

## XX.—NOTES ON THE NATURAL HISTORY OF THE SHAD AND ALEWIFE.

### A.—NOTES ON THE SHAD AS OBSERVED AT BEAUFORT HARBOR, NORTH CAROLINA, AND VICINITY.

By H. C. YARROW, M. D.

Beaufort Harbor is situated on the coast of North Carolina, about fifteen miles southwest from Cape Lookout. It communicates with Pamlico Sound to the northward through Cove Sound, and with the Atlantic Ocean by Beaufort Inlet, Onslow Bay, and a number of small inlets from Onslow Sound. The accompanying map will, perhaps, show its position better than a mere description. From its peculiar position and surroundings, having a great number of outlets, we might suppose it a favorite resort for fish of all kinds, which is indeed the case, as the locality is a noted one.

Among the fish visiting the shallow waters of this bay not the least in importance is the shad, (*Alosa præstabilis*, De Kay,) so well known as an important item of food both South and North. From the fact that the only fresh-water river leading from this body of water is small and short, we should not expect to find the shad as numerous as in more favorable localities. Indeed, the general impression among fishermen seems to be that as the schools of fish gradually work their way North early in the spring, searching for their favorite breeding-grounds, stragglers become separated from the main bodies, and are from this circumstance taken near Beaufort. However well grounded this belief may be, recent careful observation will hardly bear it out, as it is now thought by observers who have given much attention to the subject, that the fish, after leaving their breeding-grounds simply swim into deep water, not a very great distance from the mouths of their respective rivers, remaining there until the sexual instinct again impels them to re-enter. Of course, those shad hatched in the Newport River, the one mentioned, would also return. From the limited yield of the shad-fisheries at this place, I can hardly consider it at present a favorable breeding-ground, although it is stated that in former years the catch was much greater. If the fishermen's theory above named is correct in regard to stragglers, it may be possible that the few shad who enter, finding circumstances unfavorable for breeding, remain but a short time, going out to sea again soon after entering. I may here mention that the facts given below in regard to this fish are compiled from my notes taken while on duty at this point, and from the experience of a large number of fishermen with whom I have conversed.

The first shad taken near Beaufort appear about the 25th of December, and from this time until the latter part of May they are taken in more or less numbers, increasing generally toward the latter part of the season, although for some years past the largest catches have been in March.

As already stated, the number of fish captured is not very great, being about one-fiftieth, as compared to the so-called herring, (*Pomolobus pseudoharengus*;) but in making this comparison it must be remembered that this is not a good ground for the fish mentioned, nor is fishing for the herring systematically carried on to anything like the same degree it is in the waters of the Neuse River, not many miles distant. According to many observers, shad formerly were very numerous in this region, and have probably decreased 30 or 40 per cent., the reason for this diminution being, in the opinion of the fishermen, the filling up of Beaufort Inlet. In view of the fact that there still remains 14 or 15 feet of water in the channel, which is apparently sufficient to admit large schools of fish, I hardly think much credit can attach to the statement, unless some other causes operate to prevent the entrance of the fish. It may be as the channel has changed, forming shoals in some instances at right angles with the shore, the fish either coming up from the south or from the ocean, striking the shoals, are deflected off toward deep water, and thus pass the inlet. As the cause mentioned has greatly interfered with the mullet-fishing at this point, it may also have done the same with regard to other fish.

Shad taken near Beaufort, though generally small, frequently reach a length of 18 inches, such a fish weighing from 4 to 6 pounds, but the average length of those taken will not exceed 15 inches, the average weight from 3 to 4 pounds. It is supposed that about three years are required for a shad to attain its full growth, but in the absence of reliable and positive data this statement is given for what it is worth. With regard to difference of shape and rate of growth between the male and female, the latter is supposed to grow rather faster and is always the largest, having a broader back and more protuberant belly.

