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OF
THE MENHADEN.

AN ABSTRACT OF
"A HISTORY OF THE MENHADEN."

By G. BROWN GOODE.

READ BEFORE THE SARATOGA MEETING OF THE AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE, AND THE CHICAGO MEETING OF THE CENTRAL
FISH CULTURAL ASSOCIATION, AND IN AN EXTENDED FORM BEFORE
THE NEW YORK MEETING OF THE UNITED STATES
MENHADEN OIL AND GUANO ASSOCIATION.

PROVIDENCE, R. I.
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JOHN J. B. Hawley

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A SHORT BIOGRAPHY
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THE MENHADEN.

By G. BROWN GOODE,
OF MIDDLETOWN, CONN.

The herring family is represented on the Atlantic coast of the United States by ten species, all of which swim in immense schools, and several, such as the sea-herring, the shad, and the various species of the river alewives, are of great economical importance.

In abundance and value these are all surpassed by the menhaden, *Brevoortia tyrannus* (Latrobe Goode), a fish whose habits are in many respects anomalous, and concerning which very little has been known or written.

The menhaden has at least thirty distinct popular names, most of them limited in their use within narrow geographical boundaries. To this circumstance may be attributed the prevailing ignorance regarding its habits and migrations among our fishermen, which has perhaps prevented the more extensive utilization of this fish, particularly in the South.

North of Cape Cod the name "pogy" is almost universally in use, while in Southern New England the fish is known only as the "menhaden." These two names are derived from two Indian words of the same meaning; the first being the Abnaki name "pookagan," or "poghaden," which means "fertilizer," while the latter is the modification of a word which in the Narragansett

dialect meant "that which enriches the earth." About Cape Ann, "pogy" is partially replaced by "hard-head," or "hard-head shad," and in Eastern Connecticut by "bony fish." In Western Connecticut the species is usually known as the "white fish," while in New York the usage of two centuries is in favor of "mossbunker." This name is a relic of the Dutch colony of New Amsterdam, having evidently been transferred from the "scad," or "horse mackerel," *Trachurus lacerta*, a fish which visits the shores of Northern Europe in immense schools, swimming at the surface in much the same manner as our menhaden, and known to the Hollanders as the "marshbanker." New Jersey uses the New York names with its local variations, such as "bunker" and "marshbanker." In Delaware Bay, the Potomac and the Chesapeake, we meet with the "alewife," "bay wife," "pilcher" (pilchard) and "green-tail."

Virginia gives us "bug-fish," "bug-head," and "bug-shad," referring to the parasitic crustacean found in the mouths of all Southern menhaden. In North Carolina occurs the name "fat-back," which prevails as far South as Florida, and refers to the oiliness of the flesh. In this vicinity, too, the names "yellow-tail" and "yellow-tailed shad" are occasionally heard, while in Southern Florida the fish is called "shiner" and "herring." In South America among the Portuguese the name "savega" is in use. On the St. John's river, and wherever Northern fishermen are found, "menhaden" is preferred, and it is to be hoped that this name will in time be generally adopted. A number of trade names are employed by the manufacturers in New Jersey, who can this fish for food; these are "American sardine," "American club-fish," "shadine" and "ocean trout."

In 1815 the species was described by Mitchell, of New York, under the name *Clupea menhaden*, which has since been commonly accepted. A prior description by Latrobe, in 1802, long lost sight of, renders it necessary, as I have elsewhere demonstrated, to adopt the specific name *tyrannus*. The genus *Brevoortia*, of which this species is the type, was established by Gill in 1861.

The geographical range of *Brevoortia tyrannus* varies from year to year. For 1877 it was, as far as it is possible to define it in words, as follows: The wanderings of the species are bounded by the parallels of north latitude 25° and 45°; on the continen

side by the line of brackish water; on the east by the inner boundary of the gulf stream. In the summer it occurs in the coastal waters of all the Atlantic States from Maine to Florida; in winter only south of Cape Hatteras. The limits of its winter migration oceanwards cannot be defined, though it is demonstrated that the species does not occur about the Bermudas or Cuba, nor presumably in the Caribbean Sea. In Brazilian waters occurs a geographical race of the same species, *Brevoortia tyrannus*, sub-species *aurea* (the *Clupanodon aureas* of Agassiz and Spix); on the coast of Paraguay and Patagonia by *Brevoortia pectinata*; in the Gulf of Mexico by *Brevoortia patronus*.

