanation of a way in which such an accession of these ingredients may have come about has been suggested by my colleague, Professor Conn, who calls attention to the fact that some mollusks, when irritated, produce an extremely abundant secretion of mucus or "slime;" so much, indeed, as to sometimes render a small quantity of water in which the animals may be confined quite sensibly gelatinous. He suggests that the change to fresh water may induce such a secretion of mucus and perhaps of carbohydrates and fats as well, which would account for the increase of these substances in the liquids. The observation of oyster dealers that "water always thickens the natural juices that adhere to the surface of the oyster and makes it slimy," accords with Professor Conn's statement.

I have attempted to estimate the probable amount of absolute gain and loss of constituents of the liquids during the floating, by methods analogous to those employed for the flesh, as will be explained beyond; but the data at hand do not seem sufficient to make the estimate at all satisfactory. It may not be amiss to mention, however, that if we assume the weight of the shells to have remained unchanged, and on this assumption calculate the absolute amounts from the percentage composition, the total amounts of liquids appear in one experiment to grow larger, and in the other to grow smaller during the floating. The same calculation makes the protein increase in one case and decrease in the other. But the changes are very small in all the cases, and the impression left upon my mind after this weighing of probabilities is, that the apparent gain of protein and extractives in the liquids is of no very great moment. The reason for saying so much about it is its possible bearing upon the estimates of changes in the flesh, as will appear beyond.

ABSOLUTE INCREASE AND DECREASE OF CONSTITUENTS DURING THE FLOATING—CHANGES IN FLESH.

Enough has been said to illustrate the desirability of knowing how the actual weights of the shell-contents and of their several constituents before and after floating compare. If these data could be exactly obtained the actual gain or loss of each would, of course, be made certain. The desired determinations could be made with tolerable exactness by taking a sufficiently large number of oysters from the beds, dividing them in two lots of equal number and weight, floating one lot and analyzing both. The outlay of labor and money which this plan would have required was, unfortunately, larger than the circumstances permitted. In lack of such experiments we may, I think, make a tolerably correct estimate of the gain and loss of flesh and its ingredients in the experiments already described.

If we know the actual increase of weight of the flesh, the calculation of its absolute changes from the percentages shown by analyses would be simple. If there were any constituent whose absolute weight had remained constant, comparison of its percentages in the two specimens of flesh would give the desired data. I am inclined to think the protein very nearly fulfills this condition. The statements above show the probability that some of the protein, *i. e.*, nitrogenous material, left the flesh and went into the liquids during the floating, but this quantity, though it may have been considerable in comparison with the amount in the liquids before dialysis, must, it would seem, have been very small in comparison with the amount of nitrogenous material in the flesh. Of course this is only an assumption, but it seems a very probable one. The loss by metabolism and excretion of metabolized products in forty-eight hours by so inactive an animal as the oyster we should naturally expect to be very small indeed. Dr. Conn tells me that the animals live and thrive for months when their only source of nourishment is from water by which they are moistened only at long intervals and for a few hours at a time by exceptionally high tides, circumstances which preclude anything more than an extremely small food supply and in which, consequently, the metabolism must be very slight. In brief, it seems to me that we shall probably not go far astray in assuming that the whole amount of nitrogen given off from the body during the forty-eight hours in which the dialysis is taking place must be very small indeed as compared with the amount in the body (flesh) of the animal.

If, then, we assume that the amount of nitrogen remains constant during the dialysis the decrease in percentage of nitrogen, *i. e.*, protein, in the flesh during dialysis may be considered as due to the increase of total weight of flesh and will furnish a measure of that gain in weight.

Thus in the body of the James River oyster the percentages of protein before and after dialysis were, respectively, 10.63 and 8.79. That is to say, assuming the body to have neither gained nor lost protein during dialysis, 100 parts which before dialysis contained 10.63 parts of protein must during dialysis have increased to such a weight as to reduce the percentage to 8.79, and this weight must be to 100 as 8.79 to 10.63, which would give 120.93 as the weight after dialysis of the same flesh which before dialysis weighed 100. Accordingly, if we take the percentages found by analysis in the dialyzed flesh and multiply them by 1.2093, we shall have the absolute quantities of each of the several constituents after dialysis in the flesh which before dialysis weighed 100, and the quantities of whose constituents are the percentages shown by the analysis. Thus the 77.99 per cent. of water multiplied by 1.2093 give 100.09, and 100.09—77.99=22.10, the absolute gain of water in the dialysis. As 22.10 is 28.34 per cent of 77.99, the water was increased by 28.34 per cent of its amount by the dialysis. The table which follows gives a statement of calculations made in this manner.

TABLE 41.—*Increase and decrease of weights of flesh and its ingredients in floating.*

[Weights after floating estimated on assumption that the weight of the protein remained unchanged.]

Ingredients of flesh.	Weights of ingredients in 100 grammes of flesh before floating.	Estimated weights of same flesh and of its ingredients after floating.	Gain (+) or loss (—) of weight during floating.	
			Absolute.	In percentages of weights before floating.
	Grms.	*Grms.*	*Grms.*	*P. ct.*
In James River specimen:				
Water	77.99	100.09	+22.10	+28.34
Water-free substance	22.01	20.84	— 1.17	— 5.32
Total flesh	100.00	120.93	+20.93	+20.93
In water-free substance:				
Protein	10.63	10.63		
Fat	2.61	2.31	—0.30	—11.49
Carbohydrates, etc	6.56	6.03	—0.53	— 8.08
Mineral salts	2.21	1.87	—0.34	—13.57
Total water-free substance	22.01	20.84	—1.17	— 5.32
In Potomac River specimen:				
Water	77.90	93.07	+15.17	+19.47
Water-free substance	22.10	20.35	— 1.75	— 7.92
Total flesh	100.00	113.42	+13.42	+13.42
In water-free substance:				
Protein	10.31	10.31		
Fat	2.33	2.19	—0.14	— 6.01
Carbohydrates, etc	7.29	6.06	—1.23	—16.87
Mineral salts	2.17	1.79	—0.38	—17.52
Total water-free substance	22.10	20.35	—1.75	— 7.92
In average of two specimens:				
Water	77.95	96.58	+18.63	+23.90
Water-free substance	22.05	20.59	— 1.46	— 6.62
Total flesh	100.00	117.17	+17.17	+17.28
In water-free substance:				
Protein	10.47	10.47		
Fat	2.47	2.25	—0.22	— 8.75
Carbohydrates, etc	6.92	6.04	—0.88	—12.48
Mineral salts	2.19	1.83	—0.36	—15.54
Total water-free substance	22.05	20.59	—1.46	— 6.62

This computation, like that of the previous table, indicates an absolute gain of water and loss of water-free substance, fats, extractives, and mineral salts. Here, as before, the loss of fats and extractives is particularly large. The fats lose but little less, and the carbohydrates, etc., considerably more than the mineral salts.

The flesh of the James River specimen increased by dialysis from 100 to 121, *i. e.*, gained 21 per cent. in weight. The Potomac specimen gained 13.4 per cent. How these computations would compare with practical experience I have no means of learning exactly, since the oystermen's estimates include both flesh and liquids, while these apply only to the flesh. But, as stated beyond, the increase in weight does not appear to be much larger than is usual in practice.

As the assumption upon which these computations are made, namely, that the amount of protein (nitrogen) in the flesh remains constant during dialysis, is not absolutely correct, it will be worth while to note how the error must affect the calculations.

The factor used for computing the quantities of flesh and its constituents after dialysis was obtained by dividing the percentage of protein in the not-dialyzed by that in the dialyzed flesh. In the James River specimen the figures were $10.63 \div 8.79 = 1.21$ (1.2093). The percentages in the dialyzed specimen multiplied by this factor gave the absolute quantities after dialysis corresponding to 100 before dialysis. In the case of the protein we have $8.79 \times 1.2093 = 10.63$, implying no change. If, now, the protein, instead of remaining constant during dialysis, suffered loss, the correct figures for absolute gain and loss should show a loss of protein; in other words, the factor, to be correct, should itself be smaller. The smaller factor would give smaller weights of flesh and flesh constituents after dialysis, which would reduce the computed gain of flesh and of water and would make the loss of water-free substance, protein, fats, extractives, and ash greater. That is to say, if the body lost nitrogen during dialysis the actual gain of total weight of flesh and the gain of water of flesh must have been less, and the loss of water-free substance, protein, fats, extractives, and ash must have been greater than the figures in the table imply.

If, on the other hand, the body gained nitrogen during the dialysis the actual gain of total flesh and water must have been greater, and the actual loss of water-free substance and its constituents must have been less than the computations imply. It is extremely improbable that the oysters could materially increase their store of protein from any food they could get from the fresher water. The increase of protein in the liquids was apparently at the expense of that of the flesh, as above explained. On the whole, then, it seems reasonable to assume a very small loss of protein. Unless, therefore, there is a decided error in the assumptions made, the conclusion is unavoidable that the actual losses of water-free substance and of each of its ingredients could not have been less, and were probably somewhat more, than the figures in the table for absolute changes in dialysis represent.

So far as I can learn, the change in weight of oysters in the ordinary process of floating is fully as large or larger than in the cases here reported. According to such data as I have been able to obtain, oysters ordinarily increase from one-eighth to one-fifth in bulk in "floating," the latter proportion being common with "good, fat oysters." The increase in weight, which would correspond very nearly to the increase in volume, was computed in the above cases to be, in one case, one-fifth (21 per cent.), and in the other, between one-seventh and one-eighth (13½ per cent). That the oyster absorbs the more water the salter it is, is fully supported by all the experience of which I have accounts and accords entirely with what would be expected in dialysis.

Without entering into the theory of osmose, which is abundantly discussed in the text books, or speculating as to how much of the changes in the flesh was due to osmose and how much to secretion, it will suffice here to briefly recapitulate the results observed.

When the oysters, with their tissues presumably impregnated by the salts of the water in which they have lived, were placed in fresher water, their bodies gained water and lost not only salts but fats and carbohydrates also. The gain of water and loss of salts is naturally explained by the outflow of the more concentrated and inflow of dilute solution of salts in which the dialysis consists. I find it difficult to explain the loss of so much fats and carbohydrates by metabolism and discharge of metabolized products, nor does it seem natural to suppose that carbohydrates and fats would be dialyzed out of the body so much more rapidly in the brackish water than in the salt water. These considerations and the fact that mollusks excrete considerable quantities of gelatinous matters lead me to the conclusion expressed above, that the escape of fats and carbohydrates must be due largely if not entirely to processes independent of osmose. Of course, small quantities of fats and carbohydrates must have been consumed in the ordinary process of metabolism, but it is hard to believe that this could explain any considerable part of the loss observed.

EFFECT OF FLOATING UPON THE COMPOSITION OF THE TOTAL SHELL CONTENTS OF THE OYSTERS.

To compare the nutritive values of the oysters before and after floating, the liquid as well as the solid portion of the shell contents must be taken into account. The foregoing statements of changes in composition in floating apply mainly to the flesh. The data suffice for only an approximate estimate of the changes in the liquids. The difficulty in the computation is the lack of exact information as to how much of the liquid portion escaped in the floating. The oystermen say that the animals sometimes open their valves considerably while they are on the floats. This would of course give the water some opportunity to wash away the liquid contents of the shells, but the figures here given seem to me to imply that the quantity thus removed can not be very great.

An attempt to compute the changes in the composition of the total shell contents might be made by assuming the weight of the shells to be unaltered in the floating.

Table 42 may be worth inserting here, though I do not regard it as accurate, since the shells would be apt to lose weight by the washing off of adhering matters and otherwise in the handling and floating. In each case the protein seems to be slightly increased by the floating, but it is evident that we shall have to assume only a very small loss of weight of the shells to make the figures for the protein the same after as before floating. This would give, in each case, a very small loss of fats and extractives, a considerable loss of mineral matters, and a large gain of water, which is exactly what would be expected. These computations, therefore, tend to confirm the correctness of those of Table 41, in which the absolute weight of the protein of the flesh was assumed to be unaltered.

TABLE 42.—*Estimated changes in composition of whole specimens of oysters in floating.*

[Estimates based upon analyses and assumption that the weight of the shells is unchanged in floating.]

Constituents of specimens.	James River.		Potomac River.	
	Not floated.	Floated.	Not floated.	Floated.
	100 parts by weight of specimens in natural condition contained (per analysis)—	The same specimen after dialysis is estimated to contain—	100 parts by weight of specimens in natural condition contained (per analysis)—	The same specimen after dialysis is estimated to contain—
Shell contents:	*Parts by weight.*	*Parts by weight.*	*Parts by weight.*	*Parts by weight.*
Flesh	9.49	11.68	8.35	10.22
Liquids	5.51	5.90	7.78	6.50
Refuse:				
Shells	84.36	84.36	83.25	83.25
Loss, etc	0.64	0.50	0.62	0.37
Total	100.00	102.44	100.00	100.34
In shell contents:				
In water-free substance:				
Protein	1.12	1.15	1.00	1.06
Fat	0.25	0.22	0.20	0.20
Carbohydrates, etc	0.66	0.66	0.67	0.62
Mineral matters	0.35	0.26	0.37	0.24
Total water-free substance	2.38	2.29	2.24	2.12
Water	12.62	15.29	13.89	14.60
Total shell contents	15.00	17.58	16.13	16.72

The practice of floating oysters before putting them on the market is very general, and I am told that many retail dealers also add water to the oysters before delivering them to their customers, finding that their bulk and plumpness are thereby increased. A more detailed experimental study of the changes which take place in these operations would be of no little practical value. Meanwhile it is safe to say that in the floating the oysters take up water and lose small quantities of their fats and carbohydrates and a large proportion of their mineral salts. To compensate for this loss of nutritive material, there is, generally speaking, an improvement in the flavor. That is to say, the oysters as taken from the salt water, are rather salt to the taste, and many people prefer the flavor after they have been freshened in the floating. The removal of part of the salts also appears to improve the keeping quality of the oysters.

5. EUROPEAN ANALYSES OF MOLLUSKS AND CRUSTACEANS.

The following table, translated from König (König, Nahrungsmittel, I Band, S. 219), contains all the detailed analyses of European mollusks and crustaceans which have come to my notice in forms desirable for quotation here:

TABLE 43.—*European analyses of mollusks and crustaceans, from König.*

Specimens.	In flesh.					In water-free substance.			Analyst.
	Water.	Protein (nitrogen × 6.25).	Fat.	Carbohydrates, etc.	Ash.	Protein.	Fat.	Nitrogen.	
Oyster (Ostrea edulis):									
Flesh	80.38	13.31	1.51	4.80		67.83	7.70	10.85	Payen.*
Liquids	95.75	.54	......	3.72		12.71	......	2.03	Payen.*
Shell contents	89.69	4.95	.37	2.62	2.37	48.01	3.59	7.68	König.† Krauch.
Flesh (Ostend)	82.03	8.25	1.77	6.16	1.79	45.91	9.84	7.34	Stutzer.‡
Mussel (Mytilus edulis):									
Cooked flesh	75.74	15.62	2.42	6.22		64.39	9.98	10.30	Payen.*
Clam (Mactra solida)	70.76	15.56	1.90	11.78		53.22	6.50	8.52	Payen.*
Snail (Helix):									
Cooked flesh	76.17	15.62	.95	7.26		65.55	3.99	14.88	Payen.*
Lobster (Homarus vulgaris):									
Uncooked flesh	76.61	18.31	1.17	3.91		78.28	5.00	12.52	Payen.*
"Inner, white mass"	84.31	11.69	1.44	2.56		74.51	9.18	11.92	Payen.*
Eggs	62.98	21.06	8.23	7.73		56.89	22.23	9.10	Payen.*
Flesh preserved in salt water	77.49	19.09	.97	.50	1.95	84.81	4.31	13.57	König.†
River crawfish (Astacus fluviatilis):									
Salted flesh	72.74	13.63	.36	.21	13.06	50.00	1.32	8.00	König.†

* Substances Alimentaire, Paris, 1865, p. 488.
† Original contribution.
‡ Repertorium of Analyt. Chem., 1882, S. 161.

PART II.

NUTRITIVE VALUES OF FOOD-FISHES, MOLLUSKS, AND CRUSTACEANS.

1. INTRODUCTION; EXPLANATIONS.

For those who are not familiar with the newer teachings of chemistry and physiology and their application in judging of the nutritive values of the fishes and invertebrates of which analyses are given in detail in Part I and recapitulated in the pages beyond, a few words of explanation of some of the later results of experimental inquiry regarding foods and their uses in nutrition may not be entirely out of place here. The statements which follow are in part condensed from articles by the writer in the Report of the Oyster Investigation and Shellfish Commission of New York, for 1887, by E. G. Blackford, commissioner, and in the National Medical Dictionary, edited by Dr. J. S. Billings, U. S. A.

If the reader will take the pains to notice the next piece of beef that he has to carve for dinner, he will, of course, notice first of all that, along with the meat which is good to eat, there is more or less bone, which, except in so far as it may be used for soup, is of no value for food. The beef, then, may be regarded as consisting of edible portion and refuse. The same is true of fish. In eggs there is a corresponding distinction between shells and the so-called "meat," and oysters and other shellfish in like manner include the shells, which are simply refuse, and the shell contents which make up the edible portion. The inside of the potato and the wheat flour are the edible portion, and the skin and bran are refuse of potatoes and wheat.

If we take the beef and separate the meat from the bone, cut it into fine particles and keep it for a long time in a hot oven it will be gradually dried, that is to say the water will be driven out of it and the so-called nutritive substance will remain. In the same way the flesh of fish, oysters, milk, eggs, potatoes, and flour are found to consist of water and nutritive material. In estimating the values of these different materials for food we leave the refuse and the water out of account and consider only the nutritive ingredients.

We may take a piece of beef, and after cutting out the bone and drying the meat put the latter in the fire and burn it. Nearly all will be consumed, but a portion will remain as ashes. An operation of this sort is regularly carried on in the chemical laboratory in the analysis of meat and other food materials. Portions are dried with proper apparatus, and the percentages of water and water-free substances are determined; other portions are burned, and the percentages of ash are found out. If we weigh the whole meat, bone and all, to start with, and afterwards weigh bone and other refuse and the meat, we can easily calculate the percentages of refuse and edible portion. If we then determine the percentages of water, water-free substance, and ash in the meat, we have made a fair start in the analysis for determining the food value. The water-free substance contains all of the nutritive materials, or nutrients, but the analysis thus far has told only the percentage of ash, or mineral matters. The proportions of the other ingredients must be found out before we can judge exactly of the food value.

The meat consists of lean and fat. Part of the fat is in large lumps, which can be easily separated from the lean. Indeed we often cut out the fat of the meat which is served on our plates at the table, and reject it instead of eating it. But a portion of the fat is in very fine particles diffused throughout the lean. Much of this finely divided fat is in particles so small as to be invisible to the naked eye, but it is possible to separate them very completely from the lean by processes of analysis common in the laboratory. After the water and the fat have been removed from the lean meat the material which remains will contain a little mineral matter, which would be left as ash if it were burned; the rest consists of so-called protein compounds. The protein is the chief nutritive constituent of fish and eggs, as well as of lean meat. It occurs also in milk and in vegetable foods, such as wheat, corn, potatoes, etc.

Fat is familiar to us in meat, from which we get it in the form of tallow and lard; in milk, from which it is obtained as butter; in the various oils, such as olive oil, cotton-seed oil, and the oils of wheat and corn. Larger or smaller proportions of fat are found in most food materials.

Potatoes, wheat, and corn contain large proportions of starch. Sugar cane and sorghum are rich in sugar. Starch and sugar are very similar in chemical composition, and are called carbohydrates.. Other carbohydrates are found in animals and plants; such as inosite, or "muscle sugar," in muscle; and glycogen, or "liver sugar," in the liver.

The mineral matter, or ash, which is left behind when animal or vegetable matter is burned, consists of a variety of chemical compounds commonly called salts, and including phosphates, sulphates, and chlorides of the metals calcium, magnesium, potassium, and sodium. Calcium phosphate, or phosphate of lime, is the chief mineral constituent of bone. Common salt is chloride of sodium.

The number of the different chemical compounds in our animal and vegetable food materials is very large, but leaving water out of account, it is customary to divide the rest into the classes of which we have spoken, to wit, protein, fats, carbohydrates, and mineral matters, and to look upon these as the nutritive ingredients, or nutrients of food. The proportions of these ingredients are determined by the somewhat complicated methods of chemical analysis followed in the laboratory, but our everyday handling of food materials often involves processes, though crude ones, of analysis.

We let milk stand; the globules of fat rise in cream, still mingled, however, with water, protein, carbohydrates, and mineral salts. To separate the other ingredients from the fat the cream is churned. The more perfect this separation—*i. e.*, the more accurate the analysis—the more wholesome will be the butter. Put a little rennet in the skimmed milk, and the casein, called in chemical language an albuminoid or protein compound, will be curdled, and may be freed from the bulk of the water, sugar, and other ingredients by the cheese press, as is done in making cheese. To separate milk-sugar, a carbohydrate, from the whey is a simple matter. One may see it done by the Swiss shepherds in their Alpine huts. But farmers find it more profitable to put it in the pig-pen, the occupants of which are endowed with the happy faculty of transforming sugar, starch, and other carbohydrates of their food into the fat of pork.

The New England boy who on cold winter mornings goes to the barn to feed the cattle and solaces himself by taking grain from the wheat bin and chewing it into what he calls "wheat gum" makes, unknowingly, a rough sort of analysis of the wheat. With the crushing of the grain and the action of the saliva in his mouth the starch, sugar, and other carbohydrates are separated. Some of the fat—*i. e.*, oil—is also removed, and finds its way with the carbohydrates into the stomach. The tenacious gluten, which contains the albuminoids or protein and constitutes what he calls gum, is left. When, in the natural order of events, the cows are cared for and the gum is swallowed, its albuminoids enter upon a round of transformation in the boy's body, in the course of which they are changed to other forms of protein, such as albumen of blood or myosin of muscle, or are converted into fat, or are consumed with the oil and sugar and starch to yield heat to keep his body warm and give him muscular strength for his work or play.

There is, unfortunately, a little confusion of terms in the usages of different writers on these subjects. Thus the words protein, proteids, and albuminoids are all applied to what we have here called the protein compounds. The term albuminoid, albumen-like, comes from albumen, which is best known in the form of white of eggs, a typical albuminoid compound. The term proteids is applied by some writers to albuminoids and by others to very different classes of materials. The fats are sometimes spoken of as hydrocarbons, but this use of the latter term is very incorrect.

These different classes of nutrients in food, to wit, protein, fats, carbohydrates, and mineral matters have different uses in nutrition. Muscle, tendon, and bone are formed from the protein compounds. These are sometimes called flesh-formers, because they make flesh. Their chief use in the body is to make blood, and to build up the muscle, tendon, bone, and other tissues which constitute the framework of the body and repair them, as they are being continually worn out by use. Brain and nerve are also formed to a considerable extent from the protein compounds of the food. The protein of the food is also formed into fat in the body, and serves as fuel to supply it with heat and muscle energy. The fats of the food are stored as fat in the body, and may be transformed into carbohydrates, but their chief use is for fuel. The carbohydrates are transformed into fat in the body, and may be stored as body fat, but their chief use is for fuel. The mineral matters make bone and have various other uses in the body.

When we eat meat, its protein serves to make blood, bone, muscle, tendon, brain, and nerve. We can also use it to make fat, and it is consumed—*i. e.*, burned as fuel to yield its heat to keep our bodies warm and give muscular strength for work. The fat of the meat can not do the work of the protein in forming muscle, tendon, and the like, but is much more valuable than protein for fuel. Bread supplies us with protein and fat, and also with carbohydrates in the form of starch, dextrin, and sugar. The protein and fats serve the same purposes as those of meat. The carbohydrates which make up the bulk of the nutritive material of bread and potatoes, and of which only minutest quantities occur in meat, are valuable chiefly as fuel, though they also yield fat.

To recapitulate: The nutritive material of very lean meat and the leaner kinds of fish consists almost entirely of protein. Tallow, lard, oils, and butter are fats. Sugar and starch are carbohydrates. All the different food materials contain mineral matters. Animal foods supply chiefly protein and fats. Most vegetable foods contain but little of these, their nutrients being chiefly carbohydrates. Beans, pease, and other leguminous plants, however, supply considerable quantities of protein. Milk differs from most other animal foods in that it has large quantities of a carbohydrate, "milk-sugar." Oysters approach milk in composition.

For nourishment we need all of the different classes of nutrients and in proper proportions. Thus a day's food for an average man doing moderately hard muscular work may appropriately supply, on the average, about 4½ ounces of protein, the same quantity of fats, and 16 ounces of carbohydrates.

The cheapest food is that which supplies the most nutritive material for the least money; the most economical food is that which is cheapest and best adapted to the wants of the user.

From the standpoint of their uses in the nutrition of man, the constituents of ordinary foods may be succinctly classified as follows:

Edible substance, as the flesh of meats and fish, the shell contents of oysters, wheat flour.

Refuse, as bones of meat and fish, the shells of oysters, bran of wheat.

The edible substance consists of (1) water, (2) nutritive substance or nutrients.

The water, refuse, and the salt of salted meat and fish are called non-nutrients. The water contained in foods and beverages has the same composition and properties as other water; it is, of course, indispensable for nourishment, but it is not a nutrient in the sense in which it is here used. In comparing the values of different food materials for nourishment, the refuse and water are left out of account.

PRINCIPAL NUTRIENTS OF FOOD.

Protein:
- Albuminoids: e. g., albumen of egg, myosin of muscle (lean of meat), casein of milk, gluten of wheat.
- Gelatinoids: e. g., ossein of bone, collagen of tendons (which yielded gelatin).

Fats: e. g., fats of meat, butter, olive oil, oil of maize and wheat.

Carbohydrates: e. g., starch, sugar, cellulose (woody fiber).

Mineral matters or ash: e. g., calcium, potassium, and sodium, phosphates and chlorides.

WAYS IN WHICH THE NUTRIENTS ARE USED IN THE BODY.

The protein of food
- forms the (nitrogenous) basis of blood, muscle, connective tissue, etc.,
- is transformed into fats and carbohydrates,
- is consumed for fuel.

The fats of food
- are stored as fat,
- are consumed for fuel.

The carbohydrates of food
- are transformed into fat,
- are consumed for fuel.

POTENTIAL ENERGY OF FOOD.

In being consumed for fuel, the nutrients yield energy in the forms of heat, which keeps the body warm, and muscular energy, strength for work. The quantities of energy which different food materials are capable of yielding are determined by experiments with the respirative apparatus and the calorimeter. In their use as fuel in the body the nutrients appear to replace one another in proportion to their potential energy as indicated by their heats of combustion. This energy, which is accordingly taken as the measure of their fuel value, is estimated in calories. The calorie is the heat which would raise a kilogramme of water 1° C. (or 1 pound of water about 4° Fahr.). A foot-ton is the energy (power) which would lift 1 ton 1 foot. One calorie corresponds to 1.53 foot-tons. A gramme of protein or a gramme of carbohydrates is assumed to yield 4.1, and a gramme of fats 9.3 calories. A given weight of fats is thus taken to be equivalent, in fuel value, on the average, to a little over twice the same weight of protein or carbohydrates. The figures for potential energy in Table I are calculated for each food material by multiplying the number of grammes of protein and of carbohydrates in 1 pound (1 pound equals 453.6 grammes) by 4.1, and the number of grammes of fat by 9.3, and taking the sum of these three products as the number of calories of potential energy in a pound of the material.*

I have not applied these methods of calculation to shellfish in this article, because the nature of the compounds which make up their nutritive ingredients is not fully understood, and it is not certain that what we call protein, fats, and carbohydrates in them have the same fuel value as in meats, fish, etc. For the same reason I have not attempted detailed estimates of the pecuniary economy of shellfish as compared with other food materials.†

The result of analyses of food material can be stated in a variety of ways. That followed in Tables I and III, beyond, may be explained by an example.

