

Chapter 1

Fish and Shellfish as Food

Abstract

From the remains of Stone Age kitchen middens, archeologists have been able to identify the species that were most commonly eaten by early man. Humans still have a great affinity for seafood and prefer most of the same species. By the Bronze Age, people had developed skills for preserving seafood for transport over considerable distances, allowing trade of such products. Fish were preserved by cooking, drying, and later by salting. When ancient civilizations around the Mediterranean and Asia Minor expanded their trade by ship, salts and spices for preserving food became important global commodities—as they remain today. Seafood is a highly nutritious diet, offering a rich source of protein, as well as unsaturated fats, vitamins, minerals, and trace elements. Although some wild-caught species or their body organs can be naturally toxic, even lethal, today's consumer is in no danger of ingesting such toxins from farm-raised fish.

1.1 Secrets of the kitchen middens

A Neanderthal man stepping into a twenty-first century kitchen at dinner time would easily recognize the aroma of grilled fish, broiled mussels and oysters, or smoked eel as an inviting meal was prepared. There is little or no difference between the favorite seafoods of early man and those that are preferred in most modern households today. From deep in the well-preserved remains of Stone Age kitchen middens, archeologists have been able to identify the species that were the most commonly eaten at that time. In Europe, salmon, tuna, eels, and sea bass were the most typical marine or migratory species eaten by paleolithic

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humans, and trout and carps were the most popular true freshwater fish in their diet.

Further, paleontologists and marine zoologists, from their studies of fossils in marine deposits, have concluded that in general, the evolution of fish and shellfish has hardly changed these organisms over the last million or more years. This is evident from the drawings on the walls of the caves inhabited by Stone Age man and by the physical features of skeletons of fish or shells of mollusks unearthed from the large volumes of material found in the kitchen middens.

As hunters of common property resources, early tribal societies found many aquatic animals to be very accessible sources of food. Shellfish, such as oysters, mussels, and clams, were available for harvesting at low tides, and fish could be trapped, speared, and netted—all of which was probably quicker and more rewarding than catching either large wild animals or birds. Seafood would also have been easier to handle and cook than were red meats, and not quite as tough to eat.

Archeological traces of primitive cultures reveal a large number of early settlements close to the shore of the sea. Beside ancient menhirs, the large upright stone monuments erected as monoliths or groupings during the Stone Age, archeologists have found many bones of fish and shells of mollusks buried in prehistoric kitchen middens, providing firm evidence that seafood was already at that time a regular part of the diet. The same kind of identifiable remains are to be found in middens beneath the ruins of Greek and Roman occupation throughout their vast empires and under the monasteries and great churches founded in the Middle Ages. The evidence leaves no doubt that man has continued to have a great affinity for seafood for many thousands of years.

One puzzling aspect of archeological discoveries in the kitchen middens of later settlements was that the bones of marine fish were much more in evidence than those of freshwater fish, even though many of these ancient settlements were far from the coast. It would seem that freshwater fish would have been more readily available and easily trapped in inland waters. Nevertheless, perhaps these early settlers found that marine fish and shellfish naturally kept better than did their freshwater catch, or perhaps they had developed skills that allowed them to preserve fish and shellfish sufficiently for transport over considerable distances.

Such skills could have contributed to the existence of trade in marine fish and shellfish that is known to have been active from the end of the Bronze Age onward. As a result of this trade, exotic seafood was popular in Greek and Roman kitchens. Judging by the fish depicted in their mosaics and in the writings of their scholars, one of the most highly prized fish of the epicureans of that era was the herbivorous parrot wrasse. This fish was rare in the western Mediterranean, but it was consequently captured in large quantities by Roman seafarers around the Greek Islands. The species was not only brought back as a catch to be consumed directly, but also, living specimens of the wrasse were shipped home and then released along the coast of Italy. Even before the customs and social habits of the first great civilizations that influenced so much of the world were recorded, some of the more basic skills of preserving and storing



Figure 1.1 Italy, first century; marine fauna mosaic from Pompei, from the *Casa a cinque piani* (House of the Five Floors): common marine life of a rocky Mediterranean coast is portrayed in such detail that the individuals can be identified to genus and species (see Appendix, Table A4). (Courtesy of Classicalmosaics.com.)

food were discovered by early nomadic societies, as they pursued their relentless search for food.