With the advance of spring the schools of menhaden appear near our coasts in company with, and usually slightly in advance of, the other non-resident species, such as the shad, alewives, blue-fish and squeteague. The following general conclusions regarding their movements are deduced from the statements of about two hundred observers at different points on the coasts from Florida to Nova Scotia:

At the approach of settled warm weather they make their appearance in the inshore waters. It is manifestly impracticable to indicate the periods of their movements except in an approximate way. The comparison of two localities distant apart one or two hundred miles will indicate very little. When wider ranges are compared there becomes perceptible a certain proportion in the relations of the general averages. There is always a balance in favor of earlier arrivals in the more southern localities. Thus it becomes apparent that the first schools appear in Chesapeake Bay in March and April; on the coast of New Jersey in April and early May; on the south coast of New England in late April and May; off Cape Ann about the middle of May, and in the Gulf of Maine in the latter part of May and the first of June. Returning, they leave Maine in late September and October; Massachusetts in October, November and December, the latest departures being those of fish which have been detained in the land-locked bays and creeks; Long Island Sound and vicinity in November and December; Chesapeake Bay in December, and Cape Hatteras in January. Farther to the south they appear to remain more or less constantly throughout the year.

A strange fact is that their Northern range has become considerably restricted within the past twenty-five years. Perley, writing in 1852, stated that they were sometimes caught in considerable numbers about St. John's, N. B., and there is abundance of other testimony to the fact that they formerly frequented the Bay of Fundy in its lower parts. At present the eastward wanderings of the schools do not extend beyond Isle Au Haut and Great Duck Island, about forty miles west of the boundaries of Maine and New Brunswick. They have not been known to pass these limits for ten or fifteen years. They have this year hardly passed north of Cape Cod, and forty or more steamers, which have usually reaped an extensive harvest on the coast of Maine, have been obliged to return to the fishing-grounds of Southern New England, where menhaden are found as abundantly as ever.

I have elsewhere shown the arrival of the menhaden schools to be closely synchronous with the period at which the weekly average of the surface temperatures of the harbors rises to 51° F. That they do not enter waters in which, as about Eastport, Me., the midsummer surface temperatures, as indicated by monthly averages, fall below 51° F., and that their departure in the autumn is closely connected with the fall of the thermometer to 51° and below. In 1877 a cold summer seemed to threaten the success of the Maine menhaden fisheries. In September and October, however, the temperatures were higher than the corresponding months of the previous year, and the scarcity of the early part of the season was amply amended for.

The season of 1878 in Maine was fairly successful, the three summer months being warmer than in 1877, but cooler than in 1876. The absence of the menhaden schools north of Cape Cod in 1879 is also easily explained by the study of temperatures, the water of the Gulf of Maine, as indicated by the observations made in Portland harbor. The averages for the three summer months are as follows, the numerator of the fraction being the average surface temperature, the denominator that of the bottom: 1876, 62.5° - 57.9° ; 1877, 58.5° - 56.7° ; 1878, 61.5° - 58.1 ; 1879, 56.1° - 54.6° .

The average for the three summer months of 1879 is less than that of June, 1876.

This may perhaps be explained by a study of ocean temperatures. In August, 1878, there was a very rapid fall in the temperature of the surface in the Gulf of Maine, so that the average temperature of that month was less than that of July, instead of being higher, as is usual. This may have had the effect of driving the fish into the warmer water of the bays and estuaries. The monthly averages for 1876, 1877, 1878 and 1879 are as follows:

1876—June, 56.9°-54.0°; July, 66.7°-59.4°; August, 63.9°-60.4°.
1877—June, 54.9°-53.3°; July, 58.1°-56.3°; August, 62.4°-60.6°.
1878—June, 56.8°-55.2°; July, 66.9°-59.3°; August, 60.7°-59.9°.
1879—June, 52.9°-51.7°; July, 55.9°-54.1°; August, 59.6°-58.