The flesh or edible portion of a specimen of beef sirloin, of medium fatness, was analyzed and found to contain, approximately—water, 60 per cent.; protein, 19 per cent.; fats, 20 per cent.; mineral matters, 1 per cent. These, then, are the percentages of water and nutrients in the edible portion of the meat. But when we buy our sirloin steak or roast by the pound, as we ordinarily do, we get not only the flesh, the edible substance, but with it more or less bone, sinew, and other refuse matter. This specimen contained about one-fourth, or 25 per cent., of bone, and three-fourths, or 75 per cent., of flesh. If, then, we are to consider the composition of the meat as we buy it, we must take the refuse matters into account. The proportions of the several ingredients in both the edible portion and the whole piece above referred to may be stated thus:

Constituents.	In flesh, edible portion.	In meat as bought, including refuse.
	Per cent.	*Per cent.*
Refuse, bones, etc	None.	25
Water	60	45
Protein	19	14¼
Fat	20	15
Mineral matters	1	0¾
Total	100	100

* See "The Potential Energy of Food," in the Century Magazine for July, 1887.

† See article on "Pecuniary Economy of Food," in the Century Magazine for January, 1888.

This very imperfect analysis may be stated in the following form, as is done in the tables beyond:‡

Constituents of sample of beef, sirloin (medium fatness).

	Per cent.
In edible portion, *i. e.*, flesh freed from bone and other refuse:	
Water	60
Protein	19
Fats	20
Mineral matters	1
In meat as purchased (including both edible portion and refuse):	
Refuse, bones, etc	25
Edible portion:	
Water	45
Protein	14.3
Fats	15
Mineral matters	0.7

Table I, herewith, gives the composition of a number of animal foods, mostly from analyses undertaken in connection with the investigation described in Part I of this monograph, as stated in the introduction. It is only a short time since analyses of American meats, fish, etc., have been undertaken in any considerable number, and those as yet accomplished are far from sufficient for a complete survey of the subject. Indeed, the work already done can be regarded only as a beginning. Still, the figures will give a tolerably fair idea of the average composition of the articles named:

TABLE I.—*Percentages of nutrients (nutritive ingredients), water, etc., and estimated potential energy (fuel value) in specimens of food materials.*

Food materials.	Refuse: bones, skin, shells, etc.	Edible portion.						Potential energy in one pound of each material.
		Water.	Nutrients.					
			Total.	Protein.	Fats.	Carbohydrates.	Mineral matters.	
Animal foods as purchased, including edible portion and refuse:	*Per ct.*	*Per ct.*	*Per ct.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Beef, side*	19.7	44.0	36.3	13.8	21.7	....	0.8	1,170
Beef, round*	10.0	60.0	30.0	20.7	8.1	....	1.2	725
Beef, neck*	19.9	49.6	30.5	15.4	14.3	....	0.8	890
Beef, sirloin*	25.0	45.0	30.0	15.0	14.3	....	0.7	885
Beef, flank*	11.7	24.2	64.1	10.6	52.9	....	0.6	2,430
Mutton, side*	20.0	42.9	37.1	13.2	23.2	....	0.7	1,225
Mutton, leg*	18.4	50.4	31.2	15.0	15.5	....	0.7	935
Mutton, shoulder*	16.8	48.7	34.5	15.0	18.7	....	0.8	1,070
Mutton, loin (chops)*	16.3	41.3	42.4	12.5	29.3	....	0.6	1,470
Smoked ham	14.0	36.3	49.7	14.6	34.2	....	0.9	1,715
Pork, very fat	10.4	9.5	80.1	2.8	76.5	....	0.8	3,280
Chicken†	41.6	42.2	16.2	14.2	1.2	....	0.8	315
Turkey	35.4	42.8	21.8	15.4	5.6	....	0.8	525
Flounder, whole	66.8	27.2	6.0	5.2	0.3	....	0.5	110
Haddock, dressed	51.0	40.0	9.0	8.2	0.2	....	0.6	160
Bluefish, dressed	48.6	40.3	11.1	9.8	0.6	....	0.7	210
Brook trout, whole	48.1	40.4	11.5	9.8	1.1	....	0.6	230
Codfish, dressed	29.9	58.5	11.6	10.6	0.2	....	0.8	205
Whitefish, whole	53.5	32.5	14.0	10.3	3.0	....	0.7	320
Shad, whole	50.1	35.2	14.7	9.2	4.8	....	0.7	375
Turbot, whole	47.7	37.3	15.0	6.8	7.5	....	0.7	445

* From well-fattened animals. † Rather lean.

‡ The tables contain also columns for carbohydrates, etc., which occur in milk and in some shellfish, but are not found in ordinary meats in sufficient amount to warrant their presence in such tables as these.

TABLE I.—*Percentages of nutrients (nutritive ingredients), water, etc., and estimated potential energy (fuel value) in specimens of food materials*—Continued.

Food materials.	Refuse: bones, skin, shells, etc.	Edible portion.						Potential energy in one pound of each material.
		Water.	Nutrients.					
			Total.	Protein.	Fats.	Carbo-hydrates.	Mineral matters.	
Animal foods as purchased, including edible portion and refuse:	*Per ct.*	*Per ct.*	*Per ct.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Mackerel, fat, whole	33.8	42.4	23.8	12.1	10.7	....	1.0	675
Mackerel, lean, whole	38.3	48.5	13.2	11.2	1.4	....	0.6	265
Mackerel, average, whole	44.6	40.4	15.0	10.0	4.3	....	0.7	365
Halibut, dressed	17.7	61.9	20.4	15.1	4.4	....	0.9	465
Salmon, whole	35.3	40.6	24.1	14.3	8.8	....	1.0	635
Eel	36.0	33.8	30.2	8.6	21.0	....	0.6	1,045
Salt codfish	42.1	40.3	17.6	16.0	0.4	....	1.2	315
Smoked herring	50.9	19.2	29.9	20.2	8.8	....	0.9	745
Salt mackerel	40.4	28.1	31.5	14.7	15.1	....	1.7	910
Canned salmon	4.9	59.3	35.8	19.3	15.3	....	1.2	1,005
Canned sardines	5.0	53.6	41.4	24.0	12.1	....	5.3	955
Lobsters	62.1	31.0	6.9	5.5	0.7	0.1	0.6	135
Oysters in shell	82.3	15.4	2.3	1.1	0.2	0.6	0.4	40
Hens' eggs	13.7	63.1	23.2	11.8	10.2	0.4	0.8	655
Animal foods, edible portion:								
Beef, side*	....	54.7	45.3	17.2	27.1	....	1.0	1,465
Beef, round*	....	66.7	33.3	23.0	9.0	....	1.3	805
Beef, sirloin*	....	60.0	40.0	20.0	19.0	....	1.0	1,175
Mutton, side*	....	45.9	54.1	14.7	38.7	....	0.7	1,905
Mutton, leg*	....	61.8	38.2	18.3	19.0	....	0.9	1,140
Mutton, loin (chops)*	....	49.3	50.7	15.0	35.0	....	0.7	1,755
Flounder	....	84.2	15.8	13.8	0.7	....	1.3	285
Codfish	....	82.6	17.4	15.8	0.4	....	1.2	310
Mackerel, fat	....	64.0	36.0	18.2	16.3	....	1.5	1,025
Mackerel, lean	....	78.7	21.3	18.1	2.2	....	1.0	430
Mackerel, average	....	71.6	28.4	18.8	8.2	....	1.4	695
Salmon	....	63.6	36.4	21.6	13.4	....	1.4	965
Oysters, fat	....	81.7	18.3	8.0	1.7	6.7	1.9	345
Oysters, lean	....	90.9	9.1	4.2	0.6	1.8	2.5	135
Oysters, average	....	87.1	12.9	6.0	1.2	3.7	2.0	230
Hens' eggs	....	73.1	26.9	13.7	11.7	0.5	1.0	760
Cows' milk	....	87.4	12.6	3.4	3.7	4.8	0.7	310
Do	....	90.7	9.3	3.1	0.7	4.8	0.7	175
Cheese, whole milk	....	31.2	68.8	27.1	35.5	2.3	3.9	2,045
Cheese, skimmed milk	....	41.3	58.7	38.4	6.8	8.9	4.6	1,165
Butter	....	10.0	90.0	1.0	85.0	0.5	3.5	3,615
Oleomargarine	....	10.0	90.0	0.6	84.5	0.4	4.5	3,585
Lard	....	1.0	99.0	....	99.0	....	....	4,180
Vegetable foods:								
Wheat bread	....	32.7	67.3	8.9	1.9	55.5	1.0	1,280
Wheat flour	....	11.6	88.4	11.1	1.1	75.6	0.6	1,660
Graham flour	....	13.0	87.0	11.7	1.7	71.8	1.8	1,625
Rye flour	....	13.1	86.9	6.7	0.7	78.7	0.7	1,620
Buckwheat flour	....	13.5	86.5	6.5	1.3	77.6	1.1	1,620
Beans	....	13.7	86.3	23.2	2.1	57.4	3.6	1,585
Oatmeal	....	7.7	92.3	15.1	7.1	68.1	2.0	1,845
Corn (maize) meal	....	14.5	85.5	9.1	3.8	71.0	1.6	1,650
Rice	....	12.4	87.6	7.4	0.4	79.4	0.4	1,630
Sugar	....	2.2	97.8	0.3	....	96.7	0.8	1,800
Potatoes†	10.0	68.0	22.0	1.8	0.2	19.1	0.9	395
Potatoes	....	75.5	24.5	2.0	0.2	21.3	1.0	440
Sweet potatoes	....	75.8	24.2	1.5	0.4	21.1	1.2	435
Turnips	....	91.2	8.8	1.0	0.2	6.9	0.7	155
Carrots	....	87.9	12.1	1.0	0.2	10.1	0.8	215
Cabbage	....	90.0	10.0	1.9	0.2	6.2	1.2	170
Melons	....	95.2	4.8	1.1	0.6	2.5	0.6	90
Apples	....	84.8	15.2	0.4	....	14.3	0.5	275
Pears	....	83.0	17.0	0.4	....	16.3	0.3	310
Bananas	....	73.1	26.9	1.9	0.6	23.3	1.1	495
Beverages:					Alcohol.			
Lager beer	....	90.3	....	0.4	2.0	5.8	0.2	....
Porter and ale	....	88.1	....	0.6	5.1	6.8	0.4	....
Rhine wine, white	....	86.3	....	....	9.3	2.3	0.2	....
Rhine wine, red	....	86.9	....	....	8.1	3.0	0.3	....
French wine, claret	....	88.3	....	....	8.0	2.3	0.2	....
Sherry wine	....	79.5	....	....	17.0	3.2	0.3	....

* From well-fattened animals. † As purchased, including refuse, skin, etc.

DIGESTIBILITY OF FOODS.

Table II epitomizes the results of some sixty experiments, mostly with men but a few with children, in which the proportions of the ingredients of food materials actually digested have been found by comparison of amounts and composition of the food eaten with those of the undigested excreta. Table III is computed by applying the data obtained by these experiments to some of those for the composition of food materials in Table I.

TABLE II.—*Digestibility of nutrients of food materials.*

Food materials.	Of the total amounts of protein, fats, and carbohydrates, the following percentages were digested: Protein.	Fats.	Carbohydrates.
Meats and fish	Practically all.	79 to 92	....
Eggs	....do	96	....
Milk	88 to 100	93 to 98	?
Butter	....	98	....
Oleomargarine	....	96	....
Wheat bread	81 to 100	?	99
Corn (maize) meal	80	?	97
Rice	84	?	99
Pease	86	?	96
Potatoes	74	?	92
Beets	72	?	82

TABLE III.—*Proportions of nutrients digested and not digested from food materials by healthy men.*

Food materials.	Protein. Digestible.	Protein. Undigestible.	Protein. Total.	Fats. Digestible.	Fats. Undigestible.	Fats. Total.	Carbohydrates. Digestible.	Carbohydrates. Undigestible.	Carbohydrates. Total.	Mineral matters.	Water.
	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Beef, round	23.0	0.0	23.0	8.1	0.9	9.0	0.0	0.0	0.0	1.3	66.7
Beef, sirloin	20.0	0.0	20.0	17.1	1.9	19.0	0.0	0.0	0.0	1.0	60.0
Pork, very fat	3.0	0.0	3.0	74.5	6.0	80.5	......	......	......	6.5	10.0
Haddock	17.1	0.0	17.1	0.3	......	0.3	0.0	0.0	0.0	1.2	81.4
Mackerel	18.8	0.0	18.8	7.4	0.8	8.2	0.0	0.0	0.0	1.4	71.6
Hens' eggs	13.4	0.0	13.4	9.4	2.4	11.8	0.7	0.0	0.7	1.0	73.1
Cows' milk	3.4	0.0	3.4	3.6	0.1	3.7	4.8	0.0	4.8	0.7	87.4
Cheese, whole milk	27.1	0.0	27.1	34.6	0.9	35.5	2.3	0.0	2.3	3.9	31.2
Butter	1.0	......	1.0	85.8	1.7	87.5	0.5	......	0.5	2.0	9.0
Oleomargarine	0.4	......	0.4	83.9	3.3	87.2	0.0	......	0.0	2.1	10.3
Sugar	0.3	......	0.3	......	......	......	96.7	0.0	96.7	0.8	2.2
Wheat flour, very fine	7.6	1.3	8.9	1.0	......	1.0	74.4	0.8	75.2	0.3	14.0
Wheat flour, medium	9.5	2.1	11.6	0.8	......	0.8	70.4	1.8	72.2	0.4	15.0
Wheat flour coarse, whole wheat	8.2	2.7	10.9	1.8	......	1.8	66.4	5.3	71.7	1.2	14.4
Wheat bread, average	7.7	1.2	8.9	1.9	......	1.9	54.9	0.6	55.5	1.0	32.7
Black bread	4.5	1.6	6.1	......	......	......	43.3	5.3	48.6	1.5	43.8
Pease	19.7	3.2	22.9	1.8	......	1.8	55.7	2.1	57.8	2.5	15.0
Corn (maize) meal	7.9	1.2	9.1	3.8	......	3.8	68.7	2.3	71.0	1.6	14.5
Rice	6.2	1.2	7.4	0.4	......	0.4	78.7	0.7	79.4	0.4	12.4
Potatoes	1.5	0.5	2.0	0.2	......	0.2	19.7	1.6	21.3	1.0	75.5
Turnips	0.7	0.3	1.0	0.2	......	0.2	5.6	1.3	6.9	0.7	91.2

STANDARDS FOR DAILY DIETARIES FOR PEOPLE OF DIFFERENT CLASSES.

The demands of different people for nutrients in the daily food vary with age, sex, occupation, and other conditions, including especially the widely differing characteristics of individuals. The standards in Table IV, herewith, are intended to represent roughly the needs of average individuals of the classes named. Nos. 1, 3, 4, 5, and 6, are as proposed by Voit and his followers of the Munich school of physiologists, and are based upon observations of quantities actually consumed in a considerable number of cases. Nos. 7 and 8 are by Voit, and based both upon quantities consumed by individuals under experiment and upon observed dietaries of a much larger number of persons in Germany. Nos. 9, 10, and 11 are by Playfair, and are based mainly upon observations of actual dietaries in England. No. 2 is calculated by the writer from the data and results used in Nos. 1 and 3. In Nos. 12, 13, 14, and 15, by the writer, the data of Voit, Playfair, and other European observers are taken into account, but the conclusions are modified by the results of studies of a considerable number of dietaries of people in the United States.

TABLE IV.—*Standards for daily dietaries for people of different classes.*

Classes.	Nutrients.				Potential energy.
	Protein.	Fats.	Carbohydrates.	Total.	
	*Grms.**	*Grms.*	*Grms.*	*Grms.*	*Calories.*
1. Children to 1½ years	28 (20 to 36)	37 (30 to 45)	75 (60 to 90)	140	765
2. Children 2 to 6 years	55 (36 to 70)	40 (35 to 48)	200 (100 to 250)	295	1,420
3. Children 6 to 15 years	75 (70 to 80)	43 (37 to 50)	325 (250 to 400)	443	2,040
4. Aged woman	80	50	260	390	1,860
5. Aged man	100	68	350	518	2,475
6. Woman at moderate work, German	92	44	400	536	2,425
7. Man at moderate work, German	118	156	500	674	3,055
8. Man at hard work, German	145	100	450	695	3,370
9. Man with moderate exercise, English	119	51	531	701	3,140
10. Active laborer, English	156	71	568	795	3,630
11. Hard-worked laborer, English	185	71	568	824	3,750
12. Woman with light exercise, American	80	80	300	460	2,300
13. Man with light exercise (or woman with moderate work), American	100	100	360	560	2,815
14. Man at moderate work, American	125	125	450	700	3,520
15. Man at hard work, American	150	150	500	800	4,060

* One pound avoirdupois = 453.6 grammes; 1 ounce = 28.3 grammes.

ACTUAL DIETARIES OF DIFFERENT CLASSES OF PEOPLE.

Table V gives the quantities of nutrients and potential energy in a number of observed dietaries. The figures for European dietaries are mostly by Voit and his followers in Germany, and by Playfair in England. The American figures are by the writer; those for the Army and Navy rations are based upon the United States regulations, the rest upon observation of actual dietaries.

TABLE V.—*Nutrients and potential energy in dietaries of different people.*

Classes.	Nutrients.				Potential energy of nutrients.
	Protein.	Fats.	Carbohydrates.	Total.	
European and Japanese dietaries.	*Grms.*	*Grms.*	*Grms.*	*Grms.*	*Calories.*
1. Sewing girl, London, wages 93 cents (3s. 9d) per week	53	33	316	402	1, 820
2. Factory girl, Leipsic, Germany, wages $1.21 per week	52	53	301	406	1, 940
3. Weaver, England, time of scarcity	60	28	398	486	2, 138
4. Laborers, Lombardy, Italy; diet mostly vegetable	82	40	362	484	2, 192
5. Trappist monk in cloister; very little exercise, vegetable diet	68	11	469	548	2, 304
6. Students, Japan	97	16	438	551	2, 343
7. University professor, Munich, Germany; very little exercise	100	100	240	410	2, 324
8. Lawyer, Munich	80	125	222	427	2, 401
9. Physician, Munich	131	95	327	553	2, 762
10. Painter, Leipsic, Germany	87	69	366	522	2, 500
11. Cabinet-maker, Leipsic, Germany	77	57	466	600	2, 757
12. "Fully-fed" tailors, England	131	39	525	695	3, 053
13. "Well paid" mechanic, Munich, Germany	151	54	479	684	3, 085
14. Carpenter, Munich, Germany	131	68	494	693	3, 194
15. "Hard-worked" weaver, England	151	43	622	816	3, 569
16. Blacksmith, England	176	71	667	914	4, 117
17. Miners at very severe work, Germany	133	113	634	880	4, 195
18. Brick-makers (Italians at contract work), Munich	167	117	675	959	4, 641
19. Brewery laborer, Munich; very severe work, exceptional diet	223	113	909	1, 245	5, 692
20. German soldiers, peace footing	114	39	480	633	2, 798
21. German soldiers, war footing	134	58	489	681	3, 093
22. German soldiers, Franco-German war; extraordinary ration	157	285	331	773	4, 652
United States and Canadian dietaries.					
23. French Canadians, working people, in Canada	109	109	527	745	3, 622
24. French Canadians, factory operatives, mechanics, etc., in Massachusetts	118	204	549	871	4, 632
25. Other factory operatives, mechanics, etc., Massachusetts	127	186	531	844	4, 428
26. Glass-blowers, East Cambridge, Mass	95	132	481	708	3, 590
27. Factory operatives, dressmakers, clerks, etc., boarding-house	114	150	522	786	4, 002
28a. Well-to-do private family, Connecticut: food purchased	120	183	467	779	4, 146
28b. Well-to-do private family, Connecticut: food eaten	128	177	466	771	4, 082
29a. College students from Northern and Eastern States; boarding club, two dietaries of the same club: food purchased	161	204	680	1, 045	5, 345
29b. (same): food eaten	138	184	622	944	4, 827
30a. (same): food purchased	115	163	460	738	3, 874
30b. (same): food eaten	104	136	421	661	3, 417
31. College foot-ball team, food eaten	181	292	557	1, 030	5, 742
32. Machinist, Boston, Mass	182	254	617	1, 053	5, 638
33. Brick-makers, Middletown, Conn	222	263	758	1, 243	6, 464
34. Teamsters, marble-workers, etc., with hard work; Boston, Mass	254	363	826	1, 443	7, 804
35. Brick-makers, Cambridge, Mass	180	365	1, 150	1, 696	8, 848
36. U. S. Army ration	120	161	454	735	3, 851
37. U. S. Navy ration	143	184	520	847	4, 998

2. DIGESTIBILITY OF FISH.

In the explanations in the previous chapter the digestibility of food materials was touched upon and statistics of results of experiments were cited. Those for the digestibility of fish were based upon experiments made in connection with the investigations here reported. These experiments have already been described in detail,* and only the main results need be recapitulated here. In connection with them the results of other investigations may be cited.

* Zeitschrift fur Biologie, 24, 1888, p. 16.

There are two ways of studying experimentally the digestibility of foods. One is by experiments in artificial digestion, in which the food material is exposed to the action of the digestive juices in the laboratory, in apparatus fitted for the purpose. The other is by direct experiments with man or other animals.

A series of experiments upon the artificial digestion of fish in gastric juice has been made by Messrs. Chittenden and Cummins, and described in the report of the U. S. Commissioner of Fish and Fisheries for 1884, p. 1109.

In the introduction to the account of their work, they speak of these experiments as follows:

Few experiments appear to have been made on the digestibility of fish; this is the more strange when we consider what an important item of food fish constitutes, particularly along our seaboard. * * * As Voit remarks, "nothing certain is known regarding the digestibility of different kinds of fish, although much is said concerning it. Probably digestibility is in part dependent upon the nature of the fat present and the manner of its distribution; thus the presence of a difficultly fusible fat with considerable stearin would tend to hinder digestibility (as in mutton); the same thing probably occurs when the contents of the sarcolemma are permeated with much fat (as in the lobster and eel)." This statement at once suggests the probability of great variation in the digestibility of the flesh of any one species, dependent upon a large number of conditions, which, in the case of fish particularly, are somewhat difficult of control; thus age, sex, food, period of spawning, and length of time they have been preserved are a few of the many natural conditions which would tend to modify the digestibility of the flesh and render generalizations from even a large number of results somewhat uncertain.

The outcome of their work is expressed thus:

The results of the analyses show plainly that the method adopted is as good as could be expected, for it must be remembered that the two results obtained from each sample of flesh are not merely from duplicated analyses, but from duplicated digestions as well, and in these, extending as they do over 22 hours, with slight variations in temperature and agitation, small differences are to be expected. The very great divergence noticed, however, in the results obtained from different samples of the same species of flesh shows at once that there are other conditions, such as age, etc., which affect the digestibility of the flesh more or less, so that in order to obtain results from which to draw strict generalizations it would be necessary to experiment with fish of different species, of like age, sex, and reared under like conditions. As samples of this we have the very divergent results from two samples of veal, and also of two bluefish (88.69 and 73.44). As direct evidence that age, sex, etc., do exert a modifying influence on the digestibility of flesh, we have three experiments on the flesh of the lobster; one with a small young lobster, a second with a large female, and a third with a large male of the same species. The duplicate digestions gave fairly concordant results; the average relative digestibility being for the young specimen 87.81, for the large female 79.06, and for the male 69.13. This shows plainly some modifying influence in flesh itself. In composition, so far as the solid matter is concerned, there was no appreciable difference in the three samples. Bearing in mind, however, these possible variations, it is very evident from our results that the average digestibility of fish flesh is far below that of beef similarly cooked. In but two instances, in the case of shad and whitefish, does the digestibility of fish flesh approach that of beef, although from the average of our experiments several are as easily digestible as mutton, lamb, and chicken.

Pavy states that fish with white flesh, such as the whiting, etc., are less stimulating and lighter to the stomach, or more easy of digestion, than fish with more or less red flesh, as the salmon. Our experiments confirm this statement so far as digestibility is concerned. Thus the average digestibility of the salmon and trout is considerably below the average of the more digestible whitefish. The difference between the digestibility of the light and the dark meat of the same flesh is somewhat striking, as in the case of the shad, where the digestibility of the former was found to be 97.25, as compared with beef, while the dark flesh was 87.32. A similar difference, though very much smaller, is to be noticed between the light and dark meat of the chicken.

This difference in digestibility is in part due, without doubt, to the amount of fat present, for, as Pavy states, in the flesh of the white fish there is but little fat, it being accumulated mainly in the liver of the animal, while in red fish there is more or less fatty matter incorporated with the muscular fibers. For a similar reason eels, mackerel, and herring are, according to Pavy, less suited to a delicate stomach than some of the white fish, and our experiments show that in digestibility two of them stand below the more digestible white fish; mackerel, however, from our single experiment with the white portion of the flesh, showed a comparatively high digestibility. In all of our experiments, however, with white fish we rejected the outer layer of dark flesh, except in the case of the shad. The varying differences in digestibility are not to be considered as due wholly to differences in the amount of fat in the flesh; thus the flesh of fresh cod contains but little fat, and yet it is one of the most indigestible of the white fish experimented with. This agrees with Pavy's experience "that it is a more trying article of food to the stomach than is generally credited." Again Pavy makes the following statement, based on his experience in fish dietetics: "Of all fish the whiting may be regarded as the most delicate, tender, and easy of digestion." "The haddock is somewhat closely allied, but is inferior in digestibility," while "the flounder is light and easy of digestion, but insipid." With all these statements our results agree perfectly, assuming the white fish of our experiments to be analogous to the English whiting.

It thus appears that Messrs. Chittenden and Cummins found considerable divergence in the digestibility of the flesh of fishes of different kinds. This they attribute in part to the varying proportions of fat (the fatter fish being less digestible) and in part to other characteristics of the flesh. My own impression is that experiments on the actual digestion in the alimentary canal, in which other juices as well as the gastric come in play and other conditions are different, would show less difference in the digestibility of fish of different sorts than Chittenden and Cummins found in their experiments in artificial digestion with gastric juice alone, and also that there would be less variation in actual quantities and nutritive material digested than the statements made by those authors would imply; for we must not forget the distinction between the quantity digested and the ease of digestion. But of course this is a matter to be determined by actual experiments and observation.

