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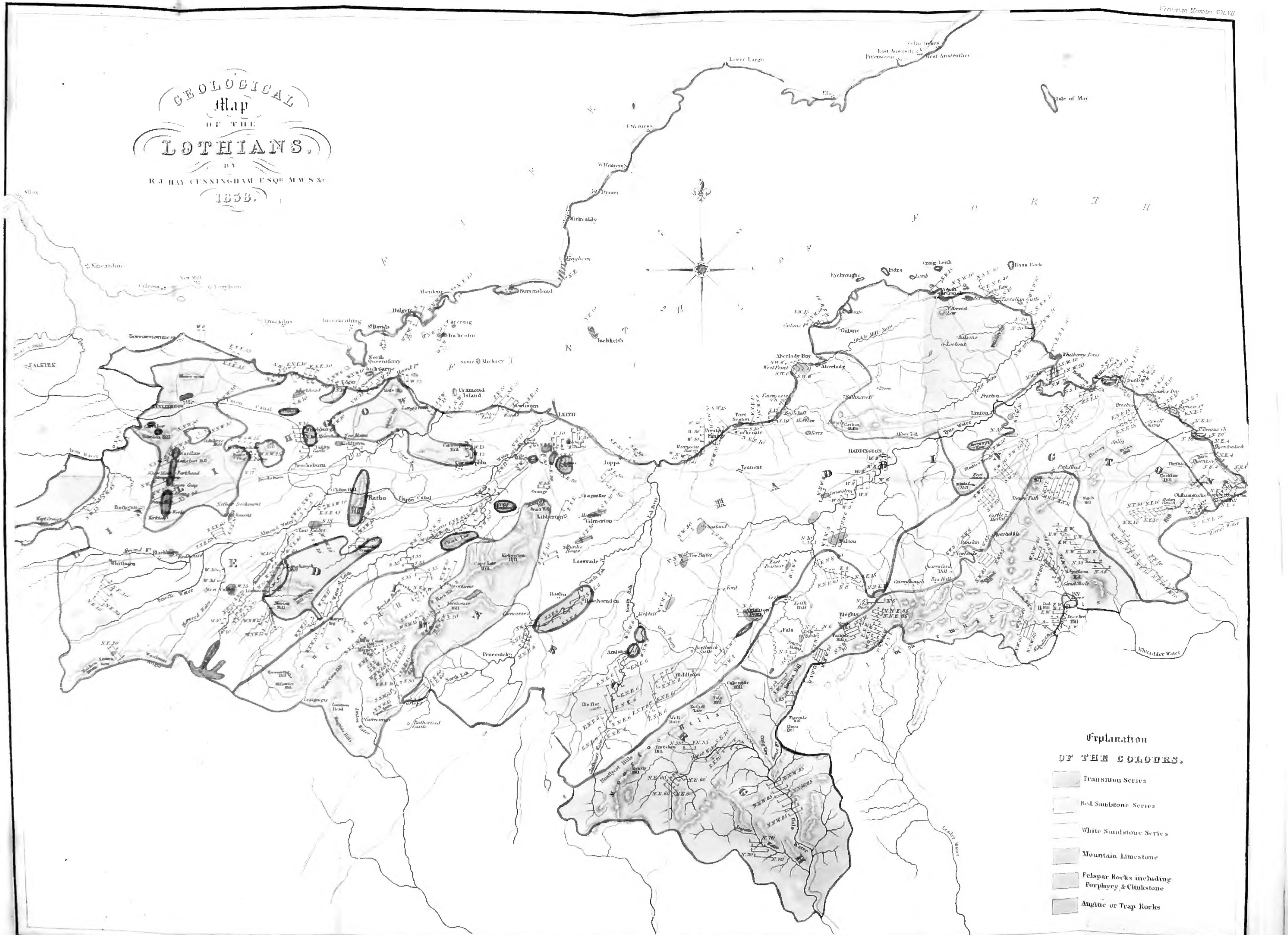
GEOLOGICAL
Map
OF THE
LOTHIANS,
BY
R. J. HAY CUNNINGHAM ESQR. M.W.S. &c.
1838.
Explanation
OF THE COLOURS.
Transition Series
Red Sandstone Series
White Sandstone Series
Mountain Limestone
Felspar Rocks including Porphyry & Clinkstone
Augitic or Trap Rocks

MEMOIRS

OF THE

WERNERIAN

NATURAL HISTORY SOCIETY,

FOR THE YEARS 1831–37.

VOL. VII.

COMPRISING,

I. MR CUNNINGHAM'S PRIZE ESSAY ON THE GEOLOGY OF THE LOTHIANS, WITH THIRTY-FIVE COLOURED SECTIONS, AND A GEOLOGICAL MAP OF THE LOTHIANS.

II. DR PARNELL'S PRIZE ESSAY ON THE FISHES OF THE DISTRICT OF THE FORTH, WITH SIXTY-SEVEN ILLUSTRATIVE FIGURES.

III. HISTORY OF THE SOCIETY FROM DECEMBER 1831 TILL APRIL 1838.

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CONTENTS.

APPENDIX.

MEMOIRS

OF THE

WERNERIAN NATURAL HISTORY SOCIETY.

ON THE

GEOLOGY OF THE LOTHIANS.*

BY

ROBERT JAMES HAY CUNNINGHAM, Esq. M. W. S.

INTRODUCTORY REMARKS.

In offering this essay to the consideration of the Wernerian Natural History Society, the author considers that, for the satisfaction of those to whose scrutiny it is submitted, he is called upon to state some of the circumstances attending its production. The necessary investigations were commenced in the beginning of the summer of the year 1834, and continued with little interruption till the middle of July, after which they were suspended till March 1835; and since that period, up to this date, few weeks have elapsed without more or less time being spent in examination. The deficiencies of the essay, therefore, whatever these may be, cannot be referred to its hasty formation; and if its shortness be considered as hardly agreeing with these state-

* The Wernerian Natural History Society's Honorary Premium of Twenty Sovereigns was adjudged to Mr Cunningham for this Essay.

ments, the author begs leave to mention, that, though the phenomena may have been few which he considered worthy of minute description, this did not (if there was to be an attempt at a geological map of the Lothians) in any way lessen the labour. The country required to be traversed in all directions in search of appearances worthy of description, and if many excursions were made without the author finding any thing to describe, or even a rock of which a specimen was requisite, still there was the same expenditure of time and labour as would have taken place if these excursions had been fraught with interest.

As the Lothians have been traversed in all directions by geologists, little novelty is to be expected in the following pages; yet the author, by verifying and correcting from actual examination all previous accounts, and by adding his own observations, trusts that he will meet the wishes of the Wernerian Natural History Society. From accompanying Professor Jameson in his excursions, he has derived much information, and has endeavoured to conduct his researches on the principles so ably taught by that experienced and celebrated geologist.

The speculative parts of the essay, and the views in regard to some points in the geology of the Lothians, bear on printed statements, and on others which, although not printed, are well known to the geologists of Edinburgh.

The maps accompanying this essay have been coloured, as far as possible, in accordance with Professor Jameson's paper "On the colouring of Geological Maps," which is published in the first volume of the Wernerian Transactions; all the tints, however, have been made more intense, as the dark engraving of the maps would, in many cases, have rendered the colours, if no deeper than those recommended in that paper, hardly visible.* The sections have been formed on the same system of colouring, and when other colours were required, those were selected which appeared to harmonize best. In regard to the objects of these sections it may be stated, that they were selected from all those points where the connections of the rocks are in any way interesting. The specimens which accompany the memoir, were selected in the same manner: no rock which the author considered interesting did he intentionally pass. In regard to the paucity of the specimens which have been collected in Linlithgowshire, it may be remarked, that few rocks were found which had not been already noticed in the counties of Haddington and Edinburgh, and, as specimens of these had been selected, the fact of finding the same rocks in a different locality, appeared to render their collection unnecessary.

There still remains to be noticed one circumstance attending this essay, and which may perhaps require explanation; and this is the fact of there being in it no attempt to give details connected with the "*Coal Workings.*" The reason which the author had for not entering on this part of the subject was, that he considered that such an investigation lay more in the way of the professional coal-viewer, than of one engaged in purely geological investigations. He did not, therefore, attempt to draw up sections or ground-plans of coal-workings, or to inquire into the quantities of known coal.

* The maps here referred to are those which were lodged with the essay. They were those published by Mr Thomson of Edinburgh.

That his non-attention to this department, however, has in no way been the means of causing him to overlook appearances of interest, in a scientific sense, he is inclined to believe, from the perfect similarity attending the relations of those various beds of coal which have actually fallen under his notice.

THE LOTHIANS.

That portion of Scotland, which is bounded on the north by a line drawn from the Firth of Forth to the Firth of Clyde, is composed entirely of rocks of the Secondary and Transition classes. The former of these is traversed by ignigenous masses of the Felspar and Trap families, while the latter, besides being connected with these rocks, is broken through in several places by different granites and syenites. As it very generally happens that the oldest rocks of a country are those which attain the greatest altitude, while the newer formations which skirt them, form, according to their relative ages, either the hilly or the low land ; so here, the mountainous districts are composed of the older rocks, viz. the greywacke and transition slates (strata, which constitute the more or less uninterrupted high land which extends from St Abb's Head to Port Patrick in Wigtonshire), while the plains and less elevated country, exhibit only rocks referable to one of those groups which collectively form the great series of secondary formations.* All the strata of this class, which occur in the southern division of Scotland, are to be referred to the carboniferous group. In several details these rocks will be found to differ from the

* The geognostical characters of the great high land mentioned in the text were first made known by Professor Jameson, who, indeed, was the first geologist who pointed out the occurrence of Transition rocks in Great Britain.

same as occurring in England ; these differences are, however, only such as might be expected to be observable in a deposit extending over a large area: one part of a formation may be more fully developed in one situation than in another, or it may even be entirely awanting. In regard to the mutual associations of the Augitic and Felspathic masses, we may remark that, although no natural sections exhibit the relative ages of these rocks; still, from the examination of other districts, which are partially composed of both ; from the circumstance of the trap family being so generally distributed among the carboniferous strata, and also from the eruptions of the trachytes (which may be considered as the modern analogues of the ancient porphyries and felspars), being, in general, anterior to those of rocks having a basaltic character, it is highly probable that the series of felspar masses, which is so generally associated with the Transition deposits, is of a formation more ancient than the basalts and greenstones. In the three counties the geognostical structure of which it is the subject of this paper to describe, extensive districts of both Transition and Secondary strata occur, and, as we have just stated, the higher grounds are composed almost entirely of the older rocks. Before entering upon a minute topographical description of these two great classes, and also before we define their geographical distribution, we shall describe both in a general manner ; and as in all geognostical descriptions, it appears to be most natural to follow the ascending series, so here we shall first notice the

TRANSITION ROCKS.

To classify, according to nature, the various mineral masses which constitute the crust of our globe, has been the endeavour of geologists, from that epoch in the history of the science when it was first discovered, that, to arrive at the knowledge of the earth's structure, we must have recourse to minute investigation. Many have proposed arrangements of the strata, which they, as the authors, have, of course, considered less liable to objection than those for which they were substituting them. In all these arrangements, there has been no one division of the stratified part of the earth, more universally considered false and unnatural, than that of the "*Transition class*." It has been said to have no natural existence, but to be the mere creation of minds fettered by preconceived theories. As an objection to the term "*transition*", some have urged that it is one derived from that theory, which affirms, that the rocks of this epoch were formed, during the passage of the globe, from a state unfitted for the existence of organic beings, to one which was calculated for their preservation. If geologists have, in the course of their investigations, come to any certainty concerning the ancient states of our globe, there is certainly no one doctrine supported by a greater number of facts, than that of progressive development. Many remains have been adduced as belonging to beings, which held a place in the zoological scale, higher than was consistent with this theory. With one exception, however, all these remains have been found, on more accurate and better conducted examination, to be, instead of dissentient facts, beautiful proofs of its truth. The exception to which we refer* is as yet, perhaps, unexplained, and by some is considered as a stumbling block which must cause the fall of this theory. If, however, we remember that all the other exceptions have been explained, and that the "*Crocodiles' teeth*" of Burdiehouse, which Lyell considered as indicative of the entire fallacy of this theory, have been found by Professor Jameson, and afterwards by Agassiz, to

* The occurrence of didelphic remains in the slate of Stonesfield, a member of the oolitic series.

belong to fishes; and that the supposed Trionyx of the old red sandstone of Caithness is also found to be a fish; we may expect that, on more extended investigations, the nature of the Stonesfield remains will appear in no way at variance with their geognostical position. As it seems most accordant with the rules of philosophical induction, to consider that as the best founded theory which is most generally applicable, so one solitary apparent exception should be the more diligently examined; it ought to be viewed on every side and in all its details, whether it may be reconcilable with the theory against which it appears to militate, rather than be eagerly laid hold of, as a weapon to subvert one derived from apparently legitimate generalizations. To account for the non-appearance of highly organized remains in old rocks, it has been asserted that causes have existed adequate to effect their complete obliteration. "Mechanical pressure, derangements by subterraneous movements, the action of chemical affinity," have all been summoned up to account for the disappearance of animal remains which have (if we may judge from evidence as strong as any attending a science, the facts of which are in few instances open to experiment), perhaps, never been in existence. How fickle in its actions must have been that "lapidifying process"! which could preserve, even to a delicate spine, a frail shell, and be too destructive to allow even the fragment of a bone of a bird or mammiferous animal to be visible in our older secondary rocks! It has been told us, that as the bottom of the existing ocean has not been dredged "throughout an area co-extensive with that occupied by the carboniferous rocks," thus enabling us to calculate the chances which will bring up the relic of a mammifer; so the fact of the non-appearance of these remains ought not to be considered as a proof of their non-existence. But, as has been well remarked, "Every island, every continent, has formed part of an ancient bed of the ocean, and this ancient bed is exposed to the examination of thousands of observers in every degree of latitude not covered by polar snows." Further, on finding this statement in a work which proposes a classification of tertiary strata, however ancient, by merely acquiring a knowledge of the extinct and existing species contained in each, are there not marks of inconsistency? It is reckoned unsafe to judge of the utter absence of highly organized animals, in very old strata, by their not having as yet been found; while the fact of a tertiary system of strata containing a greater percentage of extinct shells than another, is considered as perfectly demonstrative of its greater age. We are not wishing to inquire whether, in these instances, such a mode of examination will infallibly lead to a just conclusion or not; but it appears to be drawn as an inference from appearances precisely similar to those, which have induced geologists to believe in a progression of development. As an argument against the doctrine of progressive development, it has been affirmed that the corals and mollusca, which lived in the ancient seas, were not of a more simple structure than those which at present exist. Those, however, who advocated the opinion that, from the oldest fossiliferous deposit to the formations of our own epoch, there were proofs, from examining fossil bodies, that the standard of organization was gradually, and not instantaneously, raised, never, either directly or indirectly pronounced, as their opinion, that this "progressive development" of organized beings was evinced by comparing the members of any one genus, as they occurred in consecutive formations. It was never affirmed, as far as we are aware, by any geologist, that, if a certain natural class of organized fossil remains was observable in several formations, (the relative ages of which were indicated by superposition) we must expect to find in the oldest of these formations or series of strata, individuals of this natural class having a more simple structure than those imbedded in the newest. But it was insisted, and is yet (though some imagine that they see in the laws which now govern organized bodies in all their relations, and in the globe itself, an almost eternal and uniform system of legislation), that the earth's strata exhibit proofs from their contents, that certain epochs have been characterized by the creation of the several main links of the zoological chain.

The term "Transition" has been discarded by a celebrated geologist upon another ground; but unfortunately the reason why the term was applied has been misunderstood. Mr Phillips, in his "Guide to Geology," after saying, that some geologists make a Transition class of rocks, affirms "that this is needless, for such passages are not thought necessary to be marked in other instances." When Werner named a certain class of rocks "Transition," it was done, not from discovering that they passed into the inferior or more crystalline rocks, but from the conclusions which he drew from finding, that, in this series, for the first time, marks of animal and vegetable life occurred; and that these were remains of beings which possessed a structure of the most simple nature. He so named this series of rocks, not because it passed by mineral character, or alternation, into his "Primitive class;" but because his examination of its contents, and relations to associated rocks, made him draw the inference, that it had been formed during the passage of the globe, from a state in which vegetable and animal life existed not, to one fitted for its preservation.* The term "Transi-

* "They are supposed to have been deposited during the passage or transition of the earth from its chaotic to its habitable state."—*Jameson's Geognosy, p.* 146. *Edinburgh.* 1808.

tion" was theoretical; but it is upheld by as many proofs as any other acquired portion of geological knowledge. As regards the objection to the term Transition, that it is unnatural, inasmuch as the rocks of this class pass into the inferior and more crystalline strata, and in the upper parts into those of secondary formation, it may be asked—Where is the series of rocks, which, however distinct and separate from its associated formations it may appear to be in one country, has not been observed in other localities to alternate with and pass into them? If in all cases, however, these appearances were considered hostile to forming arrangements of the globe's strata into great divisions, it is evident that no classification could be formed from the relative superposition of strata, and that one from some other system of phenomena would be necessary. Though these transitions of strata into each other, however, are conspicuous, there is still no reason why such transitions should be considered as affording a reason that from "gisement" strata should not be arranged. When viewed on the large scale, that on which all geological appearances ought to be viewed, the series which, from superposition, is to be acknowledged as of one formation, is also, from its being characterized by one or more classes of fossilized organic bodies, and in many instances by a wonderful similarity of mineral character, to be considered as the uninterrupted production of a certain geological epoch. The mineral characters of the transition rocks which occur in the Lothians, are limited. The Greywacke is, in general, a fine aggregate of minute grains of quartz and Lydian-stone, imbedded in a base approaching to clay-slate, and containing scales of mica very generally distributed through it. In size, the components of the greywacke vary; they occur of all magnitudes, between that of the smallest sand and a fine conglomerate; and, when very compact, its mechanical nature is not very easily recognised. The Clay-slate, which is frequently associated with the greywacke, into which it passes, and with which it alternates, is of various shades of ash, bluish and smoke grey. Its general aspect is earthy, and it never assumes that crystalline appearance which eminently characterizes that of an older formation, viz. the slate associated with gneiss and mica-slate. In the strata of greywacke there is also sometimes a striped appearance, identical with that exhibited by the coal formation shales, and, in some districts, it contains numerous minute veins of massive quartz, and layers of red hæmatite. The uniform sameness of the mineral characters of the Transition rocks, in countries far removed from each other, is a proof that the causes, from the actions of which they resulted, were almost universal; a fact which is at complete variance with that system of geology, which sees only in the various rocks of our continents the long-continued action of existing causes. By the term "universal," however, it is not intended to be implied that at one period the earth was covered completely by an envelope of greywacke strata. Such an opinion, either in regard to it or any other formation, is contradicted by every appearance. But it is wished to be only understood as intimating that, during the epoch of the greywacke's formation, it is probable that, when depositions of strata took place over the globe, they were in circumstances which allowed only the deposition of a greywacke. The idea which supposes, that, if a deposition of strata took place, that deposition must in all parts be similar, because there existed a series of causes over the whole globe, which if called into action produced the same effects, is quite different from that which assumes that these causes acted at one given period over the whole globe. If all the deposits at present forming below the waters of the ocean, could be looked upon in one wide extended plain, it would be found that their mineral characters are so different in different places, that little similarity could be traced amongst them. That deposit which resulted from the erosion of a granitic district, would present the characters of various red sandstones; that which was produced by the comminution of quartz rock, would approach in character to a white sandstone; while the formations which were formed from the disintegration of secondary or tertiary districts, would consist of various alternations of sands, gravels and clays. In all these supposed cases there is nothing similar to that uniformity of mineral character which is conspicuous in older formations; a fact which indicates that the causes effecting these formations were very general, and that similar circumstances existed over an immense portion, if not over all the globe at one period.

SECONDARY ROCKS.

Having now noticed generally the transition rocks of the Lothians, we shall next describe that series of Secondary strata which forms almost the whole of the counties of Edinburgh, Haddington, and Linlithgow. The Secondary series of the Lothians is not composed of one and the same rock, but is, on the contrary, an example of a compound formation, inasmuch as it is an assemblage of red and white sandstones, variously coloured shales, and limestone, all of which are so associated with each other, that their synchronism of deposition is conspicuously evident. The white sandstone group of the Lothians has, as we have before stated, always been considered as belonging to the Independent Coal Formation. This series differs in several respects from the coal-measures of England. It would certainly indicate a state of things entirely different from the present, if a formation, whose relative position in the crust of the globe was in one country correctly ascertained, exhibited in every other a strictly uniform sameness in its mineralogical and fossilogical characters. If contemporaneous formations were identical in all their details, the determination of strata would be conducted in a manner far different from what it is. Instead of traversing extensive districts, examining the relations of an unknown rock to others whose natures were apparent, and from superposition and other characters ascertaining geological equivalents, the mere view of a characteristic specimen would be sufficient ; and from geology being one of the most intellectual of Sciences, one which requires minute investigation, it would deserve hardly to be considered as an Art.