The arrival of the menhaden is announced by their appearance at the top of the water. They swim in immense schools, their heads close to the surface, packed side by side, and often tier above tier, almost as closely as sardines in a box. A gentle ripple indicates their position, and this may be seen at a distance of nearly a mile by the lookout at the mast-head of a fishing vessel, and is of great assistance to the seiners in setting their nets. At the slightest alarm the school sinks toward the bottom, often escaping its pursuers. Sailing over a body of menhaden swimming at a short distance below the surface, one may see their glittering backs beneath, and the boat seems to be gliding over a floor inlaid with blocks of silver. At night they are phosphorescent. Their motions seem capricious and without a definite purpose; at times they swim around and around in circles; at other times they sink and rise. While they remain thus at the surface after the appearance of a vanguard they rapidly increase in abundance until the sea appears to be alive with them. They delight to play in inlets and bays, such as the Chesapeake, Peconic and Narragansett Bays, and the narrow fiords of Maine. They seem particularly fond of shallow waters protected from the wind, in which, if not molested, they will remain throughout the season, drifting in and out with the tide. Brackish water attracts them, and they abound at the mouths of streams, especially on the Southern coast. They ascend the St. John's River more than thirty miles; the St. Mary's, the Neuse, the York, the Rappahannock, the Potomac, nearly to Washington, and the Pawtuxent to Marlboro. They come in with or before

the shad, and are very troublesome to the fishermen by clogging their nets. I am not aware that this difficulty occurs in Northern rivers, though they are found in the summer in the Hudson and its tributaries, the Housatonic, Mystic, Thames and Providence Rivers, in the creeks of Cape Cod, and at the mouth of the Merrimac. A curious instance of capriciousness in their movements occurred on the coast of Maine, where much alarm was felt, because their habits were thought to have been changed through the influence of seining. The shore fishermen could obtain none for bait, and vessels followed them far out to sea, capturing them in immense quantities forty miles from land. The fisheries had produced no such effect south of Cape Cod, and it was quite inexplicable that their habits should have been so modified in the North. In 1878, however, after ten years or more, they resumed their former habits of hugging the shores, and the menhaden fishery of Maine was carried on, for the most part, in the rivers.

Why the schools swim at the surface so conspicuous a prey to men, birds and other fishes is not known. It does not appear to be for the purpose of feeding; perhaps the fisherman is right when he declares that they are playing.

An old mackerel fisherman thus describes the difference in the habits of the mackerel and menhaden: "Pogies school differently from mackerel; the pogy slaps with his tail, and in moderate weather you can hear the sound of a school of them, as first one and then another strikes the water. The mackerel go along 'gilling,'—that is, putting the sides of their heads out of the water as they swim. The pogies make a flapping sound; the mackerel a rushing sound. Sometimes in calm and foggy weather you can hear a school of mackerel miles away." They do not attract small birds as do the schools of predaceous fish. The fish-hawk often hovers above them, and some of the larger gulls occasionally follow them in quest of a meal. About Cape Cod one of the gulls, perhaps *Larus argentatus*, is called "pogy gull."

On warm, still, sunny days, the fish may always be seen at the surface, but cold or rainy weather and prevailing northerly or easterly winds quickly cause them to disappear. When it is rough they are not so often seen, though schools of them

frequently appear when the sea is too high for fishermen to set their nets. The best days for menhaden fishing are when the wind is northwesterly in the morning, dying out in the middle of the day, and springing up again in the afternoon from the south-west, with a clear sky. At the change of the wind on such a day they come to the surface in large numbers.