The ways for testing the digestibility of foods by men and animals are very ingenious and interesting. Physiologists use the salivary glands, stomach, or intestines of a living animal much as chemists do their bottles, retorts, and test tubes. It is easy to get into the way of regarding an animal as simply an organism manifesting certain reactions under given conditions, and in not a few European laboratories a janitor is readily induced by the price of a few months' supply of beer, or a student by his scientific ardor, to take this same altruistic view of his own physical organisms. In the German laboratories particularly one finds not only the needed apparatus but (what is no less important) trained assistants and servants, so that one is relieved of much of the time-consuming and disagreeable detail of experimenting, which is so much of an obstacle with us.

THE QUANTITIES OF DIGESTIBLE SUBSTANCES IN FOOD.

The first question we have now to ask may be put in this way: What proportion of each of the nutrients in different food materials is actually digestible? In a piece of meat, for instance, what percentage of the total protein and fats will be digested by a healthy person and what proportion of each will escape digestion? The proportions of food constituents digested by domestic animals has been a matter of active investigation in the European agricultural experiment stations during the past twenty years. Briefly expressed, the method consists in weighing and analyzing both the food consumed and the intestinal excretion, which latter represents the amount of food undigested. The difference is taken as the amount digested.

Such experiments upon human subjects, however, are rendered much more difficult by the fact that in order that the digestibility of each particular food material may be determined with certainty we must avoid mixing it with other materials; hence the diet during the experiments must be so plain and simple as to make it extremely unpalatable. An ox will live contentedly on a diet of hay for an indefinite time, but for an ordinary man to subsist a week on meat, or fish, or potatoes, or eggs is a very different matter. No matter how palatable such a simple food may be at first, to a man used to the ordinary diet of a well-to-do community, it will almost certainly become repugnant to him after a few days. In consequence the digestive functions are disturbed and the accuracy of the trial is impaired, a fact, by the way, which strikingly illustrates the importance of varied diet in civilized life. For instance, in an experiment conducted in the physiological laboratory at Munich by Dr. Rubner, the subject, a strong healthy Bavarian laboring man, lived for three days upon bread and water, a diet the monotony of which was much more endurable than one of meat or fish or almost any other single food material would have been. He was able to eat 1,185 grammes (about 21 pounds and 10 ounces) of bread per day. This contained 670 grammes of carbohydrates, mainly starch, of which only about $5\frac{1}{3}$ grammes, or a little less than 1 per cent., escaped digestion. In this case, therefore, about 99 per cent. of the carbohydrates of the bread was digested. The bread contained 13 grammes of protein, of which 13 per cent. was undigested, and 87 per cent., or seven-eighths of the whole protein, digested. The quantity of fatty matters in the bread was too small to permit an at all accurate test of their digestibility. In another experiment the digestibility of meat (beefsteak) was tested. The man consumed a little less than 2 pounds per day, but though it was cooked with butter, pepper, salt, and onions, so as to make it taste "extraordinarily well flavored," it was very difficult to swallow it the second day and required great effort the third. The digestion, however, seemed to be normal, and all but about 1 per cent. of the protein was digested. Other trials with meat and with fish have brought similar results, and it is reasonably safe to say that when a healthy person with sound digestive organs eats ordinary meat in proper quantities all or nearly all of the protein is digested. Some of the fats of meats, however, seem to fail of digestion.

The number of accurate experiments of this kind is still very small. Some sixty or thereabouts have been reported. Nearly all have been made within 10 years past, and the majority in one laboratory, that of the University of Munich. Most of the subjects have been men with healthy digestive organs, two or three laboratory servants, a soldier, several medical students, and a few others. Several have been made, however, with children of a few families; all but a very small number were conducted in Germany.

Sometime since it was my fortune to pass a number of months in Munich, where, through the courtesy of Professor Voit, director of the Physiological Institute of the university, I was enabled to make some experiments on the digestion of meat and fish by a man and by a dog. Each lived for 3 days upon haddock, and then for 3 days upon lean meat, beefsteak. The dog was used to such experiments, and got on very comfortably, indeed. The meat and fish were each cooked with a little lard. He did not take to the fish at first, but after he got used to it seemed to like it. The first attempt with a man was with the same healthy, rather stolid, Bavarian laborer with whom Dr. Rubner's experiments with meat and bread, above referred to, were performed. He bore up very well through the trials with both the fish and meat, but the assistant discovered at the end that he had surreptitiously eaten sourcrout, and the experiment was spoiled.

Fortunately, a medical student, then working in the laboratory, became interested in the subject, and offered himself as a martyr to the cause. He had for 3 days flesh of haddock fried with butter, flavored with salt, pepper, mustard, and Worcestershire sauce, and taken with beer and wine. Then came a period of rest; that is to say, ordinary diet, and then a similar trial of beefsteak. I was with him at every meal and can bear warm testimony to his fortitude and determination. The menu was made as appetizing as possible under the circumstances. The first day of each trial went pretty well, the second day it was difficult, and the third day extremely so, to swallow the whole. As the result, it appeared that he digested nearly the whole of both the meat and the fish. The results of the experiments are stated in tabular form herewith. The percentage of each ingredient which escaped digestion is given. In some case a correction for certain errors of experiment, which need not be discussed here, is applied to the figures for amounts "apparently undigested," to show those estimated to be "actually" digested.

Summary of results of experiments on the digestion of the constituents of meat and fish by a dog and by a man. Percentages undigested.

Food.	Dog.		Man.	
	Meat and lard.	Fish and lard.	Meat, butter, etc.	Fish, butter, etc.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Water-free substance, apparently undigested	3.4	3.2	4.3	4.9
Nitrogen (protein) from meat or fish, apparently undigested	2.2	1.6	2.5	2.0
Nitrogen (protein) from meat or fish actually undigested	0.3	0.0	0.7	0.5
Fat, mostly from lard or butter, apparently undigested	2.8	3.0	5.2	9.0
Ash, apparently undigested	14.3	14.1	21.5	22.5

Practically all the protein of both the fish and lean beef were digested by the dog, and all but one-half or three-fourths of 1 per cent. by the man; these results agree with what would be expected from the nature of the nitrogen compounds and what is known of the laws of digestion and absorption, and leave little doubt that practically all of the protein of both will be digested by a healthy organism under normal conditions.

The conclusion that the flesh of the common kinds of fish agrees very closely in digestibility with that of the common kinds of meat, at least so far as the protein (the chief constituent of the "lean" of meat and fish) is concerned, seems equally well grounded. It would seem from other considerations (especially from actual experiments with meats, in which the fat is imperfectly digested) that fish, having generally less fat than meat, is more easily and completely digested.

It is interesting to note how different food materials compare in digestibility as shown by experiments such as those just described. Results of such trials are given in Table II of the previous chapter.

The amounts of fat in the vegetable foods are so small that the experiments do not tell exactly what proportions are digested. The meats and fish contain practically no carbohydrates. The digestibility of the carbohydrates (sugar) of milk was not determined; those of the vegetable foods, except the beets, were almost completely digested. That the protein of cow's milk should be so much less completely digested than that of meat seems a little strange. Children digest a little more than adults. Dr. Camerer found his boys and girls of from 2 to 12 years of age to digest from 91 to 97 per cent. of the protein of cow's milk, while grown men in experiments by Dr. Rubner digested from 88 to 94 per cent. But in experiments in which milk and cheese were eaten together by a man, in Dr. Rubner's experiments, all or nearly all of the protein of both was digested. The percentages of fats of milk digested were practically the same with adults as with children. It is noticeable that both children and adults digest only about half of the mineral salts of the milk. Why so much of the fats of the meat, from a twelfth to a fifth, should fail to be digested it is not easy to say. Some food materials, as meat, bread, and milk, have been tested by several experiments with more than one person; with others, as eggs, corn meal, rice, pease, and potatoes, only a single trial has been made.

Doubtless extended series of tests would give averages differing more or less from these figures; some food materials may be more completely digested when taken in small quantities with others in the ordinary way than when so much is eaten and without any other food; these and other sources of slight error make more extended experiments very desirable; but enough has been done to show pretty clearly that—

1. The protein of our ordinary meats and fish is very readily and completely digestible.

2. The protein of vegetable foods is much less digestible than that of animal foods. Of that of potatoes and beets, for instance, a third or more may escape digestion and thus be useless for nourishment.

3. Much of the fat of animal food may at times fail of digestion.

4. The carbohydrates, other than fiber, which make up the larger part of vegetable foods, are very digestible.

5. Animal foods have in general the advantage of vegetable foods in containing more protein; and their protein is more digestible.

6. The comparative digestibility of fish and meats and of the different kinds of fish is not well enough decided by experiment to warrant as definite conclusions as are desirable. The leaner meats are probably more easily digested than those with more fat, and the leaner kinds of fish, such as cod, haddock, perch, pike, bluefish, sole, flounder, etc., are more easily and completely digested than the fatter kinds, as salmon, shad, and fat mackerel; and fish, which is, in general, less fat than meat, is on the average more digestible.

7. People differ in respect to the action of foods in the digestive apparatus, and fish, like other food materials, are subject to these influences of personal peculiarity.

3. TABLES OF ANALYSES OF FISHES, MOLLUSKS, ETC.

TABLE VI. (CHART A.)—*Recapitulation of analyses of American and European food-fishes. Nutrients and water in flesh (edible portion).*

[Arranged in order from those with largest to those with smallest percentages of total nutrients.]

Kinds of fish. (A, American; E, European.)	In flesh.					
	Protein.	Fats.	Ash.	Total.	Water.	Energy in 1 pound of each material.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
California salmon, A.:						
Maximum	16.96	19.25	1.11	37.32	62.68	1,125
Minimum	17.96	16.50	1.01	35.47	64.53	1,030
Average	17.46	17.87	1.06	30.39	63.61	1,080
Eel, A and E:						
Maximum	13.42	32.88	0.92	47.22	52.78	1,635
Minimum	17.61	7.88	1.11	26.60	73.40	660
Average	15.82	18.74	0.93	35.49	64.51	1,085
Salmon, A and E:						
Maximum	24.45	13.07	1.45	38.97	61.03	1,005
Minimum	18.17	4.85	1.28	24.30	75.70	545
Average	20.77	12.09	1.38	34.24	65.76	895
Spanish mackerel, A	20.97	9.43	1.50	31.90	68.10	790

TABLE VI. (CHART A.)—*Recapitulation of analyses of American and European food-fishes. Nutrients and water in flesh, edible portion*—Continued.

Kinds of fish. (A, American; E, European.)	In flesh. Protein.	Fats.	Ash.	Total.	Water.	Energy in 1 pound of each material.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
Lake trout, A:						
Maximum	17.32	12.55	1.35	31.22	68.78	850
Minimum	19.12	10.21	1.17	30.50	69.50	785
Average	18.22	11.38	1.26	30.86	69.14	820
Whitefish, A	22.06	6.49	1.62	30.17	69.83	685
Butterfish, A	17.81	11.03	1.14	29.98	70.02	795
Shad, A:						
Maximum	19.68	13.59	1.48	34.75	62.25	940
Minimum	18.05	7.03	1.36	26.44	73.56	630
Average	18.55	9.48	1.35	29.38	70.62	745
Lamprey eel, A	14.93	13.29	0.66	28.88	71.12	840
Turbot, A	12.92	14.41	1.28	28.61	71.39	850
Mackerel, A and E:						
Maximum	18.21	16.30	1.48	35.99	64.01	1,025
Minimum	18.13	2.20	1.00	21.33	78.67	430
Average	18.77	8.21	1.40	28.38	71.62	695
Herring, A and E:						
Maximum	18.46	11.01	1.50	30.97	69.03	810
Minimum	17.29	4.89	1.71	23.89	76.11	530
Average	18.19	8.02	1.69	27.90	72.10	675
Pompano, A:						
Maximum	18.15	13.51	0.96	32.62	67.38	910
Minimum	19.15	1.64	1.03	21.82	78.18	425
Average	18.65	7.57	1.00	27.22	72.78	665
Bleak, E	15.73	8.13	3.25	27.11	72.89	635
Alewife, A:						
Maximum	19.54	6.02	1.48	27.04	72.96	620
Minimum	18.80	3.82	1.46	24.08	75.92	510
Average	19.17	4.92	1.47	25.56	74.44	565
Small-mouthed black bass, A	21.50	2.44	1.24	25.18	74.82	505
Mullet, A	19.32	4.64	1.17	25.13	74.87	555
Porgy, A:						
Maximum	18.81	7.86	1.35	28.02	71.98	680
Minimum	17.46	1.46	1.40	20.32	79.68	390
Average	18.52	5.11	1.38	25.01	74.99	560
Salmon trout, E	20.83	2.49	1.33	24.65	75.35	490
Halibut, A:						
Maximum	18.16	10.57	1.14	29.87	70.13	785
Minimum	17.49	2.21	1.15	20.85	79.15	420
Average	18.35	5.18	1.05	24.58	75.42	560
Sheepshead, A:						
Maximum	20.17	6.72	1.10	27.99	72.01	660
Minimum	18.93	0.66	1.33	20.92	79.08	380
Average	19.54	3.69	1.22	24.45	75.55	520
White perch, A:						
Maximum	17.63	5.62	1.11	24.36	75.64	565
Minimum	20.43	2.52	1.28	24.23	75.77	485
Average	19.03	4.07	1.19	24.29	75.71	525
Pollock, A	21.65	0.78	1.55	23.98	76.02	435
Sturgeon, E	17.67	5.15	1.16	23.98	76.02	545
Cisco, A	19.12	3.48	1.25	23.85	76.15	505
Muskellunge, A	19.63	2.54	1.57	23.74	76.26	470
Sterlet, E	16.64	5.59	0.96	23.19	76.81	545
Gudgeon, E	16.99	2.68	3.44	23.11	76.89	430
Plaice, E	19.35	1.80	1.46	22.61	77.39	435
Striped bass, A:						
Maximum	19.33	3.64	1.27	24.24	75.76	515
Minimum	16.87	2.14	1.36	20.37	79.63	405
Average	18.31	2.83	1.16	22.30	77.70	460
Brook trout, A:						
Maximum	20.03	2.94	1.25	24.22	75.78	495
Minimum	18.45	0.75	0.96	20.16	79.84	375
Average	18.97	2.10	1.21	22.28	77.72	440
Smelt, E	16.97	3.08	1.57	21.62	78.38	445
Carp, E:						
Maximum	20.60	1.09	1.34	23.03	76.97	420
Minimum	17.55	1.42	1.14	20.11	79.89	385
Average	19.07	1.26	1.24	21.57	78.43	405
Red snapper, A:						
Maximum	19.39	1.94	1.33	22.66	77.34	440
Minimum	18.31	0.54	1.34	20.19	79.81	365
Average	19.20	1.03	1.31	21.54	78.46	400
Bluefish, A	19.02	1.25	1.27	21.54	78.46	405
Large-mouthed black bass, A	19.24	0.96	1.19	21.39	78.61	400
Small-mouthed red-horse, A	17.90	2.35	1.19	21.44	78.56	430
Sturgeon, A	17.96	1.90	1.43	21.29	78.71	415

TABLE VI. (CHART A.)—*Recapitulation of analyses of American and European food-fishes. Nutrients and water in flesh (edible portion)*—Continued.

Kinds of fish. (A, American; E, European.)	In flesh. Protein.	Fats.	Ash.	Total.	Water.	Energy in 1 pound of each material.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
Skate, A and E:						
Maximum	22.32	6.47	1.71	24.50	75.60	435
Minimum	15.32	1.39	1.14	17.85	82.15	345
Average	18.82	0.93	1.43	21.18	78.82	390
Weakfish, A	17.45	2.39	1.19	21.03	78.97	425
Blackfish, A:						
Maximum	18.06	2.81	1.28	23.05	76.95	470
Minimum	17.44	0.55	0.65	18.64	81.36	350
Average	18.47	1.35	1.08	20.90	79.10	400
Whitefish, E	18.12	1.53	1.22	20.87	79.13	400
Smelt, A:						
Maximum	18.83	1.65	1.36	21.84	78.16	420
Minimum	15.90	1.94	2.00	19.84	80.16	375
Average	17.36	1.80	1.68	20.84	79.16	400
Kingfish, A	18.66	0.95	1.18	20.79	79.21	385
Sea bass, A	18.75	0.49	1.44	20.68	79.32	370
Dab, E	16.59	2.06	1.94	20.59	79.41	395
Grouper, A:						
Maximum	19.15	0.75	1.14	21.04	78.96	385
Minimum	18.41	0.48	1.16	20.05	79.95	365
Average	18.80	0.60	1.15	20.55	79.45	375
Yellow perch, A and E:						
Maximum	19.47	1.12	1.34	21.93	78.07	410
Minimum	17.88	0.55	1.14	19.57	80.43	355
Average	18.49	0.70	1.29	20.48	79.52	375
Pike perch, Wall-eyed pike, A	18.42	0.47	1.37	20.26	79.74	360
Pickerel, A:						
Maximum	18.88	0.49	1.11	20.48	79.52	370
Minimum	18.40	0.52	1.24	20.16	79.84	365
Average	18.64	0.50	1.18	20.32	79.68	370
Pike perch, E	18.93	0.20	1.00	20.13	79.87	360
Conger eel, E	13.96	5.02	1.11	20.09	79.91	470
Pike, A and E:						
Maximum	20.58	0.60	1.29	22.47	77.53	410
Minimum	14.83	0.15	1.13	16.11	83.89	285
Average	17.95	0.41	1.16	19.52	80.48	350
Pike perch, Gray pike, A	17.26	0.76	1.13	19.15	80.85	355
Crucian carp, E	17.63	0.48	1.07	19.18	80.82	350
Russian cod, E	16.48	0.59	1.58	18.65	81.35	330
Haddock, A and E:						
Maximum	18.38	0.17	1.15	19.70	80.30	350
Minimum	15.94	0.32	1.18	17.44	82.56	310
Average	17.10	0.26	1.25	18.61	81.39	330
Tomcod, A	17.08	0.38	0.99	18.45	81.55	335
Red bass, A	16.68	0.53	1.23	18.44	81.56	335
Cusk, A	16.92	0.17	0.90	17.99	82.01	320
Cod, A and E:						
Maximum	17.59	0.30	1.40	19.29	80.71	340
Minimum	14.97	0.28	1.27	16.52	83.48	290
Average	16.00	0.30	1.24	17.54	82.46	310
Whiting, E	15.59	0.38	1.08	17.05	82.95	305
Hake, A	15.24	0.67	0.98	16.89	83.11	310
Common flounder, A:						
Maximum	14.73	0.62	1.28	16.63	83.37	300
Minimum	12.90	0.77	1.29	14.96	85.04	270
Average	13.82	0.69	1.28	15.79	84.21	285
Winter flounder, A	14.01	0.44	1.20	15.65	84.35	280
Sole, E	12.38	0.25	1.23	13.86	86.14	240
Barbel, E	9.54	0.21	0.90	10.65	89.35	185
SPENT FISH.						
Spent salmon, A:						
Maximum	10.24	4.37	1.12	24.73	75.27	540
Minimum	17.80	2.83	1.17	21.80	78.20	450
Average	18.52	3.00	1.14	23.26	76.74	495
Spent land-locked salmon, A:						
Maximum	16.84	4.01	1.27	22.12	77.88	485
Minimum	17.65	1.95	1.20	20.80	79.20	410
Average	17.24	2.98	1.24	21.46	78.54	445

TABLE VII. (CHART B.)—*Nutritive ingredients, water and salt in flesh (edible portion) of specimens of American and European preserved fish.*

Fish. (A, American; E, European.)	No. of specimens analyzed.	Edible portion.					Energy in 1 pound of each material.	Salt.
		Nutrients.				Water.		
		Protein.	Fats.	Ash.	Total.			
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calor.*	*Pr. ct.*
Desiccated codfish (fish meal) A	1	74.46	1.90	5.41	84.75	15.25	1,465	2.88
Fish meal, Gadus sp., E	1	73.55	0.70	8.73	82.98	17.02	1,395	......
Dried codfish, stock fish, E	1	78.20	1.20	6.89	86.29	13.71	1,505	......
Salt codfish, A	3	21.42	0.34	1.62	46.42	53.58	410	23.04
Salt mackerel, A	3	18.88	25.12	2.59	56.99	43.01	1,410	10.40
Salt herring, E	4	20.17	14.44	1.90	51.42	48.58	985	14.91
Salted smelt, E	1	26.38	8.03	5.33	52.88	47.12	....	13.14
Salted salmon, E	1	22.68	12.19	0.44	46.52	53.48	935	11.21
Smoked haddock, A	1	33.68	0.17	1.53	27.44	72.56	445	2.06
Smoked halibut, A	2	20.57	15.03	2.06	50.62	49.38	1,015	12.96
Smoked herring, A	1	36.44	15.82	1.53	65.45	34.55	1,345	11.66
Smoked sprat, E	1	23.71	15.94	0.46	40.11	59.89	1,115	......
Smoked anchovy, E	1	22.75	2.21	2.68	48.23	51.77	515	20.59
Smoked salmon, E	2	24.63	11.86	1.17	48.53	51.47	960	10.87
Canned sardines, E	1	25.31	12.71	5.61	43.63	56.37	1,010	......
Canned salmon, A	3	20.06	15.70	1.32	38.12	61.88	1,035	1.04
Canned mackerel, A	1	19.91	8.68	1.30	31.82	68.18	735	1.93
Canned tunny, A	1	21.52	4.05	1.69	27.26	72.74	570	......

TABLE VIII. (CHART C.)—*Recapitulation of analyses of American and European fishes. Nutrients, water, and refuse, in specimens as purchased.*

[Arranged in order, from those with largest to those with smallest percentages of total nutrients.]

Kinds of fish and portions taken for analysis. (A, American; E, European.)	No. of specimens analyzed.	Edible portion.						Energy in 1 pound of each material.	Refuse.	
		Nutrients.				Water.	Total.		Bones, skin, entrails, etc.	Salt.
		Protein.	Fats.	Ash.	Total.					
FRESH FISH.		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	Calories.	P. ct.	P. ct
California salmon, sections of body, A	2	16.5	17.0	1.0	34.5	60.3	94.8	1,024	5.2	...
Eel, whole, E	1	8.6	21.0	0.6	30.2	33.8	64.0	1,045	36.0	...
Salmon, whole, A:										
Maximum	1	13.3	10.0	1.0	24.3	42.2	66.5	670	33.5	...
Minimum	....	13.9	9.3	1.0	24.2	45.0	69.2	650	30.8	...
Average	....	14.3	8.8	1.0	24.1	40.6	64.7	635	35.3	...
Eel, skin, head, and entrails removed, A:										
Maximum	....	14.9	8.1	0.7	23.7	54.9	78.6	620	21.4	...
Minimum	....	14.3	6.4	0.9	21.6	59.4	81.0	535	19.0	...
Average	....	14.6	7.2	0.8	22.6	57.2	79.8	575	20.2	...
Spanish mackerel, A, whole	1	13.7	6.2	1.0	20.9	44.5	65.4	516	34.6	...
Halibut, sections of body, A:										
Maximum	....	16.1	9.4	1.0	26.5	62.3	88.8	695	11.2	...
Minimum	....	15.8	2.2	0.7	18.7	62.6	81.3	385	18.7	...
Average	....	15.1	4.4	0.9	20.4	61.9	82.3	465	17.7	...
Lake trout, entrails removed, A	1	12.4	6.6	0.8	19.8	45.0	64.8	508	35.2	...
Pollock, head and entrails removed, A	1	15.5	0.6	1.1	17.2	54.3	71.5	313	28.5	...
Butter-fish, whole, A	1	10.2	6.3	0.6	17.1	40.1	57.2	456	42.8	...
Herring, whole, A	1	10.0	5.9	0.8	16.7	37.3	54.0	435	46.0	...
Lamprey eel, whole, A	1	8.1	7.2	0.4	15.7	38.5	54.2	454	45.8	...
Mackerel, entrails removed, A	1	11.4	3.5	0.7	15.6	43.7	59.3	360	40.7	...
Mackerel, whole, A:										
Maximum	....	12.1	10.7	1.0	23.8	42.4	66.2	675	33.8	...
Minimum	....	9.5	2.1	0.6	12.2	37.4	49.6	265	50.4	...
Average	....	10.0	4.3	0.7	15.0	40.4	55.4	370	44.6	...
Turbot, whole, A	1	6.8	7.5	0.7	15.0	37.3	52.3	442	47.7	...
Pompano, whole, A:										
Maximum	....	10.5	7.8	0.5	18.8	38.8	57.6	525	42.4	...
Minimum	....	9.9	0.8	0.5	11.2	40.2	51.4	220	48.6	...
Average	....	10.2	4.3	0.5	15.0	39.5	54.5	370	45.5	...
Little herring, whole, E	....	10.6	3.2	0.9	14.7	40.3	55.0	332	45.0	...

TABLE VIII. (CHART C.)—*Recapitulation of analyses of American and European fishes. Nutrients, water, and refuse, in specimens as purchased*—Continued.

[Arranged in order, from those with largest to those with smallest percentages of total nutrients.]

