

Observations upon a report by the Select Committee on Salmon Fisheries, Scotland, together with the minutes of evidence, appendix, and index, 30th June 1836 / by Robert Knox.

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with the Author's
OBSERVATIONS

UPON

A "REPORT

BY THE SELECT COMMITTEE ON

SALMON FISHERIES,
SCOTLAND:

TOGETHER WITH THE

MINUTES OF EVIDENCE, APPENDIX, AND INDEX."

30TH JUNE 1836.

BY

ROBERT KNOX, F.R.S.E.

C

EDINBURGH:

ADAM & CHARLES BLACK, NORTH BRIDGE.

1837.

OBSERVATIONS

A REPORT

BY THE SELECT COMMITTEE OF

SCOTLAND

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To WILLIAM MURRAY, Esq. of Henderland.

SIR,

The following "Observations" were suggested by a conversation I had the honour to have with you and with your brother the Lord Advocate for Scotland. In that conversation the Lord Advocate and yourself expressed a desire to have the Salmon question tried upon its own merits, without a reference to what may be advantageous or disadvantageous for river proprietors or sea-side fisheries, or as to how far they are injurious to each other ; and, as a preliminary step, that the Report of the Second Committee of the House of Commons, then just published, should be examined. I have since examined, with all the care in my power, that Second Report, and I flatter myself, that the following observations will satisfy any unprejudiced person that the question ought to be tried in the way the Lord Advocate suggested, with a view not merely to put an end to a most fertile source of litigation, but likewise to protect the public, independent altogether of the advancement of Natural Science, which, in respect to the Herring and Salmon, has never yet received from the Legislature the slightest consideration.

It is scarcely necessary that I should remind you, that our conversation upon the occasion I have alluded to mainly hinged upon my remarkable discovery of

the food of the Vendace. By the kindness of your factor, Provost Thomson of Lochmaben, I enjoyed every facility for research, and left no link, I trust, deficient in the chain of an investigation entered upon with much anxiety, inasmuch as I foresaw great results to Natural Science. The Castle Loch of Lochmaben, which ornaments your property, furnished me the means of deciding the long agitated question, *the food of the vendace*; the food of a fish which refused every bait of the angler; whose habits in this respect were even more mysterious than those of the salmon and herring. Through this discovery did my brother and self go directly up to the real food of the Herring whilst in the deep seas, and proved what heretofore could not have been credited by any one, but which was yet perfectly in accordance with the grand provisions of Nature, that countless millions of fishes, of admirable quality as food for man, subsist on an animal so small as to be altogether invisible to the naked eye, and which, but for the aid of the microscope, must have remained for ever unknown to mankind.

With many thanks for your great liberality in forwarding the cause of Natural Science,

I have the honour to remain,

Sir,

Your very obedient servant,

R. KNOX.

NEWINGTON,
1st August 1837.

OBSERVATIONS, &c.

THE difficult questions connected with the Scottish Salmon Fisheries,—the conflicting interests of upper and lower heritors,—the evident destruction of river Fisheries threatened by the extension of sea-coast fisheries,—and the development and discovery of new modes of capture of this much-prized fish; modes bearing almost exclusively on coast-fisheries and discoveries, which could not be foreseen and therefore could not be provided for, by any Legislature:—these had slowly accumulated for a series of years, until something evidently required to be done for the relief and satisfaction of all parties. A Commission was accordingly appointed by the House of Commons in 1825, with power to send for persons, papers, and records. They sat during more than three years, and examined all classes of the community, scientific and otherwise, likely in the smallest degree to afford data for legislation. The landed proprietor, the tacksman, the practical or (as was to be expected) working fisherman, the London salesman, even the amateur naturalist was not forgotten, and if no professed naturalist was brought before that Committee, it cannot, we hope, be ascribed to the cause that no such person exists. The Committee failed altogether in obtaining any correct scientific knowledge of the habits of the fish; but, obliged to do something, an act was passed, known usually by the name of Home Drummond's Act, that gentleman having mainly contributed to effect its passage through the House, and to secure the co-operation of at least a majority of the parties. But as the act was merely a *compromise*, ten years

had not elapsed when it became once more necessary to re-open, as it were, the whole commission ; to appoint another committee with powers similar to those of the former one, but ostensibly more limited as to its inquiries, as may be gathered from the following preamble ;—“ Ordered, That a Select Committee be appointed, to consider the state of the Salmon Fisheries in Scotland, in as far as relates to the altering the close times in different districts in that part of the United Kingdom,—the laws for the observance of the Saturday’s slap or opening in all cruives, engines, machines, or devices of whatever description used in salmon-fishing,—the construction and regulation of cruives, the regulation of mill-leads or courses, and the removal of dams and obstructions in all rivers, streams, or waters, and to report,” &c. That the Committee did not adhere to their instructions, is not to be wondered at ; *the natural history of the salmon had not been ascertained by the former one.* Now, so long as this remains doubtful, just so long is it impracticable to legislate upon any certain principles, whether upon the matter of *close-time* or *propriety*, or, indeed, upon any other point whatever, connected with the Fisheries.