The different modes of entrance of these fish are through the different inlets into the sounds of this part of the coast, and their movements in entering and leaving are entirely similar to those of the so-called herring or alewife. It is a mooted question as to the winter-residence of the shad, some inclining to the belief that they remain in the warm waters of the Gulf of Mexico, while others believe that they run out to the deeper waters of the ocean. The latter theory will probably prove the correct one. The first appearance of shad at Beaufort Harbor, as has already been mentioned, occurs about Christmas, and from this time they are only scattering, until March, when the larger runs take place, but as

the runs become larger there is no increase in the size of the fish except the female; from this time the runs decrease, the fish leaving gradually, the same as they entered. So far as known the shad invariably appear each succeeding year, but there is a very marked irregularity of number and size, the last arrivals being nearly always the largest. On entering the inlets both sexes appear to be about equal in numbers, the ovaries of the females being about 3 inches long. Upon the entrance of these fish their presence is indicated by their swimming near the surface of the water, producing a ripple, the gathering near of birds, and lastly, their capture in the herring-nets. In common with very many other fish, they invariably run in with the tide, going out with its ebb, and these movements I believe to be invariable. As the female shad is not far advanced toward spawning on entering the sounds, it is but seldom the spawn is seen running from them when captured in nets, more especially as few are captured when the eggs are near maturity. It is believed this fish is strictly anadromous, that is, it regularly returns from the sea to the fresh-water rivers for spawning, and from its first appearance off the coast about December 1, it would seem that the sexual instinct, which impels it to visit fresh water, is strongest a short period anterior to this time, providing that the theory be true of their wintering in the deep waters of the ocean. At this time their rate of progression is estimated at about eight miles per hour. In regard to their stay in fresh water, it is probably not later than the last of May, as after this time but few are seen. At the locality under discussion, though quite a common notion, not at all likely to prove true, it is said no spent shad have ever been taken, and that but few ever live to get back to the sea, not so much on account of their feebleness after spawning, but on account of their being nearly all captured. As to the habits at this time, no difference has been observed in the sexes. In coming in the breeding-grounds, all aged fish are probably seen together, although many persons state that yearlings do not herd with older fish, and in fact remain in rivers for over a year after hatching, although as yet it has been deemed almost impossible to determine accurately their ages. The most favored localities by these fish are in deep water, with a fair running current, although for spawning they prefer shallow, sandy ground, where the water is warm, not over 16 to 20 feet deep. After spawning shad no longer keep together in schools, but scatter and make their way from the breeding-grounds singly or a few together. This statement, though not positively proven, is believed to be correct.

With regard to friends and enemies among other fish, they appear to possess few of either, though herring and rock-fish are frequently found in their company. They neither prey upon or suffer from the attacks of other fish, their principal food appearing to be sought in small pebbles and gravel, and is probably small crustacea, and perhaps

algæ, as I have noticed a greenish substance in their stomachs; the amount is doubtless small, as the stomachs are nearly always found empty. The only interference in spawning is caused by traps and nets and unusual floods of water which wash gravel over the spawn, thereby destroying it.

It is stated, and generally believed by fishermen and others, that shad begin to breed when one year old, and are able to breed for one year only; this statement cannot, I believe, be considered as reliable, as Mr. Milner has found in the ovaries of spent shad the undeveloped eggs of succeeding seasons. During the spawning-season no well-marked change of appearance has been noticed, except the larger belly of the female, and a greater brilliancy of general coloration. The act of spawning seriously affects the shad in different ways; it produces emaciation and weakness not only in the female, but male fish, and deteriorates their flesh, rendering it flabby and tasteless; these results are due not only to the propagation act, but to the amount

physical energy necessarily expended in reaching the head-waters of rivers, their favorite spawning-grounds. In the act of spawning the males and females appear to run indiscriminately together, although Mr. Lyman, of Massachusetts, has seen them at this time paired, and it is but seldom the water is seen colored with the milt of the male. The most favorable temperature for hatching is warm, the eggs being laid near the surface of the water. The size of the individual egg is larger than that of the pseudo herring, and from 100,000 to 150,000 is the number estimated for each female. The eggs when spawned sink to the bottom, and are not attached to stems or gravel floating freely in the currents; no nest of any kind being built by either male or female, nor do they watch the eggs until hatched, which event takes place late in the season, probably June or July. The time required for hatching depends mainly on the temperature of the water, from seventy hours to six days being required. Of the total number of eggs laid, it is estimated by fishermen that probably one-tenth are hatched; this I believe to be a large estimate, and of the young reaching maturity, not more than one-fifth survive. From evidence received, it is believed a much smaller number are hatched, but a larger portion reach maturity.