Kinds of fish and portions taken for analysis. (A, American; E, European.)	No. of specimens analyzed.	Edible portion. Nutrients. Protein.	Fats.	Ash.	Total.	Water.	Total.	Energy in 1 pound of each material.	Refuse. Bones, skin, entrails, etc.	Salt.
FRESH FISH—Continued.		*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*Calories.*	*P. ct.*	
Shad, whole, A:										
Maximum	....	10.5	7.3	0.8	18.6	35.0	53.6	505	46.4	....
Minimum	....	7.4	2.9	0.6	10.9	30.3	41.2	260	58.8	....
Average	....	9.2	4.8	0.7	14.7	35.2	49.9	375	50.1	....
Yellow perch, head and entrails removed, A	1	12.6	0.7	0.9	14.2	50.7	64.9	263	35.1	....
Whitefish, whole, A	1	10.3	3.0	0.7	14.0	32.5	46.5	319	53.5	....
Cisco, whole, A	1	11.0	2.0	0.7	13.7	43.6	57.3	289	42.7	....
Lake trout, whole, A	1	7.7	5.4	0.6	13.7	30.0	43.7	371	56.3	....
Red snapper, whole, A	1	11.9	0.4	0.8	13.1	46.9	60.0	239	40.0	....
Alewife, whole, A:										
Maximum	....	9.9	3.0	0.8	13.7	36.9	50.6	310	49.4	....
Minimum	....	9.5	1.9	0.8	12.2	38.3	50.5	255	49.5	....
Average	....	9.7	2.5	0.8	13.0	37.5	50.5	285	49.5	....
Sheepshead, entrails removed, A	1	8.8	2.9	0.5	12.2	31.3	43.5	285	56.5	....
Muskellunge, whole, A	1	10.0	1.3	0.8	12.1	38.7	50.8	241	49.2	....
Smelt, whole, A:										
Maximum	....	10.4	1.2	1.3	12.9	52.3	65.2	245	34.8	....
Minimum	....	9.6	0.8	0.7	11.1	39.9	51.0	215	49.0	....
Average	....	10.0	1.0	1.0	12.0	46.1	58.1	230	41.9	....
Small-mouthed black bass, whole, A	1	10.0	1.1	0.6	11.7	34.7	46.4	232	53.6	....
Cod, head and entrails removed, A:										
Maximum	....	11.4	0.2	0.8	12.4	62.1	74.5	220	25.5	....
Minimum	....	9.9	0.2	0.9	11.0	55.3	66.3	190	33.7	....
Average	....	10.6	0.2	0.8	11.6	58.5	70.1	205	29.9	....
Pike, whole, A	1	10.7	0.3	0.6	11.6	45.7	57.3	212	42.7	....
Brook trout, whole, A:										
Maximum	....	10.2	1.5	0.6	12.3	38.6	50.9	255	49.1	....
Minimum	....	10.1	0.4	0.5	11.0	43.8	54.8	205	45.2	....
Average	....	9.8	1.1	0.6	11.5	40.4	51.9	230	48.1	....
Striped bass, entrails removed, A	1	8.7	2.2	0.5	11.4	37.4	48.8	253	51.2	....
Bluefish, entrails removed, A	1	9.8	0.6	0.7	11.1	40.3	51.4	207	48.6	....
Red snapper, entrails removed, A:										
Maximum	....	10.0	0.3	0.7	11.0	43.7	54.7	200	45.3	....
Minimum	....	9.2	0.9	0.6	10.7	36.8	47.5	210	52.5	....
Average	....	9.6	0.6	0.6	10.8	40.3	51.1	205	48.9	....
Pickerel, whole, A:										
Maximum	....	10.0	0.3	0.7	11.0	43.6	54.6	200	45.4	....
Minimum	....	9.7	0.2	0.6	10.5	40.8	51.3	190	48.7	....
Average	....	9.8	0.2	0.7	10.7	42.2	52.9	190	47.1	....
Cusk, entrails removed, A	1	10.1	0.1	0.5	10.7	49.0	59.7	192	40.3	....
Mullet, whole, A	1	8.1	2.0	0.5	10.6	31.5	42.1	235	57.9	....
Small-mouthed red-horse, with entrails removed, A:	1	8.5	1.1	0.6	10.2	37.3	47.5	203	52.5	....
Weakfish, whole, A	1	8.4	1.1	0.6	10.1	38.0	48.1	201	51.9	....
Porgy, whole, A:										
Maximum	....	8.0	3.4	0.6	12.0	30.7	42.7	295	57.3	....
Minimum	....	6.1	0.5	0.5	7.1	27.8	34.9	135	65.1	....
Average	....	7.4	2.1	0.6	10.1	29.9	40.0	225	60.0	....
Striped bass, whole, A:										
Maximum	....	9.7	1.4	0.6	11.7	39.7	51.4	240	48.6	....
Minimum	....	7.2	0.9	0.6	8.7	34.4	43.1	170	56.9	....
Average	....	8.3	1.1	0.6	10.0	35.1	45.0	200	54.9	....
Large-mouthed black bass, whole, A	1	8.5	0.4	0.5	9.4	34.6	44.0	174	56.0	....
Blackfish, entrails removed, A:										
Maximum	....	8.7	0.7	0.6	10.0	36.4	46.4	190	53.6	....
Minimum	....	7.9	0.4	0.4	8.7	33.5	42.2	165	57.8	....
Average	....	8.3	0.5	0.5	9.3	35.0	44.3	175	55.7	....
White perch, whole, A:										
Maximum	....	7.8	1.0	0.5	9.3	28.9	38.2	185	61.8	....
Minimum	....	6.5	2.1	0.4	9.0	27.8	36.8	210	63.2	....
Average	....	7.2	1.5	0.4	9.1	28.4	37.5	195	62.5	....
Sea bass, whole, A	1	8.3	0.2	0.6	9.1	34.8	43.9	162	56.1	....
Red grouper, entrails removed, A:										
Maximum	....	8.5	0.3	0.5	9.3	34.8	44.1	170	55.9	....
Minimum	....	8.2	0.2	0.5	8.9	35.3	44.2	160	55.8	....
Average	....	8.4	0.2	0.5	9.1	35.0	44.1	165	55.9	....
Kingfish, whole, A	1	8.1	0.4	0.5	9.0	34.4	43.4	168	56.6	....

TABLE VIII. (CHART C).—*Recapitulation of analyses of American and European fishes. Nutrients, water and refuse in specimens as purchased*—Continued.

[Arranged in order, from those with largest to those with smallest percentages of total nutrients.]

Kinds of fish and portions taken for analysis. (A, American; E, European).	No. of specimens analyzed.	Edible portion. Nutrients. Protein.	Fats.	Ash.	Total.	Water.	Total.	Energy in 1 pound of each material.	Refuse. Bones, skin, entrails, etc.	Salt.
FRESH FISH—Continued.		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	Calories.	P. ct.	P. c.
Haddock, entrails removed, A:										
Maximum	....	8.9	0.1	0.6	9.6	39.0	48.6	170	51.4	....
Minimum	....	7.9	0.2	0.5	8.6	38.5	47.1	155	52.9	....
Average	....	8.2	C.2	0.6	9.0	40.0	49.0	160	51.0	....
Cod, whole, A:										
Maximum	....	8.3	0.3	0.6	9.2	42.3	51.5	165	48.5	....
Minimum	....	7.7	0.1	0.6	8.4	35.1	43.5	145	56.5	....
Average	....	8.0	0.2	0.6	8.8	38.7	47.5	155	52.5	....
Wall-eyed pike, whole, A	1	7.9	0.2	0.6	8.7	34.1	42.8	155	57.2	....
Pike, whole, E	2	7.8	0.1	0.6	8.5	44.5	53.0	149	47.0	....
Blackfish, whole, A:										
Maximum	....	8.3	1.2	0.6	10.1	33.7	43.8	205	56.2	....
Minimum	....	6.3	0.2	0.2	6.7	29.2	35.9	125	64.1	....
Average	....	7.3	0.7	0.4	8.4	31.5	39.9	165	60.1	....
Yellow perch, whole, E	....	7.4	0.2	0.6	8.2	32.8	41.0	146	59.0	....
Hake, entrails removed, A	1	7.2	0.3	0.5	8.0	39.5	47.5	147	52.5	....
Tomcod, whole, A	1	6.8	0.2	0.4	7.4	32.7	40.1	134	59.9	....
Yellow perch, whole, A	1	6.7	0.2	0.4	7.3	30.0	37.3	133	62.7	....
Common flounder, entrails removed, A	1	6.3	0.3	0.6	7.2	35.8	43.0	130	57.0	....
Gray pike, whole, A	1	6.4	0.3	0.4	7.1	29.7	36.8	132	63.2	....
Sheepshead, whole, A	1	6.4	0.2	0.5	7.1	26.9	34.0	127	66.0	....
Winter flounder, whole, A	1	6.1	0.2	0.5	6.8	37.0	43.8	122	56.2	....
Red bass, whole, A	1	6.1	0.2	0.4	6.7	29.8	36.5	122	63.5	....
Common flounder, whole, A	1	5.2	0.3	0.5	6.0	27.2	33.2	110	66.8	....
SPENT FISH.										
Salmon, whole, A:										
Maximum	....	10.8	2.5	0.6	13.0	42.3	56.2	305	43.8	....
Minimum	....	10.0	1.6	0.7	12.3	44.2	56.5	255	43.5	....
Average	....	10.4	2.1	0.6	13.1	43.3	56.4	280	43.6	....
Land-locked salmon, whole, A:										
Maximum	....	8.7	2.1	0.6	11.4	40.2	51.6	250	48.4	....
Minimum	....	9.5	1.0	0.7	11.2	42.6	53.8	220	46.2	....
Average	....	9.1	1.6	0.6	11.3	41.4	52.7	235	47.3	....
Roe of shad	1	23.4	3.8	1.6	28.8	71.2	100.0	596	......	....
PRESERVED FISH.										
Desiccated cod, flesh ground, A	1	74.6	1.9	5.4	81.9	15.2	97.1	1,470	......	....
"Boneless cod," flesh of salt cod, A	1	22.1	0.3	4.1	26.5	54.4	80.9	424	......	19.1
Salt codfish, A	2	16.0	0.4	1.2	17.6	40.3	57.9	315	24.9	..
Salt mackerel, No. 1 mackerel, A	1	14.7	15.1	1.7	31.5	28.1	59.6	911	33.3	7.1
Salt herring, E	....	13.5	14.1	5.1	32.7	28.1	60.8	846	34.0	5.2
Salt little herring, E	....	11.9	4.3	6.5	22.7	83.9	56.6	404	39.0	4.4
Smoked herring, A	1	20.2	8.8	0.9	29.9	19.2	49.1	745	44.4	6.5
Smoked haddock, A	1	16.1	0.1	1.0	17.2	49.2	66.4	304	32.2	1.4
Smoked halibut, A	....	19.1	14.0	1.9	35.0	46.0	81.0	945	6.9	12.1
Canned sardines, A	1	24.0	12.1	5.3	41.4	53.6	95.0	956	5.0	....
Canned salmon, A	....	19.3	15.3	1.2	35.8	59.3	95.1	1,005	3.9	1.0
Canned fresh mackerel, A	2	19.9	8.7	1.3	29.9	68.2	98.1	737	......	1.9
Canned mackerel, No. 2 mackerel, A	....	13.8	21.3	2.1	37.2	34.8	72.0	1,150	......	8.3
Canned tunny, A	1	21.5	4.1	1.7	27.3	72.7	100.0	573	......	....
Canned smoked haddock, A	1	21.8	2.3	1.6	25.7	68.7	94.4	503	......	5.6

TABLE IX.—*Composition of the flesh (body) of oysters.*

[Arranged by percentages of water-free substance in flesh, from highest to lowest.]

Localities of specimens.	Specimen No.	Taken from beds.	Flesh in whole specimen.	In flesh.					
				Water.	Water-free substance.	In water-free substance.			
						Protein (N × 6.25).	Fats (ether extract).	Extractives (by difference.)	Ash.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
East River, N. Y	57	Apr., 1881	10.27	79.92	20.08	10.44	2.16	5.74	1.74
Do	108	Nov., 1881	11.91	75.22	24.78	10.07	2.87	9.97	1.87
Do ...... (average of 2 specimens)	...	....	11.00	77.57	22.43	10.25	2.52	7.85	1.81
Potomac River, Va., transplanted *(2)	85	Nov., 1881	8.35	77.90	22.10	10.31	2.33	7.29	2.17
Oyster Bay, N. Y	180	Feb., 1882	10.85	77.90	22.10	10.61	2.35	6.95	2.19
James River, Va., transplanted *(2)	82	Nov., 1881	9.49	77.99	22.01	10.63	2.61	6.56	2.21
Blue Point, N. Y	56	Apr., 1881	13.39	76.77	23.23	10.28	2.30	8.72	1.93
Do	107	Nov., 1881	6.60	75.55	24.45	13.31	2.02	6.54	2.58
Do	182	Feb., 1882	8.01	83.97	16.03	8.81	1.62	4.01	1.59
Do ...... (average of 3 specimens)	...	....	9.30	78.76	21.24	10.80	1.98	6.43	2.03
Potomac River, Va., transplanted †(1)	73	May, 1881	6.51	78.87	21.13	9.81	2.27	6.51	2.54
Providence River, R. I	70	...do	10.88	79.01	20.99	10.30	2.58	5.98	2.13
Fair Haven, Conn	54	Apr., 1881	12.63	81.30	18.70	9.89	2.05	4.56	2.20
Do	93	Nov., 1881	12.26	76.24	23.76	10.96	2.47	8.32	2.01
Do	210	Mar., 1882	12.19	80.80	19.20	9.89	2.05	5.41	1.85
Do ...... (average of 3 specimens)	...	....	12.36	79.45	20.55	10.25	2.19	6.10	2.02
Rockaway, N. Y	58	Apr., 1881	10.68	81.27	18.73	9.18	2.13	5.75	1.67
Do	112	Nov., 1881	12.11	77.66	22.34	10.53	2.72	7.07	2.02
Do ...... (average of 3 specimens)	...	....	11.40	79.46	20.54	9.85	2.43	6.41	1.85
Stony Creek, Conn	55	Apr., 1881	7.52	81.02	18.98	10.46	1.60	4.16	2.76
Do	75	May, 1881	7.34	82.09	17.91	9.88	1.48	4.00	2.55
Do	105	Nov., 1881	10.96	77.72	22.28	10.60	2.32	6.85	2.51
Do	203	Mar., 1882	11.17	80.42	19.58	10.38	1.85	5.13	2.22
Do ...... (average of 4 specimens)	...	....	9.25	80.31	19.69	10.33	1.81	5.04	2.51
Shrewsbury, N. J	61	Apr., 1881	12.64	81.65	18.35	8.20	2.20	6.62	1.33
Do	106	Nov., 1881	11.27	77.58	22.42	9.68	2.66	8.20	1.88
Do	181	Feb., 1882	9.55	81.73	18.27	9.15	2.00	5.44	1.68
Do ...... (average of 3 specimens)	...	....	11.15	80.32	19.68	9.01	2.20	6.75	1.63
Clinton, Conn	103	Nov., 1881	11.67	80.91	19.09	9.67	1.86	5.27	2.29
Norwalk, Conn	118	Dec., 1881	7.61	81.33	18.67	9.52	1.51	5.54	2.10
Do	151	Feb., 1882	7.27	80.50	19.50	9.97	1.89	5.49	2.15
Do ...... (average of 2 specimens)	...	....	7.44	80.92	19.09	9.75	1.70	5.51	2.13
Long Island Sound, N. Y	60	Apr., 1881	9.13	84.47	15.53	8.14	1.68	4.30	1.41
Do	92	Nov., 1881	9.72	78.51	21.49	11.61	1.84	5.52	2.52
Do	109	...do	8.24	82.79	17.21	8.41	1.74	5.35	1.71
Do ...... (average of 3 specimens)	...	....	9.03	81.92	18.08	9.39	1.75	5.06	1.88
Potomac River, Va., transplanted *(3)	84	Nov., 1881	10.18	82.06	17.94	9.09	1.93	5.34	1.58
Rappahannock River, Virginia, transplanted † (3).	72	May, 1881	7.86	82.64	17.36	8.51	1.90	5.37	1.58
James River, Va., transplanted *(3)	83	Nov., 1881	11.41	82.77	17.23	8.79	1.91	4.98	1.55
James River, Va., transplanted ‡(1)	71	May, 1881	6.50	83.49	16.51	8.26	1.78	4.76	1.71
Norfolk, Va	59	Apr., 1881	4.66	83.86	16.14	9.32	1.45	3.55	1.82
Buzzard's Bay, Mass	68	May, 1881	12.50	84.21	15.79	7.75	1.57	4.99	1.48
Maximum of 34 specimens	...	....	13.39	84.47	24.78	13.31	2.87	9.97	2.76
Minimum of 34 specimens	...	....	4.66	75.22	15.53	7.75	1.45	3.55	1.33
Average of 34 specimens	...	....	9.80	80.30	19.70	9.78	2.05	5.89	1.98

* Taken about six months after transplanting to New Haven, Conn.
† About three weeks after transplanting to New Haven, Conn.
‡ About five weeks after transplanting to New Haven, Conn.
(1) To New Haven, Conn. (2) Not floated. (3) Floated.

TABLE X.—*Composition of liquids (liquid portion) of oysters.*

[Arranged by percentages of water-free substance in liquids, from highest to lowest.]

Localities of specimens.	Specimen No.	Taken from beds.	Liquids in whole specimen.	In liquids.					
				Water.	Water-free substance.	In water-free substance.			
						Protein (N × 6.25).	Fats (ether extract).	Extractives (by difference).	Ash.
			P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	P.ct.
Fair Haven, Conn	54	Apr., 1881	5.43	94.00	6.00	2.08	0.02	0.71	3.19
Do	93	Nov., 1881	12.05	94.43	5.57	2.14	0.02	0.98	2.43
Do	210	Mar., 1881	4.40	95.38	4.62	1.80	0.03	0.71	2.08
Do (average of 3 specimens)	...	....	7.29	94.60	5.40	2.01	0.02	0.80	2.57
James River, Va., transplanted* (2)	82	Nov., 1881	5.51	94.74	5.26	1.95	0.05	0.72	2.54
Rockaway, N. Y	58	Apr., 1881	7.72	95.06	4.94	1.60	0.04	1.04	2.26
Do	112	Nov., 1881	7.73	94.79	5.21	1.76	0.01	0.88	2.56
Do (average of 2 specimens)	.	....	7.72	94.92	5.08	1.68	0.03	0.96	2.41
Potomac River, Va., transplanted*(2)	85	Nov., 1881	7.78	94.99	5.01	1.81	0.02	0.71	2.47
Providence River, R. I.	70	May, 1881	6.12	95.05	4.95	1.48	0.00	1.06	2.41
James River, Va., transplanted*(3)	83	Nov., 1881	5.73	95.22	4.78	2.09	0.13	1.14	1.42
East River, N. Y	57	Apr., 1881	10.01	95.44	4.56	1.67	0.02	1.30	1.57
Do	108	Nov., 1881	8.40	94.87	5.13	1.81	0.09	0.90	2.33
Do (average of 2 specimens)	....	....	9.21	95.15	4.85	1.74	0.06	1.10	1.95
Oyster Bay, N. Y	180	Feb., 1882	6.42	95.31	4.69	1.46	0.01	0.85	2.37
Potomac River, Va., transplanted †(1)	73	May, 1881	5.64	95.51	4.49	1.45	0.01	0.56	2.47
Long Island Sound, N. Y	60	Apr., 1881	7.10	96.35	3.65	1.30	0.09	1.41	0.85
Do	92	Nov., 1881	4.90	93.81	6.19	2.29	0.02	0.72	3.16
Do	109	...do	9.35	96.64	3.36	1.09	0.01	0.39	1.87
Do (average of 3 specimens)		....	7.12	95.60	4.40	1.56	0.04	0.84	1.96
Potomac River, Va., transplanted *(3)	84	Nov., 1881	6.48	95.69	4.31	2.05	0.01	1.06	1.19
Shrewsbury, N. J	61	Apr., 1881	4.88	95.07	4.93	2.03	0.04	1.03	1.83
Do	106	Nov., 1881	8.40	95.35	4.65	1.88	0.04	0.77	1.96
Do	181	Feb., 1882	9.68	96.52	3.48	1.38	0.01	0.37	1.72
Do (average of 3 specimens)	....	....	7.66	95.65	4.35	1.76	0.03	0.72	1.84
Stony Creek, Conn	55	Apr., 1881	11.38	96.12	3.88	0.83	0.01	0.32	2.72
Do	75	May, 1881	11.81	96.33	3.67	0.65	0.05	0.36	2.61
Do	105	Nov., 1881	7.27	95.40	4.60	1.36	0.01	0.90	2.33
Do	203	Mar., 1882	9.33	95.30	4.70	1.42	0.03	0.75	2.50
Do (average of 4 specimens)		....	9.95	95.79	4.21	1.07	0.02	0.58	2.54
James River, Va., transplanted ‡ (3)	71	May, 1881	7.29	95.91	4.09	1.17	0.01	0.35	2.56
Clinton, Conn	103	Nov., 1881	13.20	96.02	3.98	1.10	0.02	0.65	2.21
Blue Point, N. Y	56	Apr., 1881	5.23	94.33	5.67	2.30	0.09	1.37	1.91
Do	107	Nov., 1881	9.67	96.89	3.11	0.75	0.01	0.45	1.90
Do	182	Feb., 1882	7.41	96.87	3.13	0.92	0.01	0.50	1.70
Do (average of 3 specimens)	..	....	7.44	96.03	3.97	1.32	0.04	0.77	1.84
Buzzard's Bay, Mass	68	May, 1881	7.51	96.40	3.60	1.23	0.00	0.74	1.63
Norwalk, Conn	118	Dec., 1881	10.24	96.46	3.54	0.79	0.01	0,42	2.32
Do	151	Feb., 1882	9.78	96.32	3.68	0.76	0.02	0.40	2.50
Do (average of 2 specimens)	....	....	10.01	96.39	3.61	0.77	0.02	0.41	2.41
Norfolk, Va	59	Apr., 1881	6.52	96.83	3.17	1.05	0.01	0.47	1.64
Rappahannock River, transplanted † (3)	72	May, 1881	7.31	97.24	2.76	1.01	0.01	0.30	1.38
Maximum of 34 specimens	...	....	13.20	97.24	6.19	2.30	0.13	1.41	3.19
Minimum of 34 specimens	...	....	4.40	93.81	2.76	0.65	0.00	0.32	0.85
Average of 34 specimens	...	....	7.87	95.61	4.39	1.48	0.03	0.75	2.13

* Taken about six months after transplanting to New Haven, Conn.
† About 3 weeks after transplanting to New Haven, Conn.
‡ About 5 weeks after transplanting to New Haven, Conn.
(1) To New Haven, Conn. (2) Not floated. (3) Floated.

TABLE XI.—*Composition of shell contents (flesh plus liquids) of oysters.*

[Arranged by percentages of water-free substance in shell contents from highest to lowest.]

Localities of specimens.	Specimen No.	Taken from beds.	Shell contents in whole specimen.	In shell contents.		In water-free substance.			
				Water.	Water-free substance.	Protein (N × 6.25).	Fats (ether extract).	Extractives (by difference).	Ash.
OYSTERS FROM SHELL.			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
James River, Va., transplanted *(4)	82	Nov., 1881	15.00	84.15	15.85	7.44	1.66	4.43	2.32
Oyster Bay, N. Y	180	Feb., 1882	17.27	84.37	15.63	7.21	1.48	4.68	2.26
Providence River, R. I	70	May, 1881	17.00	84.79	15.21	7.13	1.65	4.20	2.23
Fair Haven, Conn	54	Apr., 1881	18.06	85.12	14.88	7.54	1.43	3.41	2.50
Do	93	Nov., 1881	24.31	85.25	14.75	6.59	1.26	4.69	2.22
Do	210	Mar., 1882	16.59	84.67	15.33	7.74	1.51	4.17	1.91
Do ..... (average of 3 specimens)			19.65	85.01	14.99	7.29	1.40	4.09	2.21
East River, N. Y	57	Apr., 1881	20.28	87.57	12.43	6.11	1.11	3.55	1.66
Do	108	Nov., 1881	20.31	83.35	16.65	6.65	1.72	6.22	2.06
Do ..... (average of 2 specimens)			20.30	85.46	14.54	6.38	1.41	4.89	1.86
Rockaway, N. Y	58	Apr., 1881	18.40	87.06	12.94	6.02	1.25	3.76	1.91
Do	112	Nov., 1881	19.84	84.33	15.67	7.12	1.67	4.65	2.23
Do ..... (average of 2 specimens)			19.12	85.69	14.31	6.57	1.46	4.21	2.07
Potomac River, Va., transplanted *(3)	85	Nov., 1881	16.13	86.14	13.86	6.20	1.21	4.13	2.32
Shrewsbury, N. J	61	Apr., 1881	17.52	85.39	14.61	6.48	1.60	5.06	1.47
Do	106	Nov., 1881	19.67	85.17	14.83	6.35	1.54	5.03	1.91
Do	181	Feb., 1882	19.23	89.16	10.84	5.24	1.00	2.91	1.69
Do ..... (average of 3 specimens)			18.81	86.57	13.43	6.02	1.38	4.34	1.69
Potomac River, Va., transplanted †(1)	73	May, 1881	12.15	86.60	13.40	5.93	1.23	3.74	2.50
Blue Point, Patchogue, N. Y	56	Apr., 1881	18.02	81.70	18.30	8.04	1.08	6.66	1.92
Do.....Great South Bay, N. Y	107	Nov., 1881	16.17	88.30	11.70	5.86	0.82	2.90	2.18
Do.....L. I. Sound, N. Y	182	Feb., 1882	15.42	90.17	9.83	5.01	0.85	2.34	1.63
Do.....(average of 3 specimens)			16.74	86.72	13.28	6.28	1.12	3.97	1.91
James River, Va., transplanted *(3)	83	Nov., 1881	17.17	86.95	13.05	6.54	1.31	3.70	1.50
Potomac River, Va., transplanted *(4)	84	..do....	16.66	87.36	12.64	6.37	1.18	3.66	1.43
Long Island Sound, N. Y	60	Apr., 1881	16.23	89.67	10.33	5.15	0.99	3.03	1.16
Do	92	Nov., 1881	14.62	83.64	16.36	8.48	1.23	3.91	2.74
Do	109	...do....	17.59	90.15	9.85	4.52	0.82	2.71	1.80
Do .... (average of 3 specimens)			16.15	87.82	12.18	6.05	1.01	3.22	1.90
Stony Creek, Conn	55	Apr., 1881	18.90	90.11	9.89	4.66	0.64	1.83	2.76
Do	75	May, 1881	19.15	90.92	9.08	4.18	0.60	1.76	2.54
Do	105	Nov., 1881	18.23	84.83	15.17	6.94	1.39	4.42	2.42
Do	203	Mar., 1882	20.50	87.19	12.81	6.30	1.03	3.14	2.34
Do .....(average of 4 specimens)			19.20	88.26	11.74	5.52	0.91	2.79	2.52
Buzzard's Bay, Mass	68	May, 1881	20.01	88.80	11.20	5.31	0.99	3.37	1.53
Clinton, Conn	103	Nov., 1881	24.87	88.84	11.16	5.17	0.89	2.85	2.25
Rappahannock River, Va., transplanted †(4)	72	May, 1881	15.17	89.68	10.32	4.90	0.99	2.95	1.48
Norwalk, Conn	118	Dec., 1881	17.85	90.01	9.99	4.51	0.65	2.61	2.22
Do	151	Feb., 1882	17.05	89.58	10.42	4.68	0.81	2.58	2.35
Do..... (average of 2 specimens)			17.46	89.79	10.21	4.59	0.73	2.60	2.29
James River, Va., transplanted ‡(1)	71	May, 1881	13.79	90.05	9.95	4.53	0.84	2.43	2.15
Norfolk, Va	59	Apr., 1881	11.18	91.42	8.58	4.49	0.61	1.76	1.72
Maximum of 34 specimens			24.87	91.42	18.30	8.48	1.72	6.66	2.76
Minimum of 34 specimens			11.18	81.70	8.58	4.18	0.60	1.76	1.16
Average of 34 specimens			17.61	87.13	12.87	6.04	1.17	3.63	2.03
OYSTERS, "SOLIDS."[2]									
Fair Haven, Conn	89	Nov., 1881	100.00	85.21	14.79	6.60	1.77	5.60	0.82
Do	204	Mar., 1882	100.00	88.44	11.56	5.91	1.54	3.22	0.89
Do......(average of 2 specimens)			100.00	86.82	13.18	6.26	1.66	4.41	0.85
Virginia, transplanted (1)	104	Nov., 1881	100.00	87.27	12.73	6.56	1.54	3.61	1.06
Do	202	Mar., 1882	100.00	87.90	12.10	6.13	1.57	3.63	0.77
Do......(average of 2 specimens)			100.00	87.58	12.42	6.34	1.55	3.62	0.91
OYSTERS, CANNED.									
Chesapeake Bay	74		100.00	86.02	13.98	7.06	2.05	2.56	1.41
Do	97		100.00	85.15	14.85	7.29	2.20	4.08	1.28
Do	120		100.00	84.60	15.40	6.97	1.97	5.21	1.25
Do......(average of 3 specimens)			100.00	85.26	14.74	7.41	2.07	3.05	1.31

* Taken about 6 months after transplanting to New Haven, Conn.
† About 3 weeks after transplanting to New Haven, Conn.
‡ About 5 weeks after transplanting to New Haven, Conn.
(1) To New Haven, Conn. (2) *I. e.*, shell contents including flesh and liquids as commonly sold.
(3) Not floated. (4) Floated.