Authors, in describing that series of rocks which lies, in the regular succession, below the magnesian limestone, and above the transition formations, divide it into the Old Red Sandstone, Mountain Limestone, and Coal Formation, drawing lines of demarcation between all these deposits. Though, from observing, in some countries, that the position of one or all of these deposits is so unconformable, that it is only to be accounted for by the state of repose which existed during their several depositions, having been interrupted by disturbing causes, still there is no reason to conclude that this unconformability is to be observed in all countries. This is to assume, that igneous actions in the early ages of the world, differed entirely from those which now operate, and also that the upraisures of contemporaneous strata were themselves contemporaneous. A deposit which is completely separated from that which succeeds it in one country, may in another make a transition into it by numerous alternations; and thus we have a proof that breaks in the sequence of strata, are, if viewed with the extent of the globe, only local. In the Lothians the divisions of old red sandstone, and mountain limestone, are unnatural; for strata which, in one locality, might, from their relations to others, be considered as the old red sandstone, are, in another, found to occupy a position which renders this impossible. If these sandstones are found both above and below the mountain limestone, and are frequently seen to alternate with it on the large and small scale, it is evident that they form one deposit; that the causes which produced them were not interrupted by paroxysms of violence. In the Lothians and in Fife, there are many points which evince that the old red sandstone, mountain limestone, and coal formation, cannot, as developed in these districts, naturally be separated.

Professor Jameson, in his Mineralogical Account of Dumfries-shire, p. 165, enumerates several localities in the Lothians and in Germany, where red sandstone is found intimately connected with the white sandstone series. In regard to the occurrence of red and brown sandstone, the Professor states, " 1st, In lower Silesia, nearly the whole of the coal-field is composed of reddish-brown and cochineal coloured sandstone, with which great beds of coal alternate. 2dly, In the coal-field of Mid-Lothian we have the following instances of similar coloured sandstone occurring in the coal formation: *a.* In Dryden Water, near Loanhead, there are several beds of reddish-brown coloured sandstone, accompanied by similar coloured ironstone in the coal formation. *b.* Near Mr Cameron's paper-mills, on the banks of the Esk, there are thick beds of reddish-coloured sandstone, that evidently belong to the coal formation, and the same rock continues in the direction of the river, forming the picturesque cliffs of Hawthornden and Roslin, and extends even to Auchindinny Bridge. *c.* Immediately behind themanse of Collinton there is a beautiful section of the coal-field. The strata are semicircular and have their convexities uppermost, or form what is called a *saddle*; they are of a reddish-brown colour, and alternate with layers of greyish-black coloured slate-clay, and reddish-brown coloured clay-ironstone. On each extremity of the saddle rest the more common rocks, viz. grey-coloured sandstone, globular clay-ironstone, &c. *d.* The rock on which Craigmillar Castle is situated, belongs to the coal formation of Mid-Lothian. It is composed of horizontal beds of greyish and reddish-coloured sandstone, that alternate with their beds of reddish-coloured slate-clay and limestone conglomerate. *e.* The hill of Salisbury Crags belongs to the coal formation, and in it we observe repeated alternations of reddish-coloured sandstone, clay-ironstone, slate-clay, and limestone conglomerate."

In Fife, the coast between Dysart and Wemyss exhibits four alternations of the red with the white sandstone; and in the course of the Bevelaw Burn, a small stream which runs for a few miles at the base of the Pentland range, the white sandstone underlies the red. In other quarters this arrangement is completely reversed; as on the coast of East Lothian, between the Cove and Dunglass Burn, where the white coal-sandstone overlies the red. By following the courses of the Dunglass, Bilsdean, and Thornton burns, the transitions of the white sandstone series into the red, are most satisfactorily displayed; the strata, as they recede from the sea, gradually assuming a red colour, till, at last, they pass into the red sandstone. In that part of the Esk river which runs past Arniston and Kirkhill, there are numerous alternations of the red with the white sandstone. Much also of the country intervening between Drummore-mill and Hawthornden, through which the Esk flows, is formed of the same red sandstone: its relations, however, to the white sandstone, are evident, and exhibit nothing fitted to justify the misconceptions of some who have examined it.* The mountain limestone, which, if it preserved that position which it is generally found to occupy in other districts, would be a formation separating the white from the red sandstone series, occurs in the Lothians connected with both. While making these statements indicating that the causes which produced the Secondary formations of the Lothians were uninterrupted during the deposition of the series, and that this circumstance accounts for the various alternations of its members, we may remark, that there has been a source of error in the belief, that in all instances three distinct deposits,† viz., the Old Red Sandstone, the Mountain Lime-

* Dr Hibbert, in his paper "On the Limestone of Burdiehouse," published in the Transactions of the Royal Society of Edinburgh, vol. xiii., page 137, affirms, that, by ignigenous action, "there has been an emergence of beds even inferior to the carboniferous group," and cites the Pentlands and the coast of North Berwick as localities. The strata exposed there, however, are all of the same general nature as the red sandstones of other places, which, by their relations to the white sandstones, so clearly indicate that both series constitute one contemporaneous formation. The red sandstone of Hawthornden, exhibited also to Dr H. some appearances which caused this observer to believe that it had been deposited soon after the formation of the Transition rocks. In regard to what these were we are ignorant; but if viewed in all its relations, it will be found to form only one of those deposits of red sandstone, which, with those of white sandstone, coal, and shale, form the secondary system of the Lothians, and geognostically represent the coal formation.

† As an instance of this we may mention the conclusions to which Messrs Sedgwick and Murchison came, after examining the secondary formations of the island of Arran. In that island two red sandstones occur, the one above, the other below, the strata of white sandstone containing beds of coal, while the Mountain Limestone occurs interstratified with both. After examining this district, these geologists were led to consider that series of red sandstone strata, which was in the more immediate vicinity of the old rocks, as the Scottish representative of the old red sandstone of England: the assemblage of white sandstone was by them described as the Coal formation; while the red sandstone which lay above it, was stated to be the equivalent of the new red sandstone of England, differing from it, however, in this circumstance, that in Arran it was conformable with the coal formation. By

stone, and the Coal Formation, separate, without ever blending into each other, the New Red Sandstone from the Transition Rocks. It is this alone which has made some declare that the series of red sandstone strata, which, in some places, is found above the true Coal Deposits, belongs to the New Red Sandstone. To determine the age of strata, they must be examined through their whole extent, and their position in the globe's crust is only to be ascertained by studying all their various phenomena. Though the red sandstone, white sandstone, and limestone, of the Lothians, may not, from the circumstance of their being so intimately connected, be considered exactly similar to the carboniferous series of other districts, though, perhaps, they exhibit not that invariableness of position which characterizes them elsewhere, still, in the circumstance of the red sandstone and conglomerate being most remarkably developed in those parts of the country which are in the vicinity of the older rocks, they exhibit an appearance similar to that observable in other and more distant localities. The conglomerates of the lower parts of the series are, from the size of the masses which compose them, highly indicative of the great mechanical action which must have operated in their formation.

Though conchological contents characteristic of a formation, the position of which relatively to others is known, be found in districts at a great distance from those in which the

By comparing this series of red and white sandstone with the same as developed in the Lothians, or even in the adjoining coast of Ayrshire, the identity of the two is easily made out, and that sandstone which was by these gentlemen considered as the new red sandstone, becomes only a member of the great secondary series of the Lothians, no one of which can be naturally separated from the others, if throughout the whole extent of their distribution we examine their mode of arrangement relatively to each other. This view of the sandstone of Arran was proposed by Professor Jameson, in one of a series of memoirs on the geology of Arran, read to the Wernerian Society several years ago.

deposit of an understood geological age occurs, still we are not to consider that these far separated deposits must necessarily be of the same age. That they may be, is possible, but it is as probable that they may not, and their evidence is never to be opposed to that affordedby superposition.

That the red conglomerates and sandstones of the Lothians are not derived from the consolidation of sands and rolled masses brought from a great distance, is apparent, from the fact that no rock-fragments are found in them, but such as occur *in situ* in their more immediate neighbourhood. That vast deposit of red sandstone conglomerate which skirts continuously the Greywacke formation of the Lammermuirs, from Redheugh in Berwickshire to Heartside in Haddingtonshire, and which rises into mountain masses in several parts, is entirely composed of variously shaped rolled masses of greywacke and transition-slate. Besides containing masses of the stratified or Neptunian rocks, on which the conglomerates rest, they also, though rarely, include rolled masses of members of the felspar series. In the red sandstone hill of Chesters, near the village of Spott in East Lothian, masses of felspar-porphyry occur, and, in the conglomerates of Carlops and Habbie's How, fragments of compact felspar are abundant. These appearances therefore indicate that all the members of the felspar series of the Lothians are not newer than the carboniferous formations; but prove, on the contrary, that by being subjected to aqueous attrition, they have contributed to the formation of these strata. The white sandstone series, which alternates with the red, and has been entitled The Independent Coal Formation, is, like the red sandstone, compound; it is an assemblage of white sandstones, slate-clay, bituminous shale, clay ironstone, and coal. In the Red Sandstone series, the sandstone is in general of a bright red colour, and conglomerates are abundant; but, as the name implies, those of the white sandstone group are generally white, and conglomerates are comparatively rare. The shales accompanying the red sandstone strata, are of various shades of blue, green, yellow, and red; while those associated with the white sandstone are generally grey: bituminous shale also is very rare in the former series, while in the latter it is largely developed. The abundant diffusion of coal beds in the white sandstone series, is another characteristic feature of this group, for when these do occur connected with red sandstone, they are, with few exceptions, situated in what may be considered as a debateable ground between the two classes of strata, and in those portions which partake of characters of both. Another rock which we have mentioned as occurring in the Lothians, is the Mountain Limestone. This, as we have previously stated, is not here, as in those districts of England or Ireland where it occurs a distinct and separate formation. It occurs in the red sandstone series of the Lothians, forming, in some localities, considerable beds, but its comparative scarcity in it is to be considered as a mark eminently distinguishing this series from that of the white sandstone group.

Having now described the general relations of the various secondary rocks of the Lothians to each other, we shall enumerate their several mineralogical ranges of character. The red sandstone, which we have mentioned as the frequent occupant of the lowest part of the series, is in general a fine aggregate of grains of quartz and felspar, held together by a basis of ferruginous clay; scales of mica are profusely distributed through it, and frequently, by their great abundance, it assumes a slaty structure. A coarse conglomerate forms a part of the red sandstone series. It is of two kinds; one variety, as we have before stated, being entirely formed of variously sized masses of greywacke and its slates, and occurring in immediate connection with the transition ranges of the Lammermuirs; while another, which is met with only in different parts of the Pentland district, and in the neighbourhood of Pennycuick, is composed of rounded masses of quartz-rock, greywacke, flinty-slate, felspar, and common jasper, imbedded in a base of similar fragments. At Danskin, in East Lothian, and in the mountain valley of Glencorse, both conglomerates are well marked. The hills which occur on both sides of Dunglass Burn, are composed of this rock, which has resulted from the disintegration of the greywacke, and the masses which form it are on such a colossal scale, and held together so very loosely, that it might be mistaken for a formation of very modern date. The red sandstone forms extensive districts in Berwickshire, and much of that part of East Lothian which ranges along the northern front of the Lammermuirs. As that of several other parts of Scotland, the red sandstone of the Lothians is eminently characterized by containing in many places numerous circular yellowish-green markings, in the centre of which there is frequently a black coloured spot. Though red is the predominating colour of the red sandstone series, still, associated with it, there are other sandstones of various shades of brown and grey. Variegated sandstones are abundant, brown or red markings occurring in a field of white sandstone; as examples of these, the sandstones of Salisbury Crags and Dunbar are conspicuous. Interstratified with the shales of the red sandstone series, clay-ironstone sometimes occurs; it is, however, perfectly different in its characters from those clay-ironstones which are so abundantly interstratified with the white sandstones and shales of the white sandstone group; it is in general of a brick-red colour, and contains a considerable proportion of calcareous matter. Unlike the clay-ironstone of the coal formation, that of the red sandstone series never exhibits an internal structure, and is characterized completely by the circumstance of its never containing, as the former frequently does, an organic nucleus.

The white sandstone of the great carboniferous group is composed of minute grains of quartz, held together by a ground of argillaceous or calcareous matter: mica is often present, and, as in the red sandstone, frequently produces a schistose arrangement. Felspar, which is very generally distributed through the red sandstone in grains, is in the white far more sparingly disseminated. Bituminous matter occurs in great abundance in the coal sandstones, and frequently is so equally distributed as to cause them to assume a black colour; whereas in the other sandstones, it forms only small layers, which are arranged in positions parallel to the planes of stratification. By containing large rock fragments, this sandstone sometimes becomes conglomerated; these conglomerates are, however, seldom so coarse as those associated with the red sandstones. The fragments are jasper, quartz, Lydian stone, compact felspar, and flinty-slate, imbedded in an aggregate of smaller masses. At Liberton Brae, a conglomerate associated with the coal sandstone contains fragments of red sandstone, varying in size from the smallest dimensions to the bulk of a man's head.

The slates which accompany the white coal formation sandstone are of two kinds,—Argillaceous Shale or Slate-Clay, and Bituminous Shale; neither of these, however, possess a wide range of mineralogical character. The former is in general of a grey colour, while the latter is most frequently of a black, or blackish-brown, containing occasionally minute scales of mica. The colour of these two slates is not uniformly sufficiently indicative of their distinct natures, and as it is highly necessary, in an economical point of view, that they should be easily recognised, we may remark, that in the streak we have a character which at once decides them. The slate-clay has a streak without lustre and of a grey colour, while that of the bituminous shale has a resinous lustre and a brown colour. The bituminous shale frequently makes a transition into coal; examples of which are to be observed on the shore below Kirkaldy and Dysart.

Clay-Ironstone, the next member of this series, is possessed of several characters which render its examination a subject of considerable interest. The clay-ironstone has in general a blackish-grey colour, with a conchoidal fracture and no lustre; it occurs in two positions, either as strata of inconsiderable thickness, alternating with the several members of the coal formation, or in rows of spheroidal lenticular masses, imbedded in shales, and arranged in lines parallel to the direction of the strata. On fracturing the lenticular concretions of ironstone in a direction parallel to that of the strata containing them, there is generally to be observed an internal structure; this structure consisting of a series of veins of calcareous spar, diverging from a central point with more or less regularity, which series is crossed by another arranged round the centre of the clay-ironstone. The veins which produce this structure are generally composed of calcareous spar, which is associated, in some instances, with quartz and elastic mineral pitch; they all decrease in size from the centre to the circumference, being at their origin often sufficiently wide to allow of the crystallization of the spar in its usual forms. That these veins are of a contemporaneons formation with the clay-ironstone in which they are contained, is an opinion adopted by Dr Hutton and also by Professor Jameson, the one reasoning on Plutonian, the other on Neptunian, principles. Ichthyolitic coprolites are abundantly distributed throughout the lenticular masses of clay-ironstone, and specimens may easily be procured bearing more or less perfect intestinal impressions. In the Edinburgh Philosophical Journal, vol. xxxii. p. 165, analyses of two of these interesting organic relics, by Dr W. Gregory and Mr R. Walker, are published. The results of these analyses we may here subjoin.

1. Analysis of a Coprolite found in Clay-ironstone, Wardie.

Organic matter, Sulphuret of Iron, Siliceous matter, . . .	4.134
Carbonate of Lime, ...	61.000
Carbonate of Magnesia, . . .	13.568
Oxide of Iron with a little Alumina,	6.400
Phosphate of Lime, ...	9.576
Fluoride of Calcium, Oxide of Manganese, . .	a trace
Water and loss, ...	5.332
	100.000

2. Analysis of a Coprolite found in Clay-ironstone, Fifeshire.

Matter insoluble in Muriatic Acid and chiefly organic,	3.380
Carbonate of Lime, ...	24.255
Carbonate of Magnesia, ...	2.888
Phosphate of Lime, ...	63.596
Water, ...	3.328
Phosphate of Magnesia, Oxide of Iron, Oxide of Manganese, Fluoric Acid, ...	trace.
	97.447

Besides containing coprolites, the clay-ironstone of the

Lothians, in many instances, envelopes beautifully preserved fishes, while at other times it contains only teeth and scales. Remains of plants, as in all the other members of the coal series, occur in considerable abundance in the clay-ironstone, and on a favourable fracture, they in many instances exhibit, in the most perfect manner, numerous and well preserved relics of the flora which existed at that early period when the coal-beds were deposited. In regard to the position of the organic bodies in the ironstone concretions we may remark, that they are invariably disposed parallel to the longest diameter of the mass, an arrangement which agrees completely with a deposition from a state of mechanical suspension in water. We have before noticed that the nodules of clay-ironstone are arranged in layers parallel to the direction of the strata in which they occur, and as the shape of these masses is a sufficient indication that they could not have been so disposed in any strata but such as were originally formed in a horizontal position, we have, when these lenticular concretions occur in vertical or highly inclined strata, an evident proof that these strata have been altered. The clay-ironstone, which occurs at Wardie, near Newhaven, has lately been analyzed by Dr W. Gregory of Edinburgh (Edinburgh Philosophical Journal, vol. xxxv. p. 173). Two of the specimens which were examined by this chemist were found to have the following composition in 100 parts:—

1. Matter insoluble in acid sand,	196	
Peroxide of Iron,	125	
Alumina,	35	
Lime (a trace).		
Moisture and Loss,	44	= 100
2. Insoluble matter,	388	
Peroxide of Iron,	564	
Alumina,	25	
Lime (a trace).		
Moisture and Loss,	33	= 100

The limestone which is associated with the red and white sandstone formations of the Lothians, exhibits, throughout its whole extent, a very limited range of characters. It is usually of a grey colour, of different degrees of intensity; its fracture is more or less conchoidal, with an earthy aspect. In some quarters, as at Salton, Linton, and Sunnyside, the same limestone occurs of a reddish-brown colour. In several localities, as at Bathgate in Mid-Lothian, the limestone is associated with hornstone; this mineral forming in it numerous contemporaneous imbedded masses, containing in some places silicified madrepores. At Linton, jasper occurs similarly connected with the limetone as the hornstone. The mountain limestone, in those quarters where it is extensively worked, exhibits frequently several alternations of a compact rock, with one having a more or less perfect slaty structure, and containing a larger quantity of argillaceous matter. It is in this imperfect limestone that vegetable and animal remains are found in the greatest abundance, and in certain districts it is characterized by particular fossil bodies. At the Rhodes Quarry, near North Berwick, the limestone becomes highly fetid. This is the only point where such an appearance is to be observed on a large scale, though, in several localities, as at Salton, the same may be observed in one or more parts of a stratum.

In their organic contents the secondary strata of the Lothians are in some respects remarkably interesting, and the shortness of our remarks connected with them is not to be considered as indicating that these interesting bodies ought not to receive much attention from naturalists. Their structures, when viewed comparatively with living races, have unfolded many highly valuable portions of knowledge in regard to the ancient temperatures of our globe, its waters, and the circumstances under which its strata were deposited. The arriving at the conclusions, however, to which the study of organized fossils leads, presupposes a complete knowledge of all the kingdoms of existing nature,—an acquirement which never has been, and probably never will be, centred in one observer. As a knowledge of the natural history of the organic world cannot be obtained but by the exertions of men devoting their energies exclusively to its several grand divisions; so to these the geologist must refer, for details connected with the structure and other relations, of the animal and vegetable relics which he discovers in his investigations. The immediate duty of the geologist, in regard to fossil remains, is, to examine their relations to the several strata of the formation in which they occur, and the connection of that formation with others; while it is the department of the zoologist and botanist, and the most difficult, arduous, and philosophic part of their studies, to discover the nature of these remains, and, from the present conditions of similar living beings, to speculate on the state of the world as connected with temperature, and the distribution of land and water in those epochs when the fossil species enjoyed life. To acquire a knowledge of the ancient world, there must be a division of labour: the examination cannot be conducted by one; but, in this great work, there is required the combined efforts of a Werner, a Cuvier, a Brongniart, and an Agassiz. In this state of things, our remarks will be on this subject sufficiently brief.