The rate of growth is said to be about 4 or 5 inches per annum; but this statement has not been confirmed by personal observation. After hatching, the young fish receive no care from either parent, and suffer greatly from the attacks of other fish. In fact, there appears to be no parental instinct whatever, as shad are known to have devoured their own eggs. It is but seldom the young fish are seen after hatching, or if seen, are not recognized in the waters near Beaufort, although observed in other streams. They appear to live on similar food to their parents.

No steps, thus far, have been taken by the authorities of North Carolina to increase the abundance of this fish by artificial breeding, although a few public-spirited gentlemen of New Berne, N. C., are trying to influence local legislation with a view to this laudable object.\* Legislation upon the subject of preserving the fish-supply has received its full share of attention in the southern seaboard States, but the law is practically a dead letter.

No disease has ever been noticed prevailing as an epidemic, nor do parasites as a rule infest shad; although occasionally sea-lice are found hanging near the gills.

The only two methods of capturing shad in this locality are with draw and gill-nets; the former being from 150 to 500 yards long, 8 to 16 feet deep, with a mesh of 2½ inches; the latter, 25 yards long, 12 feet deep, with a 3-inch mesh. Although, undoubtedly, shad will bite at a hook in some of the northern rivers, the experiment has never been properly tried at Beaufort, to my knowledge. The average day's catch, in a fair season, for 200 yards of net is about 30 fish, but frequently is much less. The most favorable time of tide for fishing is low water, just at the time the fish are moving least.

The disposition made of this fish is as follows: but a small portion of the catch is eaten on the spot, as they command high prices, and it pays the fisherman better to dispose of them in the inland towns. Probably three-fourths are thus disposed of. It is considered the best food-fish that swims, and is eagerly sought for by all classes of people in its fresh state, smoked, and salted. In warm weather, although the flesh is fine and hard, after six hours decomposition rapidly ensues, rendering it unfit for food. Shad have always commanded at this point high prices, having been sold for \$1.50 per pair, wholesale, although the average price is about 50 cents. These rates are a little higher than before the war. The supply of shad is so small about Beaufort that none are exported, the principal market being New Berne, N. C., and it is but seldom that fishermen feel justified in making any extensive preparations for its capture, most of those secured being found in the so-called herring-nets.

In view of the facts given above, I would hardly feel justified in recommending that any means should be taken to increase this fish in Beaufort Harbor, its inlets, and sounds; the geographical and natural advantages not being such as would justify either the expense or trouble, more particularly as the Neuse, which is not far distant, and communicates with the Newport River, has already been well stocked.

FORT MACON,

*Beaufort Harbor, North Carolina, December 5, 1871.*

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\*Since the above was written the United States Fish Commissioner, Professor Baird, has thoroughly investigated the subject of the shad-supply of the southern rivers, and in 1873 placed in these waters a large number of young shad, hatched at New Berne, N. C., by Seth Green.

## B—NOTES ON THE SHAD, AS OBSERVED IN THE DELAWARE RIVER.

By J. H. SLACK, M. D.

### 1.—THE IMPORTANCE OF THE SHAD AS A FOOD-FISH.

Among the fishes of the eastern coast of North America the shad stands pre-eminent. From South Carolina to the Bay of Fundy they are found in every river, and the number annually captured must amount to many millions; the catch in the Delaware River alone, during the season of 1872, being at least two and a half millions.

### 2.—THE DECREASE IN THE DELAWARE.

The catch in the same river, however, varies greatly from year to year, and the reason for this is most probably as follows: Repeated experiments have shown that three years are required to mature the female fish, though the young males, called *offal-fishes* and *rebel-shad*, return during the second season. A heavy freshet during the period of spawning may bring down upon the spawn torrents of liquid mud, smothering the ova and destroying the life of the embryo fishes. The results of this will not be apparent until the third season. Unfortunately full and accurate statistics for a series of years are wanting, save in the case of one fishery, that of Dr. B. P. Howell, of Woodbury, New Jersey. This fishery has been in the possession of one family since prior to the year 1700, and a careful record of each haul of the seine has been kept. From this record it would appear that until the introduction of the gill-nets, 1820-'25, the catch averaged about 130,000 per annum.