TABLE XII.—*Composition of oysters in different months from April, 1881, to March, 1882.*

[Percentage of flesh in specimens.]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	7.5	7.3	11.0	....	11.2
Fair Haven, Conn	12.6	....	12.3	....	12.2
Norwalk, Conn	....	....	7.6	7.3	......
Blue Point, N. Y	13.4	....	6.5	8.0	......
Rockaway, N. Y	10.7	....	12.1	....	......
Long Island Sound, N. Y	9.1	....	9.0	....	......
East River, N. Y	10.3	....	11.9	....	......
Shrewsbury, N. J	12.6	....	11.3	9.6	......
Potomac River, Va., transplanted*	....	6.5	8.4	....	......
James River, Va., transplanted*	....	6.5	9.5	....	......
Average	9.9		10.2	....	......

[Percentages of liquids in specimens.]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	11.4	11.8	7.3	....	9.3
Fair Haven, Conn	5.4	....	12.1	....	4.4
Norwalk, Conn	....	....	10.2	9.8	......
Blue Point, N. Y	5.2	....	9.7	7.4	......
Rockaway, N. Y	7.7	....	7.7	....	......
Long Island Sound, N. Y	7.1	....	7.1	....	......
East River, N. Y	10.0	....	8.4	....	......
Shrewsbury, N. J	4.9	....	8.4	9.7	......
Potomac River, Va., transplanted*	....	5.6	7.8	....	......
James River, Va., transplanted*	....	7.3	5.5	....	......
Average	7.2		8.2	....	......

[Percentages of shell contents (flesh and liquid) in specimens.]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	18.9	19.2	18.2	....	20.5
Fair Haven, Conn	18.1	....	24.3	....	16.6
Norwalk, Conn	....	....	17.9	17.1	......
Blue Point, N. Y	18.6	....	16.2	15.4	......
Rockaway, N. Y	18.4	....	19.8	....	......
Long Island Sound, N. Y	16.2	....	16.1	....	......
East River, N. Y	20.3	....	20.3	....	......
Shrewsbury, N. J	17.5	....	19.7	19.2	......
Potomac River, Va., transplanted*	....	12.2	16.1	....	......
James River, Va., transplanted*	....	13.8	15.0	....	......
Average	17.1		18.4	....	......

[Percentages of water-free substance in the flesh.]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	19.0	17.9	22.3	....	19.6
Fair Haven, Conn	18.7	....	23.8	....	19.2
Norwalk, Conn	....	....	18.7	19.5	......
Blue Point, N. Y	23.2	....	24.5	16.0	......
Rockaway, N. Y	18.7	....	22.3	....	......
Long Island Sound, N. Y	15.5	....	19.4	....	......
East River, N. Y	20.1	....	24.8	....	......
Shrewsbury, N. J	18.4	....	22.4	18.3	......
Potomac River, Va., transplanted*	....	21.1	22.1	....	......
James River, Va., transplanted*	....	16.5	22.0	....	......
Average	19.0		22.6	....	......

*To New Haven, Conn.; taken in December; in calculating averages below this is omitted; unfloated; average of two specimens.

TABLE XII.—*Composition of oysters in different months*—Continued.

[Percentages of water-free substance in liquids.]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	3.9	3.7	4.6	....	4.7
Fair Haven, Conn	6.0	....	5.6	....	4.6
Norwalk, Conn	....	....	3.5	3.7	......
Blue Point, N. Y	5.7	....	3.1	3.1	......
Rockaway, N. Y	4.9	....	5.2	....	......
Long Island Sound, N. Y	3.7	....	4.8	....	......
East River, N. Y	4.6	....	5.1	....	......
Shrewsbury, N. J	4.9	....	4.7	3.5	......
Potomac River, Va., transplanted *	....	4.5	5.0	....	......
James River, Va., transplanted *	....	4.1	5.3	....	......
Average	4.7		4.8	....	......

[Percentages of water-free substance in shell contents.]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	9.9	9.1	15.2	....	12.8
Fair Haven, Conn	14.9	....	14.7	....	15.3
Norwalk, Conn	....	....	10.0	10.4	......
Blue Point, N. Y	18.3	....	11.7	9.8	......
Rockaway, N. Y	12.9	....	15.7	....	......
Long Island Sound, N. Y	10.3	....	13.1	....	......
East River, N. Y	12.4	....	16.7	....	......
Shrewsbury, N. J	14.6	....	14.8	10.8	......
Potomac River, Va., transplanted *	....	13.4	13.9	....	......
James River, Va., transplanted *	....	10.0	15.9	....	......
Average	12.9		14.6	....	......

[Percentages of water-free substance in whole specimens.]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	1.9	1.7	2.8	....	2.6
Fair Haven, Conn	2.7	....	3.6	....	2.6
Norwalk, Conn	....	....	1.8	1.8	......
Blue Point, N. Y	3.4	....	1.9	1.5	......
Rockaway, N. Y	2.4	....	3.1	....	......
Long Island Sound, N. Y	1.7	....	2.1	....	......
East River, N. Y	2.5	....	3.4	....	......
Shrewsbury, N. J	2.6	....	2.9	2.1	......
Potomac River, Va., transplanted *	....	1.6	2.2	....	......
James River, Va., transplanted *	....	1.4	2.4	....	......
Average	2.2		2.7	....	......

[Percentages of protein in water-free substance of flesh.]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	55.1	55.2	47.8	....	53.0
Fair Haven, Conn	52.9	....	46.1	....	51.5
Norwalk, Conn	....	....	51.0	51.1	......
Blue Point, N. Y	44.3	....	54.4	54.9	......
Rockaway, N. Y	49.0	....	47.1	....	......
Long Island Sound, N. Y	52.5	....	51.4	....	......
East River, N. Y	52.0	....	40.6	....	......
Shrewsbury, N. J	44.7	....	43.2	50.1	......
Potomac River, Va., transplanted *	....	46.4	46.6	....	......
James River, Va., transplanted *	....	50.1	48.3	....	......
Average	49.7		47.3	....	......

* To New Haven, Conn.; taken in December; in calculating averages below this is omitted; unfloated; average of two specimens.

TABLE XII.—*Composition of oysters in different months*—Continued.

[Percentages of fats in water-free substance of flesh.]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	8.4	8.3	10.4		9.4
Fair Haven, Conn	10.9		10.4		10.7
Norwalk, Conn			8.1	9.7	
Blue Point, N. Y	9.9		8.3	10.1	
Rockaway, N. Y	11.3		12.2		
Long Island Sound, N. Y	10.8		9.4		
East River, N. Y	10.8		11.6		
Shrewsbury, N. J	12.0		11.9	10.9	
Potomac River, Va., transplanted *		10.8	10.6		
James River, Va., transplanted *		10.8	11.8		
Average	10.6		10.7		

[Percentages of extractives in water-free substance of flesh.]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	21.9	22.2	30.5		26.3
Fair Haven, Conn	24.4		35.1		28.2
Norwalk, Conn	37.6		29.7	28.2	
Blue Point, N. Y			26.8	25.1	
Rockaway, N. Y	30.7		31.7		
Long Island Sound, N. Y	27.6		28.4		
East River, N. Y	28.5		40.3		
Shrewsbury, N. J	36.1		36.6	29.7	
Potomac River, Va., transplanted *		30.8	33.0		
James River, Va., transplanted *		28.7	29.9		
Average	29.6		32.5		

[Percentages of protein in water-free substance of shell contents (flesh and liquids).]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	47.2	46.1	45.6		49.2
Fair Haven, Conn	50.7		44.7		50.5
Norwalk, Conn			45.2	45.0	
Blue Point, N. Y	44.0		49.6	50.9	
Rockaway, N. Y	46.5		45.4		
Long Island Sound, N. Y	49.9		48.9		
East River, N. Y	49.2		39.9		
Shrewsbury, N. J	44.4		42.8	48.4	
Potomac River, Va., transplanted *		44.2	41.8		
James River, Va., transplanted *		45.5	46.9		
Average	46.8		45.4		

[Percentages of fats in water-free substance of shell contents (flesh and liquids).]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	6.5	6.6	9.2		8.0
Fair Haven, Conn	9.6		8.5		9.9
Norwalk, Conn			6.5	7.8	
Blue Point, N. Y	9.2		7.0	8.6	
Rockaway, N. Y	9.6		10.6		
Long Island Sound, N. Y	9.6		8.0		
East River, N. Y	8.9		10.3		
Shrewsbury, N. J	11.0		10.4	9.2	
Potomac River, Va., transplanted *		9.1	8.8		
James River, Va., transplanted *		8.5	10.5		
Average	9.1		9.2		

* To New Haven, Conn.; taken in December; in calculating the averages below this is omitted; unfloated; average of two specimens.

TABLE XII.—*Composition of oysters in different months*—Continued.

[Percentages of extractives in water-free substance of shell contents (flesh and liquids).]

Localities.	Apr.	May.	Nov.	Feb.	Mar.
Stony Creek, Conn	18.5	19.4	21.2	....	24.5
Fair Haven, Conn	22.9	....	31.8	....	27.2
Norwalk, Conn	....	....	26.0	24.7	......
Blue Point, N. Y	36.4	....	24.8	23.8	......
Rockaway, N. Y	29.0	....	29.7	....	......
Long Island Sound, N. Y	29.3	....	25.7	....	......
East River, N. Y	28.5	....	37.4	....	......
Shrewsbury, N. J	34.6	....	33.9	26.7	......
Potomac River, Va., transplanted *	....	28.0	29.7	....	......
James River, Va., transplanted *	....	24.3	28.0	....	......
Average	28.0		29.1	....	......

* To New Haven, Conn.; taken in December; in calculating the averages below this is omitted; unfloated; average of two specimens.

TABLE XIII.—*Composition of the flesh of clams, mussels, and scallops.*

[Arranged by percentage of water-free substance in flesh, from highest to lowest.]

Names and localities of specimens.	Laboratory No. of specimen.	Taken from beds.	Flesh in whole specimen.	In flesh.					
				Water.	Water-free substance.	In water-free substance			
						Protein (N × 6.25).	Fats (ether extract).	Extractives (by difference.)	Ash.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Long clams (Mya arenaria):									
Boston, Mass	67	May, 1881	29.26	77.96	22.04	14.65	1.79	2.94	2.76
Clinton, Conn	102	Nov., 1881	32.89	78.57	21.43	14.86	1.78	2.30	2.49
Do	201	Mar., 1882	39.37	79.91	20.06	12.62	1.69	2.64	3.11
Long Island, N. Y	65	Apr., 1881	36.49	81.05	18.95	12.52	1.52	3.35	1.56
Average of 4 specimens	....	....	....	79.38	20.62	13.64	1.69	2.81	2.48
Long clams, canned:									
Penobscot Bay, Me	122	....	42.70	74.63	25.37	17.73	2.89	1.59	3.16
Round clams (Venus mercenaria):									
Little Neck, N. Y	66	April, ——	16.80	78.24	21.76	11.59	0.74	7.21	2.22
Round clams, canned:									
Islip, Long Island, N. Y	125	....	50.55	75.56	24.44	16.70	1.27	4.14	2.33
Mussels (Mytilus edulis):									
Stony Creek, Conn	130	December	32.66	78.67	21.33	12.51	1.67	5.42	1.73
Scallops (Pecten irradians):									
Shelter Island, N. Y	51	March	....	77.70	22.21	15.05	0.03	5.65	1.48
Do	63	April	....	82.84	17.16	14.44	0.30	1.13	1.29
Average of 2 specimens	....	....	....	80.32	19.68	14.75	0.17	3.38	1.38

TABLE XIV.—*Composition of liquids of clams and mussels.*

[Arranged by percentage of water-free substance in liquids from highest to lowest.]

Names and localities of specimens.	Laboratory No. of specimen.	Taken from beds.	Liquids in whole specimen.	In liquids.					
				Water.	Water-free substance.	In water-free substance.			
						Protein (N × 6.25).	Fats (ether extract).	Extractives (by difference).	Ash.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Long clams (Mya arenaria):									
Long Island, N. Y	65	Apr., 1881	21.15	94.76	5.24	1.30	0.03	0.98	2.93
Boston, Mass	67	May, 1881	24.64	95.74	4.26	0.49	0.01	0.47	3.29
Clinton, Conn	102	Nov., 1881	25.03	96.02	3.98	0.65	0.00	0.52	2.81
Do	201	Mar., 1882	16.93	96.77	3.23	0.67	0.01	0.50	2.05
Average of 4 specimens	.....	....	....	95.82	4.18	0.78	0.01	0.62	2.77
Long clams, canned:									
Penobscot Bay, Maine	122	....	57.30	91.92	8.08	2.49	0.04	3.83	1.72
Round clams (Venus mercenaria):									
Little Neck, N. Y	66	Apr., —	14.91	95.12	4.88	0.90	0.02	0.79	3.17
Round clams, canned:									
Islip, Long Island, N. Y	125	....	40.45	90.52	9.48	4.07	0.26	1.89	3.26
Mussels (Mytilus edulis):									
Stony Creek, Conn	139	Dec., —	18.00	94.23	5.77	1.77	0.13	1.64	2.23

TABLE XV.—*Composition of shell contents of clams, mussels, and scallops.*

Names and localities of specimens.	Specimen No.	Taken from beds.	Shell contents in whole specimen.	In shell contents.					
				Water.	Water-free substance.	In water-free substance.			
						Protein (N × 6.25).	Fats (ether extract).	Extractives (by difference).	Ash.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Long clams (Mya arenaria):									
Clinton, Conn	201	Mar., 1882	56.30	85.00	15.00	9.03	1.19	1.09	2.79
Boston, Mass	67	May, 1881	53.90	86.09	13.91	8.12	0.98	1.81	3.00
Long Island, N. Y	65	Apr., 1881	57.64	86.10	13.90	8.39	0.97	2.48	2.06
Clinton, Conn	102	Nov., 1881	57.92	86.11	13.89	8.71	1.01	1.54	2.63
Average of 4 specimens	.....	....	56.44	85.82	14.18	8.56	1.04	1.96	2.62
Long clams, canned:									
Penobscot Bay, Me	122	....	100.00	84.54	15.46	9.00	1.26	2.86	2.34
Round clams (Venus mercenaria):									
Little Neck, N. Y	66	Apr., 1881	31.71	86.18	13.82	6.52	0.40	4.24	2.66
Round clams, canned:									
Islip, Long Island, N. Y	125	....	100.00	82.96	17.04	10.45	0.77	3.03	2.79
Mussels (Mytilus edulis):									
Stony Creek, Conn	139	Dec., 1881	50.66	84.20	15.80	8.69	1.12	4.08	1.91
Scallops (Pecten irradians):									
Shelter Island, N. Y	51	Mar., 1881	100.00*	77.79	22.21	15.05	0.02	5.65	1.48
Do	63	Apr., 1881	100.00*	82.84	17.16	14.44	0.30	1.13	1.29
Average of 2 specimens	....	....	.....	80.32	19.68	14.75	0.17	3.38	1.38

* The adductor muscle, the portion ordinarily eaten.

TABLE XVI.—*Composition of flesh (edible portion) of crustaceans and turtles.*

Names and localities of specimens.	Laboratory No. of specimen.	Specimen received.	In water-free substance.					
			Nitrogen.	Protein (N × 6.25).	Fats (ether extract.)	Ash.	Protein, fats, and ash.	Albuminoids (by difference).
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Lobster (Homarus americanus):								
Maine	50	Mar., 1881	1.86	11.63	1.82	1.63	15.08	12.25
Do	62	Apr., 1881	2.24	14.05	1.55	1.71	17.31	14.97
Do	239	Apr., 1882	2.76	17.24	1.45	1.62	20.31	17.76
Massachusetts	69	May, 1881	2.41	15.03	2.54	1.87	19.44	13.48
Average of 4 specimens			2.32	14.49	1.84	1.71	18.04	14.62
Lobster, canned:								
Maine	76		2.68	16.75	0.46	2.78	19.99	17.40
Do	121		3.12	19.52	1.68	2.15	23.35	20.02
Average of 2 specimens			2.90	18.13	1.07	2.47	21.67	18.71
Crayfish:								
Potomac River, Va	64	Apr., 1881	2.56	16.00	0.46	1.31	17.77	17.01
Crab (Callinectes hastatus):								
New Jersey	101	Nov., 1881	2.66	16.64	1.96	3.13	21.73	17.84
Crab, canned:								
Hampton, Va	124		2.50	15.62	0.79	1.78	18.19	16.45
Do	274		2.56	15.98	2.30	2.10	20.38	16.65
Average of 2 specimens			2.53	15.80	1.55	1.94	19.29	16.55
Shrimp, canned:								
Gulf of Mexico	123		4.06	25.38	1.00	2.58	28.96	25.62
Terrapin:								
Savannah, Ga	235	Apr., 1882	3.40	21.23	3.47	1.02	25.72	21.04
Green turtle (Chelonia mydas):								
Key West, Fla	272	May, 1882	3.17	19.84	0.53	1.20	21.57	18.49

4. FLOATING OF OYSTERS.*

Not every lover of the oyster knows that the size and plumpness which are so highly prized in the great American bivalve, and which are so attractive in specimens on the half-shell or in the stew as to lead the average man to pay a considerable extra price for extra size, are not entirely natural; and even those who do know that the majority of the oysters in the market are artificially swollen by introducing water into the tissues are not all aware that the process by which this is done is closely analogous to that by which the food in our bodies is conveyed through the walls of the stomach and other parts of the digestive apparatus and poured into the blood and lymph to do its work of nourishment.

Physiologists are, I believe, agreed that the passage of the digested food through the walls of the alimentary canal in man and other animals is, in large part, due to osmose or dialysis, and that the operation of this physical law is a very common one in the animal body. But the quantitative study of the chemical changes involved is generally rendered difficult or impossible by the very fact of their taking place in living animals where the application of chemical analysis is impossible; an opportunity is, however, offered by the oyster, which, since it lives in water and has a body so constituted as to readily permit the inflow and outflow of water and solutions of salts, may be easily used for

* The substance of this chapter was printed in the Report of the Oyster Investigation and Shellfish Commission of New York, for 1887.

experiments. The results of the experiments have a practical as well as scientific interest, since they confirm the common explanation of the increase in bulk of oysters by "floating," and show that it is essentially a process of watering in which the bulk is increased without any corresponding increase, but rather, if anything, a loss of nutritive material.

It is a common practice of oyster dealers, instead of selling the oysters in the condition in which they are taken from the beds in salt water, to first place them for a time—48 hours, more or less—in fresh or brackish water, in order, as the oyster men say, to "fatten" them, the operation being called "floating" or "laying out." By this process the body of the oyster acquires such a plumpness and rotundity, and its bulk and weight are so increased, as to materially increase its selling value.

The belief is common among oystermen that this "fattening" is due to an actual gain of flesh and fat, and that the nutritive value of the oyster is increased by the process. A moment's consideration of the chemistry and physiology of the subject will make it clear, not only that such an increase of tissue substance in so short a time and with such scanty food supply is out of the question, but that the increase of volume and weight of the bodies of the oysters is just what would be expected from the osmose which would naturally take place between the contents of the bodies of the oysters as taken from salt water and the fresh or brackish water in which they are floated.

If we fill a bladder with salt water and then put it into fresh water, the salt water will gradually work its way out through the pores of the bladder, and at the same time the fresher water will enter the bladder; and, further, the fresh water will go in much more rapidly than the salt water goes out. The result will be that the amount of water in the bladder will be increased. The bladder will swell by taking up more water than it loses, while at the same time it loses a portion of the salt. It does this in obedience to a physical law, to which the terms osmose and dialysis are applied. In accordance with this law, if a membranous sac holding salts in solution is immersed in a more dilute solution or in pure water, the more concentrated solution will pass out, and at the same time the water, or more dilute solution, will pass in, and more rapidly. The escape of the concentrated and entrance of the dilute solution will be, in general, the more rapid the greater the difference in concentration and the higher the temperature of the two solutions. After the osmose has proceeded for a time the two solutions will become equally diluted. When this equilibrium between the two is reached the osmose will stop. If the sac which has become distended is elastic, it will, after osmose has ceased, tend to come back to its normal size, the extra quantity of solution which it has received being driven out again.

We should expect these principles to apply to the oyster. Roughly speaking, the body of the animal may be regarded as a collection of membranous sacs. It seems entirely reasonable to suppose that the intercellular spaces, and probably the cells of the body, would be impregnated with the salts of the sea water in which the animal lives; and this supposition is confirmed by the large quantity of mineral salt which the body is found by analysis to contain, and which amounts in some cases to over 14 per cent. of the water-free substance of the body.

It seems equally reasonable to believe that osmose would take place through both the outer coating of the body and the cell walls of the animal's body. As long as the oyster stays in the salt water the solution of salts within its body would naturally be in equilibrium with the water outside. When the animal is brought into fresh or brackish water—*i. e.*, into a more dilute solution—we should expect the salts in the more concentrated solution within its body to pass out, and a larger amount of fresh water to enter, and produce just such a distension as actually takes place in the floating. If this assumption is correct, we should expect that the osmose would be the more rapid the less the amount of salts in the surrounding water; that it would proceed more rapidly in warm and more slowly in cold water; that it would take place whether the body of the animal is left in the shell or is previously removed from it; that the quantity of salts would be greatly reduced in floating; and that, if it were left in the water after the maximum distension had been reached, the imbibed water would pass out again and the oyster would be reduced to its original size. Just such is actually the case. Oystermen find that the oysters "fatten" much more quickly in fresh than in brackish water; warmth is so favorable to the process that it is said to be sometimes found profitable to warm artificially the water in which the oysters are floated. Although oysters are generally floated in the shell, the same effect is very commonly obtained by adding fresh water to the oysters after they have been taken out of the shell; indeed, I am told that this is by no means an unusual practice of retail dealers. Oysters lose much of their salty flavor in floating and it is a common experience of oystermen that if the "fattened" oysters are left too long on the floats they become "lean" again.

This exact agreement of theory and fact might seem to warrant the conclusion that the actual changes in the so-called fattening of oysters in floating are essentially gain of water and loss of salts. The absolute proof, however, is to be sought in chemical analysis. In the course of the investigations which have been described on the preceding pages I improved the opportunity to test this matter by some analyses of oysters before and after floating. I give here the main results, prefacing by brief accounts of the process of "floating" oysters as actually practiced by oystermen.

The following very apposite statements* are by Prof. Persifor Frazer, jr., who attributes the changes mentioned to dialytic action:

> The oysters brought to our large markets on the Atlantic seaboard are generally first subjected to a process of "laying out," which consists in placing them for a short time in fresher water than that from which they have been taken.

* "Note on Dialysis in Oyster Culture," in "Proceedings of Philadelphia Academy of Sciences," 1875, p. 472.

Persons who are fond of this animal as an article of food know how much the "fresh" exceed the "salts" in size and consistency. The "Morris Coves" of this city (Philadelphia), while very insipid, are the plumpest bivalves brought to market. On the other hand, the "Absecoms" and "Brigantines," while of a better flavor (to those who prefer salt oysters), are invariably lean compared to their transplanted rivals, as also are the "Cape Mays," though for some reason not to the same extent.

The most experienced oyster dealers inform me that the time for allowing the salt oysters taken from the seacoast to lie out varies, but is seldom over 2 or 3 days. At the end of this time the maximum plumpness is attained, and beyond this the oyster becomes lean again, besides having lost in flavor.

The subjoined statements by Prof. John A. Ryder are interesting in this connection. They are taken from a letter to Professor Baird on "Floats for the so-called Fattening of Oysters:"*

The simplest and most practical structures of the kind which I have seen are the storage and fattening floats used by Mr. Conger, of Franklin City, Maryland, and now in use by all the shippers and planters in the vicinity of Chincoteague Bay. I have been informed that similar structures, or rather structures serving similar purposes, are in use on the oyster beds along the shore of Staten Island, New York.

It is probably a fact that in all these contrivances they take advantage of the effect produced by fresher water upon oysters which have been taken from slightly salter water. The planters of Chincoteague call this "plumping the oysters for market." It does not mean that the oysters are augmented in volume by the addition of substantial matter, such as occurs during the actual appropriation of food, but only that the vascular spaces and vessels in the animals are filled with a larger relative amount of water due to endosmose. It is a dealer's trick to give his produce a better appearance in the market, and as such I do not think it deserves encouragement, but rather exposure.

Mr. Conger has actually resorted to warming fresh water to 60 F. in winter by steam pipes running underneath the wooden inclosure surrounding the "fattening" or "plumping" float. One good "drink," as he expressed himself to me, renders the animals fit for sale and of better appearance.

Conger's floats are simply a pair of windlasses, supported by two pairs of piles driven into the bottom. Chains or ropes, which wind upon the windlasses, pass down to a pair of cross-pieces, upon which the float rests, which has a perforated or strong slat bottom and a rim 18 inches to 2 feet high. These floats I should think are about 8 feet wide, and 16 feet long, perhaps 20. These structures are usually built alongside the wharves of the packing and shipping houses, and are really a great convenience in conducting the work.

Elsewhere Professor Ryder speaks of the floats thus:

The diaphragm itself was constructed of boards perforated with auger holes, and lined on the inside with gunny cloth or sacking, and the space between the perforated boards was filled with sharp, clean sand. This space between the boards was about 2 inches; through this the tide ebbed and flowed, giving a rise and fall of from 4 to 6 inches during the interval between successive tides.

Mr. F. T. Lane, of New Haven, Connecticut, writes as follows about the method of floating practiced by himself, and, as I understand, by other New Haven oyster-growers:

We do not always leave them 2 days in the floats; as a rule only 1 day. We put them into brackish water and take them out at low water or in the last of the falling tide, and then the water is the freshest and the oysters are at their best. As it is not convenient for us to put them into the floats and take them out the same day, we do

* Bulletin, U. S. Fish Commission, 1884, p. 302.

not want the water too fresh. On one occasion, wishing to know what the result would be of putting the oysters into water that was quite fresh, I had one of my floats taken up the river half a mile farther than where we commonly use them, and 100 bushels of oysters put into it at high water and taken out at low water. They were in the water from 6 to 7 hours, and came out very nice, fully as good as those floated 24 hours in the brackish water. It was a warm day, and the water was warm. Under these conditions they will drink very quickly. I have seen them open their shells in 10 minutes after they were put into the water.

For the following valuable information I am indebted to Mr. R. G. Pike, chairman of the board of shellfish commissioners of Connecticut:

Connecticut oysters, when brought from their beds in the salt waters of Long Island Sound, are seldom sent to market before they have been subjected to more or less manipulation. As soon as possible after being gathered, they are deposited in shallow tide rivers where the water is more or less brackish, and are left there from 1 to 4 days, the time varying according to the temperature of the season, the saltness of the oysters, and the freshening quality of the water. Generally two tides are sufficient for the two "good drinks" which the oystermen say they should always have.