Throughout all the various members of the white sandstone series of the Lothians, the remains of vegetables occur, and it is there only that they are to be met with. In the red sandstone series there is, in the circumstance of layers of bituminous matter, occurring in the sandstone, an indication that these strata had been formed, after the creation of vegetables, and we have never found any more marked proofs of their existence. In the Transition rocks there is only one locality in which organic relics have been discovered ; we refer to the contents of a limestone connected with this series which occurs at the Crook Inn, in Peebles-shire. The fact that well marked vegetable remains are not to be observed in strata older than the white sandstone series, or in any of the alternating groups of red sandstone, is well exemplified in that part of the coast which extends from Redheugh in Berwickshire to Aberlady in East-Lothian. On examining this portion of the country, we pass over in succession examples of each of those stratified deposits which occur in the southern division of Scotland. After leaving the Transition rocks and the red sandstone which rest upon them, we, near the Cove, meet with the carboniferous strata, and the mountain limestone, and then, for the first time, observe fossil vegetable remains. Near Dunbar, the white sandstone is succeeded by a group of red sandstone strata, which is as destitute of any fossil relics as that which rests immediately on the older rocks. Near Goolan, the coal strata again appear, and, with them, vegetable fossils. From the non-occurrence of fossil vegetables in the red sandstone, however, the conclusion can never be drawn that these sandstones are of a formation anterior to the creation of plants. It is, however, indicated, that there were, in the formation of the red sandstones, causes which did not allow the deposition of vegetables. The rocks from which they are derived may not have been covered with a vegetation so luxuriant as those, which, on decomposition, formed the white sandstone, or their deposition may have been attended with unknown actions, adequate for the destruction of such remains. Throughout the Lothian district the vegetable features of the strata observe the same general appearance, and are indiscriminately scattered through the several strata of the white sandstone series. The plants which do occur, though, perhaps, some may be unknown in other coal-fields, present, however, a general similarity to those of similar districts. The *Sphenopterides*, the *Lepidostrobi*, *Sigillariæ*, *Stigmariæ*, *Lepidodendra*, and *Lepidophyllites*, abound in numerous localities, often in a state of the greatest preservation, and in others there have been found trunks of gigantic members of the *Pine tribe*. The remains of this class, found in the sandstone of Craigleith, are well known, and their structures have been completely unfolded by Mr William Nicol, as stated in a memoir in the Edinburgh New Philosophical Journal,* the result of which is, that all belong to *coniferæ*, a series of vegetable bodies which that observer has found to form, without any intermixture with *dicotyledons* or *monocotyledons*, all the great vegetable stems of the Independent Coal Formation. Concerning the states in which these fossils are found, it may be remarked that they are more or less bituminated, some portions even being changed into coal; and that Professor Jameson, in his lectures, states it as his opinion that the vegetable matter in these fossils occurs sometimes but slightly changed, so that the earthy matter may be removed by chemical agency, leaving the wood but little changed as to structure and composition.

The fossils detected in sandstone, are most frequently found in the state of sandstone, and the whole of the vegetable structure having been removed, nothing remains to indicate their nature but the external form. The causes which have effected these changes are unknown, and the discovery of them would in all probability explain phenomena at present but imperfectly understood. If an organized body imbedded in a rock of chemical origin is found to be of the same composition as the stratum in which it oc-

* Edinburgh New Philosophical Journal, vols. xxiv. p. 361; xxviii. p. 155; xxx. pp. 137–310; xxxii. p. 338.

curs, the explanation is difficult; but when a plant is found in a rock of mechanical formation, and completely changed into that rock, the difficulty is increased; and, indeed, in our present state of knowledge, concerning the causes which effect the fossilization of organic bodies, it is, perhaps, inexplicable. In other instances, however, the fossilized trunks which are found in the sandstone, are of a composition entirely different from the sandstone, and are changed, though more or less perfect in internal structure, into a stony mass, all the characters of which indicate that its solution has been entirely chemical. In the generality of cases, there has been a conversion into imperfect limestone, which is highly impregnated with carbonaceous matter; while in others, there has been a change into a mass chiefly of a siliceous nature. In all, the ligneous structure exhibits numerous marks of derangement; it is twisted, compressed, and otherwise variously altered. In their animal relics, the strata of the Lothians exhibit considerable variety, and have lately afforded in their *ichthyolitic* remains much valuable knowledge. Like limestones having the same geognostical position in other districts, those of the Lothians are distinguished by the same characteristic fossils; they abound in *Producti*, and contain *Orthoceratites*, *Nautilites*, *Euomphali*, and various species of *Corallines*, of which there are in some places, as at Wardlaw in Linlithgowshire, and on the coast near Aberlady, considerable beds entirely formed, one species either constituting the whole bed, or two entering into its composition. In the circumstance of the shells being almost entirely confined to the limestone, there is an indication, that its formation is due to them, and their being preserved always entire, and not affording any marks of subjection to attrition, prove that they lived and died in the places where they are found: their absence, however, in the sandstone, can never be considered at variance with the mineral proofs, which are so convincing, that both the limestones and sandstones have been formed under the same general circumstances. Concerning the remains of fishes which occur in the carboniferous limestones nothing need be said, as all that is known about them at present is contained in the great work of Agassiz ; the result of whose examination is, that they exhibit no features which in any way justify the opinion, which was so hastily formed concerning them, that they belong to genera inhabiting bodies of fresh water.

In the Lothians, as in other countries, the examination of the position of strata affords data for drawing conclusions concerning the age of the mountain-chain which forms a part of them. The period at which a mountain-chain has been upraised, is fixed between the completion of the deposition of its newest upraised strata, and the commencement of the formation of those which are resting unconformably. That this mode of determining the ages of mountains, is at once natural and free from leading the observer into error, is evident, by considering those laws which regulate the deposition of sedimentary matters. Conclusive, however, though this mode of ascertaining the age of mountain-chains may at first sight appear, still it is by no means safe in every case to consider that their upraisure is contemporaneous with the production of the unhorizontal position of certain strata, which form the low country on either side of them. Under fitting circumstances, strata may be deposited at all angles under 40 degrees; and when the cause which produced the deposition of the strata at such angles becomes progressively, as we depart from the axis of the chain, more fitted for their deposition at smaller angles, the difficulty of fixing the age of the group becomes greater, and recourse must be had to other phenomena exhibited by the rocks of the chain. If such be the arrangement, the fact of the angles nearer the central part of the chain, decreasing as the ratio of the distance from the axis increases, might lead us to infer, that the violence of the upraising agents decreased from the central part of the chain to the exterior.

By what means then, since in these circumstances the age of mountain chains cannot, with certainty, be ascertained, are we to fix the date of their upraisure? To this question there appears to be a satisfactory answer. If, after having examined a wide extent of country, a series of strata, inclined at angles at which they might have been deposited, is found reposing upon another, which is in the greatest possible confusion, being vertical and contorted, there is almost as little reason to believe that the inclined position of the former, has in any way been influenced by causes operating on the upraisure and flexure of the latter, as there would be if they were horizontally arranged. When the examination of a mountain-chain, however, shews formations anticlinally tilted up, and no one more conspicuous for its alterations than another, the only conclusion to be arrived at is, that all have been upraised at one and the same time. On examining the Lammermuir range, for the purpose of determining the age of the chain, the result to which we arrive is, that the much disturbed rocks of the transition class have been upraised prior to the deposition of the slightly inclined secondary formations. In every natural or artificial section, where the transition rocks occur, they are either inclined at high angles, or are vertical and contorted in the most fantastic manner. The secondary formations, which form the low land, and which in many places occur in contact with them, are, however, never so disturbed; but, on the contrary, are elevated at angles consistent with the supposition that they are in their unaltered state. It is probable, then, that the elevation of the range took place after the deposition of the transition rocks, but before that of any of the members of the secondary series. On the coast of Berwickshire, at Danskin, and at the farm of Newlands, this arrangement is conspicuous. At Woodcot, in the neighbourhood of Fala, the red sandstone is almost in a horizontal position, though, within a very short distance, in a glen running down from the hill of Pockbie, the greywacke is arranged in vertical and highly inclined positions. At Kidlaw, a village near Newton Hall, the mountain limestone approaches very near to the almost vertical greywacke of the Lammermuirs; but here there is the same tendency to a horizontal position; it is inclined at a small angle, and could not have been altered by any force acting upon the greywacke. At Dean Mill, near Fala, the same appearances present themselves; the undisturbed red sandstone approaching the transition rocks. On the coast of Berwickshire, between Lin Head, and Red Heugh, there is a series of most satisfactory junctions of the red sandstone with the greywacke; all of which allow us only to infer, that these secondary formations have been deposited on the previously upturned transition rocks. The junctional appearances exhibited in East Lothian are interesting in the history of Geological Science. From examining them, Hutton, Hall, and Playfair formed those opinions which are now invariably held in regard to such phenomena.

As we have before stated, a very coarse conglomerate in general rests on the greywacke strata. In its position, this conglomerate is precisely similar to that which conglomerate deposits in general hold, and its formation is perfectly well explained, by the aqueous disturbances which would accompany the violent and certainly sudden upraisures of the old stratified rocks on which it rests. Causes of no greater intensity than those now in action, appear, though continued through as long a series of ages as the most confirmed Huttonian could desire, perfectly inadequate to produce such effects; but, on the contrary, in the fact of mountain chains being invariably more or less flanked with conglomerates, formed of the component rocks of these chains, and constituting mountain masses, and extensive tracts of country, there is reason to believe, that the actions at present existing, whether aqueous or igneous, though similar in nature, in their magnitude differ completely from those which existed in the primeval ages of the world. All the phenomena exhibited by the rocky masses of the globe, if viewed without any desire to explain them by a favourite theory, testify, that existing causes become progressively less adequate to explain geological appearances, as we examine from the newest to the oldest known formations.

The first locality which we have to notice as exhibiting a junction of the transition rocks with the sandstone, is in the bed of the Heriot Water, a stream which runs past the old tower of Colbrandspath. The transition rocks are inclined at great angles, and at the point where the junction is visible, they dip S. S.E. at 40°; and on these the slightly inclined sandstone conglomerate rests. (Plate I., Fig. 1.) A little to the south of the Pease Burn, the greywacke and red sandstone may, in the sea-cliffs, often be found in immediate connection, the former, dipping to the N.E. at 20°, and resting on the contorted, and in some instances vertical transition rocks, which range E. N.E. and W. S.W. (Plate I., Fig. 2. and Plate II., Fig. 1.)

At Red Heugh there is a most interesting display of the several relations of the two classes of rocks. On looking down from the cliffs, the junctional phenomena are exhibited in the most satisfactory manner. The action of the sea has partially abraded the conglomerate and sandstone, exposing the inferior rocks of greywacke, which are either vertical, or inclined to the S. and S. W. at great angles, while the red sandstone rests upon them, and dips to the N. E. at about 15° or 20°. (Plate II., Fig. 2.) Throughout all those parts of Berwickshire, where we have opportunities of examining the relations of these formations to each other, the arrangement is identical with that of the Lothians. In Mid-Lothian, strata of white sandstone, with its associated limestones, form all that part of the country which skirts the base of the transition range of the Moorfoot and Huntlycot hills; but their position indicates as little alteration from the upraisure of the mountains, as the red sandstone series does in East Lothian. In the Gladhouse water, the sandstone is almost horizontal, and continues so to the very base of the highly inclined greywacke strata. There are, however, no sections, as in East Lothian, where the two series are found in immediate contact.

Before finishing this part of the subject, we may notice a statement which Mr Milne, in his paper descriptive of the Geology of Berwickshire, has made in regard to these red sandstone and greywacke strata. This observer states, that, in some instances, both classes of rocks have been, at one and the same time, disturbed by faults. No one of these cited examples will, however, if strictly examined, be found to exhibit appearances which allow us to form this opinion. True it is that the red sandstone varies often in its height within short spaces: thus it may surmount a high sea cliff of vertical greywacke, and also form the rocks at the sea level, but in these instances there is every reason to believe that the intermediary portions have been removed by abrading agents. Every thing connected with the relations of the two rocks testifies, that the red sandstone has been quietly deposited on a most irregular surface, one presenting numerous asperities and corresponding depressions.

Having noticed the relations of the different stratified masses to each other, and their mineralogical characters, we shall next, in the same way, describe those unstratified or ignigenous formations, which are so generally associated with them. The rocks of this great natural family may be divided under two heads, the Felspathic and the Augitic.

FELSPATHIC ROCKS, INCLUDING PORPHYRY AND CLINKSTONE.

Of this class of unstratified rocks it may be affirmed, that, as a mass, it may be considered as composed entirely of felspar in different states of crystallization, and associated with various structures. Other minerals sometimes enter into its composition, but these, if viewed on the large scale, are to be considered only as of occasional occurrence. The states in which the felspar presents itself, are all those between that of a compact and an earthy mode of arrangement, and when these exhibit a determinately aggregated structure, they are porphyritic, amygdaloidal, or both. Of the structures which cannot be shewn in hand specimens, but are on a more or less colossal scale, the tabular concretionary mode of disposition is the only one exhibited by the felspar series of the Lothians, and of this in the Bass and Traprain Law there are fine examples. These tabular concretions, if examined in their relations to each other, never present appearances which can in any way justify the confusion of the tabular with the stratified structure. In the tabular structure, there is no perfect uniformity of direction, but within a limited extent the concretions dip to all points, passing into an amorphous rock ;

the lines which bound them also, never contain any matter differing from the tabular masses. In the stratified structure there is nothing precisely similar to this, and little that is analogous. True stratified masses preserve a general line of direction through a great extent, and if this is changed or obliterated, it may be referred to the action of disturbing agents. The lines of stratification are also generally produced, by the rock becoming less compact in its structure, or by the presence of a minute layer of argillaceous matter; the bounding lines of tabular concretions are, however, only lines of division. Of the felspar class there are three rocks, which may be considered as the most marked individuals of this series.

Compact Felspar, which is one of these, occurs of various shades of white, red, and grey, and by acquiring crystals of felspar, it becomes Compact Felspar Porphyry. This rock occurs in great abundance in the different felspar districts, and forms hills both in the Garleton and Pentland ranges. In size, the imbedded crystals of felspar vary from the smallest size to near an inch, and are sometimes accompanied with particles of quartz and scales of mica. Claystone, which is another member of this extensive class, is of the same general colours as compact felspar; in some instances, the various shades of colour producing a veined or mottled aspect; and as compact felspar, it occurs porphyritic. Of this rock the Lothians afford many examples; it is met with abundantly both in the Pentland and Garleton Hills. The only other rock which presents characters sufficiently well defined to justify its being considered as a marked variety of felspar, is Clinkstone. This rock occurs of various shades of bluish, yellowish, and greenish grey, and is often highly impregnated with iron; the presence of which causes it to assume various modes of marking. It has frequently a foliated structure and a glimmering lustre; very generally there is associated with clinkstone an approximation to a schistose arrangement. In this case, however, the same appearances which indicate that the causes of the tabular form are in no respect similar to those which produced the stratified, evince that the internal structure of clinkstone differs completely from that of rocks which have not resulted from a state of fusion; it is the consequence of a species of crystallization probably superinduced during the consolidation of the rock. Clinkstone also occurs porphyritic.

AUGITIC ROCKS, OR TRAP ROCKS.

The Trap or Augitic Rocks, which form the next great division of the unstratified or plutonic masses, are, it may be generally stated, composed of the two simple minerals—Augite and Felspar—all the varieties of the series being produced by differences, either in the state of their crystallization, or relative proportions. Though, in a mineralogical point of view, the members of the trap series frequently differ widely from each other, still the frequent transitions of the one into the other, are at once sufficiently indicative that the formation of all has been the effect of the same general causes, differences of structure or composition having been produced by slight diversities in attending circumstances. As in the felspathic series, so in the trap family, there are a few rocks which have the same general characters, and which may be considered as rocks which, by passing into each other, form all the varieties of this family. Of all the compounds of Augite and Felspar which occur in the Lothians, forming rock masses, Greenstone appears to be the most generally distributed. Its component minerals vary in size and colour, change in colour, however, being produced generally by the aspect of the felspar; this, however, is far from universal, for the ferruginous matter which colours much of the greenstone of East Lothian, is equably distributed throughout the augite and felspar. In size, the components of the greenstone vary from that minuteness which causes the rock to become basaltic, to the large granular, when it becomes Syenitic Greenstone. Besides appearing as syenitic and compact, greenstone occurs under several other aspects. Not unfrequently it assumes the porphyritic structure, the basis being a very minute and small granular compound of augite and felspar; while the crystals which produce the structure are of compact, glassy, or common felspar. By containing minerals, which fill or line cavities, greenstone becomes amygdaloidal; this structure appears, however, generally to attend those greenstones which are not highly crystallized, but whose components approach to an earthy state. When structure on the great scale is observable in the greenstone of the Lothians, it is of two kinds, the globular and columnar. Of the former there are many examples, and the globular concretions vary in diameter from one or two inches to several feet. The perfect columnar mode of arrangement is of less frequent occurrence, for, though there is, in many places, a disposition to be columnar, there are but few points where this arrangement is perfect; when, however, the columns are well formed, they vary in length, thickness, number of their sides, and position.

Basalt, which is another conspicuous member of the trap series, forms considerable masses in the Lothians; it is generally of a grey or black colour; and, as in greenstone, mere ocular inspection is sufficient to prove that it is a fine aggregate of crystalline masses of Augite and Felspar. Olivine abounds in some basalts, forming minute grains; and magnetic iron ore is also very generally distributed through it. The occurrence of magnetic iron-ore in basalt, forms a well-marked character of this rock, while the very general distribution of iron-pyrites through greenstone, appears to characterize it. By assuming crystals of basaltic hornblende and glassy felspar, the basalts of some districts frequently acquire an almost porphyritic structure. Though the vitreous state is that in which felspar most generally occurs in basalt, still in others common felspar appears. At Garry Point, in East Lothian, where a finely columnar basalt occurs, the contained crystals are of common felspar. Amygdaloidal cavities abound in some basalts in such quantities, that the rock assumes the perfect amygdaloidal structure. The basalt of the Lothians is very generally associated with the columnar arrangement, and, as in greenstone, the columns vary in position and number of their sides. The hill of Arthur's Seat, the limestone quarry of the Hill-house, in Linlithgowshire, and other points, exhibit beautiful groups of these columns.

Considered as a group, the augitic rocks of the Lothians are remarkable, when compared with some of the other great formations of the same class which occur in Scotland, in the circumstance of the zeolitic minerals occurring very rarely in them, and then only in comparatively small quantities. Intimately connected with the unstratified rocks of the Lothians, Trap-tufa occurs; it is composed of rounded and angular masses of limestone, sandstone, slate, and trap, inclosed in a basis of trap, in different states of compactness. In size, the imbedded masses vary from the smallest magnitude to many yards. It never contains fragments of any rock which occurs *in situ* at a great distance; but, on the contrary, all are in the more immediate neighbourhood of the tufaceous deposit. Much of the country round North

Berwick is composed of trap-tufa, the masses being formed of previously existing stratified and unstratified rocks imbedded in a green wacke. At Dunbar a trap-tufa occurs, differing from the former in the circumstance of its being highly impregnated with oxide of iron, which imparts to it a bright brick-red colour. In structure, if it were not for its mineral characters, trap-tufa frequently could not be distinguished from true Neptunian formations, inasmuch as it is distinctly stratified, and also assumes a slaty arrangement. In its mode of connexion with the stratified masses, trap-tufa exhibits characters perfectly distinct from those which attend either the greenstones or basalts. It never forms veins crossing strata, and consequently can never, like them, be found as masses alternating in the same way with strata, for these alternations are in every instance only veins, which, instead of crossing the strata at angles, have been injected between them from a central point of eruption, and from a column of more or less fluid igneous matter, which, to find egress, must have broken through the strata at an angle.

The comparison of the modern volcanic tufas with those which are associated with the various trap-rocks, affords one of the many proofs that the origin of both is the same, modifying circumstances producing those differences which cause both classes of rocks to be naturally separated. In the volcanic tufa, there is the same stratified structure as occurs in that of the trap family, and the series of alternations of volcanic tufa with volcanic basalts and lavas is analogous to that of the trap-tufas with basalt, porphyry, and greenstone. The circumstance of the tufas having a stratified arrangement, and never occurring in the form of veins, intimates that the manner of their formation was intimately connected with the action of water,—that their origin was *Neptunio-Plutonic.* If we suppose the existence of a sea sufficiently deep to allow of the eruption of igneous matter, without their assuming a vesicular structure, and that, by the decomposition of older trap rocks, there was produced a series of more or less regular strata, accidents may be found fitted for the formation of the trap-tufas and their alternations with basaltic and greenstone masses. As the comparatively modern tufas of Ætna are traversed by veins of basaltic lava, so the more ancient tufa of the carboniferous epoch is traversed by greenstone and basalt,—the posterior formation of which is evinced by their producing changes, more or less similar to those which they effect upon rocks of aqueous formation.

