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55.—FISH AND OYSTER CULTURE IN THE PROVINCE OF VENICE.***By ALEXANDER P. NINNI.****FISH-CULTURE.**

The Lagoon of Caorle is situated between the lower portions of the rivers Livenza and Tagliamento, and is laved by the waters of the sea at the ports of Falconera and Baseleghe. Several streams empty into it, producing a hurtful mingling of the waters and hindering their course at the time of high water.

By the law of June 25, 1882, a portion of this territory, containing a population of 30,356, was comprised in the first works of public improvements; and the firm of Grego, in 1883, presented a memorial to the ministry of public works, through Mr. Lionello Grego, making the proposition (which was accepted in a general way) to convert the lakes and swamps into fish-ponds, instead of either filling them or laying them dry by a mechanical process. In this way it was thought that the object which the law had in view would be reached, viz, to remove the miasmatic effluvia developed by the mingling of fresh water with the waters of the sea.

In constructing the large fish-pond, all the fresh water would be separated from the salt water, thus preventing the generation of dangerous effluvia, it having been shown that low grounds inclosed by embankments and covered only by sea-water do not show these miasms, but are always found to be in a satisfactory hygienic condition.

As this fact cannot be doubted, the question would have to be viewed not only from a hygienic but also from an economical point of view, while the problem could be solved, in part at least, with a very small expense, by utilizing these vast marshes for the raising of fish instead of reclaiming them.

In consideration of these circumstances Messrs. Grego intended to devote to fish-culture and shell-fish culture a large part of their marsh property.

I at once made a preliminary visit to the locality in question, having the good fortune to be accompanied by Messrs. Giuseppe and Lionello Grego, from whom I was able to obtain all the needed information. I commenced my journey at Val Nova (belonging to Grego). This is a fishing and hunting ground which covers 5,607.87 square rods.

* *Progetti per estendere la piscicoltura ed introdurre la coccolcoltura nel fondo situato nei comuni censuari di Lugugnana e Caorle in Distretto di Portogruaro, Provincia di Venezia.* Rome, 1885. Translated from the Italian by HERMAN JACOBSON.

The importance of these grounds will be seen from the following data:

Approximate quantity of young fish planted or which could be planted in Val Nova.

Kind of fish.	Actually planted.	Capacity.
Chrysophrys aurata	40,000	150,000
Mugil auratus	120,000	200,000
Mugil capito	170,000	400,000
Mugil saliens	300,000	400,000

Notwithstanding the insufficient quantity of fish planted, the products in the years 1882, 1883, and 1884, respectively, were 22,214, 20,254, and 23,757 kilograms of fish of the following kinds:

Anguille, *Anguilla vulgaris*, Fl.
 Labraci, *Labrax lupus*, Cuvier.
 Muggine cefalo, *Mugil cephalus*, Cuvier.
 Muggine orifrangio, *Mugil auratus*, Cuvier.
 Muggine calamita, *Mugil capito*, Cuvier.
 Muggine musino, *Mugil saliens*, Cuvier.
 Latterini, Gen. *Atherina*.
 Orate, *Chrysophrys aurata*, L.
 Muggine chelone, *Mugil chelo*, Cuvier.
 Gobio go, *Gobius ophiocephalus*, Pallas.
 Granchio di mare, *Carcinus maenas*, Leach.

One can see from these examples how the fishing industry flourishes in the estuary of Venice, and that it deserves to be aided by the Government. The marine fish-culture of these grounds, or so-called "valleys," is one of the most ancient and best-managed branches of industry, and is far ahead of anything of the kind found in other countries.

The neighboring piece of ground of about 3,700 acres, which, if an embankment was constructed, would form a large new valley, has more extensive and deeper natural canals than the former.