Before examining the labours of the former Committee, and the voluminous and conflicting evidence submitted to them, we shall first analyze the evidence submitted to, and the Report thereon by the present one ; the single heading of “ proper period of close-time for salmon-fisheries in Scotland ” would have sufficed as a heading to all we purpose saying on the matter, had the Committee adhered to their instructions ; but we shall presently find, that they did not do so, and this compels us to follow them in their digressions, which were neither few nor brief.

1. The Committee having met, agreed at once to extend their inquiries, and to *include within its range the following important subject-matter* ;—“ To inquire into the increase or decrease in the numbers or weight of salmon-grilse and sea-trout taken in the several rivers and sea coasts of Scotland since the act 9th Geo. IV, c. 39, came into operation.” This necessarily opened a wide field for inquiry,—ripping

up, as it were, old sores that had never healed well,—we mean the local, though extremely important, question of the gradual growth and vast preponderance of sea-fishing by stake and bag-net over *river-fishing*, however practised, in respect not merely of superior quality of the fish taken, but likewise the regularity of supply, its far greater abundance, and the far more *economical* mode in which it is managed.

Is the question of legislating for the salmon fisheries a national question or a particular one? We consider it a particular question, and would suggest as follows:—

1st, When a river belongs to one proprietor, it is the height of folly to pretend to advise him how to fish his river; to legislate to him about close or open cruive-dykes, legal or illegal engines, Saturday's slap, or Sunday's fishings. Let him do what he pleases with his own, nobody can better know how to study his own interests. The spendthrift of an entailed estate hurrying on to ruin might be disposed to destroy the fishings of that river of which he is a life-renter,—but those are partial evils. Let the heir-at-law look to it.

2dly, Let the heritors or proprietors of each Scottish river meet and decide by a commission, jury, or otherwise, what best suits the river which belongs to them; let them legislate for it, or submit to the Legislature regulations for it; let all modes of capture be legal to which they give their consent.

It is amusing to watch the movements of the Committee in their efforts to devise means to protect the spawning fish and fry, in other words, to prevent the total destruction of the fisheries, which could be effected in a few years by allowing the lower orders of peasantry on the upper streams of rivers to have their way. *First*, An act is passed declaring it poaching to kill salmon during a certain time called close-time, but as this is the only period when the fish appear in the upper streams, the heritors or proprietors of the banks of these upper streams having no interest whatever in the preservation of the salmon, very naturally neglect the act, or set themselves in direct opposition to it.

2dly, The Committee next endeavour to coax them into

good humour by allowing them to angle during close-time for fourteen days or more, that is, to have the pleasure but not the profit; and thus they hope to induce the proprietor of the upper streams to quarrel with his tenantry, to watch them, to prosecute as he would do for the unlawful killing of grouse, deer, or partridge; truly an excellent device, but, notwithstanding its ingenuity, we predict it to be a failure. Upon the whole, the idea of establishing a bait of fourteen days' angling in close-time as a kind of private *bon bouche*, a sort of stolen sugar-lump to secure the upper heritors in the interests of the lower, is a lamentable kind of legislating. We vastly prefer the mode adopted in the north—*buy up the rivers, and remove the peasantry* to the sea-side, or wherever they may choose to go. There is one thing which appears to me extraordinary as not having occurred to practical men—That if the upper heritors are to be consulted at all—if it be thought worth while bribing them for the sake of their protection to the spawning fish and fry, why not offer them *something substantial*, such, for example, as *the produce or value of the produce* of ten or twelve days' fishing of the first mile of the river from the mouth upwards; this would surely be better than licensing them to kill foul salmon for their amusement in September and October.

The matters inquired into by the Committee may be reduced to the following heads:—1. The regulation of the close-time, and whether it *should vary for almost every river*, or be general, and the same throughout the kingdom, that is, whether or not the varying principle should be adopted as the basis of legislation. A careful examination of the evidence has led us to conclude, that there exist no data for the determination of this question, and that in respect to river fishing, there exists a circumstance which must render it extremely difficult of decision. The circumstance we allude to is the state of the rivers as to floods; but, barring this, which must produce puzzling anomalies, we apprehend that the only way to decide the question would be the evidence of an impartial person as to the exact

condition of the fish taken in such a river, say from 1st August to 1st October, the usual latitude proposed for the commencement of the close-time. None, we think, can doubt the necessity of closing all or most rivers after the 1st October. If river fisheries were done away with, as they ought to be, the facility with which *close-time* could be determined and ordered throughout the kingdom becomes manifest. Nay, it is just possible that no such regulation would be required; and here arises another great question in the natural history of the salmon which has never been solved by proper inquiry—Are foul salmon ever taken in the sea? and, if so, under what circumstances and in what numbers? To decide an extremely important question like this, an extensive series of experiments should be instituted round the coasts, by means of bag and stake nets, fished uninterruptedly winter and summer for three or five years under the superintendence of unprejudiced persons. We lean to the opinion that foul fish can never be taken in the sea in any great numbers, and that consequently there should be no close-time whatever, and all restrictions in this matter might be done away with on this opinion being proved. The salmon remaining in the sea during winter are probably barren fish, and in the highest condition as food for man. By barren fish we mean those in whom for that season at least the milt and roe had not become developed. If this important measure were found impracticable, then the next best measure would be a journal of the state of the fish (kept by an officer appointed for the purpose), taken on each day from the 1st August to the period when by their advance towards spawning they become not only poor, but even unwholesome food, and when a continuance of the fishery would lead to destroy it root and branch by a capture of the breeding fish. An average from such journals might be taken after five years, or a person appointed annually to fix the day, by actual inspection, of the produce of the stake and bag net fisheries nearest to the river mouth; even the London salesmen could decide this point annually without much difficulty.