A comparison of the weather upon the menhaden and the herring yields some curious results. The latter is a cold water species. With the advance of summer it seeks the North, returning to our waters with the approach of cold. The menhaden prefers the temperature of 60° or more; the herring 55° and less. When the menhaden desert the Gulf of Maine they are replaced by the herring. Cold weather drives the former to the warmer strata, while it brings the latter to the surface. The conditions most favorable on our coast for the appearance of herring on the surface, and which correspond precisely with those which have been made out for the coast of Europe, are least so for the menhaden.

Their winter habitat, like that of the other cold water absentees, has never been determined. The most plausible hypothesis supposes that instead of migrating toward the tropics or hibernating near the shore, as has been claimed by many, they swim out to sea until they find a stratum of water corresponding to that frequented by them during their summer sojourn on the coast.

This is rendered probable by the following considerations: 1. That the number of menhaden in Southern waters is neither less in the season of their abundance nor greater in that of their absence from the North coast. 2. That there are local varieties of the species, distinguished by physical characters almost of specific value, by differences in habits, and in the case of the Southern schools by the universal presence in the mouth of a crustacean parasite, which is never found with those north of Cape May. 3. That the same schools usually reappear in the same waters in successive years. 4. That their very prompt arrival in the spring suggests their presence in waters near at hand. 5. That their leanness when they first appear renders it evident that they have had no food since leaving the coast in autumn. The latter consideration, since they are bottom feeders,

is the strongest confirmation of the belief that their winter home is in the mid-oceanic sub-strata.

As is indicated by the testimony of a large number of observers, whose statements are elsewhere reviewed at length, the menhaden is by far the most abundant species of fish on the Eastern coast of the United States. Several hundred thousands are frequently taken in a single draft of a purse-seine. A firm in Milford, Connecticut, captured in 1870, 8,800,000; in 1871, 8,000,000; in 1872, 10,000,000; in 1873, 12,000,000; in 1877, three sloops from New London seined 13,000,000. In 1877, an unprofitable year, the Pemaquid Oil Company took 20,000,000, and the town of Boothbay alone 50,000,000. There is no evidence whatever of any decrease in their numbers, though there can be in the nature of the case absolutely no data for comparison of their abundance in successive years. Since spawning menhaden are never taken in the nets, no one can reasonably predict a decrease in the future.

The nature of the food of the menhaden has been closely investigated; hundreds of specimens have been dissected, and every stomach examined by me has been found full of dark, greenish or brownish mud or silt, such as occurs near the mouths of rivers and on the bottoms of still bays and estuaries. When this mud is allowed to stand for a time in clear water, this becomes slightly tinged with green, indicating the presence of chlorophyl, perhaps derived from the algæ, so common on muddy bottoms. In addition to particles of fine mud, the microscope reveals a few common forms of diatoms.

There are no teeth in the mouth of the menhaden, their place being supplied by about 1,500 thread-like bristles, from one-third to three-quarters of an inch long, which are attached to the gill arches, and may be so adjusted as to form a very effective strainer; the stomach is globular, pear-shaped, with thick muscular walls, resembling the gizzard of a fowl, while the length of the coiled intestine is five or six times that of the body of the fish. The plain inference from these facts, taken in connection with what is known of the habits of the menhaden, seems to be that their food consists in large part of the sediment, containing much organic matter, which gathers upon the bottoms of still, protected bays, and also of the vegetation that grows in such

localities. Perhaps, too, when swimming at the surface with expanded jaws, they are able to gather nutritious food which floats on the water.

The rapid increase in size and fatness, which commences as soon as they approach our shores, indicates that they find an abundant supply of some kind of food. The oil manufacturers report that in the spring a barrel of fish often yields less than three quarts of oil, while late in the fall it is not uncommon to obtain five or six gallons.