I traversed these grounds in every direction, and found them well adapted to the purpose for which they are intended, possessing, besides the canals, swamps, ponds, and lakes, and along its circumference some solid soil, which would render the construction of the embankment easier and much less expensive. This part of the lagoon is, in my opinion, but poorly adapted to form inclosed grounds, containing nothing but reeds, owing to the low tides prevailing, especially in the extensive swamps found in these grounds; but, on the other hand, they are extremely well adapted to be transformed into inclosed fishing and hunting grounds.* I advised Messrs. Grego to use every possible means to reach their object, because I feel certain that the proposed inclosure of these grounds will prove a very safe and remunerative speculation, as will be seen from the following data.

* The cultivators of these "valleys" also take into account the products of the chase, which in some valleys amount to 2,000 to 4,000 lire [\$400 to \$800] per annum.

Guided by practice and a proper knowledge of the locality, it may be safe to say that the following quantities of fish could be planted and reared in the new valley :

Kind of fish.	Capacity.	Annual Product.
		<i>Kilograms.</i>
<i>Chrysophrys aurata</i>	600,000	36,000
<i>Mugil auratus</i>	1,000,000	50,000
<i>Mugil capito</i>	3,000,000	33,000
<i>Mugil saliens</i>	4,000,000	50,000
<i>Mugil cephalus</i>	100,000	25,000
<i>Labrax lupus</i>	150,000	8,500
<i>Mugil chelo</i>	100,000	6,250
Eels.....		30,000

In this calculation the smaller fisheries have not been taken into account—such as the fisheries for *Gobius ophiocephalus*, *Atherina*, *Carcinus maenas*, &c.—which ought not to be despised.

That the conditions of this site are most favorable appears not only from practical observations, and from those which I made during my visit, but also from a comparison with the adjoining Val Nova and the grounds which it is proposed to inclose.

In the first the *Mugil cephalus*, when one year old, weighs 8 to 9 ounces, in the second 12 ounces, and when two years old it reaches the weight of 35 ounces. A larger size and heavier weight are also noticed in *Labrax lupus*, *Mugil chelo*, &c., of the same age:

These facts may be caused by the absolute liberty which the fish enjoy, and if compelled to remain within an inclosure the fish would not find themselves under the same favorable conditions. But I believe that it is sufficiently proved that this new locality offers all the conditions necessary for the growth of fish.

The expense of inclosing this valley will be very considerable. The embankment surrounding it should be 2½ meters high, and on the side where it is most exposed to the prevailing winds it should be covered with Istria stone, of which 1,000 cubic meters will be needed, costing 6½ lire [about \$1.30] per cubic meter delivered. From an approximate calculation made by Mr. Lionello Grego it appears that the entire expenses, including embankments, five sewers, ditches, fish-ponds, dwelling-houses, &c., would not be much more than 200,000 lire [about \$40,000], a sum which must be considered small compared with the results which may be obtained.

OYSTERS.

From ancient times there have been oyster-beds in the Venetian lagoons, on which oysters four to six months old were planted which in a very short time became fit for the market. These places not only serve as oyster reserves, but also as pears for reproduction, as the oysters flourish here to a remarkable degree, and sound spawn becomes fixed

to poles and fragments found at the bottom of the water, so that every available surface is soon covered with diminutive oysters, which in a few months have reached a considerable size, and have a very fine flavor. Shell-fish culture in the estuary, from reasons more or less well known, is at present in a state of decline.

There are in our waters two kinds of oysters: the sea oyster and the lagoon oyster, there being two varieties of the latter kind, namely, the marsh oyster and the canal oyster. The sea oysters equal the lagoon oysters in size, but do not have so fine a flavor, as owing to the different food they have a somewhat sharp taste, described in the vernacular of the district by the term "*marinazzo*" (flavoring of the sea), which is not pleasant to epicures. This kind is at the present time found in the sea in considerable quantities, and also forms more or less extensive beds, which, however, have been almost exhausted by the fishermen, owing to the great demand for oysters.