This "floating," as it is called, results in cleaning out and freshening the oysters, and increasing their bulk; or, as many oystermen confidently assert, "fattening" them. If the weather is warm, they will "take a drink" immediately if not disturbed; but if the weather is cold, they will wait sometimes 10 or 12 hours before opening their valves. Good fat oysters generally yield 5 quarts of solid meat to the bushel; but after floating two tides or more, they will measure 6 quarts to the bushel. After they have been properly floated, they are taken from the shell, and as soon as the liquor is all strained off, they are washed in cold fresh water, and are then packed for market. In warm weather they are put into the water with ice, and are also packed with ice for shipping. Water increases their bulk by absorption and by mixing with the liquor on the surface of the oysters. The salter the oyster the more water it absorbs. In 12 hours 1 gallon of oysters with their juices strained out will take in a pint of water, but when very salt or dry, they have been known to absorb a pint in 3 hours.

Water always thickens the natural juices that adhere to the surface of the oyster, and makes them slimy. If too much water is added, the oyster loses its plumpness and firmness and becomes watery and flabby.

Oysters that have been floated bear transportation in the shell much better than when shipped directly from their beds. Oysters, too, that are taken from their shells and packed in all their native juices spoil much sooner than when their juices are strained out and the meats are washed in fresh cold water.

Long clams are not floated, but round clams are; but both, when shucked, are washed in fresh water; this cleanses them of mud, sand, and excess of salt, increases their bulk, and improves their flavor. After washing, they will keep much longer without risk of spoiling. If the salt is left in them, as they come from their native beds, their liquor will ferment and they will quickly spoil.

The above facts are gathered from the most intelligent men in the shellfish business in Connecticut—men who have had many years' experience in gathering oysters and clams and preparing them for home and foreign consumption. They are all agreed that by judicious floating in the shell, and by washing and soaking when out of the shell, the oyster and the clam increase in bulk and improve in quality and flavor. We will not presume to say that this increased bulk is anything more than a mechanical distention of the organs and the cellular tissues of the oyster by the water; or that its improved flavor is not due simply to a loss of bitter sea-salt dissolved out by the water. Many intelligent cultivators are confident that the increase in bulk is a growth of fat; while just as many, of equal intelligence, declare that it is mere "bloat" or distention, akin to that of a dry sponge when plunged into the water. The exact nature of the change the chemist alone can determine.

Experiments were made with oysters supplied by Mr. Lane, of New Haven, Conn., the details of which are given in Part I, section D. The oysters had been brought from the James and Potomac Rivers, and "planted" in the beds in New Haven Harbor (Long Island Sound) in April, and were taken for analysis in the following November.

Two experiments were made. The plan of each experiment consisted in analyzing two lots of oysters, of which both had been taken from the same bed at the same time, but one had been "floated" while the other had not. For each of the two experiments, Mr. Lane selected from a boatload of oysters, as they were taken from the salt water, a number, about three dozen, which fairly represented the whole boatload. The remainder were taken to the brackish water of a stream emptying into the bay and kept upon the floats for 48 hours, this being the usual practice in the floating of oysters in this region. At the end of that time, the oysters were taken from the floats, and a number fairly representing the whole were selected as before. Two lots, one floated and the other not floated, were thus taken from each of two different beds. The four lots were brought to our laboratory for analysis.

The principal results of the experiments described in Part I, Section D, and the inferences to be derived from them, may be briefly summarized as follows:

RECAPITULATION OF RESULTS OF THE EXPERIMENTS.

It will be remembered that the comparison was made between oysters analyzed in the condition in which they came from the beds in salt water and those which, taken from the same beds at the same time, had been "floated," *i. e.*, kept for a time (in this case 48 hours) in brackish water, as is commonly done in preparing them for the market on the Atlantic coast of the United States. The methods employed for this purpose, of course, vary widely in different localities and times, so that these results can not be taken as an exact measure of the practical effect except in this particular case. At the same time it is noticeable that the results in these experiments seem to agree very well (so far as the increase of weight is concerned, at any rate) with those of ordinary practice.

During the sojourn in brackish water both the flesh (body) and the liquid portion of the shell contents of the oysters suffered more or less alteration in composition.

CHANGES IN THE FLESH.

1. The changes in the constituents of the body were mainly such as would be caused by osmose (dialysis), though there were indications of secretion of nitrogenous matters, and especially of fats, which are not so easily explained by osmose.

2. The amount of gain and loss of constituents, which the bodies of

the oysters experienced, may be estimated either by comparing the percentages found by analysis before and after dialysis or by comparing the absolute weight of a given quantity of flesh and the weights of each of its ingredients before with the weights of the same flesh and of its ingredients after dialysis. For the estimate by the first method we have simply to compare the results of the analyses of the floated and the not-floated specimens. Taking the averages of the two experiments, it appears that:

The percentages of—	Before dialysis.		After dialysis.
Water rose from	77.9	to	82.4
Water-free substance fell from	22.1	to	17.6
	100.0		100.0
Protein (N × 6.25) fell from	10.5	to	8.9
Fat (ether extract) fell from	2.5	to	1.9
Carbohydrates, etc., fell from	6.9	to	5.2
Mineral salts (ash) fell from	2.2	to	1.6
	22.1		17.6

There was, accordingly, a gain in the percentage of water and a loss in that of each of the ingredients of the water-free substance.

It is more to the point to note the actual increase and decrease in amounts of flesh and its constituents, the absolute gain or loss of each in the floating. The estimates (see table, page 812) make it appear that 100 grammes of the flesh as it came from the salt water was increased by floating, in one specimen, to 120.9, and in the other to 113.4 grammes. This is equivalent to saying that the two specimens of flesh gained in the floating, respectively, 20.9 and 13.4 per cent., or, on the average, 17.3 per cent. of their original weight. By the same estimates the water-free substance in the 100 grammes of flesh before the floating weighed, on the average, 22.1 grammes, while that of the same flesh after dialysis weighed only 20.6 grammes, making a loss of 1.5 grammes or 6.6 per cent. of the 22.1 grammes which the water-free substance weighed before dialysis. The main results of the two experiments thus computed, may be stated as follows:

In the "floating" of 100 grammes of flesh (body) of the oysters:

The weight (in grammes) of—	Before dialysis.		After dialysis.
Water rose from	77.9	to	96.6
Water-free substance fell from	22.1	to	20.6
Whole flesh rose from	100.0	to	117.2
Protein was assumed to remain the same	10.5	to	10.5
Fat (ether extract) fell from	2.5	to	2.3
Carbohydrates, etc., fell from	6.9	to	6.0
Mineral salts (ash) fell from	2.2	to	1.8
	22.1	to	20.6

Estimating the increase or decrease of weight of each constituent in per cent. of its weight before floating, the water gained 23.9 per cent.; the water-free substance lost 6.6 per cent.; the whole flesh (body) gained 17.3 per cent. The protein was assumed to neither gain nor lose. The fat lost 8.8 per cent.; the carbohydrates, etc., lost 12.5 per cent.; the mineral salts lost 15.5 per cent.

According to these computations the flesh lost between one-sixth and one-seventh of its mineral salts, one-eighth of its carbohydrates, and one-twelfth of its fats, but gained enough water to make up this loss and to increase its whole weight by from one seventh to one-fifth.

These estimates are based on the assumption that the amount of protein (N × 6.25) in the flesh remained unchanged during the floating. It seems probable, however, that the flesh may have lost a small amount of nitrogenous material. If this was the case the actual gain of flesh and of water must have been less and the loss of fats, carbohydrates, and mineral salts greater than the estimate makes them. But there appears to be every reason to believe that the error must be very small, and since it would affect all the ingredients in the same ratio, the main result, namely, that there was a large gain of water and a considerable loss not only of mineral salts but of fats and carbohydrates as well, can not be questioned.

CHANGES IN THE COMPOSITION OF THE LIQUID PORTION.

3. The liquids might be expected to receive material from the flesh and to yield material to the surrounding water. The materials received from the flesh would be such as the latter parted with by osmose or secretion. Those yielded to the water would either escape by diffusion or be washed away when the shells were open wide enough. Comparing the percentage composition of the liquids before and after floating, as shown by the averages of the analyses in the two experiments, it appears that:

The percentages of—	Before dialysis.		After dialysis.
Water rose from	94.9	to	95.5
Water-free substance fell from	5.1	to	4.5
	100.0		100.0
Protein (N × 6.25) rose	1.9	to	2.1
Carbohydrates, etc., rose	0.7	to	1.1
Mineral salts, (ash) fell	2.5	to	1.3

The increase in the percentage of water and the decrease in that of mineral salts are very marked. The quantities of fats (ether extract) are too small to be taken into account. The increase of nitrogen and that of carbohydrates, though absolutely small, are nevertheless outside the limits of error of analysis, and must, like those of the salts, represent actual changes in the composition of the liquids.

The experiments give no reliable data for the determinations of the absolute increase and decrease of the liquids and their constituents, so that it is impossible to say with entire certainty whether there was or was not an actual gain of protein or fats or carbohydrates. It seems very probable, however, that the liquids received and retained small quantities of these materials from the flesh (bodies) of the animals.

CHANGES IN THE COMPOSITION OF THE WHOLE SHELL CONTENTS, FLESH AND LIQUIDS.

4. Comparing the average percentage composition of the total shell contents before and after floating in the two experiments, it appears:

The percentages of—	Before dialysis.		After dialysis.
Water rose from	85.2	to	87.1
Water-free substance fell from	14.8	to	12.9
	100.0		100.0
Protein (N × 6.25) fell from	6.8	to	6.5
Fats (ether extract) fell from	1.4	to	1.2
Carbohydrates, etc., fell from	4.3	to	3.7
Mineral salts (ash) fell from	2.3	to	1.5
	14.8		12.9

The changes in the total shell contents are mainly those of the flesh, since the amounts of the organic and mineral ingredients of the liquids are small. The water-free substance of the liquids makes only a small part of the whole water-free substance and consists very largely of mineral salts, a large part of which are the salts of the sea water. Here accordingly, as in the flesh, we have to do mainly with an increase of water and decrease of water-free substance and of its ingredients, though there was more loss of protein, carbohydrates, and fats than the gain in the water should account for.

5. The absolute gain and loss of material in the total shell contents can not be exactly computed from the data of these experiments; but it is safe to say that it consists almost entirely in a gain of water and loss of salts, and that, though there seems to be a loss of fats, and especially of carbohydrates, and perhaps a loss of protein also, the amount of these latter that escape during the floating must have been small.

CHANGES DUE TO OSMOSE.

6. From the standpoint of the physiological chemist the chief interest of the experiments is in the quantitative indication of the changes due to dialysis. As was to be expected, the change in composition during the dialysis consisted chiefly in a small loss of soluble materials, especially mineral salts, with some carbohydrates, and a large gain of water. But the flesh (body) of the animals, in which the chief change occurred, appeared to lose a little fat and protein also, which would hardly be taken out by osmose. Their removal is easily explained by assuming processes of secretion or excretion to accompany that of dialysis.

The absorption of digested matters through the walls of the alimentary canal in man and other animals is explained as the joint effect of dialysis and of a special action of the organs through which the materials pass. Considering the body of the oyster as a membranous sac (or as a congeries of membranous sacs) containing a more concentrated solution and immersed in a more dilute solution, and at the same time as a living organism performing its normal functions, the occurrence of physical dialysis along with the physiological processes of secretion or excretion would be perfectly natural.

But although the experiments do not show just how much of the loss of organic compounds was due to purely physical and how much to physiological agencies, it is evident that a large quantity of water was carried into the bodies of the animals and a considerable amount of mineral salts was removed by dialysis.

EFFECT OF FLOATING UPON NUTRITIVE VALUE.

7. So far as the effect of floating upon the nutritive value of the oyster is concerned, the experiments confirm in detail the perfectly evident *a priori* conclusion that with the increase in bulk and weight there is no corresponding gain but rather a slight loss of nutrients. Hence a given weight or volume of floated oysters will have considerably less nutritive material than the same quantity of oysters which have not been thus treated. According to these experiments, which agree with the results of practical experience, the difference would amount to from one-eighth to one-fifth or more in favor of the oysters in their natural condition. But the removal of the salts in floating would be considered by many consumers to improve the flavor of the oysters more than enough to make up for the inferiority in nutritive value. It seems also to be a matter of common experience that oysters keep better when part of the salts have been removed by the dialysis. While, therefore, this treatment of oysters is a device practiced by both cultivators who float and retail dealers who water them and thus increase the bulk of wares sold by bulk, it is not entirely a fraud, since both the flavor and keeping quality are often improved thereby.

5. OYSTERS AS FOOD.

Very little is popularly known, and widely varying views are held with reference to the value of oysters and other shellfish for food. Although a great deal of scientific research has of late been given to the subject of food and nutrition, these particular kinds of food have been studied but little, and what has been done is slow in getting into print and becoming generally known. The lack of popular knowledge of the subject is therefore easy to understand.

Speaking roughly, a quart of oysters contains, on the average, about the same quantity of actual nutritive substance as a quart of milk, or a pound of very lean beef, or a pound and a half of fresh codfish, or two-thirds of a pound of bread. But while the weight of actual nutriment in the different quantities of food materials named is very nearly the same, the quality is widely different. That of the very lean meat or codfish consists mostly of what are called in chemical language protein compounds or "flesh-formers," the substances which make blood, muscle, tendon, bone, brain, and other nitrogenous tissues. That of the bread contains but little of these, and consists chiefly of starch, with a little fat and other compounds which serve the body as fuel and supply it with heat and muscular power. The nutritive substance of oysters contains considerable of both the "flesh-forming" and the more especially heat-and-force giving ingredients. Oysters come nearer to milk than almost any other common food material as regards both the amounts and the relative proportions of nutrients, and the food values of equal weights of milk and oysters, *i. e.*, their values for supplying the body with material to build up its parts, repair its wastes, and furnish it with heat and energy, would be pretty nearly the same. But while this statement is reasonably correct, the studies thus far made are not sufficient to assure us of its absolute accuracy.

The differences which oystermen observe in the quality of oysters from different localities, of different age, and grown under different conditions, are made clearer and are to a considerable extent explained by chemical analysis. Taking the oysters in the shell, the proportion of shell contents, "meat" and "liquor" together, increases relatively to the whole weight as the animal grows, at least up to a certain limit. In other words a bushel of mature oysters will "open" more quarts than a bushel of the very young animals. But the differences between different kinds, or between specimens of the same kind under different conditions, are very wide.

Taking the edible portion of the oyster, after it has been removed from the shell, the differences are much greater than people commonly suppose. This is apparent when we compare either the flesh (meats) or liquids (liquor) of different specimens, or the whole edible portion, the meat and liquor (solids) together. The percentage of water in the edible portion of the different specimens of oysters reported in the tables beyond varied from 83.4 to 91.4 per cent., and averaged 87.3 per cent. This makes the amounts of "water-free substances," *i. e.*, actually nutritive ingredients, vary from 16.6 to 8.6, and average 12.7 per cent. of the whole weight of the edible portion (shell contents) of the animals. In other words the contents of nutritive material in a quart (2 pounds) of shell contents (solids) varied from 2¾ to 5⅓ ounces. The proportion of nutritive substance was twice as large in the one case as in the other.

The specimens, as received for analysis, were generally in the shell; on arrival at the laboratory they were weighed; the shell contents were then taken out and separated into flesh (meat) and liquid (liquor); each was weighed separately, as were the shells. From these weights the percentages were calculated. Table XVII gives the results:

TABLE XVII.—*Proportion of flesh, liquids, and shells in specimens of shellfish.*

Kinds of shellfish, locality, season.	Edible portion.			Refuse: shells, etc.
	Flesh.	Liquids.	Total.	
	P. ct.	P. ct.	P. ct.	P. ct.
Oysters:				
Stony Creek, April	7.5	11.4	18.9	81.1
Stony Creek, November	11.0	7.3	18.3	81.7
Stony Creek, March	11.2	9.3	20.5	79.5
Fair Haven, April	12.6	5.4	18.0	82.0
Fair Haven, November	12.3	12.1	24.4	75.6
Fair Haven, March	12.2	4.4	16.6	83.4
Blue Points, April	13.4	5.2	18.6	81.4
Blue Points, November	6.5	9.7	16.2	83.8
Blue Points, February	8.0	7.4	15.4	84.6
Shrewsbury, April	12.6	4.9	17.5	82.5
Shrewsbury, November	11.3	8.4	19.7	80.3
Shrewsbury, February	9.6	9.7	19.3	80.7
Potomac River, 3 weeks after transplanting*	6.5	5.6	12.1	87.9
Potomac River, 6 months after transplanting*	10.2	6.5	16.7	83.3
James River, 5 weeks after transplanting*	6.5	7.3	13.8	86.2
James River, 6 months after transplanting*	11.4	5.8	17.2	82.8
Specimen with maximum percentage of flesh	13.4	5.2	18.6	81.4
Specimen with maximum percentage of liquids	11.7	13.2	24.9	75.1
Specimen with maximum percentage of shells	4.7	6.5	11.2	88.8
Average of 34 specimens	9.8	7.9	17.7	82.3
Long clams:				
Specimen with maximum percentage of flesh	39.4	16.9	56.3	43.7
Specimen with maximum percentage of liquids	32.9	25.0	57.9	42.1
Specimen with maximum percentage of shells	29.3	24.6	53.9	46.1
Average of 4 specimens	34.5	21.9	56.4	43.6
Round clams	16.8	14.9	31.7	68.3
Mussels	32.7	18.0	50.7	49.3

* To New Haven Harbor.

Thus in the case of the specimen from Stony Creek, taken in April, the shells made 81.1 per cent., or a little over four-fifths; and the edible portion, flesh and liquids together, 19.9 per cent., or a little less than one-fifth of the whole weight. Of this 19.9 per cent., the flesh constituted 7.5 and the liquids 11.4 per cent. In this specimen the proportion of flesh was very small as compared with the liquids. In the specimen of Blue Points, taken at the same time, the proportion of flesh to liquids is just the other way, that of flesh being 13.4 and the liquids 5.2. The variations in the proportions of flesh, liquids, total edible portion, and shells are very striking.

We should not be warranted in assuming that the Blue Points generally have so much more flesh and liquid than the others. The figures of Table XVII are taken from a larger number obtained in a series of analysis of specimens from different localities on the Atlantic coast, from Massachusetts to New Jersey. One object of the investigation was to get light upon the effect of kind, locality, season, and other conditions upon the composition. But though the number of analyses was considerable, enough to cost a large amount of labor, the result can be taken only as a general indication of the range of variation and not as showing the characteristic composition of specimens of a given source or at a given time. To find, for instance, the average composition of oysters from a given locality, and the differences in composition in different seasons of the year and in different years, would require an investigation to extend through a year or several years, and to include a large number of analyses of specimens especially gathered for the purpose.

The variations in the proportions of flesh, liquids, and shell are so clearly shown in Table XVII that further explanation is hardly necessary.

The details of the proportion of flesh, liquids, and shells and of the composition of the flesh, liquids, and whole edible portion are given in Table XIX, which includes all the specimens analyzed. Table XVIII recapitulates the composition of the edible portion of a number of specimens of oysters, clams, and mussels. It is interesting to note the variations in the composition of the oysters in this table. The percentages of water range from 84.8 to 90.1 per cent. in the specimens here cited. In one of those not here given, but included in Table IV, the percentage of water rose to 91.5. The percentage of water-free substance, *i. e.*, total nutrients, in each case, is the difference between the percentage of water and 100. The nutrients accordingly range from 18.3 to 8.5 per cent. In other words, the proportion of nutritive matérial was more than twice as large in some cases as in others. The largest proportion of nutrients was in a specimen of Blue Points, taken in April; the smallest is in one from Norfolk, Va., also taken in April.

TABLE XVIII.—*Proportions of water and nutritive ingredients in edible portion of specimens of shellfish from different localities and at different times.*

Kind, locality, and time.	Water.	Nutrients.	Nutrients. Protein.	Fats.	Carbohydrates.	Mineral matters.
	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Oysters:						
Stony Creek, April	90.1	9.9	4.6	0.6	2.0	2.7
Stony Creek, November	84.8	15.2	6.9	1.4	4.5	2.4
Stony Creek, March	87.2	12.8	6.3	1.0	3.2	2.3
Fair Haven, April	85.1	14.9	7.5	1.4	3.5	2.5
Fair Haven, November	85.3	14.7	6.2	1.3	5.0	2.2
Fair Haven, March	84.6	15.4	7.7	1.3	3.5	2.9
Blue Points, April	81.7	18.3	8.2	1.7	6.5	1.9
Blue Points, November	88.3	11.7	5.8	0.8	2.9	2.2
Blue Points, February	90.2	9.8	5.0	0.9	2.3	1.6
Shrewsbury, April	85.4	14.6	6.5	1.6	5.0	1.5
Shrewsbury, November	89.2	10.8	4.9	1.0	3.2	1.7
Shrewsbury, February	85.2	14.8	6.2	1.5	5.2	1.9
Potomac River, 3 weeks after transplanting*	86.6	13.4	5.9	1.2	3.8	2.5
Potomac River, 6 months after transplanting*	87.4	12.6	6.3	1.2	3.7	1.4
James River, 5 weeks after transplanting*	90.1	9.9	4.6	0.8	2.3	2.2
James River, 6 months after transplanting*	87.0	13.0	8.0	1.3	2.2	1.5
Specimen with maximum of nutrients	81.7	18.3	8.2	1.7	6.5	1.9
Specimen with minimum of nutrients	91.5	8.5	4.5	0.6	1.7	1.7
Average of 34 specimens	87.3	12.7	5.9	1.2	3.6	2.0
Long clams:						
Specimen with maximum of nutrients	85.0	15.0	7.6	1.2	3.4	2.8
Specimen with minimum of nutrients	86.1	13.9	8.4	1.0	2.4	2.1
Average of four specimens	85.9	14.1	8.2	1.0	2.3	2.6
Round clams	86.2	13.8	6.6	0.4	4.1	2.7
Mussels	84.2	15.8	8.7	1.1	4.1	1.9

* To New Haven Harbor.

TABLE XIX.—*Percentages of water and nutritive ingredients in specimens of American invertebrates used for food.*

Name and locality of specimen.	Laboratory No. of specimen.	Specimen received.	Edible portion.														In whole sample.*	
			In flesh.				In liquids.				In edible portion. (Flesh plus liquids.)							
			Water.	Protein. Nitrogen × 6.25.	Fat. Ether extract.	Ash.	Water.	Protein. Nitrogen × 6.25.	Fat. Ether extract.	Ash.	Water.	Water-free substance.	Protein. Nitrogen × 6.25.	Fat. Ether extract.	Ash.	Carbohydrates.	Total edible portion.	Total water-free substance, actual nutrients.
			P. ct.	P. ct	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Oysters, (Ostrea virginica) in shell:																		
Buzzard's Bay, Mass	68	May	84.21	7.75	1.57	1.48	96.40	1.23	0.00	1.63	88.80	11.20	5.30	0.99	1.54	3.37	20.01	2.22
Providence River, R. I	70	do	79.01	10.30	2.58	2.13	95.05	1.48	0.00	2.41	84.79	15.21	7.12	1.65	2.23	4.21	17.00	2.59
Clinton, Conn	103	Nov	80.91	9.67	1.86	2.29	96.02	1.10	0.02	2.21	88.21	11.09	5.13	0.88	2.24	2.84	24.87	2.76
Stony Creek, Conn	55	Apr	81.02	10.46	1.60	2.76	96.12	0.83	0.01	2.72	90.11	9.89	4.64	0.64	2.73	1.95	18.90	1.89
Do	75	May	82.09	9.81	1.48	2.55	96.33	0.63	0.05	2.61	90.89	9.11	4.19	0.60	2.59	1.73	19.15	1.75
Do	105	Nov	77.82	10.60	2.32	2.51	95.40	1.36	0.01	2.33	84.83	15.17	6.94	1.39	2.44	4.40	18.23	2.76
Do	203	Mar	80.42	10.38	1.85	2.22	95.30	1.42	0.03	2.50	87.19	12.81	6.31	1.02	2.34	3.14	20.50	2.62
Do. (average of 4 samples)			80.34	10.33	1.81	2.51	95.79	1.06	0.02	2.54	88.24	11.76	5.52	0.9[illegible]	2.52	2.80	19.20	2.26
Fair Haven, Conn	54	Apr	81.30	9.89	2.05	2.20	94.00	2.06	0.02	3.19	85.12	14.88	7.53	1.44	2.50	3.41	18.06	2.69
Do	93	Nov	76.24	10.96	2.47	2.01	94.43	2.14	0.02	2.43	85.25	14.75	6.24	1.26	2.22	5.03	24.31	3.59
Do	210	Mar	80.80	9.89	2.05	1.85	95.12	1.94	0.03	2.21	84.64	15.36	7.75	1.28	2.92	3.81	16.59	2.55
Do. (average of 3 samples)			79.44	10.25	2.19	2.02	94.52	2.06	0.02	2.61	85.00	15.00	7.17	1.33	2.54	4.08	19.65	2.95
Norwalk, Conn	118	Dec	81.33	9.52	1.51	2.10	96.46	0.75	0.01	2.32	90.04	9.90	4.60	0.65	2.23	2.52	17.85	1.78
Do	151	Feb	80.50	9.97	1.89	2.15	96.32	0.76	0.02	2.50	89.60	10.40	4.69	0.82	2.35	2.54	17.05	1.77
Do. (average of 2 samples)			80.92	9.75	1.70	2.13	96.39	0.77	0.02	2.41	89.82	10.18	4.59	0.73	9.29	2.51	17.45	1.76
Blue Point, N. Y	56	Apr	76.77	10.06	2.30	1.93	94.33	2.31	0.09	1.91	81.70	18.30	8.22	1.72	1.92	6.46	18.62	3.41
Do	107	Nov	75.55	13.31	2.02	2.58	96.89	0.75	0.01	1.90	88.30	11.70	5.81	0.82	2.17	2.90	16.17	1.95
Do	182	Feb	83.97	8.81	1.62	1.59	96.87	0.92	0.01	1.70	90.15	9.85	5.00	0.85	1.64	2.36	15.42	1.52
Do. (average of 3 samples)			78.76	10.73	1.98	2.03	96.03	0.31	0.04	1.88	86.75	13.28	6.34	1.13	1.91	3.91	16.74	2.33
Rockaway, N. Y	58	Apr	81.27	9.18	2.13	1.67	95.06	1.60	0.04	2.26	87.06	12.94	6.00	1.25	1.92	3.85	18.40	2.40
Do	112	Nov	77.66	10.53	2.72	2.02	94.79	1.76	0.01	2.50	89.31	15.69	7.06	1.66	2.23	4.74	19.84	3.13
Do. (average of 2 samples)			79.46	9.85	2.43	1.85	94.92	1.68	0.03	2.40	85.65	14.35	6.53	1.46	2.07	4.29	10.12	2.75
Long Island Sound, N. Y	60	Apr	84.47	8.14	1.68	1.41	96.35	1.30	0.09	0.85	89.67	10.33	5.24	0.98	1.17	3.03	16.23	1.69
Do	92	Nov	78.51	11.61	1.84	2.52	94.81	2.29	0.02	3.16	83.64	16.36	8.50	1.23	2.73	3.90	14.62	2.39
Do	109	do	82.79	8.41	1.74	1.71	96.64	1.09	0.01	1.87	90.15	9.85	4.56	0.82	1.79	2.68	17.59	1.73
Do. (average of 3 samples)			81.92	9.39	1.75	1.88	95.60	1.56	0.04	1.96	87.79	12.21	6.10	1.01	1.89	3.20	16.15	1.97
Oyster Bay, N. Y	180	Feb	77.90	10.61	2.85	2.19	95.31	1.46	0.01	2.37	84.34	15.66	7.19	1.48	2.26	4.73	17.27	2.70
East River, N. Y	57	Apr	79.92	10.44	2.16	1.74	95.44	1.63	0.02	1.57	87.57	12.43	6.31	1.10	1.87	3.15	20.28	2.52
Do	108	Nov	75.22	10.07	2.87	1.87	94.87	1.81	0.09	2.33	83.35	16.65	6.39	1.72	2.06	6.48	20.31	3.38
Do. (average of 2 samples)			77.57	10.25	2.52	1.81	95.16	1.74	0.06	1.95	85.46	14.54	6.35	1.41	1.97	4.82	20.30	2.87
Shrewsbury, N. J	61	Apr	81.65	8.20	2.20	1.33	95.07	2.06	0.04	1.83	85.37	14.63	6.48	1.60	1.47	5.08	17.52	2.56
Do	106	May	77.58	9.68	2.66	1.88	95.35	1.88	0.04	1.96	85.17	14.83	6.24	1.54	1.91	5.14	19.67	2.93