The structure of the trap-rocks is never vesicular, and all their relations to associated masses are such as indicate that their formation and the changes which they have produced, were effected under a compression sufficient for a perfect crystallization of the rocks from a fluid state. Through all the districts in which they occur, there is, in the arrangements of the trap-rocks, nothing partaking of that aspect which characterizes the volcanic cone—no hills formed of consolidated igneous matters arranged concentrically. There are, however, many analogous appearances; for the marks of fracture, upraisure, and all the indications of altered states of the Neptunian formations, become gradually less apparent as the strata recede from the masses which are to be considered as the disturbing agents. In regard to the question, Whether have the unstratified rocks of the Lothians been the product of one eruption, or have they been sent from below at different periods? no very satisfactory answer can be given, the want of sections exposing their mode of connection, rendering this impracticable. From the circumstance of finding, however, in a few localities ignigenous masses, traversed by veins of the same nature, it may be at once affirmed that two eruptions of trap are indicated; but this seems to be the full extent of our knowledge. If our opinion in regard to the elevation of the greywacke systems of the Lammermuir and Moorfoot hills be correct, it is rendered highly probable that the unstratified rocks associated with these transition formations have been erupted before the deposition of the carboniferous group, or the protrusion of the Plutonic rocks associated with them; and that their upburst, perhaps, in some respects, may have been the cause of the upraisure of the previously undisturbed greywacke and transition slates. Though this may have been the case, however, it does not follow that the actions of the igneous rocks associated with the secondary strata, were confined to them: on the contrary, they may have sent erupted masses into the older rocks; so that, though amongst the one series of strata, rocks of a formation posterior to them, perhaps, only occur; in the transition series two classes of Plutonic rocks, each of different relative ages, may be found.

We have now arrived at a part of the subject which is replete with interest. We are to describe those changes which igneous matters, erupted in former ages of the world, have effected on the rocks through which they issued, and between and over which they have flowed. When we consider that we now live in a land where the shock of the earthquake, and the impetuosity and desolation attending a lava stream, are neither felt nor dreaded, it is highly interesting to find, by geological examination, that the country in which we dwell with such repose was, at one time, ravaged by subterraneous action,—that its strata have been traversed by streams of liquid mineral matters,—that it has had its "phasis" of disturbance.

In contemplating these interesting relations of rocks, the mind cannot but be led to consider the great age of the world; for such eruptions took place long before the creation of man, and, in all probability, long before that of those animals which stand high in the scale of being. He who is ignorant of Geology, and of the splendid results at which, by the study of the mineral and fossil bodies of our globe, we arrive, considers the days of creation which are enumerated in the Mosaic record, as indicating the time which elapsed from the period when God first called the world out of nothing, to that when, his work being completed, he shewed the greatness of his power by calling Man into being. But he who is acquainted with the legible characters engraven on the rocks of our continents, and the various proofs which allow us to believe that Omnipotence willed that, to bring the world to a state fitted for Man, it should, before his appearance, exist for a long series of ages, can, with retrospective soul, look to the existence of beings which enjoyed life, long before the creation of his species; he can contemplate the state of the world when the higher animals existed not, and watch the hand of Deity in the progressive act of creation. Happily for science, the days have gone by when geological speculation was trammelled by the too literal interpretation of the first chapter of Genesis. The layman who dares to discover that the world was not created in six of our days, now fears not the brand of atheism, nor is in danger of being considered one who doubts the divine origin of the Scriptures, by any but those for whose opinion he need little care. The churchman, skilled in the original of the Pentateuch, tells him that there is no overstretching of the language, though an undefined period of years be considered as having elapsed between "The beginning," in which "God created the heaven and the earth," and the commencement of the first day of creation. Some, poisoned by infidelity, and voluntarily blinded to a sense of the unphilosophical nature of arguments which they considered conclusive, have, that they might not see in this science indubitable proofs of Deity, held it up to scorn; but we are not aware that any have enlisted under the banners of scepticism from finding that, after properly studying Nature, it appeared at variance with Revelation, or that "He who made the world, and revealed its date to Moses, was mistaken of its age."

Before entering into a minute detail of the various changes exhibited in different localities, which the stratified rocks have undergone, by being in connexion with the unstratified, we shall notice the characters which rocks of both classes when in contact are found to exhibit in a greater or less degree. When in contact with Neptunian formations, all the unstratified rocks of the Lothians exhibit more or less a change of structure. If the rock is granular, when at a distance from the stratified; when in contact with it, it is found small granular or compact, and apparently homogeneous throughout. If, when at a distance from the stratified rock, the unstratified rock is compact, as it approaches the former it becomes still more dense. Greenstone passes into basalt, and compact felspar into one still more compact. It is probable that the causes of all these changes are to be found in differences in the rate of cooling, a cause which, no doubt, has been productive of much of that endless variety which is observable in the Trap series. That the planes of contact of the igneous rock with that of Neptunian origin were the very places where such changes would be produced, is to be supposed, if we recollect that, before the appearance of these igneous rocks, they had been undisturbed, and all undergoing from various actions a process of consolidation. Besides these appearances being observable in igneous rocks, when in contact with such depositions, they are also conspicuous in some of those plutonic masses which traverse others of the same origin. In this situation, however, such appearances cannot always be expected ; the igneous mass, which traverses one of a more ancient formation, may have been sent up before the previously erupted mass had cooled down, and this is rendered the more likely, when we remember, that if rocks are bad conductors of heat, when not far from the surface, they must be much more so, when deeply seated in the globe's crust. In addition to these changes in structure, there is another which appears to be referable to the same cause: very generally the traps associated with the coal strata become, as they approach the strata, gradually more and more felspathic, till at last they pass into a rock of compact felspar or claystone. In some localities associated with the strata which contain beds of trap, making such transitions, there are similarly disposed masses of the claystone felspar. In the former case the transition may be supposed to have been effected by the more rapid cooling, and in the latter the refrigeration may have been too quick to allow of the existence of the mass as Greenstone. Some strata, when in contact with these associated unstratified rocks, exhibit characters which, if the origin of the two classes of rocks were not admitted to be perfectly distinct, might easily lead the observer to consider both of contemporaneous origin. Such appearances are, however, perfectly reconcilable with the igneous formation of trap-rocks, and it would rather be a matter of astonishment, if, in some cases, they were not to be observed. By the very long continued action of heat, it might be expected that both rocks would undergo a commixture the one with the other, and that in certain places, the junction would be so complete that there would be no line of distinct separation exhibited by the two masses in contact. Such are the changes which plutonic rocks are found to undergo when in contact with those of aqueous origin. Neptunian Rocks are variously affected by those of ignigenous formation, and very few instances can be adduced, where the structure is not in some degree changed: it may only be slightly altered; but on minute examination changes are more or less apparent.

Of the three chief rocks, Sandstone, Shale, and Limestone, the various alternations of which form the secondary series of the Lothians, the states of change are innumerable. When the sandstone, whether it be white or red, is in contact with rocks of the trap series, it either acquires the characters of hornstone, jasper, or granular quartz-rock; and, of course, between all these extremes, there are many different stages of alteration. The changes which are produced upon the various shales are also of great variety; all are altered in a greater or less degree, the extreme of the alteration being observable in those cases where the shale assumes the characters of flinty-slate or Lydian stone. In the case of the indurated shales, it very generally happens, that although the hardness, fracture, and other external mineral characters are changed, there still exist the remains of a schistose arrangement, and when layers of the shale are of various colours, the rock assumes much of the appearance of the Striped Siberian Jasper. The characters which the limestone assumes, when in contact with the unstratified rocks, are in some places of the most interesting description; it is however, to be remarked, that this rock is less frequently than any other member of the stratified series in connection with such masses; when, however, there is a change, it is similar to that exhibited in other districts, the limestone loses its compact for a granular structure, and its grey colour for one more or less white, these marks of alteration becoming gradually less conspicuous as the distance from the igneous mass increases. The various individuals which comprise the trap series, evince, by two modes of position, a formation posterior to that of the Neptunian strata, as well as to those older igneous masses with which they may happen to be connected. The first is that of the *vein* or *dyke*; the second is that of the *overlying* mass. In the vein, a body of trap of varying magnitude crosses the strata at an angle, or, originating in a mass which does, obtrudes itself between the strata parallel to their direction. In the Lothians the greater number of veins traverse the strata in this conformable manner, and the reason of this may in all probability be found in the fact of the planes of stratification being those which would afford the greatest facility of separation. Trap, in the overlying position, forms the most of the great trap deposits of the Lothians; when it occurs as veinous masses it is seen in its progress through the strata; but when as overlying it is to be considered as more or less in the position which it assumed when, after rising through the previously formed rocks, it flowed over their surface. The changes in position which the various stratified rocks exhibit are very great; and all are exactly such as might be conceived to attend the violent expulsion of a more or less fluid body from the interior. Fragments of the disturbed rocks are enveloped in the erupted mass, and vary in size from a few inches to many yards. Contortion, a striking position of strata, and one which is most indicative of their having been subjected to violent action, is in the three Lothians frequently well exhibited. In considering in detail the relations of the unstratified rocks of the Lothians to the stratified, we shall not endeavour to follow any natural arrangement, but, on the contrary, will describe separately the geology of the counties of Edinburgh, Haddington, and Linlithgow.

Mid-Lothian, like the other counties, contains both classes of unstratified rocks, viz. the augitic and felspathic. The former constitutes various hills, while in the Pentlands the latter rises into mountain masses of greater or less height. The principal trap formations of Mid-Lothian occur within a circuit of nine miles round Edinburgh. Immediately to the east of the city the hills of Salisbury Crags and Arthur's Seat rise to the heights of 550 and 822 feet above the level of the Firth of Forth. The splendid geological appearances which these hills exhibit render an examination of them interesting in the highest degree, and few points can be mentioned which, within the same compass, present so many beautiful and instructive illustrations of the Plutonic origin of trap rocks. Salisbury Crags and St Leonard's Hill, which may almost be considered as constituting one hill, are each formed of a mass of trap, surmounting and rising through the slates and sandstone of the coal-formation. The igneous portions of these hills appear to have been produced by the intrusion of masses of trap, parallel to the strata, and forming lateral expansions from dykes which cross these at angles. Both the classes of rock which form these eminences dip to the east at an angle of about 30°. The trap rock of St Leonard's Hill is a slightly porphyritic greenstone; but, as it approaches the sandstone on which it rests, it changes its mineralogical characters and passes into a red greenstone of a more compact structure, or into a brownish red ferruginous claystone-felspar: it contains small imbedded masses of calcareous spar, and is also traversed by veins of the same mineral, which are frequently associated with radiated red hæmatite. Immediately below the trap lies the sandstone, which, in the vicinity of the greenstone, becomes quartzose, and also exhibits in several places various undulations. In one place there is a fine display of one of those veins, which are to be considered as forming the points of eruption. It is about 4 feet in breadth, and is vertical. (Pl. III. Fig. 1.) From this vein a lateral expansion takes its origin, running into the strata parallel to their direction ; at its origin it is about 2 feet broad, and after running for 10 feet a slightly tortuous course, it gradually thins out. On the principal vein arriving at the surface of the sandstone it flows over it, and forms the overlying trap-rock of St Leonard's Hill, and near this point the trap appears to have sunk down, and filled a hollow in the previously formed sandstone. This mass of trap is at its greatest breadth 4½ feet wide, and is almost of a circular form. At its upper extremity the mass which connects it with the overlaying trap is 1½ feet broad, and at its lower extremity there issues from it a small vein 5 inches long and 2 broad. This ridge continues to run southwards for about half a mile, and then appears to unite with the southern extremity of the trap of Salisbury Crags, and at its termination the porphyritic greenstone affords a very beautiful example of the columnar arrangement. The columns vary in length, thickness, number of their sides, and position ; those of the upper portion of the mass being inclined at a great angle, while those of the lower part are horizontal. Veins of compact and crystallized prehnite very generally occur between the sides of the columns, and in thickness these vary from half an inch to 3 inches.

The ridge of Salisbury Crags rises immediately above St Leonard's Hill, from which it is separated by a deep valley. Quarrying operations, and the making of the Radical Walk which runs along the base of the mural precipice of this hill, have exposed in the clearest manner the various connexions of the trap with the stratified rocks. At its southern extremity both rocks, the greenstone and sandstone, dip to the N. E. by E., in the more central parts of the hill E., and at the northern end S. E. by E. and E. S. E. At the southern extremity of the ridge there is a fine example of the entanglement of masses of sandstone in the greenstone; these are changed in some places into granular quartz and in others into hornstone, the masses are several feet in length, but do not exceed a few inches in breadth. (Pl. III. Fig. 2.) The greenstone, as it does through a considerable portion of the hill, here rests upon an arenaceous limestone of a brownish-red colour, a portion of which is broken off and bent upwards amongst the greenstone. (Pl. III. Fig. 3.) On proceeding along the road in a northerly direction another mass of sandstone, but on a much larger scale, is enveloped in the greenstone: it is of a square form, and is traversed by veins of Compact Greenstone. At this point the sandstone and arenaceous limestone are contorted in various ways; and fractured in many places. (Pl. IV.) From the great disturbance manifested here, and also from the absence of that sandstone which is found under the trap, it is likely that this point has been one of the openings through which the greenstone matters flowed, and that through this fissure the mass of sandstone has been floated upwards. For a considerable way the sandstone, which is here of a red colour, is indurated, and in some places almost assumes the character of jasper, this induration decreasing as we examine at a greater distance from the indurating cause. By still advancing to the north, near a narrow pass in the greenstone called the Cat Nick, (Pl. V. Fig. 1.), where there is a shift in the sandstone, a vein of greenstone about four feet wide traverses both the sandstone and greenstone of the Crags (Pl. VI. Fig. 2,), it must consequently be the product of an eruption posterior to that of the Crags. It runs in an uninterrupted course through the various rocks, and alters the sandstone both in position and mineral structure. As it approaches the greenstone which it traverses, this greenstone passes gradually into a more compact variety, an appearance which is not of difficult explanation, if we consider that, when in a fluid state, this vein was in contact with previously consolidated rocks.

After leaving this point, there is a beautiful display of the stratified rocks of the hill underlying the trap. These strata are various alternations of argillaceous sandstone, a brick-red calcareous clay-ironstone, and variously tinted slate-clays, all of which are arranged in perfect parallelism. These occur for a considerable way, till at last they are cut off by a great vertical vein of greenstone. It does not traverse as the other the overlying greenstone, but appears to have been one of the openings through which the protrusion of the trap has been effected. It is about twenty yards broad, and, when next the several rocks, produces alterations, and assumes at its planes of contact a compact structure. Near the northern extremity of the Crags, a vein of a highly felspathic uncrystalline greenstone issues from the principal greenstone mass, and traverses the sandstone parallel to its direction. It is about twenty feet long, and at its origin two feet broad. At the northern extremity of the hill, the greenstone sinks rapidly below the plain at the back of the Palace of Holyrood, and is covered by an assemblage of strata similar to those on which it lies. (Plate VI. Fig. 1.) These strata, lying upon the greenstone, occur more or less interruptedly throughout the whole extent of the hill, and the same changes which the greenstone effects upon the sandstone strata at the foot of the trap escarpment, are in the upper portions conspicuous. Besides the changes which the stratified rocks exhibit from the agency of the trap, the greenstone also evinces alterations as it approaches the strata on which it rests and which surmount it: it gradually acquires a compact structure, either passing into an almost perfect basalt, or into a very compact ferruginous felspathic greenstone. From the circumstance of finding the characters of both rocks the same, whether at the top or bottom of the greenstone mass, it is evident that the sandstone and slate which lie above the greenstone, have not been deposited upon it; but have been separated from the strata which lie below the greenstone, by the subsequent intrusion of the trap-rock.

The greenstone of Salisbury Crags is in general fine granular, the felspar occurring of various shades of white, and of brick and flesh red. Sometimes, though rarely, Natrolite is associated with it, appearing to form masses not of subsequent infiltration, but of an origin contemporaneous with the rock; and very generally the compact greenstone of Salisbury Crags is traversed by numerous contemporaneous veins of greenstone. These veins vary in the compactness of their structure, sometimes being more perfectly crystallized than the containing rock, and at other times almost homogeneous throughout. They run a tortuous course through the greenstone, and are frequently of great length, while the breadth is very inconsiderable,—perhaps not exceeding two or three inches. In structure, the greenstone of Salisbury Crags exhibits nothing remarkable; it in many places has a tendency to the columnar arrangement, and very frequently assumes a globular mode of distribution, the globular concretions varying in size. In the rocks of Salisbury Crags several simple minerals are to be met with. Calcareous spar occurs most frequently, forming either veins or imbedded masses, and is occasionally associated with radiated hæmatite. Quartz occurs in drusy cavities, being either common or amethystine, and is crystallized in the usual six-sided pyramid. Prehnite, of various shades of yellow and green, occurs in the same position, and is arranged in botryoidal or imperfectly crystallized masses. Cubicite or Analcime, is also generally associated with it. A datholitic mineral (as mentioned by Professor Jameson), to which the name of Humboldite has been given, was also at one time found in the same situation. Iron-pyrites is very generally distributed through the greenstone, and on decomposition causes the rock to assume a brownish-yellow colour. Sulphate of barytes and agaric mineral occur associated with the sandstone ; the former constituting minute veins, while the latter encrusts its exposed surface.

Separated from Salisbury Crags, by the valley of the Hunters' Bog, the hill of Arthur's Seat rises.* Taken as a whole, it appears to rest upon Salisbury Crags, and is, therefore, consequently of newer formation. The various details connected with it are perhaps not so satisfactory as those of the former ; they are, however, in many respects interesting. At the eastern extremity of the Hunter's Bog, sandstone occurs lying under a mass of porphyritic greenstone, and both dip to the S. E. at 20°. This sandstone may be traced, for a considerable way, lying under the porphyry, in which numerous masses of the sandstone occur imbedded. One of these masses is seventy feet long by two in breadth ; several of a smaller size also occur completely enveloped in the trap, one of which is visible for about twenty-five feet. (Plate VI. Fig. 2.) When in contact with the ig-

* The first published account of the geognosy of this hill and of Salisbury Crags appeared in Professor Jameson's Mineralogy of Dumfriesshire ; the description here given is nearly that which the Professor now delivers to his pupils during his geological excursions.

neous rock, the sandstone acquires all the characters of granular quartz and hornstone, and frequently assumes a green colour from containing a portion of the augite, which enters into the composition of the greenstone. Resting upon the greenstone is an alternating series of tufa and basalt. The tufa varies in its composition; it is either formed of variously sized fragments of previously existing rocks, as greenstone, sandstone, shale, and limestone, or is a fine aggregate of red ferruginous trap sand. In the tufa, a little to the south of Sampson's Ribs, a mass of red sandstone is imbedded ; a portion of which is visible for about eight feet, and has a breadth of four. It is much changed, some portions acquiring all the characters of jasper. Though the relations of this tufa to the series of trap and sandstone, which we have just mentioned, are not very evident, still it is highly probable that it is of newer formation, and that it has been protruded through them.

The summit of the hill is entirely formed of a greyish-black compact basalt, containing in some places large crystals of basaltic hornblende. On examining that portion of the hill which forms one side of the Hunter's Bog, this basalt is found to traverse the tufa in the form of a great vein, and to produce, at its planes of junction, changes similar to those exhibited by aqueous formations, when in the same situations. Near the summit of the hill, and from the western side of the large vein, a smaller one takes its origin, and traverses the tufa which it indurates. About half way down the hill, the basalt divides into two distinct veins, being separated from each other by the tufa. (Plate VII. Fig. 1.) The basalt of these veins is arranged in irregular columns. Owing to the thick covering of debris, the basalt of this part of Arthur's Seat cannot be traced to the base of the hill; it is, however, probable that if it could be so examined, it would be found to rise directly through it, and also the sandstones and greenstones of Salisbury Crags. (Plate VII. Fig. 2.) Imbedded in the tufa on the east side of the principal basaltic vein, a mass of white sandstone occurs; it is not, however, much altered in structure. Forming the highest point of that part of the hill which rises above the village of Duddingston, another basalt is to be observed; it is arranged in perfect columns, which vary in the number of their sides. The composition of this basalt differs from that which forms the summit, in being less compact, and containing large crystals of Labradorite Felspar, Basaltic Hornblende, and numerous disseminated masses of Olivine. Imbedded in the trap which forms the southern acclivity, there occur several masses of calcareous sandstone of many yards extent; they are completely changed in character, some portions becoming a conchoidal hornstone, while others pass into chalcedonic quartz.

At the northern extremity of Duddingston Loch, there is a mass of greenstone, identical in mineralogical characters with that of Salisbury Crags, and upon it reposes a series of sandstone and slate strata, presenting all the characters of induration. On examining the points of contact of these rocks, masses of the sandstone may be found partially enveloped in the greenstone, and compressed into the form of a vein; similar appearances are also to be observed in Salisbury Crags. On the side of the road which runs through the ravine of Windy Gowl, fragments of mountain limestone crop out, but their relations to the Plutonic rock cannot be made out. Concerning the relations of the trap of Arthur's Seat to the sandstone of Duddingston, it may be mentioned, that the want of sections prevents us from acquiring information in regard to its intimate connections with the igneous rocks; as, however, at Niddry Mill, a distance of two miles, the coal strata are found inclining against it 50°, and as the same arrangement is to be observed at Joppa, a village near Portobello, it is evident that the disturbing influences of Arthur's Seat have extended over a considerable area. In the rocks of Arthur's Seat several minerals occur. Calcareous spar abounds, both forming veins and lining cavities ; quartz occurs, either common or amethystine, and is sometimes found penetrated with spiculæ of titanium. Jasper is to be met with in several places ; a vein of it occurs near the summit of the hill traversing the basalt, and another is met with in a similar position below the old chapel of St Anthony. All of these veins appear to have been produced by infiltration from above ; while chalcedony is frequently to be observed as nodules imbedded in the basalt.