Among the lagoon oysters the most highly esteemed are those taken in swamps which are not very deep. They have a pleasant flavor, a dark-green color, and equal in price the best oysters known. These mollusks found in the estuaries generally live isolated, and at any early age usually become fixed to some little shell of *Cardium*, *Venus*, *Trochus*, *Murex*, *Cerithium*, &c., which, when the oyster is taken from the water, will always be attached to the lower shell near its apex. For a time this oyster was very common throughout the entire lagoon, both in running and stagnant water, but now it has become less frequent, and, in fact, has almost disappeared from the greater portion of these marshes.

The threatened destruction of our best mollusks is probably caused by the influx of fresh water in the lagoon, and chiefly by the tracts of cultivated ground which bring about conditions which are hurtful to the life of the oyster and other shell-fish. It seems that similar causes have made the oysters become scarce in other parts of Italy.

This hurtful influence has also extended very rapidly to the lagoon with running water, doing serious injury to the oyster grounds nearest to the mouth of the port, in which during the last few years young sea oysters have been scattered, which after a certain time had reached the size and acquired the flavor which is demanded in the markets, without, however, equaling in flavor those raised in the marshes.

This condition of affairs caused several attempts to restock these marshes, among which there deserve to be specially noticed those made by Chevalier D'Erco, who, not being acquainted with our peculiar hydrographic conditions, attempted to pursue in the estuary of Venice the method of oyster culture employed in the Bay of Arcachon and along the coasts of France and Belgium. The reservoirs (*claires*) of D'Erco constructed along the canal of Sant' Antonio, near Burano, which I visited several times, proved a failure, as practical men had predicted, as neither the oysters nor the mussels could bear the heat of the sun, which heightened the temperature of the inclosed water and increased

its saltness. While, as a general rule, the oysters in the reservoirs in the middle of the swamp perished, excellent oysters, though not in great abundance, were taken from the Canal Sant' Antonio. The conclusion which may be drawn from this circumstance is, as I have already stated, that fresh water is not injurious to the life of the oyster.*

Another experiment was recently made by Count L. Torelli, formerly royal prefect of Venice. He appointed a commission, of which I was a member, for the purpose of studying the question of oyster culture and proposing more efficient means of promoting it. This commission went all over the lagoon, looked for places suitable for the reproduction and rearing of oysters, studied the causes which are injurious to the life of the mollusk, and reached the conclusion that the principal cause is the influx into the basin of the lagoon of fresh water coming from the adjoining land, which, possibly in conjunction with other less known causes, produces a slow but continuous change of the water, making it in many places less and less adapted to the life of the oyster. As the lagoon regulations prohibited the inclosing of this lagoon, in which perhaps the most successful attempts at oyster culture might be made, the commission had to exclude from its consideration this entire vast region. The labors of the commission were restricted to the lagoon of Venice, and for this reason it did not visit any localities outside of these limits.

As the ministry of agriculture had expressed its desire to promote the raising of mollusks on the shores of Italy, and to encourage the planting of new shell-fish, it was natural that among the persons who, provided with the necessary means, responded to this appeal were the enterprising Messrs. Grego, who asked the authorities for their support, so as to enable them to carry out a plan which would prove a great advantage, not only to themselves, but to all the inhabitants of this neighborhood.

A distinguished and highly-intelligent marsh cultivator, the Chevalier Antonio Bullo, wrote that our sea-coasts in the province of Venice are no longer adapted to the raising and cultivation of oysters. Both by the sand which is brought by the many rivers emptying into the sea along this coast and by streams of fresh water, which abound in this coast region, these coasts have become such as not to justify any expectations of favorable results in oyster culture.†

Chevalier Bullo's opinion appears to me to be somewhat too absolute, as long as it has not been proved by practical experiments, but nevertheless deserves to be taken into account, as coming from a person having great experience in all matters pertaining to the fisheries.

I must say that I do not altogether share Chevalier Bullo's opinion, as attempts at oyster culture could be made in bottoms where there are

* Reference is here made to the mass of fresh water which enters the canal as far as Burano from Porte Grandi.