There is still some mystery about their breeding habits; thousands of specimens have been dissected since 1871 without the discovery of mature ova. In early summer the genitalia are quite undeveloped, but as the season advances they slowly increase in size and vascularity. Among the October fish a few ovaries were noticed in which the eggs could be seen with the naked eye. A school of large fish driven ashore in November in Delaware Bay by the blue-fish contained spawn nearly ripe, and others taken at Christmas-time in Provincetown harbor, evidently stragglers accidentally delayed, contained eggs quite mature. Young menhaden from one to three inches in length and upward are common in summer south of New York, and those of five to eight inches in late summer and autumn in the southern part of New England. These are in schools and make their appearance suddenly from the open ocean like the adult fish. Menhaden have never been observed spawning on the Southern coast, and the egg-bearing individuals when observed are always heading out to sea. These considerations appear to warrant the theory that their breeding-grounds are on the offshore shoals which skirt the coast from Georges Banks to the Florida Keys.

The fecundity of the menhaden is very great, much surpassing that of the shad and herring. The ovaries of a fish taken in Narragansett Bay, November 1, 1879, contained at least 150,000 eggs.

Among the enemies of the menhaden may be counted every predaceous animal which swims in the same waters. Whales and dolphins follow the schools and consume them by the hogshead; sharks of all kinds prey upon them largely; one hundred have been taken from the stomach of one shark; all the large carnivorous fishes feed upon them. The tunny is the most destructive.

"I have often," writes a gentleman in Maine, "watched their antics from the mast-head of my vessel; rushing and thrashing like demons among a school of fish; darting with almost lightning swiftness, scattering them in every direction, and throwing hundreds of them in the air with their tails." The pollock, the whiting, the striped bass, the cod, the squeteague and the gar-fish are savage foes. The sword-fish and the bayonet-fish destroy many, rushing through the schools and striking right and left with their powerful swords. The blue-fish and bonito are, however, the most destructive enemies, not even excepting man. These corsairs of the sea, not content with what they eat, which is of itself an enormous quantity, rush ravenously through the closely crowded schools, cutting and tearing the living fish as they go, and leaving in their wake the mangled fragments. Traces of their carnage remain for weeks in the great "slicks" of oil so commonly seen on smooth water in summer. Professor Baird, in his well-known and often quoted estimates of food annually consumed by the blue-fish, states that probably ten thousand millions of fish or twenty-five millions of pounds daily, or twelve hundred million millions of fish and three hundred thousands of millions of pounds, are much below the real figures. This estimate is for the period of four months in the middle of the summer and fall, and for the coast of New England only.

Such estimates are professedly only approximations, but are legitimate in their way, since they enable us to appreciate more clearly the luxuriance of marine life. Applying similar methods of calculation to the menhaden I estimate the total number destroyed annually on our coast by predaceous animals at a million million of millions, in comparison with which the quantities destroyed by man yearly sink into insignificance.

It is not hard to surmise the menhaden's place in nature; swarming our waters in countless myriads, swimming in closely packed, unwieldy masses, helpless as flocks of sheep, near to the surface and at the mercy of every enemy, destitute of means of defence and offence, their mission is unmistakably to be eaten.

In the economy of nature certain orders of terrestrial animals, feeding entirely upon vegetable substances, seem intended for one purpose,—to elaborate simple materials into the nitrogenous tissues necessary for the food of other animals, which are wholly

or in part carnivorous in their diet; so the menhaden, feeding upon otherwise unutilized organic matter, is pre-eminently a meat-producing agent. Man takes from the water every year eight or nine hundred millions of these fish, weighing from two hundred to three hundred thousand tons, but his indebtedness does not end here. When he brings upon his table blue-fish, bonitoes, weak-fish, sword-fish, or bass, he has before him usually menhaden flesh in another form.