Again, we repeat that there is no evidence in this Report to satisfy any one "when the close-time should commence and when it should cease," keeping in view the interests of all parties. Above all, there is no evidence to shew that close-time should vary throughout the kingdom.

That this will appear a strong statement to some, after all the labours, as well of the present as of former committees, we have no doubt; but it is a statement made after the most careful and deliberate examination of every passage calculated to bear on the point. The statement, that in many rivers, clean salmon may be captured on all days of the year, is below all notice. The question for the nation, is not whether a few clean salmon can be taken during the *natural close-time* of rivers or on the shores, (if a close-time were then required, which we doubt,) for the pampered and over-satiated appetite of the London Alderman, or Grand Proprietaire, or whether the national interests are to be consulted. The occasional presence of a few clean salmon in rivers, at times when thousands foul may easily be proved to be also present, even by the few scanty facts naturalists and fishermen have been pleased to give us, by no means warrants the fishing these rivers.

The Committee is in error, as we shall afterwards shew, in saying that there existed, at the period of their deliberation, one uniform season of close time or fence months; there were always three at least for Scotland, unless the Tweed and Solway and their tributaries be reckoned purely English rivers, these latter having always had their own fence months distinct from the Tay and others.

We cannot believe that any practical man, open to conviction, who has watched the fishings of the Tweed, Tay, &c., can have any doubt that all fishings above the entrance of a river into the sea, or into an estuary, should be abolished, were it only in order to put a stop to the enormous expense connected with it. The farce of fishing the Tweed above Berwick Bridge, is a most expensive farce, but still it is one; it is almost inconceivable that any one can be found silly enough to pay for it. Why not let the entire

river fishings to one company or to one individual, who, of course, would fish it only at one point, (the Bar,) and thus save an incredible labour and expense. I rather think that the same remarks might be applied to the Tay, &c. Indeed, during the progress of the former enquiry, members of the committee and others who read the evidence, must have been forcibly struck with the present truly absurd mode of fishing the Tweed, Tay, &c., by net and coble, throughout miles of river, and, of course, at an enormous expense, whilst it was evident to all who had deeply studied the question, and combined that study with the habits of the fish, in so far as they were known, that fishing for salmon in rivers above the tideway, ought to be put an entire stop to, with the exception, perhaps, of one single active fishing party on the bar of the river, and during the height of the season.* But one thing appears evident, that no effectual or satisfactory legislative measure can be made out, until the whole question be tried on its scientific and practical points. In 1825, bag-nets were little if at all used, now they are most extensively; an act against fixed engines could scarcely be applied to them. We could even imagine it possible to withdraw them, and re-set them so frequently as to give them more the character of a moveable than a fixed engine.

It must always be remembered, that Mr Home Drummond's act was after all but a partial one, it did not include the Tweed and Solway.† These rivers had separate acts, and a distinct close-time, and hence arose the singular fact

* This seems to have been the opinion of Mr Oliphant, M.P., and a member of the Committee.

† Have any steps been taken to ascertain the natural close-time of any Scotch river? Any journals of observation been kept by persons worthy of credit? Any scientific data collected? Every one knows that there are no such data, no such journals in existence. The Committee of the House of Commons took the evidence of a naturalist with respect to the natural history of the salmon; of a naturalist who had never seen the spawning of the salmon; had never visited the spawning beds; had never examined the ova; had never observed their growth; had never experimented nor dissected at all; this was the kind of evidence submitted to the Committee of the House and to the public.

and occurrence pressed on Mr H. Drummond himself by Mr Wallace, at a dinner given to 600 gentlemen at Stirling, *after close-time in all Scotch rivers*, except the Tweed and Solway; the table was covered with good fresh salmon. Now, where did these salmon come from? We have no doubt Mr Drummond would say, from the Tweed or Solway. No such thing; they came simply and very naturally from the nearest rivers. Thus, in point of fact, there never was one close-time for all Scotland, and Mr Drummond's act had no effect whatever in stopping poaching on the most extensive scale. In truth the law has been set at defiance by the Duchess of Sutherland; her rivers are opened and closed when she pleases, and impassable cruive-dykes are built in due season across most of them. Now all these doings are against the act. Year after year, all fishings above the mouths of rivers, near which there are also sea-side fishings, have become of less and less value; the expense of the coble-net fishing is great; the management of the Tweed fishings, for example, in 1830, was most extraordinary. At that time, now seven years ago, after the most deliberate examination of the fishings, we declared the fishing of rivers by net and coble, as the greatest delusion and imposture we had ever seen. We further recommended, that the mode of fishing for salmon throughout the kingdom should be entirely altered; all river fishings above the tideway (or any proper part to be determined by practical men,) put an end to in all rivers, and the salmon fished for, at or near their feeding grounds, by stake and bag-nets, &c.