†The journal *Tempo* for March 27, 1879, No. 73.

not such heavy deposits of sand, &c., and as oysters are found in the Adriatic at a depth of 30 to 40 meters [about 20 fathoms].* On the other hand, we know that young oysters have become attached, in the sea near Taranto, to fascines placed on banks at the depth of 30 meters. As regards fresh water, facts have proved that it is not injurious to the life of the oyster.

We perfectly agree with Chevalier Bullo in his advice that the lagoons are to be preferred to the coast. Professor Issel, speaking of oyster culture in the Mediterranean, says that the places destined for oyster culture should be well protected from the direct action of the waves. The most suitable places should be looked for in the estuaries, and especially in those parts of the lagoon which are nearest to the sea, and where it is safe to assume that the water is continually renewed.

Another reason in favor of this selection must be found in the fact already referred to that the oysters from the quiet waters of the lagoon have a far better flavor than those from the sea, and are therefore more sought after by dealers.

The above-mentioned conditions are not easily found, and I can state that one of the very best locations is the one of which I shall now speak.

It was the intention of Messrs. Grego to devote a portion of their property to the reproduction and raising of oysters, and eventually of other mollusks.

The most favorable region, at least for the raising of oysters, is certainly the swamp of Dossetto, and this entire region is called *Il Merlo*.

In visiting this pond we entered through the principal canal, about four meters deep, which empties directly into the swamp. On its side towards the sea it has a breadth of about 100 meters, but including also the land alongside of the water its extent is about 1 kilometer.

Owing to the proximity of the sea, the water is continually renewed; and, although the average depth of the lake is only 32 to 35 centimeters, the dangers arising from stagnant water do not exist, viz, the higher temperature and increased saltness, which in many of these swamps do a great deal of harm to fish-culture.

The bottom of the pond presents all the conditions which are necessary for the successful raising of mollusks, although a greater depth would be desirable. There are large portions entirely destitute of marine vegetation, while others are rich in plants, particularly *Zostera nana*, which I found fresh and healthy notwithstanding the heat of summer to which they had been exposed during several months, which is another fact tending to show that the temperature of the water is not very high. I observed here and there shells of different mollusks (*Trochus*, *Cardium*, &c.); and alive I found *Cerythium afrum* D. S., *Nassa prismatica*, *Trochus albidus*, *Mytilus galloprovincialis* (all young individuals), and some other species common in such places.

* Some were also caught about the middle of the Quarnero.

During the second half of May Mr. Lionello Grego had the happy idea of planting 400 young oysters caught in the harbor of Baseleghe, and distributed them in three boxes of pine wood, filled with branches and stones. I believe that this combination injured the growth and development of the oysters. At any rate no useful data resulted from this experiment. The oysters selected for planting were of the following two sizes: 22, 16, and 34, 30,* the first five to six months old, and the second about one year old. Those which I saw on July 30, *i. e.*, after two or two and a half months, had the following dimensions: Size No. I: 33, 21; 32, 25; 30, 23; 33, 17. Size No. II: 50, 47; 48, 44; 53, 56; and 43, 58. They all belonged to the kind *Ostrea edulis* L., var. *venetiana* Issel. They were, to express it in a technical term, "well made," normally developed, and almost entirely free from the small animals and plants which in many places are almost invariably found on oysters.

All, or nearly all, had near the apex of the lower valve the body to which they had become fixed when young (*Venus gallina*, *Murex brandaris*, *Cerithium*, *Trochus*, and *Cardium*). The lower valve of the shell is quite convex, while the upper is flat. In some of them a certain anomaly was noticed, namely, an excessive growth of the margin of the lower shell, which prevents the two halves of the shell from closing perfectly, a portion of the enamel which lines the inside of the shell being exposed.

From this place I went to the port of Baseleghe, and visited the waters known in the neighborhood by the name of *Carrozza*. I found them to be about 2 to 3 meters deep, and maintaining this depth for several miles out at sea. Here, as in all the places of this neighborhood, oysters develop naturally, and give rise to some fisheries of no great importance, carried on by the inhabitants of Caorle. The *Carrozza* is exposed to winds, and to accumulations of sand, &c., and as far as I can see, there seems to be no means to remedy this evil, and make this locality fit for raising oysters; I doubt, in fact, whether these oysters will ever fetch the same price as the lagoon oysters.