Do	181	Nov	81.73	9.13	2.00	1.68	96.52	1.38	0.01	1.72	89.16	10.84	4.87	1.00	1.70	3.27	19.23	2.08
Do. (average of 3 samples)			80.32	9.00	2.29	1.63	95.65	1.76	0.03	1.83	86.57	13.43	5.88	1.38	1.69	4.49	18.81	2.53
Norfolk, Va	59	Apr	83.86	9.32	1.45	1.82	96.83	1.05	0.01	1.64	91.45	8.55	4.50	0.61	1.71	1.73	11.18	0.95
Potomac River, Va. (transplanted)†	73	May	78.87	9.81	2.27	2.54	95.51	1.42	0.01	2.47	86.60	13.40	5.92	1.22	2.51	3.75	12.15	1.63
Do†	84	Nov	82.06	9.06	1.93	1.58	95.69	2.05	0.01	1.19	87.36	12.64	6.25	1.18	1.43	3.78	16.66	2.11
Do†	85	do	77.90	10.31	2.33	2.17	94.99	1.81	0.02	2.47	86.14	13.86	6.19	1.21	2.31	4.15	16.13	2.23
Do. (average of 3 samples)			79.61	9.74	2.18	2.10	95.40	1.76	0.01	2.04	86.70	13.30	6.12	1.20	2.08	3.89	14.98	2.00
Rappahannock River, Va. (transplanted)	72	May	82.64	8.49	1.90	1.58	97.24	1.01	0.01	1.38	89.77	10.23	4.88	0.99	1.52	2.73	15.17	1.53
James River, Va. (transplanted)†	71	do	83.49	8.26	1.78	1.71	95.91	1.17	0.01	2.56	90.05	9.95	4.63	0.84	2.16	2.48	13.79	1.41
Do†	82	Nov	77.99	10.63	2.61	2.21	94.74	1.95	0.05	2.54	84.15	15.85	7.00	1.67	2.33	4.85	15.00	2.38
Do†	83	do	82.77	8.75	1.91	1.55	95.22	2.14	0.13	1.42	86.95	13.05	8.00	1.31	1.51	2.23	17.17	2.19
Do. (average of 3 samples)			81.42	9.23	2.10	1.82	95.29	1.76	0.07	2.17	87.05	12.95	6.54	1.27	2.00	3.19	15.32	1.98
Average of 34 samples (average of averages)			80.52	9.04	2.04	1.96	95.76	1.42	0.03	2.09	87.30	12.70	5.95	1.15	2.03	3.55	17.70	2.32
Oysters, "solids" (out of shell):‡																		
Fair Haven, Conn	89	Nov	84.04	7.12	1.96	0.86	96.19	1.60	0.02	0.55	85.21	14.79	6.60	1.77	0.83	5.50	100.00	14.79
Do	204	Mar									88.44	11.56	5.91	1.54	0.89	3.22	100.00	11.56
Virginia (transplanted)†	104	Nov	85.50	7.51	1.83	1.12	96.43	1.43	0.02	0.77	87.23	12.77	6.38	1.54	1.06	3.79	100.00	12.77
Do	202	Mar									87.90	12.10	6.44	1.57	0.77	3.63	100.00	12.10
Do. (average of 4 samples)											87.19	12.81	6.33	1.60	0.89	4.07	100.00	12.81
Oysters, "cove" (canned):																		
Chesapeake Bay	74	May	78.53	14.00	3.78	1.60	93.57	1.77	0.27	1.21	86.01	13.99	7.89	2.04	1.42	2.51	100.00	13.99
Do	97	Nov	76.75	13.25	4.35	1.63	93.35	1.40	0.09	0.91	85.14	14.86	7.25	2.19	1.27	4.25	100.00	14.86
Do	120	do	77.25	13.44	4.24	1.45	90.57	1.88	0.12	1.10	84.60	15.40	7.00	1.96	1.26	5.18	100.00	15.40
Do. (average of 3 samples)			77.51	13.46	4.12	1.56	92.50	1.70	0.16	1.08	85.25	14.75	7.38	2.06	1.32	3.98	100.00	14.75
Scallops (Pecten irradians):																		
Shelter Island, N. Y	56	Mar									77.79	22.21	15.05	0.03	1.48	5.65	100.00	22.21
Do	63	Apr									82.84	17.16	14.44	0.20	1.29	1.13	100.00	17.16
Do. (average of 2 samples)											80.32	19.68	14.75	0.17	1.38	3.38	100.00	19.68
Long clams (Mya arenaria) (in shell):																		
Boston, Mass	69	May	77.96	14.55	1.79	2.76	95.73	0.49	0.01	3.29	86.11	13.89	8.13	0.98	3.00	1.78	53.90	7.50
Clinton, Conn	102	Nov	78.57	14.86	1.78	2.49	96.02	0.69		2.81	86.11	13.89	8.69	1.01	2.63	1.56	57.92	8.05
Do	201	Mar	79.94	12.62	1.69	3.11	96.77	0.69	0.01	2.05	85.00	15.00	7.60	1.18	2.79	3.43	56.30	8.45
Do. (average of 2 samples)			79.26	13.74	1.74	2.80	96.40	0.66	0.01	2.43	85.56	14.44	8.15	1.09	2.71	2.49	57.11	8.25
Long Island, N. Y	65	Apr	81.05	12.52	1.52	1.56	94.76	1.30	0.03	2.93	86.05	13.95	8.40	0.97	2.06	2.52	57.64	8.04
Average of 4 samples (average of averages)			79.42	13.63	1.68	2.37	95.63	0.82	0.02	2.88	85.91	14.09	8.23	1.01	2.59	2.29	56.44	8.17
Long clams, canned:																		
Penobscot Bay, Me	122	Nov	74.63	17.94	2.92	3.18	91.92	2.44	0.04	1.72	84.54	15.46	9.06	1.27	2.34	2.79	100.00	15.46
Round clams (Venus mercenaria) in shell:																		
Little Neck, N. Y	66	Apr	78.24	11.59	0.74	2.22	95.12	0.88	0.02	3.17	86.20	13.80	6.56	0.40	2.67	4.17	31.71	4.38
Round clams, canned:																		
Islip, Long Island, N. Y	125	Nov	75.56	16.70	1.27	2.33	90.52	4.07	0.26	3.26	82.91	17.09	9.54	0.68	3.74	3.13	100.00	17.09
Mussels (Mytilus edulis) in shell:																		
Stony Creek, Conn	139	Dec	78.67	12.51	1.67	1.73	94.23	1.77	0.13	*2.25	84.16	15.84	8.69	1.12	1.91	4.12	50.66	3.02
Lobster (Homarus americanus) in shell:																		
Maine	50	Mar									84.30	15.70	11.63	1.82	1.63	0.62	52.52	8.24
Do	62	Apr									81.77	18.23	14.00	1.55	1.71	0.92	36.24	6.60
Do	239	do									79.17	20.83	17.24	1.45	1.62	0.52		

* In sample as received for analysis; in the majority of cases the whole animal, including both edible portion and shell.
† To New Haven, Conn.
‡ Shell contents, including flesh and liquids.

TABLE XIX.—*Percentages of water and nutritive ingredients in specimens of American invertebrates used for food*—Continued.

Name and locality of specimen.	Laboratory No. of specimen.	Specimen received.	Edible portion.														In whole sample.*	
			In flesh.				In liquids.				In edible portion. (Flesh plus liquids.)							
			Water.	Protein. Nitrogen × 6.25.	Fat. Ether extract.	Ash.	Water.	Protein. Nitrogen × 6.25.	Fat. Ether extract.	Ash.	Water.	Water-free substance.	Protein. Nitrogen × 6.25.	Fat. Ether extract.	Ash.	Carbohydrates.	Total edible portion.	Total water-free substance, actual nutrients.
				P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Lobster (Homarus americanus) in shell:																		
Massachusetts	69	May									82.11	17.89	15.03	2.54	1.87	......	30.56	5.47
Do. (average of 4 samples)											81.84	18.16	14.49	1.84	1.71	......	39.77	6.80
Lobster, canned:																		
Maine	76	May									79.36	20.64	16.75	0.46	2.78	0.65	100.00	20.64
Do	121	Nov									76.15	23.85	19.52	1.68	2.15	0.50	100.00	23.85
Do. (average of 2 samples)											77.75	22.25	18.13	1.07	2.47	0.58	100.00	22.25
Crayfish, in shell:																		
Potomac River, Va	64	Apr									81.22	18.78	16.00	0.46	1.31	1.01	12.30	2.31
Crab (Callinectes hastatus) in shell:																		
New Jersey	101	Nov									77.07	22.93	16.64	1.96	3.13	1.20	44.16	10.12
Crabs, canned:																		
Hampton, Va	124	Nov									80.98	19.02	15.62	0.79	1.78	0.83	100.00	19.02
Do	274	Apr									78.95	21.05	15.98	2.30	2.10	0.67	100.00	21.05
Do. (average of 2 samples)											79.97	20.03	15.80	1.54	1.94	0.75	100.00	20.04
Shrimp, canned:																		
Gulf of Mexico	123	Nov									70.80	29.20	25.38	1.00	2.58	0.24	100.00	29.20

* In sample as received for analysis: in the majority of cases the whole animal, including both edible portion and shell.

It would seem from the figures in Table XIX that the northern oysters are, on the whole, richer in nutritive material than the southern, but more analyses are needed to show the true average ranges of variation. One reason why the Virginia oysters appear to disadvantage here may be that they were younger. It appears that as the oyster grows older, at least up to a certain time, not only do the proportions of flesh and liquids increase more rapidly than the shells, but the proportion of natural nutrients in the edible portion increases also; that is to say, 100 pounds of young oysters in the shell would appear from these analyses to contain less of flesh and of liquids than 100 pounds of older ones, and when both have been shucked a pound of shell contents from the older animals would contain more nutriment than a pound from the younger. I wish, however, to be very careful in making these statements, because the number of examinations is too small to warrant very definite generalizations; indeed, the only figures which bear directly upon this especial point are those for the oysters transplanted from the James and Potomac Rivers to New Haven Harbor in the spring and taken out in the following fall or winter. These show a notable increase during this period, both in the quantities of shell contents in a given weight of shell and in the amount of actual nutriment in a given weight of shell contents. Perhaps this change is more a matter of feeding and fattening than of age. However it may be, it is not unnatural that changes of this kind, which take place in other animals, should occur in the oyster. Thus calves and pigs in growing and in fattening increase in both the proportion of meat to bone and in the proportion of nutritive material in the meat. As regards shellfish, this particular point especially demands more extended study.

The figures of Table XIX show a slight difference between the average composition of the edible portion of the oysters taken from the shell in the laboratory and that of those purchased out of the shells, in the form commonly called "solids" in the markets. Whether this difference is accidental or due to the fact that as they are ordinarily shucked for sale less of the liquids is saved than was done in preparing our specimens for analysis, it is impossible to say.

Table XIX is somewhat complex, and calls for further explanation. The specimens of oysters are arranged according to locality, from Buzzard's Bay, Massachusetts, to the James River, Virginia. The proportions of water, protein, fat, and mineral matters in the flesh and in the liquids are given separately. The proportions of carbohydrates are not stated, since they are not directly determined by the analysis, but are estimated by subtracting the sum of the protein, fat, and ash from the total water-free substance, which latter is determined along with the percentage of water, and is the difference between the latter and 100. Details of the methods of analysis may be found in Part I.

The last two columns of the table, it will be observed, give the percentages of total edible portions and of total nutrients in the edible portion of each specimen as received for analysis. Where the specimen consisted simply of the edible portion, as in the case of the "solids" of oysters, canned oysters, etc., the percentage of total edible portion is, of course, 100.

I have already stated that some of the conclusions as to the values of fats, which are ordinarily drawn from the chemical composition of meats and fish, are not ventured upon here because the precise nature of the nutritive ingredients of oysters and other shellfish is not definitely understood.

Perhaps further experimental study will show that what we call the protein of the oyster is very nearly the same as that of meat or milk; that what we reckon as carbohydrates of the shellfish have about the same nutritive value as the carbohydrates of other foods—milk, sugar, and starch, for instance. Meanwhile, what is known implies that the differences are probably not very great, though they may be considerable.

The composition of the liquid portion demands a few words of explanation. The amount of nutriment is very small indeed, the principal constituents being water and salts of sea water. How much food value these minute quantities of nutriment have it is impossible to say. Perhaps a given weight of what is called protein in the liquids of oysters may be not far inferior to the same quantity in the flesh, but this is a matter of doubt.

Taking all in all, the variations in composition of oysters are very wide. The same would very likely be found to be the case with clams and other shellfish if a large enough number of analyses were made to show the range of variation, but probably the averages of the analyses here given represent pretty nearly the average composition of the shellfish as they are ordinarily found in the water and in the markets.

Most of the specimens of oysters and other shellfish here reported upon were received without statement as to whether they had been "floated" or not, but we suppose that, except when otherwise stated, they had usually been floated and the specimens were such as are ordinarily sold. The effect of floating on the composition is described in another place in this report. Briefly stated, floating increases the proportions of water and diminishes the proportions of nutritive ingredients, and especially those of mineral salts. Floated oysters will therefore have on the average more water and less nutritive material than those not floated. The same is true of clams, mussels, etc.

It is then safe to say that while the variation in the composition of oysters, clams, and the like are considerable, just as they are in different kinds of meat, such as beef, mutton, and pork, yet it is probable that the proportions which are expressed in the figures of Table I, and graphically set forth in the colored diagram, make a reasonably fair exhibit of the average composition of these food materials in the condition in which we ordinarily buy them, and hence represent pretty nearly their relative nutritive values. While we must wait for further research before we can with perfect confidence accept these figures as the actual measure of the nutritive effects, we may say, in a general way, that the relative food values are indicated very nearly by the chemical compositions as here given.*

The cheapest food is that which furnishes the actually nutritive material at the lowest cost. The most economical food is that which is cheapest and best adapted to the wants of the user. Various methods have been proposed for estimating the relative cheapness or dearness of food materials. For instance, the cost of actually nutritive ingredients in a given food material may be computed by comparing the amounts of the several nutrients, protein, fats, and carbohydrates it contains, with its market price, 1 pound of protein being assumed to cost, on the average, five times as much, and a pound of fats three times as much as a pound of carbohydrates. The computed costs of the same nutrient, *e. g.*, protein, in different foods, thus affords a basis for comparing the relative expensiveness of the foods, as in the figures below.†

Comparative costs of protein in food materials.

Food materials.	Ordinary price per pound.	Cost of protein per pound.
Beef, sirloin, medium fatness	$0.25	$1.06
Beef, sirloin, at lower price	.20	.85
Beef, round, rather lean	.16	.63
Mutton, leg	.22	.91
Milk (7 cents per quart)	.03½	.53
Salmon, early in season	1.00	5.11
Salmon, when plenty	.30	1.53
Mackerel	.10	.79
Salt cod	.07	.43
Oysters (25 cents per quart)	.12½	1.68
Oysters (50 cents per quart, choice)	.25	3.35
Lobsters	.12	2.09
Wheat flour	.03	.11

Shellfish are delicacies rather than staple foods. The above figures illustrate the fact that, like other delicacies, they are not economical from the strictly pecuniary standpoint, yet they have an important use. The conditions of our advanced civilization make variety in diet desirable, and to a greater or less extent essential, and oftentimes flavor has a value which can not be counted in dollars and cents.

The nutritive value of the shellfish, as of other foods, depends to a considerable extent upon their digestibility, but so little is positively known of the digestibility of shellfish as compared with meats and other animal foods that it has not seemed fitting to say a great deal

* See article on "Pecuniary Economy of Food" in Century Magazine for January, 1888.

† This method of computation is German; assumed relative costs of the nutrients are based upon market prices in Germany. The protein is selected for the estimate because it is physiologically the most important of the nutrients. For other and more accurate, though more complex, methods see seventeenth annual report of Massachusetts Bureau of Statistics of Labor, 1886, p. 253.

about it here. Perhaps, indeed, the most that can be said is that while there are people with whom such substances do not always agree, yet oysters belong to the more easily digestible class of foods.

FOOD VALUE OF FISH.

The ingredients of the flesh of fish are essentially the same in kind as those of the flesh of domestic animals used for food, such as beef and mutton. The chief difference is that the flesh of fish contains relatively less fat and more water than ordinary meats. Or, to put it more specifically, the flesh of fish contains in general about the same proportion of protein, less fat, more water, and hence on the whole less nutritive material, pound for pound, than that of domestic animals used for food. Thus we have in the flesh of flounder only 16 per cent., and in that of cod 18 per cent., of nutrients, while ordinary lean beef has from 25 to to 33 per cent., and the fatter meats considerably more. The fatter kinds of fish, however, as herring, mackerel, salmon, shad, and whitefish approach nearer to medium beef. Dried and salted fish also contain good proportions of nutrients, the specimens of ordinary salt codfish having 28 per cent., salt mackerel 47, and desiccated cod, a material as yet less known commercially, 82 per cent. of nutrients. The edible portion of shellfish is poor in nutrients, oysters varying from 9 to 19, and lobsters averaging 18 per cent.

Fish as found in the markets generally contain more refuse, bone, skin, etc., than meats, as is illustrated in Tables VI and VIII. With the larger proportions of both refuse and water the proportions of nutrients, though variable, are usually much less than in meats. Thus a sample of flounder contained 67 per cent. of refuse, 28 of water, and only 5 per cent. of nutritive substance, while the salmon averaged 23, the salt cod 22, and the salt mackerel 36 per cent. of nutrients. The nutrients in meats ranged from 30 per cent. in beef to 46 in mutton and 87½ in very fat pork (bacon). The canned fish compare very favorably with the meats. It is worth noting that the nutrients in dressed fresh codfish, in edible portion of oysters, and in milk were nearly the same in amount, about 12½ per cent., though differing in kind and proportions.

Vegetable foods have generally less water and more nutrients than animal foods. Ordinary flour, meal, etc., contain from 85 to 90 per cent. or more of nutritive material. But the nutritive value is not proportional to the quantity of nutrients, because the vegetable foods consist mostly of carbohydrates, starch, sugar, cellulose, etc., of inferior nutritive effect, and because their protein is less digestible than that of animal foods. Potatoes especially contain a large amount of water and extremely little protein or fats.

PLACE OF FISH IN DIETARIES—IMPORTANCE OF FISH-CULTURE.

The chief uses of fish as food are (1) as an economical source of nutriment and (2) to supply the demand for variety in diet, which increases with the advance of civilization and culture.

As nutriment, the place of fish is that of a supplement to vegetable foods, the most of which, as wheat, rye, maize, rice, potatoes, etc., are deficient in protein, the chief nutriment of fish. The so-called nitrogenous extractives (meat extract), contained in small quantities in fish as in other animal foods, are doubtless useful in nutrition.

There is a widespread notion that fish contains large proportions of phosphorus, and is on that account particularly valuable for brain food. The percentages of phosphorus in the analyses above reported are not larger than are found, according to the best analyses, in the flesh of other animals used for food. The number of reliable determinations of flesh in the latter are, however, small, and it is, though very improbable, yet within the range of possibility that a more complete investigation of the subject might reveal a smaller proportion of phosphorus in meats than in fish.

But even if the fish be richer in phosphorus, there is no proof that it would on that account be better for brain food. The question of the nourishment of the brain and the sources of the intellectual energy are too indeterminate to allow decisive statements and too abstruse for speedy solution. There is no experimental evidence to warrant the assumption that fish is more valuable than meats or other food material for the nourishment of the brain.

It is an interesting fact that the poorer classes of people and communities almost universally select those foods which chemical analysis shows to supply the actual nutrients at the lowest cost; but, unfortunately, the proportions of the nutrients in their dietaries are often very defective. Thus, in portions of India and China, rice; in Northern Italy, maize-meal; in certain districts of Germany, and in some regions and seasons in Ireland, potatoes; and among the poor whites of the southern United States maize-meal and bacon make a large part and in some cases almost the sole food of the people. These foods supply the nutrients in the cheapest forms, but are all deficient in protein. The people who live upon them are ill-nourished and suffer physically, intellectually, and morally thereby.

On the other hand, the Scotchman finds a most economical supply of protein in oatmeal, haddock, and herring; and the rural inhabitants of New England supplement the fat of their pork with protein of beans, and the carbohydrates of potatoes, maize, and wheat flour with the protein of codfish and mackerel, and, while subsisting largely upon such frugal but rational diets, are well nourished, physically strong, and noted for their intellectual and moral force.

Late inquiry in agricultural and biological chemistry has brought out some facts which emphasize the importance of fish-culture and the greater use of fish as food, from the standpoints of hygiene and domestic, agricultural, and even national economy.

Our national dietary is one-sided. Our food contains relatively too much of fat, sugar, and starch, and too little of protein. This is a natural result of our agricultural conditions which have led to the production of large quantities of maize, which is relatively deficient in protein, and of excessively fat beef and pork. Our agricultural production is, in this sense, one-sided.

Our soils are becoming depleted by culture. The evil results of this are already evident in the older and are becoming so even in some of the newer States of the Union. Of the ingredients of plant food which are needed for the restoration of fertility, the costliest and scarcest is nitrogen, which is the characteristic element of the protein compounds of our food.

A very large amount of the waste products which are left from the consumption of food, instead of being returned to the soil for restoring its fertility and increasing its production, is carried off in drainage waters and through the sewers of large cities into the rivers and sea. The nitrogenous products are thus especially exposed to loss. The nitrogen, however, is not lost necessarily in this way. It goes for the support of marine vegetation which forms the food of fish. It may thus again be utilized as food for man. Fish has relatively less of fats and more of protein than meats and vegetable foods. By fish culture, then, we are enabled to supply the very materials which are lacking in our dietaries and from the waste products may be saved the valuable fertilizing elements, including phosphorus and especially nitrogen.

As population becomes denser, the capacity of the soil to supply food for man gradually nears its limit. Fish gather materials that would otherwise be inaccessible and lost, and store them in the very forms that are most deficient in the produce of the soil. Thus, by proper culture and use of fish, the rivers and sea are made to fulfill their office with the land in supplying nutriment for man.

CHART A.

PERCENTAGES OF NUTRITIVE INGREDIENTS AND WATER IN FLESH, EDIBLE PORTION, OF SPECIMENS OF AMERICAN AND EUROPEAN FOOD FISHES.

A. INDICATES AMERICAN FISHES. E. INDICATES EUROPEAN FISHES.

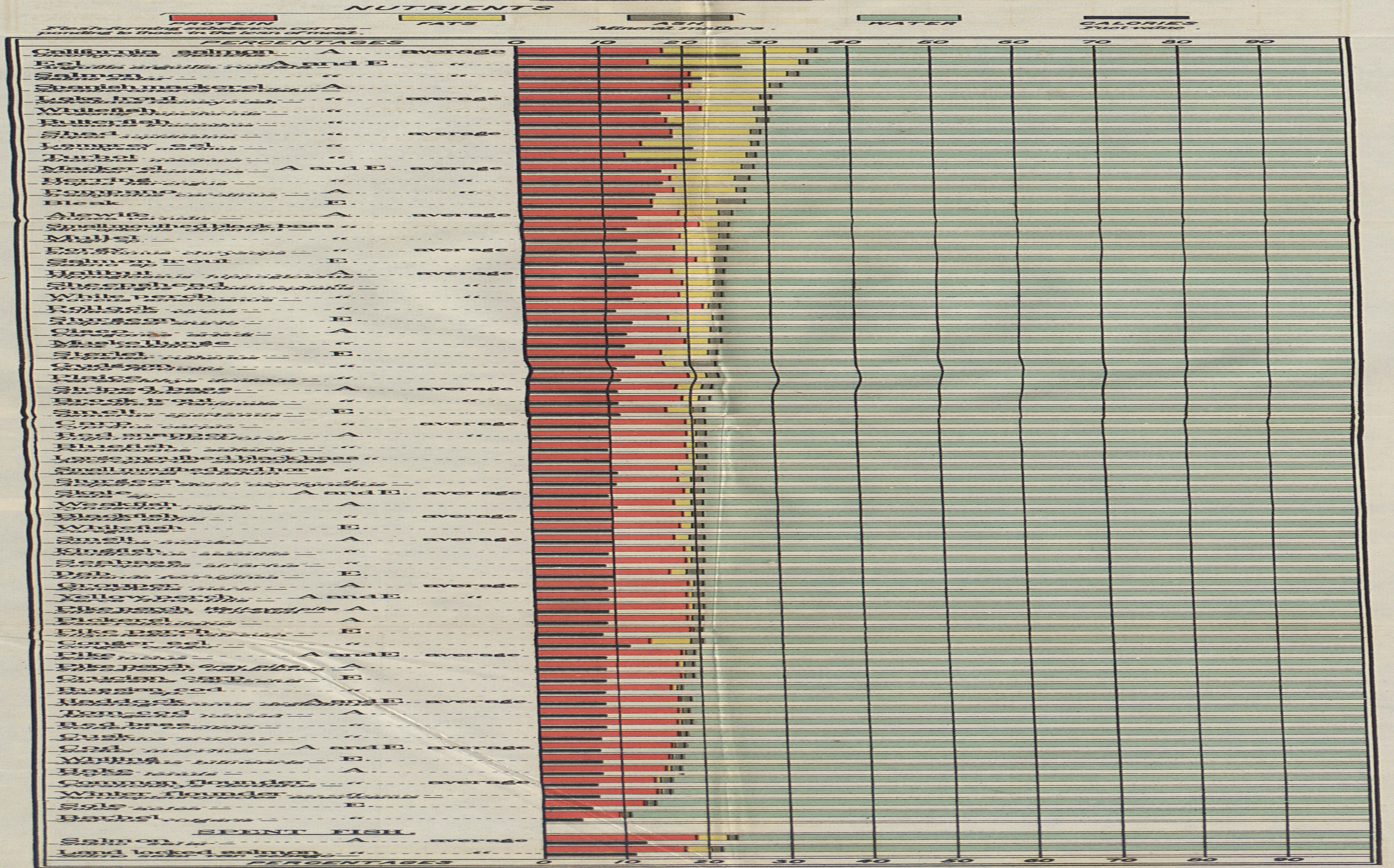


CHART B.