If river fishings must still be maintained "as a nursery for seamen," in despite of the existing evidence, then come again all the difficult questions of close-time, proprietorship, protection of fry and of spawned and spawning fish, &c. &c.

In every river of any consequence, the "lowest stream where salmon spawn ought to be ascertained," and all fishing above it strictly prohibited. This most important point has never been made out, it is not known positively in re-

spect to any Scotch river. It is easy to find book naturalists who will make assertions on these points, but of what real value are such opinions?

The *principle of a varying close-time* means simply an act for each river. *Thus the Legislature returns to the point from which it started.* If the close-time be late in commencing, you destroy the spawning fish. If it terminates too early, you destroy the kelts or spawned fish. Of these two evils the former is decidedly the greater. In fact, it would be advisable to close all river fishings on the 14th August; but why not prohibit river fishings above the tide-way altogether. We contend that this is quite a practical measure, and that it would produce incalculable benefit to all concerned.*

What is the latest period of spawning? Mr Hogarth says that a great number of fish in the Tay have not spawned on the 15th December. Mr Hogarth's theory as to the cause of the good condition of these fish which enter the rivers early in spring may be found at page 48 of the Report. We have ventured elsewhere another theory; they are certainly both theories, but ours is founded on practical examination and analogy. It is curious to trace the gradual correction of the theory of the *distant migration* of the salmon. Every year brings him during his feeding and fattening season nearer to the coasts. The same has happened in respect to the herring. All these erroneous notions about the distant migrations of the salmon and of the herring originated in naturalists not knowing the *food of these fishes and their feeding ground.*

Are there early rivers and late rivers? This is a scien-

* The consideration of a close-time for any of the salmon rivers in Britain or Ireland, involves at least two questions in Natural History which ought to be previously settled: 1st, What is the average period of the run of the spawning fish? 2d, When do clean fish begin running in sufficient numbers to make it worth while opening the rives? If the evidence offered the former Committee of the House of Commons be worth any thing, it proved, that, from the extreme north of Scotland to the River of Cork, the *spawning fish* run all at *one time*; when clean fish begin to ascend in spring in any numbers could not be made out.

tific question. Can the early rivers be fished without injury to the salmon fisheries generally, by the taking of unspawned fish? This is a practical question, and these are quite independent of each other. They are most important, and must not only be viewed separately, but handled separately. To what extent does the taking kelts or spawned fish early in the season injure the fisheries? This also seems a purely practical question, but still it requires, previous to coming to a decision respecting it, the settlement of a scientific question, viz. How many, on an average, of salmon that have once spawned, return to the same or other rivers?

Although the Committees of the House of Commons were both altogether unequal to the investigation of the questions submitted to them, which I hope may be said without disparagement, they still could not but discover, from the extraordinary conflicting testimony brought out, that the *food of the salmon* and his feeding ground had not been made out. We imagined that we decided both these points in 1832. The discovery of the food of the vendace of Lochmaben preceded that of the salmon and herring; and, with regard to the two latter, the field of inquiry is so extensive, and the expense attending minute investigations concerning them so very great, that many points require still to be investigated. Whilst all admit our discoveries respecting the *vendace* (a fish closely allied as a natural order to the herring and salmon, that is, the *clupeadæ* and *salmonidæ*), and their great results upon certain geological and ichthyological questions, some yet dispute how far such discoveries apply to the salmon and to the herring! Thus Mr Yarrell, Sir William Jardine, and other active amateur naturalists, admit fully and readily our discoveries in respect to the food of the vendace, but they think that the salmon lives upon a grosser food than we have stated. Sir William says that salmon are caught in the sea on the north coast with hooks baited with sand-eels or small fish; it is just possible, but in the mean time we doubt the accuracy of the statement; and it appears to us to rest on no positive evidence. We have ourselves taken salmon at Kelso with

a thing called a salmon-fly, and with lobworm and other bait, but then we never for a moment imagined that they live upon these. We are aware that herring-fry forms a good bait for the common river trout, although the trout may never have had access to the sea, and certainly never saw a herring or its fry.

The following brief statement of facts may serve to remove some difficulties in the way of a complete settlement of these great practical questions, viz. 1st, What is the usual food of the herring, and what part of the ocean is his usual feeding ground? 2dly, What is the usual food of the true salmon and grilse (supposing the latter to be distinct from the former) whilst in the sea, and where is their usual feeding ground? To answer these questions properly requires me to state the opinions of others; from my not having done so formerly, that is, in my Memoirs presented to the Royal Society of Edinburgh, the most extraordinary misstatements have been indulged in respecting my views by persons not only altogether ignorant of the subject, but by their education and habits incompetent to arrive at any rational conclusion respecting them.