The best oysters which I saw in any of the places which I visited are those from the Canal Canadare (in old times called Canal Dare), which receives its water from the port of Falconera, and runs between Val Nova (the property of Messrs. Grego) and Val Vecchia (the property of the township of Caorle). In this canal the oysters not merely live isolated, fixing themselves to some shell, but have a tendency to form beds, one lying on the top of the other. Their shell is generally curved a little to the right; it is darker than that of the *Carrozza* oyster; the upper valve is not quite so flat, and the lower one is sometimes concave; in various respects, among the rest the brittleness of the shell, it resembles the Taranto oyster. I gathered five having the following dimensions: 82, 78; 90, 77; 86, 82; 90, 83; 54, 33. I found them all fat and of excellent flavor.

* Millimeters. The first indicates the length and the second the breadth.

From my preliminary observations I have reached the conclusion that there is some difference between the two localities Falconera and Baseleghe. Owing to various untoward circumstances,* however, I was not able to take all the observations necessary for forming a definite opinion, and I must, therefore, for the present at least, refrain from pronouncing an opinion on the subject.

I hope during the coming year to make all the necessary observations on the saltness, the temperature of the water, &c., without which it will be impossible to pronounce a satisfactory opinion on the suitability of different places for constructing oyster-ponds, and to express my views on the manner in which this useful industry should be introduced.

In oyster culture a distinction should be made between places for reproducing and places for raising oysters; it is very rare to find a place which is adapted to both these purposes. I think that the swamp of Dossetto is well adapted to the raising of oysters, but I doubt whether they can be reproduced here; and to get the exact truth of the matter, experiments should be made. With the view to make success more probable, I would not hesitate to place this swamp, which is only about 200 meters from the coast, in direct communication with the sea by an artificial canal. In this way the renewal of the water would be more complete and more constant. In front and by the sides of the mouth of this canal oyster-ponds might be constructed, furnished with small canals, by means of which a sufficient level of water might be maintained, so as better to protect the oysters from atmospheric and hydrographic changes.

The most suitable depth of water both for reproducing and raising oysters cannot be ascertained without a series of experiments. In the Little Sea of Taranto, and in the lagoons of Venice, where oysters are found, there are seen in some places near the surface of the water the leaves of the *Zostera*, which grows on the bottom, but near Fusaro, in shallow water, these plants are not so plentiful (so says Issel). But in our case the proposed new current would no longer permit the temperature to rise too high, and by using little canals for the inclosed spaces intended for reproduction, the excessive current would be avoided, which would carry the embryos into the open sea, and prove a hindrance to their becoming fixed to shells and other bodies (anything having a rough surface), which should be scattered on the bottom.† The free current in the open part of the pond will increase the depth, thus making it still better adapted to the purpose for which it is intended.

Having observed in the *Carrozza* numerous medusas, which, in some cases, might prove injurious, I would consider it useful to keep them

* Among the rest the delay in sending my instruments.

† If the current is too strong, it will be necessary to provide a larger number of mother oysters, which it is not always easy for an oyster cultivator to procure.

out of the new canal by means of fascines, which might also serve as collectors, and of which I will speak below.

The ordinary dimensions of the oyster parc should be 30 by 20 meters, and the embankment should inclose a quadrilateral space, containing 8 to 10 mother oysters per square meter—that is to say, if reproduction is intended. If the object is merely the raising of oysters, 150 may be placed in the same space.

On the coast between Baseleghe and Falconera oysters propagate, and it appears that the number of their enemies is not very great. It is true that I noticed the usual *Murex*, which devours marine shells; but which, as it seems, gives the preference to the *Venus*. I did not, however, see a single oyster shell pierced by a *Vioa* or *Clione*. I believe that the *Carcinus*, the *Pagurus*, and the *Asterina*, which abound here, do not do any harm to the oysters, and I cannot share the opinion of De la Blanchere as regards the first-mentioned species.