To the north of Salisbury Crags, in the hill of the Calton,* there is another example of igneous rocks associated with the coal formation ; the form of this hill approaches to the round backed shape, and it rises to the height of 365 feet. At the new High School, forming the eminence of the Miller's Knowe, a greenstone occurs of a compact earthy structure. This greenstone is, throughout its whole extent, traversed by contemporaneous veins, which are frequently so abundant, as in numerous places almost to exceed in quantity the traversed rock. The minerals which form these veins are calcareous spar and quartz, small crystals of which associated with amethyst line the walls of minute drusy cavities. On the northern side of the hill, and also at the summit, a similar greenstone occurs, differing however in this, that it wants the contemporaneous veins. The struc-

* The first geognostical account of the Calton Hill, with a section of its structure, was given by Dr Boué in his "Essai Geologique sur l'Ecosse," from the demonstrations and lectures of Professor Jameson. The account here given is from the same source.

ture of this greenstone in some places approaches to a globular mode of arrangement, which is rendered very conspicuous by red hæmatite, forming a minute layer between the concretions ; it is traversed also by a vein of compact greenstone about six feet in breadth. Porphyry forms the principal mass of the hill, having a base in general of a bluish-grey claystone, while in others it assumes the characters of an earthy greenstone, containing crystals of basaltic hornblende and flesh-red felspar. In many places the porphyritic structure is associated with the amygdaloidal, thus forming an amygdaloidal porphyry ; the cavities in general contain only calcareous spar ; but flesh-red cubicite has been found in some places in the same position. Trap-tufa occurs in the Calton Hill associated with the porphyry, and at the back of the new High School it forms considerable beds ; the components of this tufa are in general in a state of minute division, and are principally composed of an indurated wacke. In regard to the relations of the ignigenous mass of the Calton Hill to the stratified rocks, it may be stated that it appears to have been protruded through them, in a direction more or less parallel to that of the strata. During the excavating operations which were carried on for the foundation of the Waterloo Bridge, sandstone strata were found underlying the trap of the hill, and dipping to the east at a considerable angle. Resting upon the trap, and also dipping east at angles, which decrease as the distance from the upraising agent increases, is that series of sandstone, conglomerate, and shale strata, which commences at the west end of Regent Terrace and terminates at the sea. At the stairs which lead up from the Waterloo Bridge to the hill, several strata of a red trap-tufa are found completely imbedded in the porphyry ; they dip like the sandstone upon which the Regent Terrace is built, to the east at 20° and sink completely below the trap, near the new High School. Immediately below the old Observatory, and on the road which leads round Dugald Stewart's monument, strata of trap-tufa are again found cropping out, being included between the porphyry which overlies the masses of trap-tufa we have mentioned, and underlying those Neptunian deposits which form the western acclivity of the hill. The tufaceous strata may be traced more or less interruptedly till they disappear under the porphyry of Nelson's monument. The changes which the masses of trap-tufa exhibit when in contact with the porphyry are very great, inasmuch as they are intensely indurated. The porphyry also acquires, when next the tufa, an aspect different from that which it exhibits when at a distance from it; it becomes very compact, and frequently passes into compact felspar. On examining the points of contact of these two rocks, there is frequently exhibited an almost gradual transition of the one into the other, so that it requires considerable attention in some instances to discover where one rock terminates and where the other begins. All these appearances may, however, be easily explained, if we remember that as both rocks were in all probability once in a fluid and highly heated state, there may have been in some places a complete intermixture of the one with the other. Several simple minerals occur in the Calton Hill; jasper traverses the porphyry in minute veins; sulphate of barytes occurs in the same manner, and also masses of native copper. In the porphyry immediately below the old Observatory, veins of calcareous spar are found; and associated with the calcareous spar, glance-coal is to be met with, forming imbedded masses of various sizes. The situation of this mineral is highly interesting, and when the vegetable origin of coal is admitted, its mineralogical characters and relations to the associated rock are only to be explained by referring them to altering agents of great power, agents of which the effects are visible more or less in almost every stratified rock of any extent. In intensely heated igneous matters rising through beds of coal under a great compressing power, circumstances may be found adequate to produce an alteration from the more evident vegetable product to this highly crystalline mineral.

Many greenstones in the Lothians (Bathgate, Uphall) contain coaly matter so disseminated through them, that it is only by the bituminous odour which they give out when struck that its presence can be recognised; this case is similar, and may be explained in the same way. The glance-coal of the Calton Hill is interesting, as it is connected with some views relative to the origin of veins. Veins of calcareous spar are in many instances well explained by an infiltration from above; here, however, such an origin is rendered doubtful from the fact of such a mineral as glance-coal occurring in them; and we appear to have a more probable explanation of some, as those of this locality, if we consider them as being produced by changes altering enveloped masses of limestone and coal. This explanation, however, rests principally on the supposition that glance-coal is of a vegetable nature. About a mile to the east of Edinburgh, at Lochend, greenstone occurs overlying strata of sandstone, and dipping to the east. Imbedded in this greenstone, there are numerous fragments of slate-clay, all of which are completely changed in mineralogical character: veins of calcareous spar traverse the greenstone, in which occur minute disseminated masses of sulphuret of lead. Near Restalrig, a village about half a mile to the east of Lochend, two beds of greenstone occur in the sandstone strata, both of these also dipping to the east. The greenstone of Restalrig is in general fine granular, and sometimes passes into claystone. The sandstone, when in connection with the greenstone, is much indurated, and contains grains of iron-pyrites distributed through it. (Plate VII. Fig. 3.) In Broughton Street, which runs across the northern acclivity upon which the city of Edinburgh is built, trap again occurs associated with sandstone.

As the greenstone has been well exposed by quarrying operations, its various modes of connexion with the strata have been disclosed, and the result of all these observations is, that it has been protruded through the strata in some places parallel to their direction, and in others has crossed them at various angles. From the upper surface of this dyke of greenstone another takes its origin, running through the sandstone to the distance of three feet and a half; at its point of contact with the principal mass, its breadth is about one foot, and thins out gradually as it recedes from it. The sandstone on approaching the greenstone becomes indurated, while the greenstone acquires a compact structure, and is traversed in several places by veins of amethyst, common quartz, and calcareous spar. Besides these veins others have been observed in the neighbourhood of Edinburgh, but all are now completely covered. In Lothian Street one of these veins occurs associated with the strata, dipping to the east; and at the Custom-House in Albany Street and Leith Walk, there were at one time interesting exposures of trap-rocks and of the phenomena attending their relations to the various sandstones and shales.*

In the bed of the Water of Leith three other trap-dykes occur, the first of these veins, on proceeding up the stream, is to be observed a short way above Stockbridge; one of its

* In the first volume of the Edinburgh Philosophical Journal these trap-rocks are all minutely described by Professor Jameson.

ends only is visible, the mean breadth being about three feet and a half; it is vertical, and indurates the sandstone strata which dip to the N. W. at 12°. At St George's mineral well a vein of compact greenstone crosses the strata of sandstone and bituminous shale. In its progress through the strata it entangles portions of the shale, which become completely indurated, and from the minute veins which shoot from out the central mass into the stratified rocks, the high state of fluidity in which the greenstone has been erupted is apparent. (Pl. VIII. Fig. 1 and 2.) On the north bank of the river a thin stratum of clay-ironstone is shifted for about a foot, and the vein of greenstone entangles a wedge-shaped mass of bituminous shale. Like the other veins which we have mentioned, this greenstone, as it approaches the strata, passes into a yellowish-white claystone, of which the small veins which arise from the chief mass are entirely composed, —a fact at once shewing that the causes allowing the formation of the felspar have only existed in those portions of the trap which were in contact with the traversed rock, or in those which were of small size (Pl. VIII. Sec. 3.) Above the village of Bell's Mills another vein of greenstone is to be found dipping with the strata to the N. by W. It is about twelve feet in thickness, and approaches to the syenitic character; the slate which rests upon it is slightly indurated, and when in contact with it the greenstone of the vein becomes compact. On the coast extending from Newhaven to Queensferry, there is a fine section of the various rocks of the coal-formation, and these, from their relations to igneous masses, present several interesting appearances.

About half a mile to the west of Newhaven there is a distinct example of the mantle-shaped mode of stratification; it is on a small scale, and a central point may be found, from which the strata dip to all points of the compass.

The rocks which form this assemblage of strata are slate-clay, bituminous shale, clay-ironstone, and sandstone. On proceeding in the direction of Cramond, they dip to the S.E. at 25°, against the mantle-shaped stratification, and in several places the sandstone and shale are invaded by masses of compact felspar, of yellow and grey colours; but in consequence of their great disintegration, the exact relations of the rocks to each other are not seen. The sandstone and shale when in contact with the felspar are changed both in mineral character and disposition; the sandstone becoming quartzose, and the slate approaching in some places to Lydian-stone. Farther to the west the strata contain four beds of trap; one of these is entirely composed of felspar, a rock into which the others, which are of greenstone, pass, as they approach the stratified series. As usual, induration is conspicuous, and in one part a breccia is formed at the planes of contact, being composed of variously sized fragments of slate and felspar. Iron-pyrites is abundantly distributed through both the felspar and greenstone.* On following the shore, no other rocks are observable till within a short distance of Cramond, where on the beach there are three alternations of sandstone and greenstone, all of which dip to the N.W. at 20°; when in contact the sandstone becomes indurated, and the greenstone passes into compact felspar. On the western side of the river Almond which enters the sea here, another bed of greenstone occurs: it dips to the north-west, and is succeeded by strata of sandstone

* The beautiful display of Plutonian and Neptunian rocks on this part of the coast was, after its relations had been pointed out by Professor Jameson, visited by Von Buch, Boué, Mohs, Brochant, Beaumont, and many other geological chiefs. There the rival theorists discussed their geological systems. Unfortunately for the geologist, these rocks have been lately nearly entirely removed, in preparing for the new harbour in that quarter.

and shale, which continue as far as Long Green, where they are associated with a great body of greenstone, which appears to hold the same relations to the strata as the others. From this to Hound Point in Linlithgowshire, there are no interesting phenomena exhibited by any of the rocks; there, however, two veins of greenstone occur, running parallel with the strata, which dip to the west at 26°. These veins in their relations to the stratified rocks, afford exhibitions at once of the violence of their eruptions and of their changing influences, and few points in the Lothians exhibit in a more marked manner the various and interesting effects of trap rocks on stratified masses. The lowest of the two dykes which are at this point associated with the stratified deposits, rests upon sandstone, while the uppermost reposes upon slate-clay. The trap, as it approaches the sandstone, passes into claystone felspar, and when in contact with the slate becomes a very compact greenstone. (Pl. IX.) The greenstone of these veins is of the common description, and in some places, like several other greenstones associated with the coal strata, emits, on fracturing, a strong bituminous smell. The sandstone on which the lowest trap vein reposes, becomes completely changed as it approaches the greenstone, passing either into granular quartz or hornstone, while a portion of it is partially imbedded in the greenstone, the fissure produced by its separation from the other parts of the stratum having been filled up by the trap. About four feet above the junction of the trap with the sandstone on which it rests, and entirely included in it, a mass of sandstone may be observed; it is visible for about twenty-four feet, and thins gradually out, from a breadth of six inches to that of a mere thread. The slate-clay, which overlies the uppermost bed of greenstone, is in its position not remarkably altered; the line of junction is undulating, and in several places it is slightly bent up amongst the superincumbent trap. In its mineral characters, the slate-clay exhibits marks of great alteration, and, from being a soft slate, becomes changed into a rock having little of a schistose structure, and so compact as to afford an uneven conchoidal fracture. From this to the Queensferry, there is no other junction of the trap and sandstone visible; to the west of the Queensferry, however, there are, on the shore, one or two dykes of trap associated with a tufa, the components of which are angular and on a small scale.

In the centre of the city of Edinburgh, the Castle Rock rises to the height of 445 feet, forming an eminence which, with the exception of its eastern side, presents on all quarters a perfect mural ascent. The rock of the Castle is composed, throughout its whole extent, of a basaltic clinkstone of a greyish-black colour, which is in general arranged in more or less perfect tabular concretions, and contains minute veins of calcareous spar, sulphate of barytes, prehnite, and Wollastonite. The forming of the New West Approach has displayed, in the clearest manner, the relations of the Plutonic rock of the Castle to a series of sandstone and shale which dips to the east at about 12°, and forms a gentle descent to the Palace of Holyrood. In their position the strata exhibit much disorder, being shifted and variously waved; and all, when in contact with the trap, become indurated, the sandstone passing into a quartzose variety, and the shale assuming a more compact structure. Near the gate of the Castle, several masses of the sandstone may be observed completely enveloped in the trap, all of which exhibit intense induration. Concerning the more immediate relations of the Castle Rock to the strata which occur on its western side, little can be ascertained, from the almost entire absence of openings, either natural or artificial; it may be stated, however, that all dip to the N. W. Near Bread Street, the sandstone is crossed vertically by a greenstone dyke about six feet broad.

Immediately to the west of the city, the hill of Corstorphin rises with its wooded front, presenting a beautifully undulating surface. This hill is formed by a mass of greenstone reposing upon strata of sandstone, sandstone-flag, bituminous shale, and clay-ironstone, which dip to the N.W. at about 25° ; from the encumbered state of the surface, however, no opportunity is afforded for examining any junctional appearances. The greenstone of Corstorphin is syenitic, and in several places is found to contain minute scales of pinchbeck-brown mica, and iron-pyrites, while prehnite, calcareous spar, amethyst, and common quartz are to be observed in drusy cavities.

On examining the position of the several rocks entering into the composition of the hills of Arthur's Seat, Salisbury Crags, and the Calton, it will be found that all present a uniform inclination to the W. or N. W. ; and that a similar arrangement exists in the strata forming the bed of the Firth of Forth, is evinced in the island of Inchkeith.

On proceeding along the coast of Fife, the strata which at Pettycur and Kinghorn have an easterly dip, gradually assume, as we approach Aberdour, a more northerly inclination, till at last they sink completely to the north ; and that this position is also held by those in the adjacent parts of the Firth, is indicated from an examination of the island of Inchcolm. After leaving the strata with the northerly dip, and advancing westward, the exposed rocks acquire progressively a westerly inclination. On the opposite coast of Linlithgowshire, the same arrangement is visible near Queensferry, and in the series of sandstone, shale, and greenstone which occurs between the river Almond and Newhaven.

The rocks around Edinburgh, and in the adjoining parts of Fifeshire, thus appear to exhibit a certain tendency to a concentric disposition. When, however, the whole district is examined, there is far from being visible that symmetrical aspect which characterizes a locality where the various mineral masses, whether aqueous or igneous, have been tilted up around an axis; but, on the contrary, the numerous instances which occur of strata, within the area of this somewhat mantle-shaped stratification, dipping to points in accordance with the supposition that an anticlinal elevating force had operated, render it probable that the appearances indicative of such an action are merely accidental. The Castle rock is a point from which many of the rocks dip, but if it had exerted an influence over so great a space, the sandstone which in many places, as at the Grange and Burntsfield, has a northerly dip, ought to plunge to the south, while many other strata, dipping to N. W., as those of Colinton, Slateford, and Craig-Lockhart, ought to sink to the S. W.

Concerning the mode by which these Plutonic and Neptunian rocks have assumed their present position, it may be difficult to conjecture; it must, however, either have been contemporaneous with the formation of the former class of rocks, or subsequent to that of both. If it is affirmed that the arrangement which the Plutonic rocks of this district exhibits is original, it may be no easy matter to explain how trap could be erupted, so as to overhang valleys without flowing into them; but, still, there certainly appears little reason to believe that the causes which have made the trap-rocks in the neighbourhood of Edinburgh to assume their existing appearances, have been others than those which arranged the alternations of trap-rock which constitute, in many districts, mountain masses. When such beds are inclined, they have as good a right to be considered as elevated after their formation and consolidation, as the greenstone of Salisbury Crags or Corstorphin; and their vertical fronts have an aspect as like the effect of fracture as these. If all the trap rocks which exhibit a vertical front had acquired this form by being subjected to fractures, hardly one Plutonic rock in the Lothians would be exempted—all would be considered as having been elevated after their eruption and consolidation. The Dalmahoy Hills, the Bathgate Hills, Blackford Hill, and the principal trap-rocks of Haddingtonshire must, then, all be imagined to have been disturbed by igneous actions different from those which effected their protrusion; for they present perpendicular faces, and are frequently inclined at high angles.

As an instance of the pseudo-fractured appearance, we may mention Binny Craig in West-Lothian. Here there is the same gentle acclivity on one side of the hill, and mural face on the other, as is so well seen in Salisbury Crags; and there is, in short, an appearance as like fracture; but the circumstance of its resting upon horizontal strata is a sufficient proof that it could not have been elevated after its consolidation, for any upraising agent operating on it, must also have acted on the sandstone and shale. When we endeavour to shew, however, from such facts, that these trap-rocks have not been tilted up after their eruption amongst the strata, but that the inclined position is contemporaneous with their formation, it is not to be understood that we imply the same concerning the period when the Neptunian deposits were raised; for, on the contrary, these evince that they were elevated by actions subsequent to their deposition and solidification, and referable to the trap-rocks with which they are connected. The one set of rocks may be in an unaltered state, as far as their being moved *en masse* after their eruption is concerned, but the appearances visible in the position of the latter, prove that they are not.

Protruded, as the trap-rocks undubitably were, under great superincumbent pressure, arising either from the presence of an immense body of water or rock, it is evident that they were not in a situation which could allow such a perfect motion of the particles on each other, as exists in a stream of fluid rocky matter, erupted only under the pressure of the atmosphere; and such a great compressing force might allow the ejected igneous matters to be piled up, one above the other, in that more or less bedded arrangement, which characterizes a trap-hill. The structure of the trap-rocks also appears favourable for their having mural precipices; for in beds which have a tendency to a prismatic mode of aggregation, and are composed of concretions arranged at right angles to the plane of the bed, there appears to exist a disposition, which of all others is best fitted for producing, in length of time, a cliff with a vertical front. Immediately after the formation and consolidation of a trap-rock erupted under the pressure of the ocean, it would begin to be subjected to the destroying action of water; and if raised above the ocean, and forming dry land, would be subjected to both the mechanical and chemical decomposing influences of air and water. By whatever agents, however, the decomposition of the mass was effected, it would proceed chiefly in the direction of the vertical concretions, so that whether the rock presented a mural front originally or not, it would, when acted on by the various agents productive of decay, assume one in a greater or less degree. By this uniform mode of disintegration going on through a long series of geological epochs, the original aspect of a trap country might be modified to such a great extent, that there might exist hardly any similarity between its former appearance and its present outline; what then formed one mountain, may now be broken down into several, and the once perfect continuity of a bed of basalt or greenstone over one mountain, may now only be inferred by finding it forming mountain caps to portions of that mountain.*

In addition to the different points which we have described, where the relations of the various rocks to each other are observable, there are others; but few of these exhibit any thing remarkable. In the bed of the river Almond, at the Aqueduct Bridge, the slate and sandstone are associated with a greenstone, which forms, for a considerable length, the entire bed of the river; it is surmounted by an assemblage of shale strata, and in all probability forms a great vein which runs parallel with their direction. On the north side of the bridge these strata are found under a second bed of trap, which can be traced for several hundred yards: the slates, when in contact with the greenstone, are slightly indurated, and the trap as it approaches them, becomes gradually more compact. A short way up the river a vein of trap about four feet broad traverses the sandstone, and near this another is to be seen running parallel with the strata, which dip at about 30°, pursuing a determined course for many yards; it cannot be traced throughout its whole extent, but may be examined in the bed of the river, and also in several parts of the cliffs. Near Almondell the strata present, within a very short space, several examples of undulation, and are traversed by a vein of greenstone, having a thickness of three feet. In the limestone quarries of East Calder there are several interesting phenomena attending the relation of the limestone to the greenstone, which is of

* In the island of Rum there are several good examples of mountains being formed by the decomposition of one. The large granular augitic greenstone ridges of Haleval are only continuations of Aisgobhall, though now both of these mountains are separated by a deep glen.

the usual description, and in some places assumes the globularly concretionary structure. In the first quarry to the east of East Calder, the mountain limestone dips S. E. at 20°, under a mass of greenstone, which in the second quarry is found in immediate contact with it. In the quarry where the junction is exposed, the limestone abutts against the greenstone at a small angle, dipping E. S.E.; a position which, at the eastern extremity of this opening, is completely reversed, as the strata sink to the W. S.W. at 15°. The limestone, which at a distance from the greenstone is of a bluish or yellowish-grey colour, becomes, on approaching it, white and beautifully crystalline, acquiring much of the aspect of primitive marble. No exact line of boundary can be drawn between the greenstone and the limestone; on the contrary, both rocks are so intimately blended, that this locality might, if the true nature of them was not known to be distinct, be considered as exhibiting appearances only to be explained by awarding a synchronous and similar origin to both. The greenstone may be observed in all stages between a mass distinctly imbedded, to one in which it is so perfectly diffused through the limestone, as to impart to it a dark green colour: in accordance with the received igneous formation of trap, such an appearance may be explained, by supposing that circumstances caused such a perfect fluidity of both rocks, that the intermixture of the one with the other was the consequence. Like all the other trap-rocks, this greenstone, in the neighbourhood of the strata, becomes compact, and, as is often the case with trap in contact with limestone, assumes much of the serpentinous character.