From the earliest times, nearly all practical and experienced fishermen, and most naturalists of reputation, have candidly admitted, that the food of the herring and of the salmon was *altogether unknown*, and likewise that it was not known into what part of the ocean they retired, when, quitting our coasts, they disappear for a season; leaving these coasts and rivers generally in a state of great exhaustion and meagreness, and returning renovated, strong, and in the highest order as food for man. I find that I must first establish the fact that this was, and still is, nearly the universal opinion of practical fishermen and of experienced naturalists; for, singular to say, when I on a former occasion made this statement, it was denied by those whose very denial of a well known fact in the natural history of these fishes shewed their utter ignorance of the whole question. Instances were cited by those persons of herring and salmon having been examined in whose stomachs a

very palpable food had been detected, viz. the ova of other fishes, and even the young of their own and of analogous species! That occasionally, though very rarely, in the stomachs of a few herrings haunting the shores, and always in bad condition, there may be found small fishes, and even the fry of their own species; and that this is true also of the salmon, to a still more limited extent, may be admitted, and is a fact indeed which we had thought was known to all the world. It is quite unnecessary for any one to state that such or such a naturalist found some young fishes in the stomachs of grown herring or salmon, because any one who has been in the habit of opening numbers of these must have observed the fact long before the discovery of such naturalists. *But this is not the question.* The question is, What inference do these persons mean to draw from this circumstance, which had been known from the most remote times? Do they mean to say that these small fishes or fry constitute the usual food of the herring and of the salmon? If this is their opinion, why not candidly say so at once? Being quite aware that the herring and salmon, especially if out of order, were occasionally known to take a common bait, such as any small fish, &c., I felt it necessary to proceed with the inquiry in a different manner than heretofore. It required little reflection to foresee, that although a thousand salmon and ten thousand herring were shewn to have nothing in their stomachs cognisable by the eye (unaided by the microscope, in the hands of a person scientifically and liberally educated), yet the circumstance of one or two being *occasionally* found in a different state would at all times form a *sufficient ground* with such persons to deny the whole of my inferences. I took care to select, as the first object of my inquiry, a fish *in whose stomach no naturalist or other person had ever detected any food*, a fish which had never been known to take a bait; that fish was the vendace of Lochmaben, whose food I discovered in 1832. The inquiry into the salmon, herring, and still later the char, followed in succession, and having got a key to the whole mystery by discovering the food of the vendace, which served as a "light

to our path," difficulties disappeared which must otherwise have proved insurmountable, had the examination and discovery of the food of the vendace not preceded that of the herring, salmon, &c. The fact of the vendace, a fish of considerable size, and very numerous, not only thriving and subsisting entirely, but becoming the most delicious of all fishes, *on microscopic food only*, opened up a vast field of inquiry, both in regard to the existing and to the extinct or fossil race of animals. It is even quite possible that the fresh waters abounding with microscopic entomostraca might be nutritious to man himself. But to return, *1st*, I never yet found a practical fisherman who would offer even a conjecture as to what might be the food of the herring or of the salmon whilst in the sea; but, on being pushed to an answer, some would say, that perhaps the herring lived by suction (for of the food of the salmon they usually declare their utter ignorance), to which term, however, they do not attach any very precise meaning. Others seemed to think that they might live on air and water, and many again going up to first causes, which the ignorant generally do, did not see any necessity for herrings requiring any food. Herrings, say they, were a gift of Providence to man, and as their numbers are miraculous, so is their food.* That

* It is curious to remark that the illiterate fishermen came nearer to the truth than the half-educated scientific man. The fishermen being ignorant of the use of the microscope, simply asserted a fact, viz. that no food was to be made out with the naked eye. The half educated man on the contrary affirmed that, although he could not see the food it ought to be present in a palpable shape, and of a size proportioned to the fish that lived upon it; he then set about inventing an hypothesis to explain what he could not understand.

The less these persons know of the matter, the bolder uniformly are their assertions; and as they care not one farthing about scientific truths, they fearlessly affirm whatever seems best calculated to support their hypothesis. An instance occurred a few years ago, when a very respectable person asserted in a newspaper, that herrings live on fry and small fish, although he was perfectly incompetent by habits and education to engage in any scientific inquiry, and never had, and could not examine the question in any shape. It has been long remarked of these persons generally, that "what they imagine to be true, that they believe to be true; and what they believe to be true, that they will swear to be true."

these are the almost universal opinions, could be proved by the most extended evidence. Since, however, many of these practical men know extremely well that the herring and salmon could not live on air and water, whether singly or combined, and that nobody doubted the food of haddocks, cod, skate, &c., they devised various hypotheses to meet the excessively difficult question, viz. How it happened that the stomachs of the salmon and herring seemed always empty, more especially if the fish themselves were in good condition, for it is a notorious fact, known even to the cook, that if any putrescent *debris* be found in the stomachs or intestines, the fish as food is not good. Of these *hypotheses* I shall mention only two by which the rest may be judged of. In compliment to the great name of Sir Humphrey Davy, we shall give his theory the preference over his more practical followers. Sir Humphrey having no idea that a fish of the magnitude of the salmon, or indeed perhaps that any fish, could live, fatten, and thrive exceedingly on a food whose nature was discoverable only with the microscope (the ova of the echinodermata, and probably also of most crustacea), invented a hypothesis to explain the emptiness of the salmon's stomach; like the vulgar he went up directly to a final cause, and boldly conjectured that the salmon, foreseeing his length of journey in ascending the freshwater streams, took special care to avoid using any food for some time, in order to lighten himself as much as possible. The other hypothesis to which I have alluded was a more ingenious one. We owe it to a Mr Fraser, a practical fisherman, and the tacksman of Dalnacarloch. He finding, as all had done before him, that the stomach and intestines of salmon seemed uniformly empty, but at the same time fully persuaded, and having his mind altogether preoccupied with the idea that the salmon, from his bulk and richness, must eat voraciously of some large palpable kind of food, threw out the very bold conjecture, that the digestive powers of the salmon were so extraordinary, that they digested their food, which he supposed to be other small fishes, almost in an instant of time. His words are: "The

digestive powers of the salmon's stomach are like a consuming fire." It never occurred to him that in sea-side fisheries the stomach of the salmon ought even then to be found full pretty often if his views were right. I trust it cannot be required by any rational person that I should seriously refute either of these hypotheses. No animal living, not even the shark, possesses such digestive powers as to consume in a few minutes the bones, tendons, and other less digestible parts of their prey.