Oysters are likewise reproduced in the Canal Canadare, and it would be well to put collectors in both places for a trial. I would always give the preference to fascines, similar to those used at Taranto—*i e.*, about 2 meters long and 1 meter in circumference—proper care being taken not to have too thick stems and too thin branches.

Fascines tied with a cord or zinc wire are to be preferred. They should be raised somewhat above the ground, and attached to a large rock by a cord of broom-corn.

Another practical method is to use pales covered with hydraulic cement, mixed with sand; but they have the disadvantage of presenting fewer points for fixation to the embryos while being carried along by the currents.

A third kind of collector which I proposed, because I think it is well adapted to many points in the localities visited by me, might be formed by a pale, if desirable, covered with cement, to which at a certain height fascines are attached. All that is required would be to ram the lower end of the pale, which should be pointed, into the bottom in a neighborhood where there are mother oysters. When the young oysters are to be transported these pales are simply pulled out. I advised Messrs. Grego to place some of these collectors near the mouth of the canal, which leads to the principal canal of Val Nova.

As regards the spawn, I would always prefer that from the lagoon. There is no difficulty in procuring mother oysters, because they are quite frequent in many places of the estuary; and when it is remembered that one oyster can furnish from 600,000 to upwards of a million of embryos,* there is no fear that the principal elements of oyster culture will ever be wanting, and that the experiment will prove a failure, provided the locality selected is favorable to the life and development of the oyster.

* DAVAINÉ: *Recherches sur la génération des huîtres*. Paris, 1853, p. 45.

CONCLUSIONS.—From the foregoing facts I conclude as follows:

(1) The fish-culture practiced for many years at Val Nova proves beyond a doubt the suitability of the lagoon of Caorle for constructing inclosed fish ponds.

(2) The tract selected for the inclosure of new grounds offers every condition necessary for insuring happy and very remunerative results.

(3) The swamp of Dossetto is the best of all the localities visited by me for constructing piers for raising oysters.

(4) Oysters are reproduced along the coast of Caorle, and in the Canal Canadare, for which reason it would be well if Messrs. Grego could obtain exclusive control of the fisheries, at least in one of the localities, which, owing to the proximity of the Dossetto swamp, are well adapted to the reproduction of oysters.

(5) In the waters of Caorle there is also found the *Mytilus galloprovincialis*, and it is possible that the cultivation of this mollusk could also be carried on successfully.

(6) It is necessary that the Government should issue strict orders for the better observance of the fishery laws, so as to avert the dangers resulting from the destruction of the young oysters, and this not only in the interest of cultivators, but for the preservation of the species.

56.—A REASONING LOBSTER.

By WILLARD NYE, Jr.

While at Bird Island, Buzzard's Bay, Massachusetts, I noticed what seemed to point at reason rather than instinct in the lobster. One had his home for the time in a hole under a rock, where the water was about 5 feet deep. Thinking to catch him, I made a noose at the end of a fish-line, and by means of a stick spread it carefully around the hole; then let down a piece of menhaden, holding it 6 or 8 inches away in front. The lobster soon reached out to take such a nice morsel, when, by jerking the string, I had him noosed around one of his big claws near the end; but after I had him half out of his hole the string slipped off and he got back. However, I had no doubt of catching him the next time, so, spreading the noose as carefully as before, and again letting down the piece of menhaden, I awaited results, when, instead of boldly putting out his claws as before, he first put his feelers through the noose, and, with a waving motion, felt the string all the way around, then pushed one claw under the string and grabbed the bait. Three or four times I tried him with the same result. He first carefully felt the noose all around, then rooted one claw under the string and secured the bait. I finally had to give up all thoughts of getting him, and came away firmly believing that until this fellow dies of old age the lobster will not be exterminated in our waters.

NEW BEDFORD, MASS., May 10, 1886.