The commercial importance of the menhaden has but lately come into appreciation. Twenty-five years ago, and before, it was thought to be of very small value. A few millions were taken every year in Massachusetts Bay, Long Island Sound and the inlets of New Jersey. A small portion of these were used for bait; a few barrels occasionally salted in Massachusetts to be exported into the West Indies. Large quantities were ploughed into the soil of the farms along the shores, stimulating the crops for a time, but in the end filling the soil with oil, parching it and making it unfit for tillage.* Since that time manifold uses have been found. As a bait-fish this excels all others; for many years much the greater share of our mackerel was caught by its aid,

* Professor Trumbull tells us that the Indian names of *Brevoortia*, "menhaden" and "poghaden" (pogy), mean "fertilizer," that which manures, and that the Indians were accustomed to employ this species, with others of the herring tribe (*aumsuog* and *munna-whateaug*), mostly the alewife (*Pomolobus sp.*), in enriching their corn-fields. Thomas Morton wrote in 1632 of Virginia: "There is a fish (by some called shadds, by some allizes) that at the Spring of the yeare passe up the rivers to spawn in the ponds, & are taken in such multitudes in every river that hath a pond at the end that the inhabitants dounge their grounds with them. You may see in one township a hundred acres together, set with these fish, every acre taking 1,000 of them, & an acre thus dressed will produce and yeald as much corne as three acres without fish; & (least any Virginea man would inferre hereupon that the ground of New England is barren, because they use no fish in setting their corne, I desire them to be remembered, the cause is plaine in Virginea) they have it not to sett. But this practice is onely for the Indian maize which must be set by hands), not for English grain: and this is, therefore, a commodity there."

This passage is very interesting, showing the use of fish fertilizers in Virginia two hundred and fifty years ago or more, and, from what is known of the habits of the herring family in Virginia rivers and the persistency of local names, there can be little doubt that many menhaden were used among the fertilizing fish, though "shadds and allizes" doubtless includes the shad (*Alosa sapidissima*), the mattowocca (*Pomolobus mediocris*), the alewife (*Pomolobus vernalis* and *P. æstivalis*), and the thread-herring (*Dorosoma cepedianum*), all of which are common in spring in the Potomac and other rivers which empty into Chesapeake Bay.

In Governor Bradford's "History of Plimoth Plantation" an account is given of the early agricultural experiences of the Plymouth colonists. In April, 1621, at the close of the first long dreary winter, "they (as many as were able) began to plant their corne, in which service Squanto (an Indian) stood them in great stead, showing them both ye manner how to set it and after how to dress and tend it. Also he tould them, axcepte they got fish & set with it (in these

while the cod and halibut fleet use it rather than any other fish when it can be procured. The total consumption of menhaden for bait, 1877, did not fall below 80,000 barrels, or 26,000,000 of fish, valued at \$500,000. Ten years before, when the entire mackerel fleet was fishing with hooks, the consumption was much greater. The Dominion mackerel fleet buy menhaden bait in quantity, and its value has been thought an important element

old grounds) it would come to nothing; and he showed them yt in ye middle of April they should have store enough come up ye brooke by which they begane to build and taught them how to take it."

An allusion to the practice of the Indians in this respect may be found in George Mourt's "Relation or journal of the beginning and proceedings of the English plantation settled at Plimoth, in New England, by certain English adventurers both merchants and others." * * * "London, 1622: " "We set the last Spring some twenty acres of Indian corn, and sowed some six acres of barley and peas, and, according to the manner of Indians, we manured our ground with herrings, or rather shads, which we have in great abundance and take with great ease at our doors. Our corn did prove well, and God be praised, we had a good increase of Indian corn, and our barley indifferently good." * * * *

Again, in Edward Johnson's "Wonder-working Providence of Sion's Saviour in New England, Being a Relation of the firste planting in New England in the yeere 1628, London, 1654," written in 1652, the author says: "But the Lord is pleased to provide for them [the colonists] great store of fish in the Spring time, especially alewives, about the bignes of a herring. Many thousands of these they used to put under their Indian corn, which they plant in hills five foot assunder; and assuredly when the Lord created this corne, hee had a special eye to supply these his people's wants with it, for ordinarily five or six grains doth produce six hundred."

Menhaden do not appear to have been much used by agriculturists of Cape Cod in the beginning of this century, though the old record shows that the horse-shoe crab and sea-weed were extensively applied.

