

9. *Trichotropis acuminatus*. Jeffreys in 'Malacological and Conchological Magazine,' No. II. p. 36. In Lerwick Sound : not uncommon. I found one specimen of the *Chiton albus* which was half an inch long.
- Pecten obsoletus*, var. *omnino alba*. In Lerwick Sound ; only one specimen.
10. *Crenella elliptica*, Brown [*Mytilus decussatus*, Montagu]. In Lerwick Sound : not uncommon.
11. *Arca fusca*. In Lerwick Sound : a single valve.
12. *Montacuta substriata*, Turton. Lerwick, attached to the ventral spines of the *Spatangus purpureus*, its usual habitat.
13. ——— *ferruginosa*, Turton. Scalloway ; a single valve.
14. *Lucina lactea*. At Scalloway : rare.
15. ——— *spinifera* [*Venus spinifera*, Montagu]. In Lerwick Sound : rare.
16. *Cyprina minima*, Turton. In Lerwick Sound : not uncommon.
17. *Astarte? triangularis* [*Mactra triangularis*, Montagu]. In Lerwick Sound ; one specimen only.
18. *Venus Virginea* and var. *Sarniensis*, Turton. Lerwick : not uncommon.
19. *Anatina prætenuis*. Lerwick and Scalloway : rare.
20. ——— *intermedia*. Jeffreys in 'Malacological and Conchological Magazine,' No. II. p. 45. In Lerwick Sound : not uncommon.
21. *Psammobia florida*. In Lerwick Sound : not uncommon.

Swansea, Sept. 1841.

XXI.—*Brief and Practical Instructions for the Breeding of Salmon and other Fish artificially.* By Sir FRANCIS A. MACKENZIE, Bart.

IN the autumn of 1840, having chosen a brook flowing rapidly into the river Ewe, a hollow spot adjoining to it was selected and cleared out, of the following dimensions : length 23 yards, breadth from 12 to 18 feet ; and all large stones having been taken away, the bottom was covered 1 foot thick with coarse sand and small gravel, the largest stones not exceeding the size of a walnut. A stream from the brook was then led into this hollow, so as to form a pool of about 8 inches in depth at the upper and 3 feet at the lower end, thus giving it one uniform gentle current over the whole pool ; whilst the supply of water was so regulated by a sluice as to have the same depth at all times, and a strong stone wall excluded all eels or trout, so destructive both to spawn and fry.

On the 13th of November, four pair of salmon, male and female, were taken by net from the Ewe, and carefully placed in the pool ; on the 18th they showed a disposition to spawn, but on the 20th the whole were carried away by some ill-dis-

posed persons, and on examining the pool, only a small quantity of ova appeared to have been deposited. On the 23rd of November four pair of salmon were again caught and placed in the pool, which were observed to commence spawning on the day following;—caught them carefully,—squeezed gently about 1200 ova from a female into a basin of water, and then pressed about an equal quantity of milt from a male fish over them; stirred the two about gently, but well together, with the fingers, and after allowing them rest for an hour, the whole was deposited and spread in one of the wicker baskets recommended by Professor Agassiz, having about 4 inches of gravel below them and 2 or 3 inches of gravel above. A similar quantity of ova, treated in the same way, was also deposited in one of the copper wire bags, as used by Mr. Shaw, and both were then immediately placed under water in the pool; a little of the ova was buried in the open gravel at about 3 inches in depth. In another basket, and also in another copper wire bag, 2 or 3 inches of gravel were placed over the bottom of each, and both basket and bag laid in the pool, covered with about 4 inches of water. The ova of a female and milt of a male were then successively squeezed from two fish on the gravel in both basket and bag, and spread over it regularly with the hand one after the other; and after leaving them exposed, in this state, to the water for a few minutes, the whole was covered with 2 or 3 inches of gravel and left in the pool. These four pair of fish afterwards emitted voluntarily a small quantity of spawn which had been left with them, and on the 1st of December they were all turned out into the river. On the 3rd of December, caught three pair of salmon which had already partially spawned in the Ewe;—used another basket and also another wire bag, treating the spawn in the same manner as last described; these fish were then also allowed to deposit voluntarily the little spawn of which they had not been deprived, and afterwards turned out into the river. On the 19th of February examined the ova, and life was plainly observed in the baskets, wire bags, and unprotected gravel, both where placed artificially and where deposited by the salmon themselves.