1.2 Processing fish and shellfish

Fish and shellfish offered early human societies a rich source of animal protein to balance diets that were typically high in root and cereal foods. However, it would have been obvious to all early coastal dwellers that any seafood was an extremely perishable food commodity. If a fish was not eaten soon after it was caught, the flesh was quickly covered on the surface with colorful growths of molds and yeasts, which would have produced a noxious, rancid smell as chemical and enzymatic actions broke down the oils and fats, turning the flesh to a watery pulp. In turn, the odor would have attracted flying insects and scavengers. If these early hunting societies were to survive, they had to be able to carry food along with them and to safely store it to sustain themselves in times when conditions were poor and hunting was not possible. Consequently, there was a burden on them to discover measures that would at least slow down the processes of deterioration in their foods.

Preservation of any type of food requires some form of processing or curing to arrest microbiological or biochemical actions that accelerate decomposition.

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Curing can also change certain properties of the tissues or flesh without necessarily causing the loss of the food's natural palatability. In some cases, curing can enhance palatability in interesting ways that could add an individual appeal for discerning consumers.

The most basic form of curing is cooking, or heating food directly over an open fire. Cooking foods in this simple way began in the Stone Age, when shellfish were scavenged from the beaches at low tide, and fish were harpooned with wooden spears tipped with arrowheads made of flint. The high temperatures associated with cooking kill the bacteria and thereby retard the processes of decay for one or two days. With the coming of the Bronze Age and tough metal pots, the same effect was achieved by boiling food in water.

A more subtle form of curing is drying, which reduces microbial decay and the buildup of molds. Fish can be dried in the sun or in the wind by simply opening them and leaving them exposed for a time, either on the ground or spread out on crude trestles. Neolithic fishermen, who were the first to use boats and who made fish hooks from animal bones and the parts of large insects, also were culturally advanced in their storage of dried foods. Such basic fish-drying practices are all still evident in primitive jungle societies surviving in remote parts of Southern Asia and South America to this day.

Drying can also be achieved artificially by using heat from a fire. Experimenting with this practice could have introduced primitive fish-eaters to the delights of smoking. In addition to destroying bacteria and proteolytic enzymes while the flesh is being partially cooked, smoking induces chemical processes that can introduce a new taste, flavor, or aroma to the flesh, usually characteristic of the different woods that are chosen as fuels.

The last and most important method of curing is dry salting, which first began to appear among Bronze Age cultures. By this period in history, fishermen of Mesopotamia and Egypt were using woven nets and fishing lines with metal hooks. Dry salting is a simple and effective technique, and it is one that can be applied in diverse ways to suppress microbial growth. Salts in crystal form rubbed into the flesh before it is dried can preserve products for many weeks. If salts are applied instead in solutions of varying concentrations, they can pickle or ferment whole products that can be kept in pots for many months to years. Salting became very important to the early Sumerians and Egyptians. In ancient Egypt, picklers of birds and fish were artisans attached to the temples, no doubt trained by the priests responsible for the mummification of the country's royalty. The Romans produced garum, a concentrated fish sauce, through a process of fermenting salted, pickled fish scraps and small whole fish. It was a very popular condiment, judging by the numbers of garum-filled amphorae that have been identified in old Roman kitchens, alongside those containing wine and olive oil.

Although these are the traditional and basic methods of preservation or processing, there are many and often subtle differences in their use by the different human societies that followed the Stone Age. For one reason or another, some of these differences would have been simply due to choice—the natural human preference for things that had good taste, texture, smell, and color of the flesh. Other differences would have been due to the geographic location of the society,

particularly because of the different climates, and consequently, the many possible types of habitation, all of which would have affected and limited the type of protection and storage used for fish.

Other differences would have been based on the local availability of the diverse raw materials for processing. Each locality offered a particular set of fish and shellfish, distinctive types of wood to fuel the fires, and a characteristic composition of salt or other spices that might have been available. Then, the fish and shellfish gathered would have varied by season: that is, at different times of the year, there could have been obvious differences in the quality, texture, color, and other characteristics of their flesh. As a result, early societies would have discovered that in general, each type of fish and shellfish had to be handled and cured quite differently. The most apparent differences were to be found in the curing of nearshore fatty fish, such as mackerels and herring. Much stronger methods of smoking and salting had to be applied to prevent the highly unsaturated fish oils from becoming oxidized and rancid. All the less oily fish and shellfish needed only milder cures.

In time, the choice of food and the preferred processing and cooking practices would have become the accepted way for all the families of a tribe. The characteristic habits of their society would have been subsequently ingrained into their traditions and customs. Finally, a few of them would have become a part of their folklore.

1.3 The importance of salt

The extent to which all these different options for preserving fish and shellfish were used depended as they do today as much on the local demand and preference as on the resources to hand. By and large, primitive coastal communities and island societies with ready access to fresh fish and shellfish all year round had little need to cure a lot of fish for their own use. That which was preserved was sun-dried, wind-dried, or smoked. Inland communities living in temperate regions without the luxury of year-round fresh fish and sunshine relied more on smoking foods for preservation. Those living close to natural solar salt pans, which were found both on the coast and in desert areas, likely would have exploited their opportunity to use salt to preserve fish.