The difficulty, however, as we have seen, was not confined to practical men. The most experienced naturalists and anatomists have uniformly avoided the question of the food of the herring and salmon, or candidly admitted their ignorance. The following quotations ought to put this question at rest.

Salmo Salar, Linne.—Habitat in oceano, &c. Præter pisces, vermibus insectisque aquaticis victitans." P. 1365.

Salmo Trutta, Linne.—Habitat alternatim in mare Europæo et fluviis, &c. Præter pisces, vermibus insectisque victitans. P. 1367.

Salmo Sylveticus.—Habitat in Europa, Sibiriaë aliarumque terrarum mari Caspio finitimarum rivis torrentibusque alpinis, &c. Præter pisciculis, vermibus etiam testaceis et insectis aquaticis victitans, et ne propriaë quidem speciei parcens. P. 1365.

Salmo Eperlanus.—Habitat in Europæ lacuum fundo arenoso, in mari, vere parturiens, magnis gregibus in fluvios ascendens, vitæ minus tenax, vermibus testaceis potissimum victitans. P. 1375.

Salmo Laveretus, Guinied, Lavaret.—Habitat in maris Europæ septentrionalis profundis, harengo, cujus ovis inhiat, &c. P. 1377.

Salmo Thymallus, Linne. (*the Grayling*).—Habitat in Europæ fluviis, &c., testaceis, coleopteris, piscibus minoribus, ovis potissimum favoris, et Salaris victitans. P. 1380.

Salmo Maræna.—Aut vere testacea quæ siturus. P. 1381.

Salmo Marænula.—Gregarius in Germaniæ, &c. ; vermibus et insectis victitans. P. 1382.

Salmo Wartmanni.—Habitat in lacus Aeronici profundis ; et vermibus, insectis spongiæ quædem speciei victitans. P. 1382.

Clupea Harengus, Linne.—Habitat in maris Europæi Septentrionalis et Atlantici profundis, vere, &c.

NOTE.—No mention is made of the food of the Herring by this the greatest of naturalists.

Clupea Harengus, Linne.

Clupea Alosa ; *Shad*, Linné.—Vermibus insectisque victitans.

Clupea Thrissa.—Habitat in mari Jamaicam, Indiam alluente ; crustaceis minoribus, testaceis, piscium ovis, victitans. P. 1405.

Des Saumons, Cuvier.—Ils sont d'un naturel vorace.

Le Honting ou Hanten, des Belges. Salmo Oxyrhincus, Cuvier.—De la mer du Nord de la Baltique, où il poursuit les bandes de Harengs ; on le prend dans le Lac de Harlem. P. 307.

Des Clupes, Clupea, Les Harengs, Cuvier.

NOTE.—No mention is made of the food of any of the species.

The Rev. Dr Walker, late Professor in the University of Edinburgh, published an Essay on the Natural, Commercial, and Economical History of the Herring. Extracts from this essay were published by the Highland Society, and from these extracts I take the following observations in proof of my statements:—"The food of the herrings, and especially that on which they fatten, is very little known. I have examined their stomach at the different seasons of the year, without finding in it any sort of palpable aliment." In the same volume of the Transactions of the Highland Society, Mr John Mackenzie has published some remarks respecting the herring and its fisheries. He states them to be the result of personal observation and experience, but this is hardly reconcileable with the following passage:—"In regard to the food of the herrings, it has been frequently observed that the small fry seek their nutrition out of the marine algæ, or from some matter adhering to them ; that herrings will swallow a small clear unbaited hook such as is used for catching haddocks, when tied on a fine line ; a device which has been successfully adopted when the herring fishery is carried on in deep water, in order to discover the arrival of the shoal. It seems certain, therefore, that the herrings take these hooks for such animalculæ as they at least sometimes feed upon."*

"Another article of their food is an oozy substance at the bottom of the sea," &c. &c. "But no man can say with

* Practical fishermen state, that they can at all times, and in most situations, take a few herrings by means of half-a-dozen hooks tied on a horizontal piece of stick, which again is suspended to a long line. This is simply let down and quickly drawn up again, and the herrings are found transfixed at various parts of the body, but seldom or never by the mouth.

certainly, of what variety of articles the food of herring consists, nor how, for instance, it is produced in the Frith of Forth in such abundance as to nourish the myriads of these fishes that subsist therein, from their arrival in October till their departure in spring."