Immediately to the south of East Calder, there is a considerable district of trap, which rises at its eastern extremity into the two marked eminences of the Dalmahoy Crags; it runs E. and W., forming the hilly range of

Kirknewton and Lawhead, and appears to terminate at the Linhouse water near Longhaugh Mill. The hills of Auchinown, Morton, and Corston, form a part of this trap range. From Longhaugh Mill to Linhouse, the bed and both sides of the stream exhibit one of those alternating groups of variously coloured shales and red sandstone, which so often occur, both on the large and small scale, associated with the white sandstone series of the Lothians. A short distance to the eastward of the stream the strata are cut off by the trap-rock, which constitute all the hills on that side. Opposite Linhouse it sends out a great dyke of grey compact basalt, which crosses the river; it cannot be traced on the western side of the stream, but, judging from the external aspect of the country, it is probable that it terminates near this point. To the south of this trap-dyke, nothing in any way interesting presents itself; but in the course of the Linhouse water, there are numerous exposures of the white sandstone and its concomitant shale strata; which form, without any visible association with Plutonic rocks, a wide extent of moor ground, bounded on the south by the red sandstone hills which constitute the western extremity of the Pentland range. The greenstone of Dalmahoy rests upon white sandstone dipping west; but as it is covered at the planes of contact, its aspect, if there changed, cannot be seen. At the western extremity of this trap range, at Longhaugh Mill, there is a very satisfactory junction of the greenstone and sandstone, both of which are much altered in mineralogical character; the strata of sandstone become vertical or exhibit various undulations, and are indurated into a granular quartz, while the greenstone with which they are in contact passes into a very compact greenstone or a felspar. At the southern extremity of Auchinown Hill, and at the farm of Harper Rig, a dyke of greenstone crosses the stream, running parallel with the sandstone strata; and in the bed of the Gogar burn at Wester Haggs, another dyke traverses the sandstone vertically, which abutts against it on both sides. At Stoneyrig also, a similar dyke occurs; there are no junctions visible, but the strata are fractured, contorted, and inclined at high angles.

Having now described the relations of the trap-rocks which occur in the more immediate vicinity of Edinburgh to the various Neptunian strata, the present appears a convenient place to introduce a description of the islands which rise above the waters of the Firth of Forth, in as much as there are circumstances which connect them with the several rocky masses which we have just noticed. Of these islands, two only, Inchkeith and Inchcolm, contain stratified rocks, and both exhibit several interesting appearances. The strata which occur in Inchkeith consist of limestone, calcareous sandstone, slate-clay, and bituminous shale, all of which dip to the S. S.W.* The igneous rocks of this island are amygdaloid, earthy greenstone, basalt, and tufa, and at the lines of junction with the stratified rocks there are produced all those changes which so frequently occur; the slate becomes indurated, the limestone crystalline, and the sandstone quartzose. In several places, masses of the stratified rocks are carried up, and completely enveloped in the trap; these masses varying from the smallest size to the magnitude of many yards. On the eastern side of the island the columnar mode of arrangement is well displayed in the greenstone. The tufa which occurs in Inchkeith is formed by a base of earthy trap containing variously sized masses of basalt, greenstone, sand-

* Vide pp. 216, 17, 18, 19, and 220 of Dr Neill's translation of Daubuison's Memoir on Basalt, for an interesting account of the geognosy of the coast of Fyfe.

stone, and limestone; it appears to constitute the lowest rock of the island, and is in general traversed by a multiplicity of veins of calcareous spar, which is sometimes fibrous. The other minerals which are met with in the rocks of Inchkeith are common jasper, and Lydian-stone, the latter of which forms contemporaneous imbedded masses and layers in the limestone. Glassy felspar occurs in the basalt, which also contains minute masses of steatite.

A little to the west of Inchkeith, Inchcolm rises. A considerable portion of this island is composed of greenstone, exhibiting either the earthy, syenitic, or common appearance, and which, by the felspar being replaced by steatite, frequently passes into an imperfect serpentine. On the south side of the island, a variety of greenstone occurs containing numerous scales of pinchbeck-brown mica; it is traversed by a number of contemporaneous veins of greenstone, which frequently passes into steatite; this mineral occurs also in minute strings without exhibiting any such transition, and in them sometimes there may be observed threads of amianthus. On the south of the island, where a junction of the trap and the sandstone is exposed, the latter dips to the north at 52°; while the greenstone, as it approaches the sandstone, passes into a compact yellowish-white claystone, a vein of which occurs running parallel (Plate X., Fig. 1.) with the strata. With the exception of a body of sandstone, which is enveloped in the greenstone, the western half of the island is entirely composed of trap, having in some places a slightly columnar disposition. Farther up the Firth, the islands of Cramond, Carcaig, Mickrey, Mickrey Stone, and Inchgarvey occur: from being entirely formed of trap, however, these exhibit nothing interesting. The greenstone of Cramond Island and Mickrey is syenitic, the felspar being white and of a light brick-red colour. At the mouth of the Firth, a range of trap islands runs for a considerable way round the coast of East-Lothian, of which Eyebroughy and the Bass Rock form the two extremities. The Bass Rock is composed of a very minute greenstone, in which the felspar, which is compact and of a reddish-brown colour, sometimes becomes so abundant, that the rock almost passes into a compact felspar or a clinkstone. Throughout its whole extent it exhibits more or less the tabular structure, the concretions varying both in thickness and mode of position. In several places, by the incessant action of the waves upon the rock, caves have been produced, one of which perforates it completely, and is accessible at low water.

Having noticed the relations of the several detached masses of trap to the strata, we shall now describe in the same way those clinkstones, claystones, and compact felspars, which form a considerable portion of the Pentlands. The hill of Blackford, which forms the northern termination of this range, is entirely composed of clinkstone of a dark grey colour: it contains in some places crystals of felspar, and is traversed by veins of agate. The claystones and compact felspars of the Braid Hills are of various shades of grey, yellow, and brown, and are all easily decomposed by atmospherical agents. Concerning the more minute relations of these ignigenous masses to the stratified formations, the completely covered state of the country renders it impossible to determine; by examining, however, the position of the strata in the few places where this can be done, the result is, that all are found to abutt against the unstratified rocks. In the Grange Quarry, which is situated but a short distance from the clinkstone of Blackford, strata of red sandstone dip to the N. by E. at 40°; and a coarse conglomerate, which is visible for a few yards at Libertonbrae, sinks to the E. S.E. at about 35°, exhibiting, in many places, signs of disorder. Near the village of Burdie-house, and at Straiton Mill, the coal formation sandstone, and a bed of the mountain limestone, plunge to the S. S.E. at 40° and 35°. To the west of the Braid Hills, and separated from them by about half a mile of gently undulating country, the hill of Craig-Lockhart rises, and on its east side the red sandstone which occurs at the Grange, is to be observed dipping W. at 35°. The rock which forms the igneous portion of Craig-Lockhart, is, in some places, a well-marked greenstone, exhibiting an imperfect columnar structure; while in others it approaches to basalt, containing numerous small crystals of velvet-black basaltic hornblende, and a few large crystals of glassy-white felspar. Within the space of a few feet, this rock passes into a greenstone of an earthy aspect, which makes a transition in some parts into a claystone, and in others into a wacke. The claystone into which the greenstone passes is, in general, of a greyish colour, and contains crystals of black hornblende, the crystalline form of which may often be exposed on a favourable fracture; contemporaneous veins of felspar traverse the rock in many places. In some parts of the hill a fine greenstone is found, which contains large and well-defined crystals of felspar, and resembles, in some degree, the green porphyry of the ancients; while in other parts a trap-tufa occurs, which is always distinctly stratified. On the side of the Colinton road, the sandstone strata dip N. W. at 30°, thus abutting against the trap of Craig-Lockhart.

The Pentland Hills,* as we have already said, rise immediately to the south of the Braid Hills, forming numerous rounded and conical summits, and attaining, in some

* Vide Memoirs of the Wernerian Natural History Society, vol. 2d, for Professor Jameson's outline of the Mineralogy of the Pentland Hills; and Dr Charles Mackenzie on the compact felspar of the Pentlands in vol. i. Wernerian Memoirs.

instances, to the heights of 1876 feet and 1856 feet. Mineralogically, they may be separated into two series of hills, viz. that composed of felspathic rocks, and that formed of sandstone; the former class constitutes the eastern half of the range, while the latter occurs chiefly in the western. As in the Braid Hills, the ignigenous portion of the Pentlands is composed principally of various porphyries, claystones, and compact felspars, all of which pass into one another, and preserve in their several relations no definite mode of grouping, inasmuch as the formation of all appears to have been strictly contemporaneous. A greenish-grey clinkstone occurs in several places, and in other parts a compact felspar is to be met with, which varies in colour from flesh to brownish-red, and by assuming crystals of felspar, makes, in some places, a transition into porphyry. Claystone of various colours forms many of the Pentland hills, and exists in all stages between an easily friable rock, and one of considerable solidity; very generally, it is associated with the porphyritic structure, the felspar crystals in some instances being of considerable size. Besides this claystone exhibiting the porphyritic arrangement, it becomes frequently amygdaloidal, and contains concretionary masses of calcareous spar, amethyst, quartz, chalcedony, agate, lithomarge, and green-earth. Of the claystone of the Pentlands, one only may be noticed more particularly, in as much as its characters might easily cause its true nature to be mistaken; it forms the whole of the hill of Kirkyetton, and occurs also in the Turnhouse hill. On examining this rock at first sight, it will appear as if composed of fragments of compact felspar and claystone; but, after studying it minutely and in all its details, these fragments will be discovered to be such in appearance only. The same varieties of the compact felspar, which in some places might be easily mistaken for fragments, are found in others to occur as veins, of an origin contemporaneous with the apparently fragmentary rock; and farther, the pseudo fragments are all found, when the true fracture of the rock is obtained, to pass gradually into the containing basis.

In the augitic series of the Lothians there are greenstones which, from containing angular masses of greenstone, imbedded in a trap basis, might in some cases be confounded with a true tufa. In many instances, however, there may be observed a gradual transition of the apparently tufaceous rock into a perfectly well characterized greenstone; a fact which at once appears to prove, that the fragmentary aspect may, in some instances, be deceptive. It is almost impossible to conceive circumstances adequate to produce the passage of a true tufa—a rock which is of an evident mechanical origin—into greenstone, which is a true aggregate of more or less perfect crystals, and has resulted from the cooling of a fused mass. It may be said, that the long action of the greenstone upon the tufa, might make the semblance of a transition. When trap-tufa, however, from a proximity to such a mass, appears to have been altered, the appearances are only of that description which, in some instances, attend the junctions of true aqueous rocks with Plutonic masses. Throughout the whole extent of the Pentland range, there are but few localities where the connexions of the igneous with the stratified rocks are well exposed. Near the extremity of the valley of Glencorse, which runs in a N. E. and S. W. direction through the Pentlands, and beside the ruins of an old chapel, sandstone occurs, dipping S. at 15° or 20°, thus resting upon the porphyry which forms the north side of the glen, and sinking under that which composes the hills on the south. As to the appearance exhibited at the junction of the sandstone with the porphyry nothing can be said: throughout its whole visible extent, however, it is changed, in some places passing into quartz-rock, and in others becoming a conchoidal hornstone. At the western extremity of the valley, and on the south of Black Hill, a natural section exhibits numerous alternating strata, of a very fine granular brown sandstone and slate. The mineral characters of the latter are in some places similar to those of the slates associated with greywacke: if, however, its position, in regard to the rocks with which it is connected, be observed, and its aspect compared with that of slates whose place in the carboniferous group is more apparent, its geological age becomes sufficiently evident. In the course of the North Esk river, from its rise in the Dodrig to Carlops, there are many fine sections of this slate; it is found alternating with the coarse sandstone conglomerate of the Pentlands, and in some places with the sandstone of the coal series. At Habbie's How the slate, which is vertical and ranges S. W. and N. E., rests upon the compact felspar of Black Hill, and throughout its whole extent exhibits evident marks of having been at one time subjected to energetic upraising actions. Conglomerate forms the western extremity of the valley of Glencorse; it dips to the W. by S. at 15°, being thus in a position anything but conformable with the slate. As we have already stated, however, that the synchronism of deposition of these two rocks is well seen in other parts of the Pentlands, the causes of this may in all probability be referred to the upburst of the Plutonic rocks, with which both are so intimately connected. On examining the conglomerate, as exposed by the cascade of Habbie's How, it is found traversed by minute veins of a compact felspar, similar to that which is associated with the slate; it is however more compact, and thus affords another instance of that change of mineral character which the ignigenous rocks evince, when they traverse Neptunian strata in the form of veins, or come in contact with them as overlying masses.

Concerning the appearances which the conglomerate exhibits, when near these veins, it may be remarked, that they are the same as many which we have before described as attending similar rocks in similar situations; it become intensely indurated, and has a more or less perfect conchoidal surface. The felspar of Black Hill is found to contain imbedded masses of this conglomerate many yards in extent, and on its eastern side, near the farm of Craigentarrie, strata of red sandstone are found in an almost vertical position; slate the same as that of Habbie's How is also to be observed in several places intimately connected with the compact felspar.

Besides all these interesting relations of stratified to unstratified rocks, we have, in the formation of the valley which separates the hill of felspar from the conglomerate of Habbie's How, a subject of considerable interest, and an example of one of the many valleys which cannot be satisfactorily explained by referring them to the long-continued action of the streams which traverse them. In speculating upon the origin of valleys, it is necessary to examine whether these have been produced by actions aqueous or igneous, and subsequent to the formation of the rocks which they traverse, or whether they are to be considered as original depressions. In regard to the valley of Glencorse, the relations of the several rocks which we have just noticed, render it evident that it is not an original depression, but that subsequent actions, whether aqueous or igneous, have produced the existing arrangements. That this valley has been formed by the long-continued action of the insignificant stream which at present runs through it, is, as we have just remarked, highly improbable; on the contrary, however, it and all other valleys, presenting the same characters, may be satisfactorily explained by considering them as having originated in more or less limited lines of fracture.

In the three Lothians, we might cite innumerable examples of gorges and ravines, which, though traversed by streams, still, from the great disproportion which exists in their relative magnitudes, have evidently been produced by agents in no way connected with the water which flows through them. To form these valleys by water, some geologists may only demand a great lapse of time; but others, from considering their various appearances, and remembering that, if a given cause is inadequate to produce a given effect, the endless operation of that cause avails nothing, will only refer them to great and instantaneous convulsions.

The high vertical faces of the rocks, in every instance, exhibit evident proofs of fracture, and present no appearances which can reasonably be considered as produced by the long-continued action of a stream. Though alterations in the position of strata, are, in the generality of cases, to be referred to the presence of unstratified rocks, still many of the rents which we are noticing, seem, from crossing strata which are in a horizontal position, and, in many instances, far removed from igneous masses, to be referable to other Plutonic actions than those which have protruded the augitic and felspathic series. On the nature of these we have no intention to speculate at length. May they not, however, be traced to the actions which raised the countries we are noticing above the waters of an ancient ocean? As some localities where fissures appear to traverse the strata, we may mention the Heriot, Dunglass, and Pease burns, the glen of Pockbie near Soutra Hill, and numerous points in the courses of the rivers Almond, Leith, Gladhouse, and North Esk.

The slate which is seen in an upraised position at Habbie's How, is to be met with in other parts of the Pentlands: near Bevelaw House, it occurs in vertical strata, ranging

N. E. and S. W., and is traversed by two vertical dykes of greenstone, the largest of which is about twenty feet wide; but neither the greenstone nor the slate exhibit any marked signs of alteration.

Above the village of Currie, the hill of Warklaw rises through the white sandstone series, which occurs abutting against it in the bed of the Water of Leith; it is partly composed of a common greenstone, and partly of a porphyritic clinkstone, and on its south side, strata of red sandstone, in some places highly calcareous, are found reposing. On the banks of a rivulet which takes its rise at the foot of Harbour Hill and joins the Braidsburn here, the white sandstone is found dipping N. N.E., being cut through by a dyke of trap which dips N. at 80°. All the rocks are indurated, the sandstone passing almost into granular quartz, and the argillaceous shale becoming compact. The greenstone which occurs here is of the usual description, and is arranged in perfect globular concretions. On the other side of the greenstone dyke, the strata dip to the S. S.W., resting upon the red sandstone, which reclines against a rock of compact felspar. After leaving Bevelaw Quarry, and proceeding along the Pentland range, the igneous rocks are found to be replaced by the red sandstone, which constitutes, with the exception of one or two veinous masses of trap, all the remaining Mid-Lothian portion of the Pentlands. In East Cairn Hill, the sandstone rises to the height of 1802 feet, forming a well-marked table-shaped mountain, and on its south side, the strata of sandstone crop out, and dip to the north at about 25°. Concerning the immediate agents which have caused the red sandstone of this quarter to rise into mountain masses, we cannot speak with certainty, inasmuch as they are all completely concealed. In the porphyry hills of the range, however, there exist causes quite sufficient for their upraisure, and the existence of these or similar rocks, below the sandstone, may easily have produced the disturbances which the position of the various slates and sandstones evinces they must have been subjected to. The sandstone-conglomerate which occurs in the bed of the Linton Water is, near the farm of Cairn Muir, traversed by a large vein of greenstone, which is in some places amygdaloidal; it cannot be traced throughout its whole extent, but it runs a course parallel with the direction of the strata, and gradually thins out. The conglomerate, at its planes of junction with the greenstone, however, exhibits no appearance of induration. (Plate X. Fig. 2.)

The only other trap-rock which occurs in the Pentlands, and deserves to be noticed, is a greenstone associated with the red sandstone of Carlops. This mass of trap forms the central part of a valley running E. and W. for nearly a mile; its sides are composed of red sandstone and conglomerate, having a position which, though not very satisfactorily displayed, appears to indicate that the strata have been tilted up anticlinally. The trap which appears to have been the agent in causing this arrangement does not form an uninterrupted ridge, but, on the contrary, has been broken up by subsequent actions, which have left only portions expressive of its former complete continuity. At the eastern extremity of this dyke of trap, the cutting of a new road has exposed a vein of earthy greenstone, which runs parallel with the strata of the white sandstone series, and can only be considered as a lateral expansion of the principal trap vein. The strata when in contact with it are not altered, and both rocks dip S. S.W. at about 35°. At the village of Carlops, the eastern extremity of this great trap-dyke is traversed by an infinity of veins composed of quartz, in the different states of hornstone, jasper, chalcedony, and cachalong: they run a determined course; and in breadth vary from the smallest size to two feet. The fact of there being exhibited in the structure of the larger of these veins evident marks of mechanical actions, renders it probable that none are of an origin contemporaneous with the trap. Many of the veins are composed of an aggregate of fragments of white and black hornstone, cemented together by a similar basis; all these fragments are angular, and frequently they may be reunited to each other in the imagination. As to the variety of the hornstone which constitutes these fragmentary masses, or forms the base which contains them, there is no regularity observed, for in some portions of a vein the masses are of black hornstone, imbedded in a white hornstone ground, while, in other parts angular fragments of white hornstone are inclosed in a base of the black. To explain the mode in which these veins have been formed in the existing state of knowledge in regard to this subject is perhaps impossible; an infiltration from above, however, of the minerals which constitute them, is the most probable mode of their formation, while a breaking up of the previously formed veins and their reconsolidation, by a new infiltration of quartzose matters, may have effected those appearances which indicate mechanical actions.