The value of salting became most apparent at the beginning of the Iron Age. With the increasing use and size of ships, the ancient civilizations, especially those around the Mediterranean and Asia Minor, had discovered trade. With the coming of trade among societies, salts and spices for preserving food became important global commodities that enabled most fishing communities to cure and store whatever seafood was important to them, and then to trade any surplus of dried and salted fish, including salted and pickled fish in jars.

Both the Mediterranean region and Asia Minor were rich in natural salt pans and salt mines. The value of owning sources of salt was recognized by the early civilizations, so much so that the great Ptolomy family of Egypt grabbed a monopoly for itself, which helped it to become even more powerful.

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Subsequently, most of the early Egyptian sites in and around the Mediterranean came under the control of the Greeks.

For the early Greeks, fishing was not a particularly popular occupation, but as the civilization expanded its influence throughout the Mediterranean and the Black Sea, fishing and eating fish became an important part of the social lives of upper classes. Many small communities around the coast of the two seas at the center of the world's civilization thrived on the catching and trading of dried fish and salted fish with Greece. The Greek armies were known to carry salted fish in pots when they were on the march.

The Romans picked up where the Greeks left off, making fishing and salt processing important industries, which made seafood more readily available to the general public. Fishing was also becoming more skilled, and in addition to the common Mediterranean coastal fish, such as mullet, bream, and eel, the Roman kitchens were used to cooking salted tuna fish, mackerel, conger eel, amberjack, and even swordfish. Few of the ancient recipes used freshwater fish, although it is known that fishermen of the lakes and rivers to the north of Italy sent salted fish to Rome.

By the Middle Ages, both salt and seafood were important commodities that were traded widely. This continued for another five hundred years, until the railways of the Industrial Revolution made possible the overnight deliveries of fresh seafood to the capital cities of Europe. But also during the Middle Ages, freshwater fish became a regular part of the diet of the feudal lords and the more educated people. For the first time, bones of freshwater fish were evident in kitchen middens of the large estates and religious monasteries. Fresh fish played an increasingly important role in the religious life of the monks as it became more readily available, even in locations far removed from the coast. As the monks harnessed the energy of rivers and streams to power their flour mills, they discovered that the storage dams constructed to regulate the flow to the mill were useful ponds for holding trout. Subsequently, they were used to hold a new fish that the monks themselves were spreading around Europe. It was called the carp. The carp would provide them with a regular source of fresh fish, and "stew ponds" soon became a necessary adjunct to the kitchen gardens of all the new monasteries and abbeys that followed.

1.4 Seafood and its nutritional value

For the early societies who hunted for survival up and down the coast, fresh fish and shellfish must have tasted just as good as it does today. But, in addition to the good taste, and unbeknown to these early consumers, of course, seafood was a highly nutritious diet. The large resources of protein in the flesh of fish and shellfish contain many readily available amino acids, such as lysine, methionine, and tryptophan, in quantities comparable with those in eggs, meat, and milk. With their unsaturated fats, vitamins, minerals, and trace elements, all equally important to the human diet, fish and shellfish are considered to be almost as beneficial to the body as mother's milk.

Clearly, quantitative differences in nutritional composition occur among the many large groups of species, and also within groups at different times of the year. In general, freshwater and brackish-water species contain about 14% to 25% protein, whereas marine species contain 9% to 26%. Freshwater species usually have a low percentage of fat (the leanest fish have less than 2.5%), whereas some marine fish may be as high as 20% fat. Compared with animal fats, fish oils contain more polyunsaturated components and are therefore beneficial in reducing the buildup of cholesterol in blood.

Fish and shellfish are both good sources of calcium and phosphorus, but more so when small fish and crustaceans, such as soft shell crabs and shrimps, are consumed whole with bones or shell. Iron and traces of copper are also useful contributors to the general composition, as are the B-vitamins in high proportion.

1.5 Dangers of the diet

The modern but traditional preservation methods of indigenous cultures around the world today are probably indicative of great trial and error that went on in primitive societies as they perfected their processes and built up their experience in storing food. At the same time, they would have learned the hard way that some species of fish and shellfish or their body organs were highly toxic and often lethal. What no doubt was very puzzling to them was that exactly the same types of seafood were safe to eat one day and made everyone ill the next. Furthermore, they found that risks were greater at different times of the year. After harvesting and eating oysters or mussels from their usual beds on a fine midsummer day, everyone sharing the meal might have become drowsy and feverish, and their mouths could have suddenly grown numb. This mystifying experience would have occurred more frequently in summer; hot weather increases the buildup of phytoplankton capable of concentrating dangerous toxins or bacteria to levels that are harmful and sometimes poisonous.