In plain terms he *never saw the food*, and knew nothing of it.*

On the food of the salmon, Dr Walker remarks:—"On examining the stomach, little is found in it except slime, or some half digested and some half entire insects. These appear to be the food of the salmon while in the fresh water," &c. &c. "It is probable that they receive in the sea a more copious food, and of a different kind, but the precise nature of this is unknown."

Mr John Mackenzie, in the same volume of the Highland Society Transactions, says, in regard to the food of the salmon, that "what salmon live upon while in the sea it is not possible to discover."

The opinion of a Mr James Morrison (p. 392), is that salmon occasionally live on herrings. "Some have asserted," &c. It is needless to say that this opinion is directly contradicted by all the evidence.

Mr Drummond, who had also written some practical remarks on the herring, observes of the food of the salmon, "A remarkable thing in the habits of the salmon is, that the longer they remain in fresh water, the more

* In the third volume of the Prize Essays of the Highland Society of Scotland, is a paper by Archibald Drummond, Esq. This gentleman evidently writes from much personal knowledge and experience. "On what they (herring) live we can only form a conjecture. I have seen their stomachs opened at all seasons of the year in which they appear here (), but never found any thing in them excepting some slimy matter." "A friend of mine, when at Loch Lhynne, near Fort William, this season, upon the arrival of the boats cut up many herrings, but never discovered any thing in their stomachs; the fishermen, however, assured him that they frequently got in the *foul or spent fish*, several of their own fry, sand-eels, &c. It has been asserted that to the northward of Shetland they feed and fatten on a species of Medusa. I cannot help combating this opinion, as I never took any of these blubbers in my hand without having it disagreeably blistered, and naturally conclude that they cannot be a delicate morsel for the herring."

voracious they become; in the spring, when foul fish, they will eagerly take every kind of bait. Yet voracious as they are, and desirous as they appear for all this variety of food, they still exhibit the singular phenomenon, that when their stomachs are opened, you will never find the appearance of food of any kind."

It was to explain away this difficulty, the usual empty state of the stomach of the salmon, and the absence of the *debris* of such substantial and palpable food as they imagined the salmon *must* live on, that the hypotheses of Sir H. Davy, and of Mr Fraser of Dalnacarloch were devised. But, in fact, the stomach and intestines of the salmon are not usually empty, being always more or less filled with the ova of the echinodermata, and of other shell-fish, than which kind of food nothing can be imagined more nutritious.

Mr Smith of Deanston thinks, that "salmon feed on animalcula." He has forgot to state to what species these animalcula belong, but he thinks these animalcula may find food in common sewers! *

This is an exact state of the knowledge respecting the food of these fishes, previous to our researches.

Mr Rennie, late Professor of Zoology in King's College, London, has the following statement in an edition of White's Selbourne, published by him so late as 1834. His authority has always been reckoned a good one in Natural History. "The food of the salmon and of the herring is perfectly unknown, nothing having been ever found in their stomachs and intestines but a little yellowish liquor."

In the minutes of evidence taken before the Parliamentary Committee which sat in 1825, the opinions of the witnesses are extremely conflicting. The greater number declare the food of the salmon to be unknown; some conjecture that they live on *worms*, and other *insects* got in the sea! and several have mistaken the *tape-worm*, which almost always infests the *cæca* and intestines of the salmon, for their food! On these points the evidence is below the notice of any scientific person, but proves my original posi-

* Parliamentary Report, p. 273.

tion, that heretofore the food of these valuable fishes was altogether unknown.

From the preceding quotation, it is evident that these distinguished men knew nothing of the food of the salmon or herring. The names of twenty compilers, and copyists of their writings, may be given to prove that they also were naturally enough unacquainted with the subject.

Having thus shewn that the best naturalists, anatomists, and practical fishermen, were, and still are, totally ignorant of the nature of the food of these two remarkable species of fish, and that many have had the candour to state so, whilst others were at least ingenious enough to maintain a profound silence on the point, I trust it cannot be necessary to reply any further to those persons who merely repeat the hackneyed facts, that herring (out of condition) occasionally eat the young of their own species, and that salmon, whilst in fresh water, will take a bait, such as worms, flies, &c. *These circumstances have been known from all times*, but what I think we have a right to ask of the persons who seem to attach importance to these insulated facts, is, to take the next step, and say at once that, in their opinion, small fishes, insects, &c., constitute the natural food of the two species. *But they have not yet said so*, and knowing what reply practical fishermen, who open thousands of these fishes annually, would make to such nonsense, I do not think, however much inclined, that they will venture to err so greatly against common sense.

I shall next state the steps taken by me in the prosecution of these researches. For reasons already stated, the vendace of Lochmaben was selected as the first in the series, in preference to the herring or char, both of which species were known occasionally to take common bait. We were sure, in respect to the vendace, of two points, *First, No one had ever thrown out even a conjecture as to its food, and it did not take any bait of the angler*; *Secondly*, The locality was better suited for inquiry; inhabitant of a small fresh water lake, we were certain of getting more readily at its habits; the habitat of the herring, on the other hand, is the ocean, a field boundless, if I may so say, in extent, and beyond our

grasp. The food of the vendace was quickly found by us to be the *microscopic entomostraca* with which the waters of the lake abound.*

In the autumn of the same year (1832) in which we discovered the food of the vendace, we had an opportunity of examining considerable numbers of very fine herrings, taken off the Isle of May, and particularly in those first examined by us, we found abundance of marine entomostraca, of extreme minuteness.