Not to enter into detailed statements, but dividing the period between 1818 and 1873 into four cycles, each of which may be taken as representative of the intervening period, we have:

Average catch, 1818 to 1822, 131,000 per annum.

Average catch, 1845 to 1849, 66,890 per annum.

Average catch, 1865 to 1869, 60,739 per annum.

Average catch, 1870 to 1873, less than 25,000 per annum.

The season of 1873 did not pay expenses. But not only have these fishes decreased in numbers, but also in size. In 1843 shad of seven and eight pounds weight were by no means uncommon, and the average run was between five and five and a half pounds. Now in the Delaware River a four-pound fish is a curiosity. A catch is recorded as having been made near Burlington, New Jersey, in 1843, of three hundred and seventeen shad, averaging over six pounds each. Forty shad then filled a pork-barrel, mackerel-barrels not being in use. Over a hundred of the present deteriorated fishes are now required for this purpose.

### 3.—THE CAUSES OF DECREASE.

The cause of this is evident. The size of net-mesh in the river has been greatly reduced; only the smaller fishes can pass up the river

to their spawning-grounds, and from these puny parents nought but small puny offspring can be propagated.

The cause of decrease in the number of fishes taken can, I think, be placed under the following heads:

1. Erection of insurmountable dams: 2. Destruction of young fry: 3. Destruction of seed-fishes: 4. Destruction of spawn.

(3 a.) *Erection of dams.*—The erection of an insurmountable dam, cutting off parent fish from their wonted spawning-grounds, has been frequently followed by the total disappearance of the fishes from even the lower reaches of the river. A notable example of this took place upon the erection of the dam at Fairmount, Philadelphia. Before this large numbers of shad were taken in the reach of the river between the falls and its mouth. In a few years they had utterly vanished.

I am aware that it is the general belief that the fishes were driven away by the coal-tar thrown into the river from the city gas-works, but careful investigation has shown that shad-fishing was extinct several years previous to the construction of the gas-works.

A fish-way, capable of carrying shad, has long been a desideratum. Great hopes are entertained of the capabilities of that recently erected by Mr. Brackett at Holyoke, but the matter is still but an experiment.

Shad are taken in large numbers directly below the Lackawaxen Dam upon the Delaware; but few, if any, ascend beyond this point. However, in this case there are ample spawning-grounds below. Should any of the new plans for fish-ways now before the public prove a success the removal of these impediments is but a work of time.

(3 b.) *Destruction of fry.*—Few persons have any idea of the immense quantity of young fishes destroyed on their way to the sea. In our more northern rivers, with which I am best acquainted, the number devoured by carnivorous fishes is enormous. In 1870 a large number of young rock-fishes were examined, and in every case young shad were found in their stomachs. From one fish, eighteen inches in length, seven young shad were taken.

Fish-baskets destroy millions. In 1871 I made a careful and thorough examination of the upper waters of the Delaware River, for the purpose of investigating this point. The facts elucidated were astounding. It was ascertained that a scoop-shovel, with which to shovel out the dead young shad which accumulated in the basket, was an important part of the fishermen's equipment. One proprietor acknowledged that as much as a two-horse load of dead young shad had been shoveled from his basket during a single day. I am happy to state that through the active exertions of the fish-police these engines of destruction have entirely disappeared from the River Delaware, and I believe also from the Susquehanna, though they still abound in the more southern streams. The good effect of their destruction in the Delaware is already shown by the fact that the number of young shad seen descending that river during the past autumn has been far greater than ever previously noticed. Wing-

dams and water-power sluices, by carrying the young fishes into turbine-wheels and feeders of canals, carrying them into locks, where, as a witness remarked, they are *churned* to death by the rush of waters against the flood-gates, also contribute to destroy the fry.