Communities living around the Indian and Pacific Oceans would have come to know, too, that some fish were always extremely dangerous or deadly to eat. Puffer fish and trigger fish had to be carefully avoided, although in Japan the former is now recognized as a delicacy, once the viscera have been carefully removed completely intact by a skilled and licensed handler. Some common reef fish and their predators that served as part of the early islanders' diet would have been more of a challenge, because on rare occasion, individuals of species that were normally fine to eat could become deadly poisonous, when they happened to have been carrying ciguatoxin. This toxin is accumulated in the fish, moving up the food chain as herbivores that are affected are eaten in turn by carnivores, which are eaten by other carnivores, and so on. The toxin is not removed from the flesh by conventional cooking. For some early island societies that depended on seafood, the chances of eating an affected fish would have been high. In modern times, for example, the small populations inhabiting the Maldives and Kiribati Islands have the largest per capita consumption of seafood in the world

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and could therefore be more likely than others in the tropical or subtropical setting to encounter a ciguatoxic reef fish, however rare the occurrence may be in nature.

Today, the public consumer is in no danger of these or other toxins from farm-raised fish. Fish nutrition has been studied more in depth than has any other fisheries field, and manufacturing artificial fish feeds to very strict formulas is a major component of the animal feed industry. The industry is also strictly regulated, and all feed-producing countries are signatories of the United Nations Codex Alimentarius.

Most captive aquatic animals are almost entirely dependent on artificially prepared diets, together with natural foods that might be available in their enclosures. Artificial diets are invariably high in animal protein (15% to 40%, depending on the age and specific needs of the population), complemented by cereal proteins and carbohydrates, oils, and additives of minerals and vitamins. In recent years, efforts have been made to formulate diets using only polyunsaturated fats and to include approved chemical attractants and growth promoters.

Farmed fish, particularly those grown in accelerating temperature regimes, can be fatty. Unsightly excess fat is sometimes removed by greatly reducing the diet before harvest and by increasing water circulation to increase the fish's energy use.

Off-flavors, mainly caused by the direct absorption of a compound called geosmin from the water, can affect the taste of farmed products. Geosmin is produced by certain species of actinomycetes and cyanobacteria that can bloom under particular chemical and physical conditions. These earthy-muddy flavors are common in catfish and other freshwater pond fish and are now reported in some marine shrimps. These can be easily purged by maintaining stocks in high-quality geosmin-free water conditions before harvesting.

The color of the flesh of farmed aquatic animals is readily changed by additives in the diet. The salmonids, for example, are often fed carotenoid pigments in the diet for some weeks prior to harvest to redden the flesh for increased marketing appeal.

In addition to all the nutritional advantages inherent in fish and shellfish, there are other particular benefits of seafood raised on farms. The nutritional qualities of most species are preserved, because fish and shellfish from farms are almost entirely sold on the fresh fish markets, either chilled or iced. This is not true of the natural harvests. Only about one-third of the natural harvests are sold as fresh products; most are frozen into blocks, preserved in some way in cans or bottles, or reduced into commercial fish meals and oils. Another advantage is that a population of farmed fish or shellfish is invariably uniform in size, or similarly sized individuals can be conveniently harvested as needed. Uniformity is a characteristic greatly appreciated by those who first handle the products for the marketplace, because there is no sorting required for the harvest and shipping of the fish and shellfish to the processors, and standard boxes or containers can be used for more efficient transportation. At the receiving end, those who process the products can automate many of the necessary steps, such

as gutting and filleting, by using machines instead of by employing more costly hand labor.

1.6 Into history

So we must ask ourselves, where and when did the movement away from the unstable supply of strictly wild-capture fish begin? When did it change to live storing, to feeding, and then finally, to farming fish and shellfish? Is it a modern phenomenon promoted by the nineteenth century Manifest Destiny movement urging mankind to overcome nature, following Biblical tenets to “be fruitful and multiply?” Did it start in the medieval period, or even earlier in the classical periods when Roman Empires provided the wealth and leisure to experiment with raising live fish and shellfish for food? Or do the roots lie even deeper in early societies, with both the needs and desires of early civilizations to obtain fresh seafood and to transcend the unsustainable hand-to-mouth nature of the hunter/gatherers in developing civilizations? The answer actually lies in all of the above hypotheses, as we shall see.

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