In the latter end of July 1834 fresh herrings were brought to the Edinburgh market in considerable numbers, and of superior quality. The best, as an article of food, averaged about $9\frac{1}{2}$ inches in length, and in the greater number of these we found abundance of entomostraca still of extreme minuteness. We sent a short account of the condition of these herring, and drawings of the entomostraca, to the most liberal of the weekly journals, but they thought proper not to publish this communication; on the ground, perhaps, of not being of sufficient general interest, and also of its reflecting too strongly on the recklessness with which amateur anglers and traders in herrings will persist in publishing the most incredible nonsense on matters respecting which they are profoundly ignorant. The least informed practical fisherman or salesman of good sense is generally superior, in point of sound knowledge derived from positive observation, to these half-informed persons who see every thing, in fact, through a veil of prejudice.

In the month of August 1835, during a short residence in Glasgow, we observed that fresh herrings of very superior quality were exposed to sale and brought readily a penny each. The average size of these herrings was $9\frac{1}{2}$ or 10 inches, and their organs of generation were scarcely, if at all, upon the increase. The stomachs of most of them were quite full of a rich orange-coloured granular substance; we at first thought this substance entirely composed of the ova of testaceous marine animals, but subsequent careful examination con-

* Muller says, that marine microscopic shell-fish (*Entomostraca*) abound so much in some Norwegian Bays, as to tinge the waters of a purple colour.

vinced us that they were entomostraca of extreme delicacy. These herrings were brought to Glasgow by the steamers up the Clyde from Lochfine, and particularly the Gareloch. A curious kind of imposture was attempted on the Glasgow folk by the introduction of herring taken in the Firth of Forth, and brought up the Union Canal; they were at least $1\frac{1}{2}$ inch larger, but of so inferior a quality as to be instantly detected.

We feel confident from intuitive evidence (independently altogether of the most direct analogy) that marine microscopic entomostraca did also form the food of vast numbers of those fishes now fossilized in the limestone and other formations; indeed microscopic entomostraca seem to have so abounded in former ages previous to the destruction of the then existing species of fishes, that I have little doubt of their forming a great proportion of the food of many of these animals. Then was the remark strictly true, that all nature teemed with life.

In March 1835 we read a paper to the Royal Society of Edinburgh on the food of the char, (*Salmo Alpinus*, Linné), and produced specimens, shewing in the most conclusive manner, that the proper food of these fishes was microscopic entomostraca, and that if, by any accident, the nature of the lake in which char are found be changed, as by draining, &c., so as to destroy the entomostraca, the char dies out.

In conclusion, we are desirous that some public body interested in the prosperity of the fisheries would cause a minute and searching inquiry, with a view to the deciding how far our opinions on these great questions are correct or otherwise; we have no farther object in this than a wish to extend the boundaries of natural science, and to prevent, if possible, whatever merit may be due to our discoveries and labours from being appropriated by others.

The following brief summary may serve to render our views clearer to those unaccustomed to scientific research.

1st, That any fish so large as the Vendace of Lochmaben or the Herring, should be supported exclusively, or even mainly, upon a species of shell-fish (*entomostraca* of naturalists) so small as to be invisible to the naked eye, was a fact never hinted at previous to our discovery of the natural food of these fishes.

2dly, The same minute animals seem to have served as food to vast numbers of those fishes whose remains now abound in a fossilized state in the limestone formations.

3dly, The Herring, when disordered by the spawning condition, as well before as after the deposition of the milt and roe, will, *like all other animals, including even the human race*, take to other food than what is natural to them; it is then that occasionally its own fry, or that of other fishes, or very small fishes, may be found in *a few* of their stomachs; at these times, and under these conditions, the herring is quite insipid, and unfit to serve as food to man.

4thly, The remarks just made in No. 3, apply equally to the Salmon, whose *natural feeding ground* is in the *sea* only: there he obtains that remarkably rich food, the ova or eggs of the *asteria*, and no doubt of many crustaceous animals, and even perhaps of fishes, but chiefly, so far as our researches go, the *sea food* of the real salomon is the eggs of the *asteria* and of the crustacea. When he enters rivers in a spawning condition, he deteriorates constantly, takes little food (if any), and becomes wholly useless to man as an article of diet. His habits in this state are like those of other cold-blooded animals; and after spawning, he takes to whatever food he finds within his reach.

5th, There are many both herrings and salmon which are barren at least for a season. These do not deteriorate nearly so fast as those which become foul by spawning. This accords with well known physiological laws. The Journals of Observations kept by us do not yet afford data to determine the average numbers of those barren fish, but we believe it to be considerable.

6th, The petition lately submitted by the West Country Herring Fishers against the Caithness or East Country ones, viz. that they the Northern and Eastern Fishers were destroying the fisheries of both coasts, by catching the herrings upon their spawning ground, contains both truths and errors: truths in respect to certain facts, but deep errors in regard to the conclusions drawn from these facts. We propose returning to the subject-matter of this remarkable "petition" shortly.

EDINBURGH, 22d July 1837.