PERCENTAGES OF NUTRITIVE INGREDIENTS, WATER AND SALT, IN FLESH, EDIBLE PORTION, OF SPECIMENS OF AMERICAN AND EUROPEAN PRESERVED FISH.

A INDICATES AMERICAN FISHES. *E* INDICATES EUROPEAN FISHES.

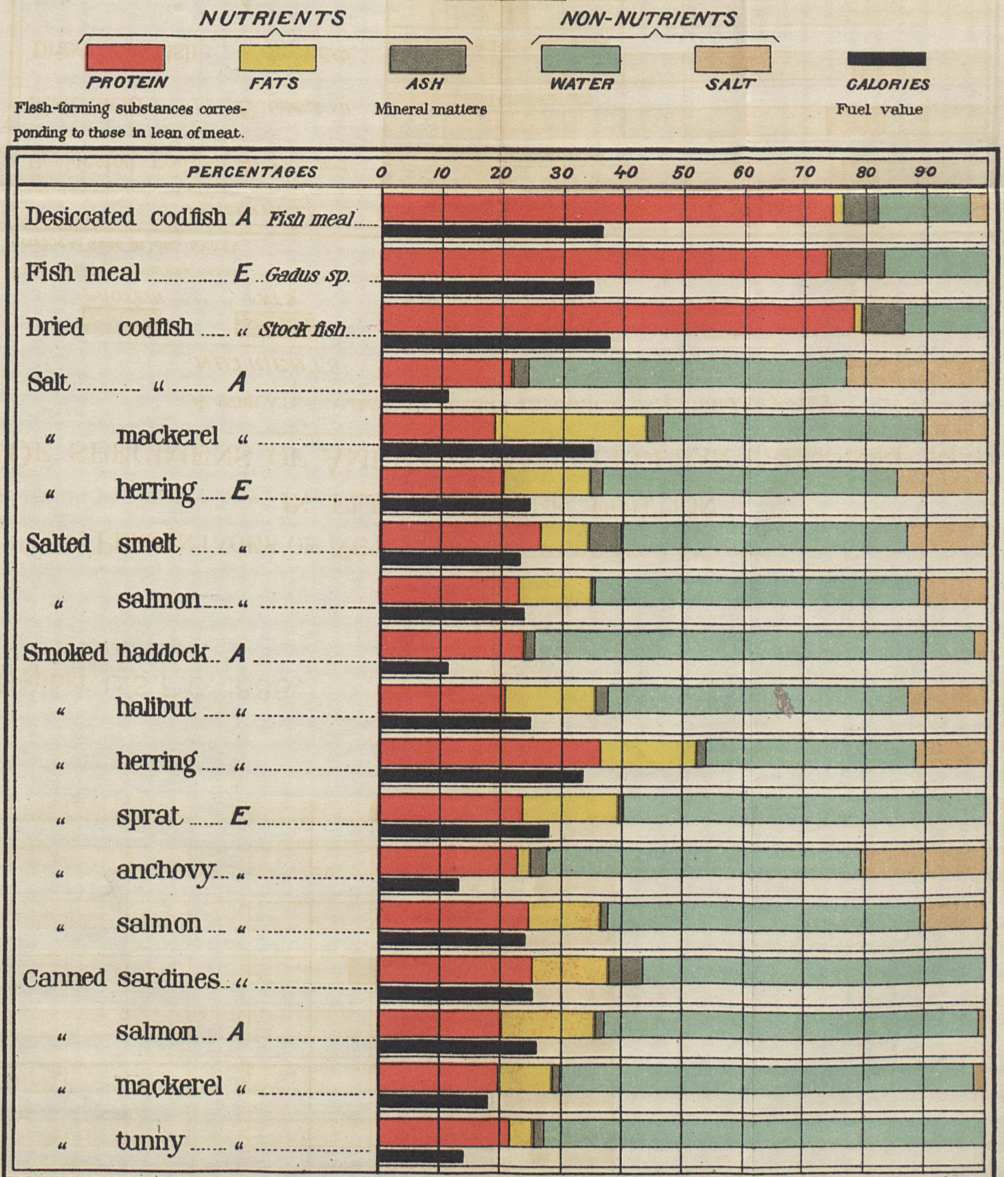
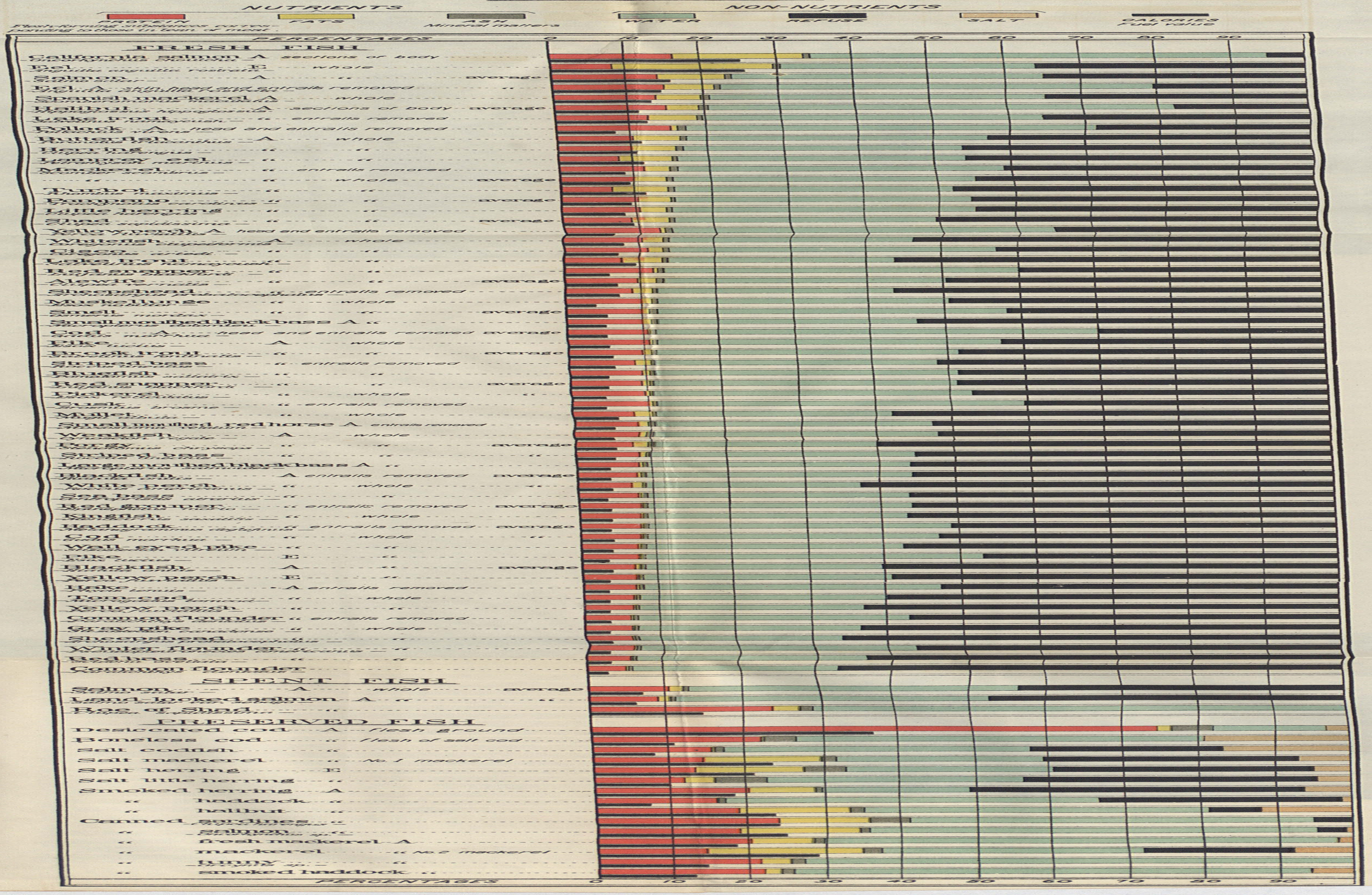


CHART C.

PERCENTAGES OF NUTRITIVE INGREDIENTS, WATER, AND REFUSE, IN SPECIMENS OF AMERICAN AND EUROPEAN FOOD FISHES AS FOUND IN THE MARKETS.

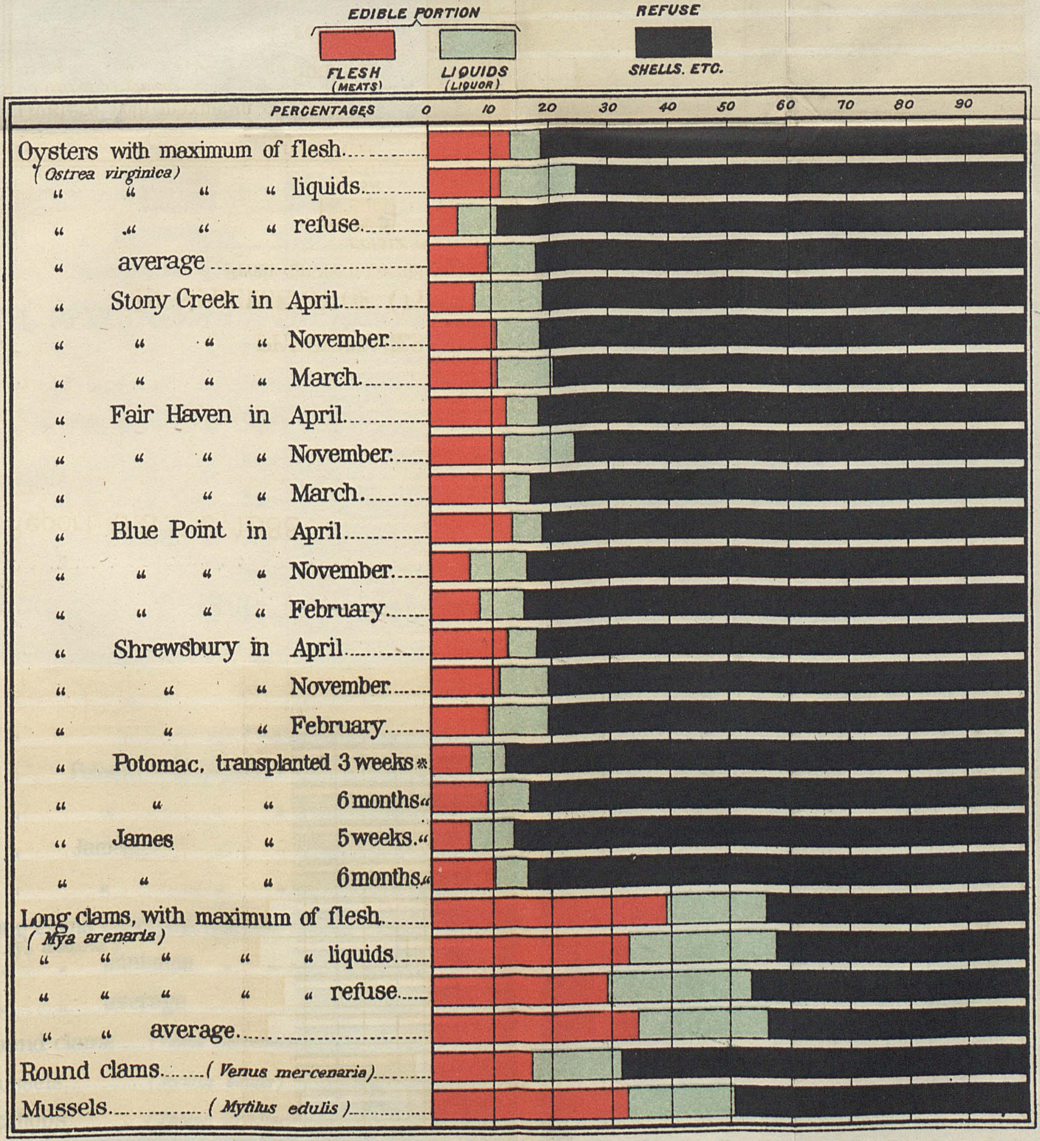
A. INDICATES AMERICAN FISHES. E. INDICATES EUROPEAN FISHES.



CHART, D.

PERCENTAGES OF FLESH, LIQUIDS, AND SHELLS IN SPECIMENS OF OYSTERS, CLAMS AND MUSSELS.

From different Localities and from the same Locality at different times.

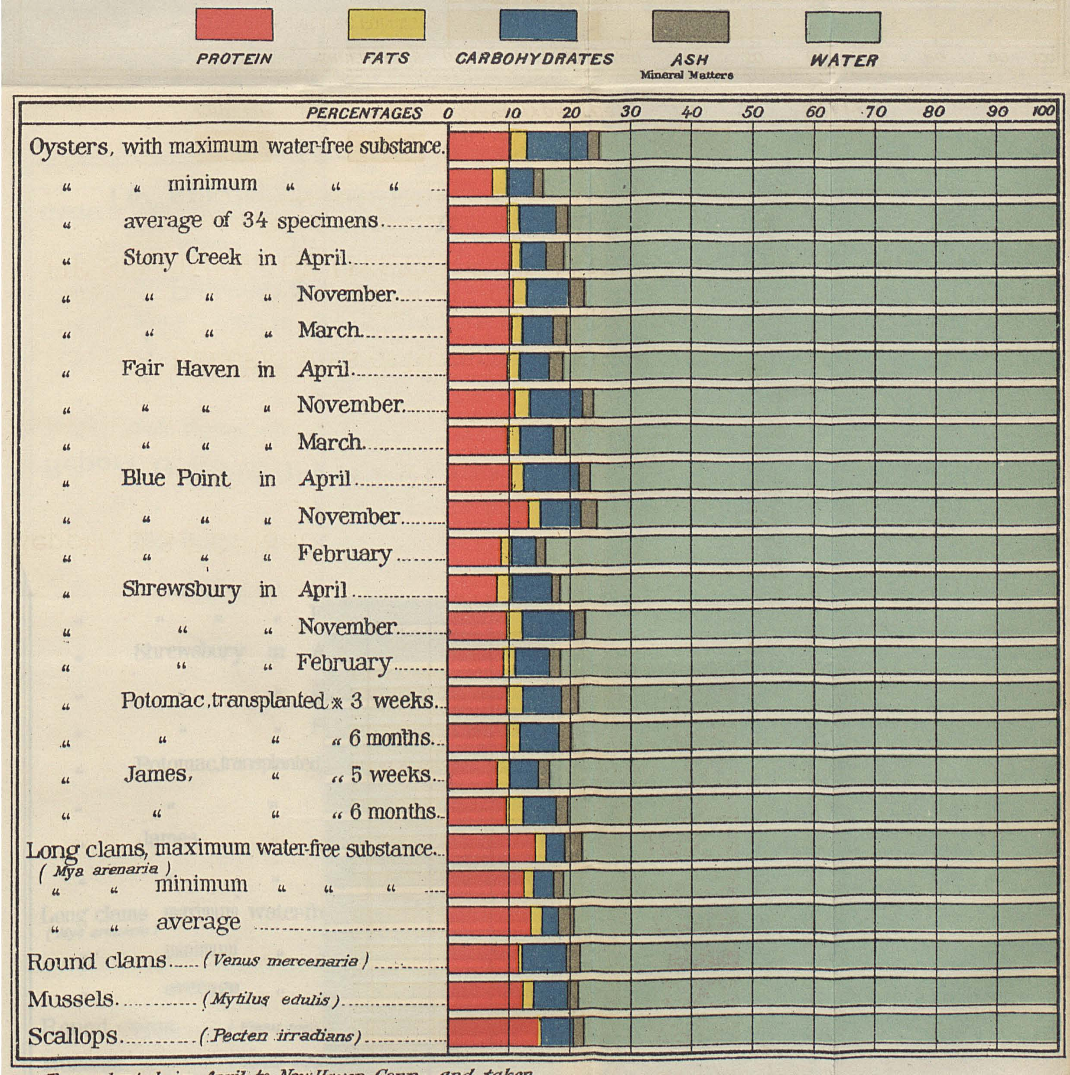


* *Transplanted in April to New Haven, Conn, and then taken after lying in the New Haven beds for the time indicated.*

CHART E.

PERCENTAGES OF NUTRITIVE INGREDIENTS AND WATER
— IN FLESH —
OF SPECIMENS OF OYSTERS, CLAMS, MUSSELS, AND SCALLOPS.

From different localities, and from the same locality at different times.

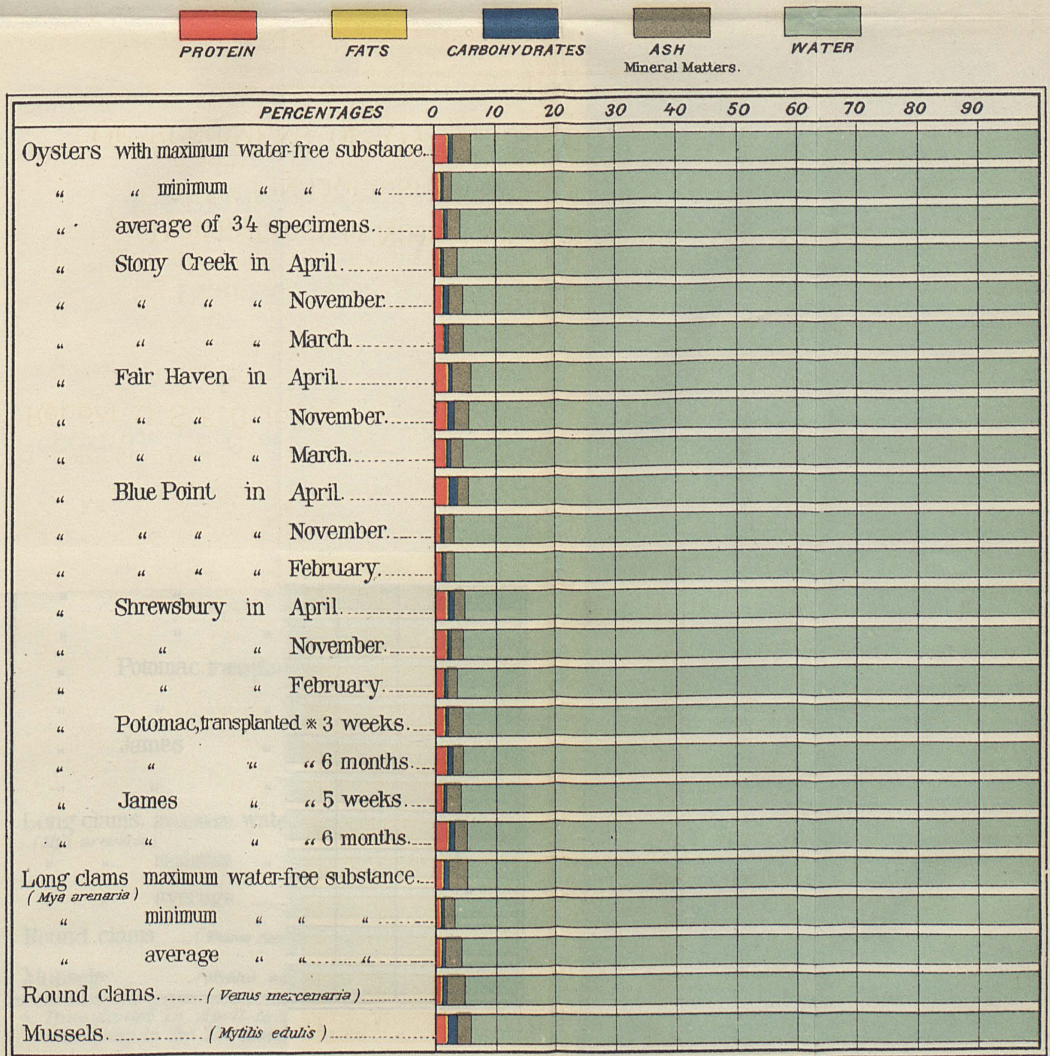


⁎ *Transplanted in April to New Haven, Conn, and taken after lying in the New Haven beds for the time indicated.*

CHART F.

PERCENTAGES OF NUTRITIVE INGREDIENTS AND WATER IN LIQUIDS OF SHELL CONTENTS OF SPECIMENS OF OYSTERS, CLAMS, AND MUSSELS.

From different localities and from the same locality at different times.

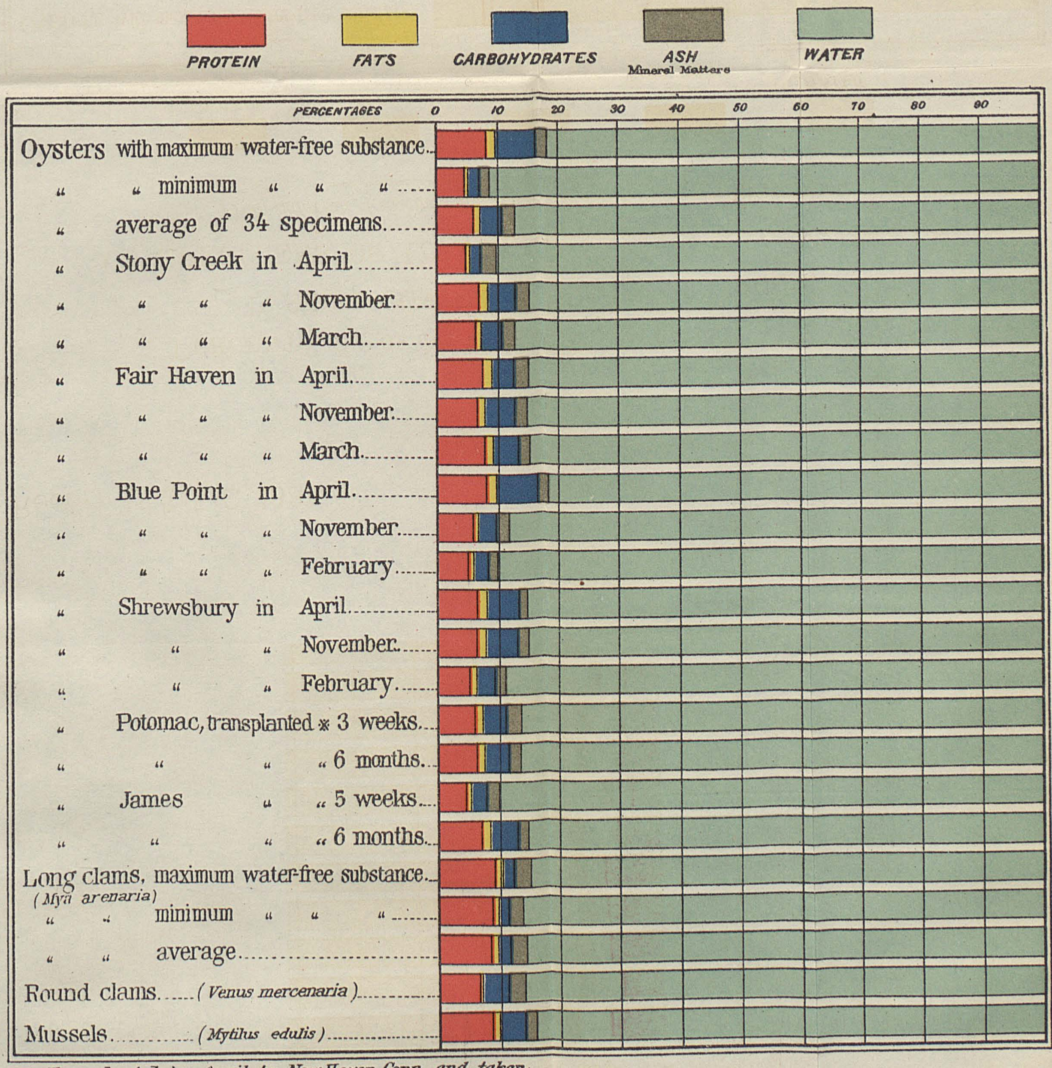


** Transplanted in April to New Haven, Conn, and then taken after lying in the New Haven beds for the time indicated.*

CHART G.

PERCENTAGES OF NUTRITIVE INGREDIENTS AND WATER IN SHELL CONTENTS, FLESH AND LIQUIDS, OF SPECIMENS OF OYSTERS, CLAMS, AND MUSSELS.

From different localities, and from the same locality at different times.

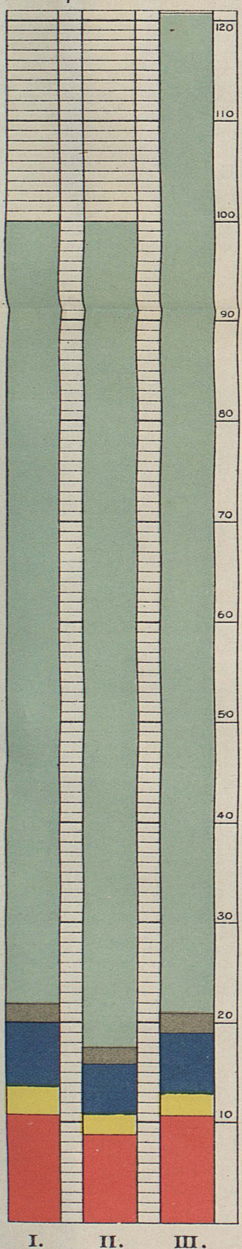


* *Transplanted in April to New Haven, Conn, and taken after lying in the New Haven beds for the time indicated.*

Chart H.

Changes in Composition of Flesh of Oysters in Floating.

Experiment 1.



Water.

Nutritive Ingredients.

MINERAL MATTERS.

Salts, e.g, Chlorides, Sulphates, etc.

CARBOHYDRATES.

Substances allied to Starch, Sugar, etc.

FATS.

Substances more or less similar to the fat of meat, butter, and the fatty and oily matters of wheat, potatoes, etc.

PROTEIN.

Flesh (muscle) forming substances like those in the "lean" of meats and fish, casein (curd) of milk, gluten of wheat, etc.

I *Constituents in 100 parts by weight before floating.*

II *Constituents in 100 parts by weight after floating.*

III *In floating, 100 parts were increased to 120.8 and 113.6 in the respective experiments.*

Experiment 2.

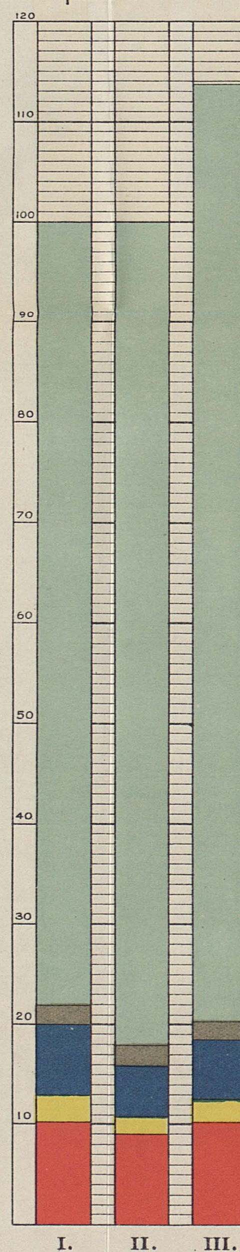


Chart I.

Nutritive Ingredients and Refuse, and Amounts of Potential Energy in Food Materials.