(3 c.) *Destruction of seed-fishes.*—Under the name seed-fishes I would include parent shad during the season of actual spawning; in the latitude of 41°, it would be from June 10 to August 1. The capture of the parent fishes is, in most of our Northern States, strictly forbidden by law during this period, and the fishermen themselves are the most ardent advocates for its strict enforcement. The organization of a fish police in New Jersey has prevented any infraction of this law, even were the fishermen so disposed.

(3 d.) *Destruction of impregnated ova.*—As has been previously mentioned, a flood, by covering the ova with mud, may stifle them and prevent their incubation, but other and equally great dangers surround them. The number eaten by other fishes is enormous. I have fished much in the Delaware during the month of July, the height of the spawning season, and almost every sucker, minnow or cat-fish taken was found to contain shad spawn. I have seen suckers literally crammed with ova, so much so in fact, that upon holding them by the tail the spawn would flow from the mouth. The spawn of shad are peculiarly liable to depredations from these fishes, as, unlike the bass, sun-fish, and cat-fish, the nest, if nest it may be called, is not protected by the parents. By a special law of the State of New Jersey no net of any kind is allowed to be drawn in the Delaware River between June 15 and August 20, it being believed by the commissioners of fisheries of that State that the drawing of the heavy lead line of the net over the gravel-beds upon which the ova is deposited would destroy the vitality of the spawn. The great increase in the number of small fishes during the past few years has proven the truth of this theory. Seth Green has stated that in nature not two per cent. of shad-spawn will hatch, and this is proven by the comparatively small number of fishes in our waters in proportion to the immense numbers of ova annually deposited. The number of spawn deposited by a shad will average about forty thousand. Allowing but  $\frac{1}{50}$  of one per cent. to return from the sea as adult fishes, and supposing the parent fishes to be entirely removed, the number of fishes in the river would be yearly doubled. Now, in fact, we know that they have been for some years past yearly diminishing, so that less than  $\frac{1}{100}$  of one per cent. return as food-fishes.

#### 4.—HABITS OF SHAD IN THE SPAWNING SEASON.

Though varying somewhat from year to year, the average date of the appearance of the shad in our waters is as follows, as far as I have been able to ascertain :

South Carolina, January; Norfolk, February; New York and New

Jersey,\* March; Boston, early in April; Bay of Fundy, late in April or May.

It is the opinion of many fish-culturists that shad never spawn in tide-water. This, I think, is an error. Shad, so ripe that it was impossible to handle them ever so gently without causing a flow of spawn, have been repeatedly taken more than a hundred miles below the head of tide-water, and at Mull's Fishery on the Hudson, where millions of shad-spawn are annually taken, the tide ebbs and flows. From observations made by me at Camp Baird during the summer of 1873, it would appear that the ripe females with their attendant males feeling the time of spawning approaching, lurk during the day in the deepest portions of the river. At night, between an hour after sunset and midnight, they move into shallow waters, and, though for the proper incubation of the spawn clean gravel has been regarded as absolutely necessary, most ripe shad are taken upon bottoms thickly covered with aquatic plants. At Mull's Fishery so great is this growth of vegetation as to sometimes put a stop to the operations of the fishermen.

The noise of the splashes made by the fishes in the act of emitting the spawn and milt are the best guides for the fish-culturist in selecting a proper locality for a fish-camp, and the most favorable locations I have met with are on flats covered with aquatic vegetation in the immediate vicinity of deep reaches of the river. The splash, or wash of the shad, as it is termed by the fishermen, is apparently but a single sound, yet a carefully-trained ear can frequently distinguish two sounds, the second following instantaneously that of the first, being made by the male in the act of emitting the milt.

My attention was called to this second sound after observing the process of impregnation of the spawn of the gold-fish in a pond at my establishment at Troutdale. The male and female fishes swim side by side, the male generally upon the left with his head on a line with the dorsal fin of the female. Suddenly, on passing near a clump of aquatic plants, the female makes a leap out of water, throwing the whole body in the air, and scattering her spawn over the plants; she is immediately followed by the male, ejecting milt. So rapidly is this done that even while watching the process it is difficult at all times to distinguish more than one sound. Having frequently observed this, it occurred to me that the spawning of the shad might be similar, and observation has confirmed this impression.