Concerning the relations of the porphyry of the Pentlands to the strata which skirt their southern base, little can be said, inasmuch as there are no natural or artificial openings sufficiently near the junction of the two rocks. In the bed of North Esk river there is almost throughout its whole course, a fine section of the various strata of the coal formation, but in no part are they in any way connected with rocks of ignigenous origin, though that they have been acted upon by disturbing agents, their position renders sufficiently evident.*

Having now noticed, with considerable minuteness, the various relations of the ignigenous rocks of Mid-Lothian, to the associated stratified formations, we shall in the same way describe similar phenomena which are exhibited in Haddingtonshire.† A considerable portion of this county is composed of igneous masses; they form all that part which which is included by a line, stretching from Whitberry Point to Linton and Pople: the line of trap-rock here assumes a westerly direction, running along the north back of the Tyne as far as Haddington; and, making a 'detour' by Bangly, passes near Ballencrief and Drem toll, till at last it terminates in the sea, forming Goolan Point. Though this is the most extensive body of trap which occurs in East Lothian, still there are others of a smaller size which exhibit many interesting relations. As in Mid-Lothian the augitic or trap-rocks are associated with those of the felspathic or porphyry series. Rocks of the latter class constitute the Garleton Hills, a range forming the high land which occurs above the town of Haddington, and they enter also into the composition of the eminences of North Berwick-Law and Traprain. The

* Near the town of West Linton, situated at the farther extremity of the Pentlands, felspathic rocks again appear, rising through the red sandstone. The hill of Mendic is entirely composed of a brown claystone porphyry. In its characters, the white sandstone which occurs around West Linton, exhibits some appearances differing from any of the other white sandstones of the Lothians. It contains, as an ingredient, a great abundance of yellowish-white claystone, and indeed, it is only by examining this rock in all its details that its true nature can be ascertained; for, when the lines of stratification are imperfect, and no alternations with a more characteristic sandstone visible, it might easily be mistaken for one of those claystones, which in some parts of this district rise through and occur between the sedimentary deposits.

† Vide Dr Ogilvy on the Trap-Veins of East Lothians, Wernerian Memoirs, vol. i. Also Professor Jameson on the Geognosy of the Lothians, Wernerian Memoirs, vol. ii.

mineral characters which these rocks exhibit are on a general view similar to those which occur in the former county; there are, however, some which merit a detailed description. The porphyry of the Garleton Hills has in general a basis of a largely foliated clinkstone, inclosing crystals of felspar; it passes into clinkstone, and in other parts into compact felspar; and associated with these porphyry and clinkstone rocks, there occurs at the Abbey toll of Haddington a felspar tufa, containing imbedded angular fragments of porphyry and compact felspar. Much of the country in the neighbourhood of Linton is composed of a highly felspathic greenstone, which passes in many places into claystone. The augite and felspar which form this rock are, from being highly impregnated with iron, of a brownish-red colour; it is very small granular, exhibiting in some places a tendency to a tabular arrangement; and in the quarry of Pencraik, where the felspathic greenstone is worked to a considerable extent for road material, it is traversed by numerous veins of sulphate of barytes, associated with calcareous spar and fibrous brown hæmatite.

In describing the relations of this great deposit of trap and felspar rock, to the stratified formations, we shall commence at the southern extremity, which rises above the village of Garvald, forming Whitelaw Hill. At this point the strata of red sandstone are found dipping at 10° to S.W. by S., thus abutting against the igneous rocks,—a position, however, which they are far from universally holding; for, in tracing the sandstone round the unstratified rocks, it is found in many places to sink under them, or to be inclined at a small angle. Such apparently unchanged positions of the strata may, however, easily be reconciled with the intrusive origin of trap or felspathic rocks; if it be remembered that much of this ignigenous mass may be in an overlying position, and occurring only as a great body, which, after being erupted through the strata, has flowed over them. Near Hollandside, and on the southern acclivity of Trap-rain-Law, sandstone is exposed for a few yards, dipping to the S. W. at about 20°, thus resting upon the porphyry, to which a slight appearance of induration is probably to be attributed. It sinks below a porphyritic basalt, which with claystone forms one of the sides of the valley of Blakie's Haugh. The felspar porphyry of this hill is in many places arranged in very distinct tabular concretions, which vary both in magnitude and position. Of the southern part of this extensive formation of trap, the only point which exhibits in a very clear manner the protrusion of the trap, subsequent to the formation of strata, is in the limestone quarries of Sunnyside. In one of these openings, the mountain limestone, with its associated variously coloured slate-clays, dip to the north at 30°, lying under a ferruginous felspathic greenstone, which is found rising through them in the form of a dyke of about three feet in thickness; there are no appearances of induration, but the slates exhibit several undulations. (Pl. X. Fig. 3.) The effects of the trap upon the limestone cannot be observed, though that it does traverse it, the fact of crossing strata which rest upon the limestone at once proves.

At Phantassie the same limestone appears, in the immediate vicinity of trap; and tracing it eastward, it may be examined at Balgone in the neighbourhood of the ignigenous rocks. The limestone here is considerably indurated, and contains numerous small veins of calcareous spar, in which drusy cavities occur, lined with minute groups of quartz-crystals. In position, this limestone is very much altered; it is fractured and contorted, and in many places the lines of stratification are much obliterated. The position of the white sandstone of this part of East Lothian, as it is exposed in artificial openings, and in the bed of the Tyne, is more or less horizontal, an arrangement of the strata, which, but for junctional phenomena visible at other points in this district, might lead us to imagine that they had not been acted on by ignigenous masses.

To trace the junctions of the two classes of rocks through that part of the country which extends from Haddington to the shores of the Firth of Forth, is, from the obstacles which so often mar the progress of the geologist, impossible. On examining, however, the shore which stretches from Morrison's Haven to Dunbar, numerous rock sections of the most interesting nature may be observed. The strata are traversed by intruding masses of trap, and these, it is highly probable, are connected (though the encumbered state of the surface prevents such connections from being seen,) with that great East Lothian district of trap, the boundaries of which we have just defined. On examining the northern shore of East Lothian, the first mass of trap which is observed occurs at Morrison's Haven; it is a greenstone of the usual description, and rises directly through the sandstone, which on one side rests upon it, and on the other sinks below it; no junctions are, however, to be found. On proceeding along the coast in the direction of Cockenzie, the various strata of sandstone and slate evince much disturbance, and preserve no general line of bearing, but, on the contrary, dip at varying angles to various points of the compass. At the harbour of Cockenzie a great mass of large granular greenstone occurs; it rises directly through the strata which, on one side, dip to the E. S.E. at 30°, and on the other to the S. Between this and the greenstone which forms Goolan Point, other greenstones are found associated with the coal sandstones and slates; one of these at Bogle Hill is rudely columnar, and throughout its whole visible extent runs parallel with the strata, which, when in contact with it, become indurated, while the trap passes into a yellowish-white claystone felspar. On passing Goolan Point, strata of sandstone and mountain limestone crop out at the shore: they dip under the greenstone and exhibit many marks of a disturbed position. About two miles farther to the east many other greenstones occur, but their modes of connection with the strata are not exposed. Near Red House a basalt rises through the sandstone: it is arranged in columns of the most symmetrical character, which, in some places, are inclined at a small angle, while in others they are variously bent or completely vertical. By assuming crystals of felspar, the basalt acquires, in some places, a slightly porphyritic character. From this to Weaklaw, a point almost opposite the island of Fidra, there is nothing which deserves minute detail; strata of sandstone, with alternating limestone, are exposed on the shore, but their position is so disturbed, and they are so covered with debris, that little can be ascertained respecting them; they alternate, however, with various felspars, both compact and tufaceous. At Weaklaw the strata of the white sandstone series are replaced by the red sandstone conglomerate in a horizontal position, and exhibiting several gentle curvatures, which are probably to be referred to the presence of a body of earthy ferruginous greenstone upon which the conglomerate reposes; but in regard to induration, there is nothing very conspicuous, the conglomerate being highly compact throughout. Between this point and North Berwick several other trap dykes occur, associated with the red sandstone; none, however, are remarkable: they are all composed of greenstone, different varieties of which occur in different parts of the same vein:—thus one part of a vein may be composed of a greenstone of an earthy character, and containing oxide of iron as a colouring matter, while other portions may consist of amygdaloid, or be rendered porphyritic by containing numerous crystals of felspar. Veins of calcareous spar, associated with quartz, traverse the greenstone, and both these minerals occur crystallized in drusy cavities. Nearly opposite the Lamb island a few minute strata of fetid limestone appear, but nothing in regard to their relations with other rocks can be ascertained. At North Berwick a mass of trap runs boldly into the sea, intruding more or less parallelly among the red sandstone strata, forming one side of the harbour. The island of Craig Leithie lies immediately opposite the trap of the harbour of North Berwick, indicating, as do all the other trap islands which skirt this coast, a continuity with the trap-rocks occurring on the shore. About a mile from North Berwick the hill of North Berwick-Law rises, with its beautifully conical form, above a comparatively level country; in its geological structure, however, it exhibits nothing interesting, and its relations to any of the stratified rocks are in no place observable. A brownish-red felspathic greenstone, associated with trap-tufa, forms the lower part of the hill, while the summit is composed of a clinkstone, which exhibits a slightly tabular arrangement; its mode of connexion, however, with the greenstone and the tufa is completely obscured. The series of strata which sinks under the trap of North Berwick Harbour, is, after being visible for a short space, covered up by a sandy beach, through which rocks of green trap-tufa are afterwards found emerging. This tufa is in many places distinctly stratified, and is composed of variously sized fragments of red sandstone, limestone, and trap, cemented together by a basis of comminuted trap. Veins of greenstone, in one or two places, traverse the tufa, and some, by effecting changes on it, produce those appearances, which at one period were considered as indicating a precisely similar mode of formation.*

On examining the coast between Canty Bay and Sea Cliff, several detached masses of red sandstone may be observed underlying the tufaceous deposit, which, in some places, forms mural cliffs of great thickness, and presents an almost uniform horizontality of its beds. Near Scougal the green trap-tufa is succeeded by one of a brick-red colour, containing fragments of the same description as those which occur in the green. After this an extensive sandy beach covers up the subjacent rocks, and nothing can be observed till we arrive at Whitberry Point. The trap-rock which forms this headland has been described as exhibiting appearances which were considered inconsistent with a Plutonic origin, and, instead of being viewed as a protrusion through the strata, its position was thought to be more naturally explained, by precipitation from above; that it had sunk down upon the previously formed strata when they were in a soft state. If there existed no similitude between trap-rocks and productions of modern igneous formation,—if there were no changes effected on the strata by the trap of Whitberry, such a deposition from above might appear a legitimate inference; but in the present case it has been deduced from the observation of one class of facts only. (Plate X. Fig. 4.) On the northern side of the trap of Whitberry Point, which ranges E. N.E. and W. S.W., strata of red sandstone and va-

* A rock near St Andrew's, which is known by the name of the Rock and Spindle, affords a fine example of a basaltic vein traversing trap-tufa; when near the basalt, the tufa becomes indurated and the basalt more compact than when at a distance from it. Vide Memoirs of Wernerian Natural History Society, vol. ii. for a Memoir on the Mineralogy of the Neighbourhood of St Andrew's, in Fife, by Dr Fleming.

riously coloured slates dip under the trap to the E. S.E. at 20° and 25°; but on crossing the ridge of trap, the strata completely change their position, and dip under it to the N. N.W. at 45°. The appearances which the strata assume when near the trap are of the most satisfactory nature; all are indurated, the sandstone passing into granular quartz and hornstone, while the slates assume those characters which they usually exhibit, when acted upon by ignigenous rocks. The trap of Whitberry varies in different parts; it is however principally composed of a rock of very large granular greenstone, arranged in beautifully regular tabular concretions, and associated with a ferruginous basaltic greenstone, exhibiting also in many places the tabular structure. When next the stratified rocks, the Plutonic masses become more compact, losing their crystalline structure for a more or less earthy state of aggregation. Interposed between the sandstone strata and the greenstone a trap-tufa in some places occurs, consisting of a basis of red wackaceous trap, in which are imbedded angular-shaped masses of red sandstone, limestone, and slate, identical with those which are in contact with the greenstone.*

We have now described the various relations of the principal mass of the unstratified rocks of East Lothian to its attending strata, and shall now finish this part of the subject by noticing other, but less extensive, examples of ignigenous formations.

On leaving Whitberry Point, and proceeding in the direction of Dunbar, a vast extent of flat sandy beach completely hides, as far as Belhaven, all the subjacent rocks; at the confluence, however, of the Belton water and the sea,

* Dr Macknight, in the 2d volume of the Transactions of the Wernerian Natural History Society, has described this point under the name of "*Ravensheugh.*"

strata of sandstone, shale, and red calcareous ironstone, similar to those exposed at Whitberry Point, again appear, dipping S. S.E. at a small angle. At Wilkie Haugh a great mass of greenstone rises through the strata and traverses them in veins, which, in some instances, run a distinct course for several hundred yards. On examining these veins numerous masses of the various stratified rocks which they traverse are found completely enveloped, all of which are intensely indurated. Forming a mass imbedded in this greenstone, a body of trap-tufa, several yards in extent, is to be observed; it is composed of angular fragments of sandstone, slate, trap, and felspar porphyry, which are held together by a basis of red trap. The greenstone of this point is of the usual description, but as it approaches the sandstone it becomes highly charged with iron, which causes it to assume a reddish-brown colour. Cavities lined with crystals of amethyst and quartz occur in the trap; it is also traversed by numerous minute veins of calcareous spar, and in one place by two of sulphate of barytes, which vary from one to four inches in breadth. Proceeding along the shore in the direction of Dunbar, slightly inclined strata of sandstone, ironstone, and shale are exposed for a considerable way, lying under a deposit of a red trap-tufa of great thickness, which forms the sea-cliffs till within a short distance of the Castle. The tufa which occurs in such abundance in this part of the coast is composed of fragments of various trap-rocks, of sandstone, limestone, ironstone, and shale, all of which vary in size from the smallest magnitude to one or two feet, and are imbedded in a base of red wackaceous clay, which, in some instances, without containing the usual fragments, occurs for a considerable extent, and, throughout, exhibits a more or less stratified arrangement. The tufa is in some places traversed by veins of greenstone, but these afford no remarkable appearances.

A short distance from the coast, the hill of Knockinghair rises; it is composed of a highly ferruginous compact trap, and exhibits a structure which might at first be considered brecciated. On examination, however, this fragmentary appearance will be found to be only an instance of that original concretionary structure, which, in many instances, may with little difficulty be confounded with a rock of a true fragmentary nature. Numerous large and well defined crystals of basaltic hornblende are frequently to be found in the trap of Knockinghair.

Between the termination of the tufa, which forms the cliffs to the west of Dunbar, and the trap on which the castle is built, the shore is formed of sandstone, which dips to the E. S.E. at a small angle. At this point a mass of trap, which is known by the name of the Doo Rock, rises through the sandstone strata; it is in some places a basaltic or amygdaloidal greenstone, while in others it partakes of the tufaceous character. The strata with which this rock is in connection in some instances abutt against it, and in others sink below it. In several places great masses of the sandstone are enveloped in the trap, all of which are changed in their mineralogical characters, becoming either conchoidal hornstone or granular quartz-rock, and frequently acquiring a green colour, from an intimate commixture with the augite of the trap. At a short distance from this rock the trap of the Castle rises vertically through the strata of sandstone; the western part of this mass is composed of a red felspathose porphyritic greenstone, and, at the junction of the sandstone with the trap, and for the distance of several yards, the strata become intensely indurated, almost passing into jasper, and losing, to a considerable extent, the distinctness of the lines of stratification so apparent in other places. After rising through the sandstone the trap flows over it, and joins another mass of trap; the strata are slightly bent up by these

Plutonic rocks, and large portions are enveloped in them and indurated to a great extent. The trap deposit on which the Castle of Dunbar is built differs in different parts —in some places being composed of varieties of red basaltic greenstone, and in others of tufa; and in one place, where the sea has formed an arch, masses of indurated sandstone of many yards extent are entangled in the trap rock. Concerning the relations of the greenstone of the rock of Dunbar Castle to the tufa, we may state that, though in some places it appears of a newer formation, still a complete examination allows only the conclusion to be drawn, that the rocks of this point have been the result of igneous actions, which were not discontinued till all these masses were elaborated.*

Between this and Dunbar Harbour, sandstone strata occur arranged in the most irregular manner, dipping to various points, and in some places sinking under the trap of the Castle; they are here also broken through by another intrusive mass of greenstone, but their immediate modes of connection cannot be made out. At the harbour tufa occurs of the same description as that which we have already noticed, and is traversed by a rock which may be described as a very fine granular ferruginous felspathic greenstone, which, in some places, becomes porphyritic from containing minute crystals of felspar. The structure of this rock is beautifully prismatic, the columnar concretions being, in some instances, fifteen feet in length: they vary in the number of their sides; figures of three, five, and six sides are,

* The interesting geological phenomena which the castle rock of Dunbar exhibits can only be perfectly examined from a boat, and observers who desire to investigate this locality in detail, will find a correct guide in a map lately published by Mr J. Mason, Land-surveyor, Belhaven, and entitled "Plan of Dunbar Castle and Bay Rocks."

however, the most usual forms, and on decomposition, these columns appear to consist of globular concretions, regularly superimposed on each other. On examining this columnar rock at right angles to the axis of the prism, the globules exhibit an alternating series of layers of a very ferruginous trap, with others having a less quantity of iron disseminated through them, and separating the columns: there very generally occur veins of iron flint.

The late Dr M'Culloch, in his System of Geology, vol. i. p. 172, describes this rock as a sandstone rendered columnar by a slow refrigeration from a state of igneous fusion. In a theoretical point of view, this is an error of much importance, as it is awarding a changing power to igneous action, of greater magnitude than, in this instance, nature warrants us to do. The situation of this rock, erroneously described as columnar sandstone, is one which is the reverse of harmonizing with a metamorphosis on so gigantic a scale as exists in the altering of a stratified sandstone into one perfectly columnar. It is interposed between beds of trap-tufa, a rock which does not, in the generality of cases, appear to have been in so highly-heated a state as to change, to a great extent, the original structure of strata. In regard to its chemical composition, we may mention, that this is as incongruous with its being an altered sandstone, as are its mineralogical characters, all of which are too plain to allow it to be a subject on which two opinions can with propriety be held.* The only other trap rock which occurs on this shore appears about a mile to the south of Dunbar ; it is composed of greenstone, either compact or amygdaloidal, and is many yards broad. It contains numerous veins of calca-

* A rock having the same mineral characters as that of Dunbar, but amorphous, occurs at Usan, a fishing village near Montrose. It is associated with claystone amygdaloid.

reous par, and also, though very rarely, minute imbedded masses of amianthus. The strata of red sandstone, which are exposed on the shore between Dunbar and this point, dip in general at about 20° to the E. S.E.; but as they approach this dyke of trap they gradually pass into the white sandstone series, and progressively assume higher angles, till at last there is a complete reversion of position, and they dip to N. W. at 50° reposing on the greenstone. (Pl. XI. Sec. 2.) In the interior of the county of East Lothian, there are several other points where ignigenous rocks have intruded among the sandstone strata; few of these, however, exhibit any appearances which require a detailed description. By following a mountain rivulet, which rises in the Hill of Wightman, and joins Stonecleugh Water, near Stotancleugh, five dykes of ferruginous red greenstone cross vertically the conglomerate, which is inclined to the N. E. at 10°; these veins are all parallel the one with the other, and stand up in the form of walls, the strata in which they occur having been partially removed by the action of the atmosphere. In regard to the appearances which the conglomerate puts on, when in contact with the trap, they are not of a marked nature, induration being only recognizable in the fact of small portions of the conglomerate still adhering to the sides of the trap veins. (Pl. XII. Fig. 1.) If we consider, however, the coarseness of this conglomerate, and that it is held together so imperfectly, as to be liker shingle on a sea-beach than a rock of such antiquity, the want of induration may not be wondered at. In no place can there be a more conclusive evidence that the origin of greenstone and these stratified rocks is perfectly distinct; for, in this instance, a rock, bearing on its front all the characters which might be expected to occur, in a mass at one period in a state adequate for the crystalline arrangement of its components, rises through another, which, if it is not of as mechanical an origin as the most modern detritus, could not, if it were so, present any other suite of characters. Another point, where we have found a greenstone connected with the sandstone conglomerate, is on the side of the road, near the farm of the Brunt; there is, however, nothing in its relations different from those we have just mentioned. At Oldhamstocks also, a great dyke traverses the sandstone, appearing on both sides of the Stonecleugh burn, and also in its bed; no junctions of this rock with the sandstone are visible, and throughout its whole extent it presents only the characters of a basaltic greenstone.