In 1792, the Hon. Ezra L. Hommedieu, of New York, published a paper in the New York Agricultural Transactions, which gives somewhat more accurate data and directions concerning the use of fish as a fertilizer. He says: "Experiments made by using the fish called menhaden or mossbankers as a manure have succeeded beyond all expectation. * * * In dunging corn in the holes, put two in a hill, on any kind of soil where corn will grow, and you will have a good crop." He recommends them as a top-dressing for grass. "Put them on a piece of poor loamy land, at the distance of fifteen inches from each other. * * * And by their putrefaction they so enrich the land that you may mow about two tons per acre." But he adds very wisely: "How long this manure will last has not been determined." He gives in his quaintly interesting way an account of "an experiment made the last Summer by one of my near neighbors, Mr. Tuthill, in raising vegetables with this fish manure," which is worth citing as an illustration of the curious combinations of truth and error which, in their lack of definite knowledge of the laws of plant growth and the action of manures, the theorizers of that time invented.

The following order from the records of the town of Ipswich, Mass., May 11, 1644, illustrates, in a comical way, the customs of using fish for manure in these early days:

"It is ordered that all doggs, for the space of three weeks after the publishing hereof, shall have one legg tyed up, and if such a dogg shall break loose and be found doing any harm, the owner of the dogg shall pay damage. If a man refuse to tie up his dogg's legg, and hee bee found scraping up fish in a cornfield, the owner thereof shall pay twelve pence damage beside whatever damage the dogg doth. But if any fish their house lotts and receive damage by doggs, the owners of those house lotts shall bear the damage themselves."

in framing treaties between our government and that of Great Britain.

As a food resource it is found to have great possibilities. Many hundreds of barrels are sold in the West Indies, while thousands of barrels are salted down for domestic use by families living near the shore. In many sections they are sold fresh in the market. Within six years there has sprung up an important industry, which consists in packing these fish in oil, after the manner of sardines, for home and foreign consumption. In 1874 the production of canned fish did not fall below 500,000 boxes.

The discovery made by Mr. S. L. Goodale, that from these fish may be extracted, for the cost of carefully boiling them, a substance possessing all the properties of Liebig's "Extract of Beef," opens up a vast field for future development. As a food for the domestic animals in the form of "fish meal," there seems also to be a broad opening. As a source of oil, the menhaden is of more importance than any other marine animal. Its annual yield usually exceeds that of the whale (from the American fisheries) by about 200,000 gallons, and in 1874 did not fall far short of the aggregate of all the whale, seal and cod oil made in America. In 1878 the menhaden oil and guano industry employed capital to the amount of \$2,350,000, 3,337 men, 64 steamers, 279 sailing vessels, and consumed 777,000,000 of fish; there were 56 factories, which produced 1,392,644 gallons of oil, valued at \$450,000, and 55,154 tons of crude guano, valued at \$600,000; this was a poor year. In 1874 the number of gallons produced was 3,373,000; in 1875, 2,681,000; in 1876, 2,992,000; in 1877, 2,427,000. In 1878 the total value of manufactured products was \$1,050,000; in 1874 this was \$1,809,000; in 1875, \$1,582,000; in 1876, \$1,671,000; in 1877, \$1,608,000. It should be stated that in these reports only four-fifths of the whole number of factories are included. The refuse of the oil factories supplies a material of much value for manures. As a base for nitrogen it enters largely into the composition of most of the manufactured fertilizers. The amount of nitrogen derived from this source in 1875 was estimated to be equivalent to that contained in 60,000,000 pounds of Peruvian guano, the gold value of which would not have been far from \$1,920,000. The yield of the menhaden fishery in pounds is probably triple that of any other

carried on by the fishermen of the United States. In the value of its products it is surpassed only by three; the cod fishery, which in 1876 was estimated to be worth \$4,826,000; the whale fishery, \$2,850,000, and the mackerel fishery, \$2,275,000,—the value of the menhaden fishery for this year being \$1,658,000.

In estimating the importance of the menhaden to the United States, it should be borne in mind that its absence from our waters would probably reduce all our other sea fisheries to at least one-fourth their present extent.