19th of March, the fry had increased in size and went on gradually increasing, much in proportion to the temperature of the weather.

22nd, the eyes were easily visible, and a few of the ova had burst, the young fry having a small, watery, bladder-like sac attached to the throat.

18th of April, the baskets and bags were all opened; the sacs had become detached from their throats, the fry measured

about three-quarters of an inch in length, and they swam about easily, all marked distinctly as Par. The baskets recommended by Professor Agassiz proved superior to the wire bags of Mr. Shaw. In the latter only about 20 per cent. came to maturity, whilst in the former not above 10 per cent. proved barren, and in the baskets used 5th of December not above 5 per cent. was unproductive. It is impossible to say exactly the proportion of ova which came to life either of that artificially impregnated and deposited in the open gravel, or of what was spawned by the fish themselves naturally, but so far as could be judged, they succeeded equally well with that in the baskets. Perhaps the baskets may have a preference over the other methods tried, as affording more certain protection to the spawn during winter; and it is proper to state, that the last-described mode of depositing the ova and milt was most successful. There can be no doubt, from the success which has attended these experiments, that the breeding of salmon or other fish in large quantities is, comparatively speaking, easy, and that millions may be produced, protected from every danger, and turned out into their natural element at the proper age, which Mr. Shaw has proved by repeated experiments on a small scale to be when they have attained about two years of age. When the par marks disappear they assume the silvery scales of their parents, and distinctly show a strong inclination to escape from confinement and proceed downwards to the sea.

Professor Agassiz asserts, and I fully believe with truth, that the ova of all fish, when properly impregnated, can be conveyed in water of a proper temperature even across the Atlantic, as safely as if it were naturally deposited by the parent fish; so that any quantity of salmon or other spawn can (after impregnation on the banks of a river) be carried to other streams, however distant, which may be favourable for hatching. It may be right to observe, that as the fry are to remain two years in the artificial pools where hatched, fresh places must be used every second year for the spawn, as even one-year-old fry will destroy spawn, or their more infantile brethren, if left together; old spent salmon are also destructive both to spawn and fry.

It can only be ascertained by experience what kind or quantity of food will be required for the fry. Carrion hung at the top of the pool in which they are, would, in the opinion of Professor Agassiz and Mr. Shaw, supply them with maggots; but in this there are difficulties, and when tried by me this season, a few of the fry were found dead round the carrion given to them. The droppings of cattle allowed to

rest till half dry, and occupied by worms and the ova of insects, appear to suit them best. About the 1st of September last, when on an agricultural tour of Belgium, I visited an establishment belonging to King Leopold, and adjoining his new palace of Ardennes, on a much more expensive scale than that now described, where the breeding of trout had been tried for the three previous seasons, though with but little success. A very few small trout bred 1839-40 were still alive, but the ova of 1841 were a complete failure, chiefly from not properly covering the spawn with gravel, and other errors. Bread made of brown and white flour mixed was the food found best suited to the few living, who, judging from their shape as seen swimming about in a small pool, were in excellent condition. The trout-breeding establishment of Ardennes, however, proves that their spawn, if treated in the same way as that of salmon above described, will produce the same successful results, and that any one possessing a convenient pond or stream may stock it with the best kinds of trout or other fish in one or two years, and by good feeding have them in high condition. Where trout already exists of small size and inferior quality, I would recommend wholly destroying the breed by saturating the water with quick-lime or any other mode more advisable, and procuring spawn or fry from lakes where the best kinds of trout are found, in Scotland or elsewhere. The same may be said of grayling, pike, or any other kind of fish suited to ponds or brooks and rivers as may be desired by their owners, which renders the discovery now made known of value to all, and in all quarters, as well as to salmon-fishing proprietors. In conclusion, I hope that the above brief account may not only be well understood, but that the ease and comparatively trifling expense at which the breeding of fry can be accomplished may induce many this season to try this novel but successful mode of increasing our stocks of salmon and other fish, and consequently adding largely to the wealth of our country.—F. M.

Should any further information be wanted, Sir F. will gladly reply to such inquiries; and he now expresses a hope, that those who may be successful in spring 1842, or after years, will communicate to him any account of improvement on the mode of breeding, feeding, &c. now described; as, though perfectly satisfied with the results of his own experiments, Sir F. is ready to acknowledge that there exists nothing so perfect devised by man as not to admit of improvement.

Conan House, Ross-shire, Oct. 1st, 1841. }



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