The practical details and journals of my work having been presented in my previous report, I have, in the present paper, only given you my theories.

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\* First shad taken in the Delaware Bay in 1874, February 10, an unprecedentedly early fish.

## C.—THE SHAD AND GASPHEREAU OR ALEWIFE OF NEW BRUNSWICK AND NOVA SCOTIA.

BY CHARLES LANMAN.

## 1.—THE SHAD.

The shad of America, like the common herring, having been found to differ materially from the shad of Europe, has received a distinct name; the designation given by Wilson, and adopted by Dr. Storef, (*Alosa sapidissima*,) is here followed. Unlike most fish which frequent the northern seas, this species comes from the south to deposit its spawn.

At Charleston shad appear in January; at Norfolk in February; on the coast of New York at the latter end of March or beginning of April; at Boston in the latter part of April. In the Bay of Fundy they seldom appear until the middle of May. The first fish which arrive ascend the river Saint John to spawn; it is believed that they remain in the fresh water no longer than is necessary to deposit their ova, and then proceed up the Bay of Fundy to their favorite feeding-grounds, there to fatten upon the shrimp and "shad-worm" until they attain that degree of excellence which renders them so much sought after. The other shad, which are found in the autumn upon the same feeding-grounds, and in which no roe has yet been seen, are probably fish that have not attained a sufficient age for spawning, as those which ascend the river for that purpose are of large size and apparently old fish. The body of this fish is deep and compressed; its length varies from one to two feet. The width across the body, from the commencement of the dorsal-fin to the anal, is nearly equal to one-fifth the length of the fish. The usual weight of this fish is from one to four pounds, although it sometimes attains the weight of six pounds.

Of the sea-shad, none are so fine as those taken at the head of the Bay of Fundy, in the muddy waters of which they attain the highest perfection, owing to the great abundance there of their favorite food, the "shad-worm" and the shrimp. The shad is but rarely seen on the Atlantic coast of Nova Scotia. It is found in the Gulf of Saint Lawrence, the various rivers of which it ascends as far north as the Miramichi, which seems to be its limit in that direction, none having been seen in the bay of Chaleur.

The shad enters the Miramichi in the latter part of May, and remains until the middle of July; occasionally it ascends the Southwest as far as Boiestown, but the greatest numbers are found below the mouth of Etienne's River, always resting in deep, quiet water. The shad which frequent the gulf are greatly inferior to those taken in the Bay of Fundy.

The shad which ascend the Saint John resort for spawning to Darling's Lake, (Kennebecasis,) Douglas Lake, (Nerepis,) the Washademac Lake, the Ocnabog Lake, the Grand Lake, and the Oromocto

River. They are caught in the Saint John, near Fredericton, but not above, the water being too rapid. The shad taken in the fresh water are very inferior to those which remain exclusively in the salt water of the bay, and the longer they are in the river the more worthless they become.

## 2.—THE GASPÉREAU, OR ALEWIFE.

The alewife appears in great quantities in the Chesapeake in March; at New York it appears with the shad. The earliest fish appear in the harbor of Saint John in April, but the main body does not enter the river before the 10th of May. It would, therefore, appear that the alewife also comes from the south, like the common shad, to deposit its spawn in northern rivers.

The usual length of this species of shad, which is best known in New Brunswick and Nova Scotia by the name of gaspereau, is from 8 to 10 inches; the back a blue-green, approaching to purple; sides, silvery. The head, dark green above, and the tip of the lower jaw of the same color; opercles, yellow.

In the Bay of Fundy this fish is abundant; in the Gulf of Saint Lawrence it is less plentiful and of much smaller size; in the bay of Ohaleur it has not yet been noticed, and, like the shad, the bay of Miramichi would seem to be its extreme limit north.

The catch of gaspereau in the harbor of Saint John varies from 12,000 to 16,000 barrels each season, and sometimes reaches 20,000 barrels. It ascends the Saint John to the same localities as the shad, in order to deposit its spawn. In the Miramichi it ascends to the source, and spawns in the Miramichi Lake.