Concerning the relations of the transition rocks to the unstratified masses, there are few points in the Lothians where we have noticed any thing interesting, and the comparative rarity of such rocks in this group is, in some degree, remarkable. The disturbed position of the secondary strata is, in general, referable to the presence of augitic or porphyry rocks: the numerous flexures, however, which are visible in the transition series, can, with few exceptions, be traced to visible masses of an eruptive nature. To explain this appearance is, in the existing state of our knowledge concerning the causes productive of mountain chains, a subject of no little difficulty; but it is not unlikely that the great high land of the south of Scotland has, as other chains, been elevated by actions of a more general nature (as far as the mass of the globe is concerned) than those which effect the protrusion of igneous rocks. It has been proposed to explain the marks of violence which are visible throughout mountain chains, by the influence of innumerable earthquakes acting along a given line, during a period of great duration. A geologist, however, who, without any preconceived notions or blind adherence to any theory, examines the structure of such chains as the transition range of the Lammermuirs will, when he finds strata extending through immense tracts of country fractured, and exhibiting flexures of great extent, observe little which he can consider similar to the effects of modern earthquakes. In the disturbances visible in mountain chains, we can only discover proofs of energetic actions which had not been subject to innumerable interruptions, but were, on the contrary, of comparatively short duration.

Forming a considerable part of the bed of the Fassney water, and also extending for a short distance down the Whitadder, after the confluence of the two streams, an unstratified rock occurs, exhibiting rather interesting characters. It is a highly crystalline aggregate of variously sized concretions of felspar and hornblende; black mica in some places occurs, but is to be considered more as an accidental mineral than a true constituent of the rock. The felspar which enters into the composition of this rock is in general of a flesh-red colour; at other times, however, it is white or grey, and then the rock can only be considered as an ordinary greenstone. The structure of this syenitic greenstone is in general tabular, but in some places it exhibits a globular arrangement; the decomposing influence of the atmosphere removing a softer and more easily disintegrated rock, in which are imbedded concretionary masses of a more compact and lasting variety. In several places, this syenitic greenstone makes a transition into compact felspar, and at the Keelstone pool it is traversed by a broad and apparently contemporaneous vein of brownish-red felspar. Veins of sulphate of barytes, associated with the green carbonate of copper and prismatic copper-glance, occur also in one or two places, but never of a size sufficient to be of importance in an economical point of view. Concerning the relations of this crystalline rock to the greywacke series, it is to be regretted, that the entire absence of sections at those points where the two rocks come into junction, prevents any change, either in mineralogical structure or position, from being observed; in one place only, the greywacke is found in the neighbourhood of the syenitic greenstone rock, and then, there is no greater appearance of alteration than is exhibited in other parts where no plutonic rocks are visible. It must, however, be stated that the strata abut against the ignigenous mass at about 75°, but in no instance is the syenitic rock found to alternate with the greywacke. The same covered state of this country, which renders the exact relations of these two rocks to each other impossible to be seen, causes also the topographical boundaries of both to be obscure. After minute examination, however, the crystalline rock of Fassney may be stated to be bounded by a line running along the lower part of the acclivity of Priestlaw Hill to Painshiel; it then runs along the foot of Dod Hill, to nearly opposite the old castle of Gamelshiel, when it bends with a circular direction to Mill-know; stretches along the foot of Spartleton Hill, and joins the southern line of its boundary at about half a mile to the west of Snailscleugh; and thus appears to form the lowest rock or basis of the Hills of Priestlaw, Spartleton, and Painshiel.* After the greenstone rock has disappeared in this stream, near the farm

* In Berwickshire a syenitic greenstone, similar to that of Fassney Water, forms the hill of Cockburn Law, and like it, is connected with the greywacke strata. The modes of its association here, however, are better exposed than in the Fassney, and in several places it may be found traversing the transition strata. The Syenitic Greenstone of Fassney

of Painshiel, rocks of greywacke are exposed, being arranged in more or less vertical strata. The greywacke varies in mineralogical character from a rock of which the compounds are distinct, to one homogeneous throughout; to determine the true nature of which, if all its relations were not distinctly seen, would be attended with no little difficulty. It has a very dark blackish-brown or bluish-grey colour, a conchoidal fracture, a slight translucency on the edges, and on being struck, emits a highly sonorous sound. Associated with these greywacke strata, near Bull's Leap, felspar occurs, containing a few acicular crystals of augite: it is conformable to the strata which are vertical, but its more immediate relations are not observable. Farther up the stream, and near the junction of the Kilpallet Burn with the Fassney, two dykes of felspar, in some places slightly porphyritic, cross the strata. (Pl. XII. Fig. 2.) On the eastern side of the first of these veins the strata dip to the north at about 80°, and on the western side, to the south, at the same angle. At the junction of these rocks, there are appearances the very reverse of induration, inasmuch as both the greywacke and the felspar are completely disintegrated. On advancing up the stream other two dykes present themselves, running parallel with the vertical strata; the first of these is a porphyry with a base of compact felspar, containing crystals of felspar,

Water is described, by Professor Playfair in his "Illustrations of the Huttonian Theory," as a "true granite." If, however, the term "granite" is meant to express a definite mineral aggregate, and is not applied in that vague and general manner in which it has become unfortunately fashionable to use it; the natural class to which the rock of Fassney belongs may easily be discovered. By paying little attention to the various marked characters and connexions of the true granites and syenites, the nature of many unstratified rocks has been misunderstood, and to the same inattention we may refer many of those inferences which have, in no inconsiderable degree, affected theoretical geology.

along with minute masses of quartz ; it is only visible *in situ* in the bed of the stream, but as numerous blocks are strewed over the surface of the adjacent hill, it is probable that this vein is related to the strata, both as a dyke which runs parallel to their direction, and also as an overlying mass. Near this, a rock of felspar containing crystals of augite appears, but there are no opportunities afforded for determining its relations. Felspar, both compact and porphyritic, occurs in many of the hills in this quarter, but its modes of connexion with the greywacke are in no instance ascertainable. In the hills of Redstone Rig and Newland, felspar rocks are met with, and at Kidlaw, a farm near the House of Newton, there are exposed two dykes of felspar, which traverse vertically the greywacke slate; and on proceeding up a stream, which runs from the hill of Middlemuir, the same strata are associated with a vesicular felspar, which is quarried and used for lining kilns, but nothing can be discovered in regard to the modes of its connexion with the strata. In the bed of a stream which runs past the farm of Newlands, a compact felspar is associated with the transition slate, on which horizontal strata of red sandstone conglomerate rest, a circumstance of importance, as it renders it highly probable that the eruption of the unstratified rocks connected with the greywacke has been anterior to the deposition of the secondary strata of this district. Near Fala, in a ravine which leads down from the hill of Pockbie, several veins of porphyry occur, associated with the vertical strata of greywacke. The basis of this porphyry is of a yellowish-red compact felspar, and contains numerous acicular crystals of a light green hornblende ; its associations with the strata are, however, in no instance interesting.

Concerning the relations of the unstratified rocks of West Lothian to the several strata with which they are connected, little appears worthy of a detailed description, and as the country is covered to a great extent with peat and alluvial matter, and is traversed by comparatively few large streams, satisfactory junctions of the igneous with the aqueous rocks are of unfrequent occurrence. In regard to the relative distribution of these rocks the greatest disorder exists, small deposits of the coal series appearing in many places completely isolated and enveloped in the ignigenous formations. The position of the strata is also of the most irregular description, since in one part they are found dipping to one point, and in another are disposed in the reverse, or lying in an apparently unaltered and horizontal state; in general, however, the angle of their inclination is, with few exceptions, far from high; a circumstance which can perhaps only be explained by supposing the greater part of the augitic rocks of this district, as a series of sheets of trap overlying the surfaces of the strata and at a distance from the eruptive openings. In regard to the points which may have been those of greatest disturbance, there are no certain indications. The hills which range from Bathgate to Borrowstownness, the Riccarton Hills, and the trap deposits of Corstorphin, Craigiehall Hill, and Mons, may, however, be considered with some probability as the more immediate centres of the trap eruptions. In describing the modes of connection of the trap of West Lothian with the strata, we will notice first the Bathgate Hills, and conclude with a detail of any remarkable phenomena observable at other points.

At the most southern part of this range of trap hills near the village of Kirkton, the quarrying of the limestone which forms a considerable portion of this district, has exposed several interesting phenomena in regard to its relations to the trap rocks. The general inclination of the limestone is to the N.W. In the old quarry of Kirkton, the surface rock is a greenstone which, in some places, partakes of the characters of basalt, and frequently evinces a tendency to the columnar arrangement; it rests in its course on different rocks in different parts of the quarry, in one part being directly superimposed on a fine slaty tufa, composed of a minute aggregation of wacke and trap sand, while in another it is in immediate connection with a thin bed of mountain-limestone which gradually wedges out at both extremities.* Below these thin strata of limestone, a thick bed of slaty green tufa occurs, resting through the whole extent of the quarry on the principal limestone stratum. (Plate XII. Fig. 3.) In regard to changes in mineral character, neither the tufa nor the limestone exhibit any thing marked; they are as compact at a distance from the greenstone, as when in immediate contact with it; they present however, numerous flexures, and in one or two places shifts have taken place in the limestone. Near the old quarry of Kirkton, and almost on the same line, another opening has been made, and there the same general arrangement is visible; the limestone, with its concomitant strata of slate-clay and ironstone, is surmounted by the same trap and green tufa, the latter of which is connected with the limestone in the most irregular manner. The mineral characters of this limestone differ in some degree from the other; it abounds in contemporaneous imbedded masses of hornstone, and alternates with strata composed of siliceous,

* To those who are inclined to consider the limestone of Kirkton as of fresh-water origin, from the statement of Dr Hibbert in the 13th volume of the Transactions of the Royal Society of Edinburgh, "that a decidedly fresh-water limestone is there exposed, which is characterized by the absence of all marine shells, coral, &c.;" we may mention, that the fact of its being so characterized is incorrect, inasmuch as we have found in it specimens of the Productus.

argillaceous, and calcareous layers, which exhibit, in regard to each other, a perfect parallelism. In position all the rocks afford evident marks of disturbance, they are waved and contorted in the most fantastic manner, these wavings varying from an extent which may be recognizable in a small specimen to an undulation of many yards. The limestone contains the usual plants of the coal series, and also fossilized wood.* On crossing the country from Kirkton, in the direction of Bathgate, the strata which are exposed in these quarries appear to be cut off by a mass of greenstone, against which, the limestone of Peter's Hill abuts, at an angle of 30°, apparently underlying a deposit of trap, which rises immediately above the town of Bathgate.

In the limestone of Peter's Hill, hornstone is abundant, forming contemporaneous masses; madrepores also abound,

* Having forwarded a specimen of the wood from this locality to Mr Nicol of Edinburgh, he very kindly offered to examine it, and after doing so, sent me the following description of its internal structure:—

"Dear Sir,—I have examined the specimen of fossil wood you discovered in the carboniferous limestone of Bathgate, and shall now give you the result.

"Externally the specimen is of a bluish-grey colour; when recently broken the fracture is greyish-black, but on being polished the bluish-grey colour returns. It is penetrated with veins of quartz and calcareous spar, and its hardness is such as to give fire, though faintly, when struck with steel. On inspecting the cross fracture, the ligneous structure, even without being polished, may be distinctly seen. When cut transversely into a thin slice the reticulated texture appears in the most perfect state of preservation, and more closely resembles that of the recent Araucaria than any other fossil I have hitherto met with. To see, however, the structure to advantage, it is necessary that the slice be moistened with water, for when dry its opacity is such as to render the structure very obscure. The longitudinal section parallel to a radius displays with great distinctness the araucarian polygonal discs arranged in single, double, triple, and quadruple rows, but, as in the cross section, to see these in perfection the slice must be penetrated with water, for when dry, even in the thinnest possible slice, the opacity is so great that scarcely a trace of them can any where be seen.—Yours, &c.

"Wm. Nicol."

and the productus is of very frequent occurrence. At Galla Braes, the limestone is penetrated by a large mass of earthy greenstone running parallel with the strata. Though the covered state of the quarry completely obscures the exact relations of these rocks; still, from the fact of the greenstone appearing only on one side of the quarry, it is probable that, if circumstances allowed a complete examination, it would be found to wedge out. From near Galla Braes to Mount Eerie, there is a very long and deep opening, exposing strata of clay, ironstone, sandstone, and limestone, dipping under a thick overlying mass of greenstone, and abutting against some trap cliffs, which occur at a few hundred yards distance. At the eastern extremity of this quarry, working operations have exposed the direct junction of the trap with the slate-clay, but there is no mark of alteration in position or structure; the slate-clay however assumes, to the distance of two feet from the trap, a yellowish-brown colour. On the side of the road leading from Mount Eerie to Bathgate, felspathose greenstone occurs intimately associated with fine granular slaty tufa, and contains imbedded masses of elastic mineral pitch. A short distance to the north of Mount Eerie, in the north and south Silver-Mine quarries, the strata of slate, ironstone, and limestone, are well exposed, but exhibit no junction with the trap rocks which cover them, and against which they abut. The limestone of these two quarries is of a dark bluish-grey colour; while that of Kirkton, Galla Braes, and Mount Eerie, is yellowish-grey, and passes into a black flint, which generally contains well preserved madrepores. Between the Silver Mine and Wardlaw, there are no openings which afford junctions of the stratified rocks with the greenstone; there, however, the trap is found connected with the limestone, both as a vein and also as an overlying mass; when in the latter mode of position it, in every instance, rests upon slate-clay, which is indurated to a considerable extent, but concerning the appearances which the limestone exhibits when in contact with the traversing mass of trap, the encumbered state of the surface prevents any determination. The only other quarry where the stratified rocks are well exposed, as regards their relations to the trap, is at Hill-house; the strata consist of slate-clay, sandstone, and limestone, and dip N. W. under the trap at 40°. None of the Neptunian rocks, however, when in contact with the Plutonic mass, afford altered appearances. The trap which reposes upon this series of strata is a beautifully columnar basalt, and becomes in some places porphyritic, from containing crystals of glassy felspar. The columns are regularly formed, and are arranged, in general, at right angles to the plane of the bed. In the neighbourhood of Linlithgow, the limestone is quarried at several openings, but can in no place be examined at its junction with the several trap rocks, which are invariably found overlying it. At the village of Winchburgh, there is a mass of trap which, in two places, is found in immediate contact with the strata; it is in general a greenstone of the common character, but in some places becomes syenitic; and is frequently globularly arranged, the concretions varying in size. Near the bridge which crosses the Canal, two dykes of greenstone occur, traversing the strata parallelly, and dipping to the north at about 25°, being separated from each other by several layers of slate-clay, which are indurated to a considerable extent, and assume the characters of a slate which is found in a similar situation at Lochend, near Edinburgh. At the line of junction with the trap, the strata exhibit wavings and other indications of violence, and are crossed by an infinity of rents or joints at right angles to the plane of the bed. On these dykes there reposes an extensive series of sandstone, slate, and ironstone, but there are no opportunities afforded for examining the connexions of the strata with the hanging side of the uppermost vein. (Plate XIII. Fig. 1.) The other opening where the Winchburgh trap rock is seen in contact with the sandstone, is in a field on the side of the road at Muiryhall (Plate XIII., Fig. 2.) ; it is highly satisfactory, and the quarrying operations have exposed the several relations of the rock in a manner sufficiently distinct. A mass of greenstone rises through the sandstone, and, on arriving at the surface, flows over it, forming an overlying body of variable thickness, and issuing from this mass, a minute vein runs a short course between the strata of sandstone, and decreases in thickness as the distance from the vein in which it originates increases. The characters which the several stratified rocks assume when next the unstratified, are here well displayed, but are precisely similar to those which may be remarked in almost every locality in the Lothians, where the two classes of rocks are found in contact or near connexion. The sandstone, as it approaches the greenstone, gradually assumes a compact structure, till at last it acquires such a degree of induration as to present the appearance of a granular quartz ; while the greenstone, as it approaches the sandstone, becomes felspathose. By following the Ecclesmachen burn from Niddry Castle, strata of sandstone are seen cropping out in several places, appearing to constitute the bottom of the valley, while the sides are composed of greenstones which rise into the eminences of Tar Hill, Craig, &c. At the village of Ecclesmachen, several inconsiderable strata of limestone are to be noticed in the bed of the stream, but though trap is in their immediate neighbourhood, there are no junctions exposed.

To the west of the house of East Binny, the picturesque rock of Binny Craig rises, presenting on this side a gentle acclivity, while its western side forms an almost mural front. It is connected with strata of slate clay, but exhibits no remarkable appearances. Near the inn of West Craigs several interesting phenomena were once exposed at the junction of greenstone with a bed of coal, which was completely changed into glance-coal;* at present however, the quarry where this appearance was observable is completely covered up, so that not even a specimen of the coal can be found to indicate its existence.

At Magdalenes, where the Union Canal crosses the road near Linlithgow, an earthy tufaceous greenstone occurs, containing numerous imbedded nodules of splendent glance-coal; it is frequently associated with calcareous spar, and in some instances, when the coal is less highly crystallized, a ligneous structure may be detected.

In addition to the points in Linlithgow which we have detailed, there does not appear another worthy of minute investigation.†

We shall now notice the matters which form an envelope of varying thickness to those ignigenous and aqueous mssses, the mutual relations of which we have just detailed. In

* This glance-coal was particularly examined and described to the Wernerian Society by Professor Jameson many years ago.

† The chemical composition of the rocks of the Lothians has been very partially examined; details connected with this department of science are, however, highly interesting, and when rock masses have become more generally analysed, results will, in all probability, be obtained which will bear on some of the more speculative parts of geology. The mineralogical and structural changes which the several stratified and unstratified rocks exhibit when in contact, are now investigated and generally understood, but to such junctions chemical analysis has, with few exceptions, been applied. We quote the following analysis of rocks of the coal formation from the 29th volume of the Edinburgh New Philosophical Journal. The rocks were selected by Professor Jameson, and the analysis entrusted

describing these deposits, geologists have, very generally, classed them under two heads, viz. Alluvium and Diluvium, and in this order we shall very shortly examine the several loosely aggregated masses which are met with in the Lothians.

The alluvial rocks which occur in this district may conveniently be considered as of three kinds, viz. those resulting from vegetable decomposition, and thus forming the modern analogue of coal, "*peat;*" those derived from the

by him to Dr Wm. Gregory who had them conducted under his own immediate superintendence by two of his pupils, viz. Mr John Drysdale, who analyzed Nos. 1, 2, 3, 4, and 5, and Mr J. Walker, who analyzed Nos. 6, 7, and 8.

1. Basaltic rock of Largo Law, in Fifeshire.

Silica,	45.2
Alumina,	14.4
Protoxide of Iron,	14.0
Lime,	12.7
Magnesia,	6.55
Soda,	5.22
Water,	2.4
	100.47

Edin. New Phil. Jour. xxix. p. 388.

2. Compact felspar from the Pentlands.

Silica,	73.5
Alumina, with a trace of Iron,	11.23
Carbonate of Lime,	2.5
Potash,	3.55
Soda,	3.8
Water,	4.6
	99.20

Edin. New Phil. Jour. xxix. p. 195.

3. Felspar rock, Wardie, near Newhaven.

Silica,	37.20
Alumina,	9.75
Iron,	20.00
Lime,	8.57
Magnesia,	3.78
Carbonic acid and Water,	20.80
	100.10

Edin. New Phil. Jour. xxix. p. 195.

4. Greenstone from Wardie, near Newhaven.

Silica,	44.00
Alumina,	11.4
Protoxide of Iron,	22.32
Lime,	8.8
Magnesia,	2.5
Water and Carbonic acid,	10.5
	99.52

Edin. New Phil. Jour. xxix. p. 195.

5.

decomposition of the subjacent rocks, and thus forming various kinds of *Soils* or *Earths*, and, finally, those pro-

5. Slate-clay from Wardie, Newhaven.

Silica, . .	60.00
Alumina, .	17.60
Oxide of Iron,	15.21
Lime, . .	2.36
Loss by Heat,	4.41
	99.58

Edin. New Phil. Jour. xxix. p. 195.

6. Unaltered slate-clay from Lochend.

Silica, .	58.22
Alumina, .	17.50
Protoxide of Iron,	10.53
Lime, . .	trace
Magnesia, .	4.62
Soda, .	2.02
Water, .	6.70
	99.59

Edin. New Phil. Jour. xxix. p. 387.

7. Altered slate-clay from Lochend.

Silica, . .	53.25
Alumina, .	17.56
Oxide of Iron,	8.64
Lime, .	6.62
Magnesia, .	2.70
Soda, . .	7.85
Water, .	2.23
	98.85

Edin. New Phil. Jour. xxix. p. 387.

8. Altered slate-clay from Salisbury Crags.

Silica, .	66.100
Alumina, .	19.5
Oxide of Iron,	trace
Lime, . .	6.4
Soda, . .	4.45
Water and Carbonic acid,	3.3
	99.65

Edin. New Phil. Jour. xxix. p. 387.

To the above we now add the early analysis of the late Dr Kennedy of Edinburgh :—

Analysis of the "Whin" (Greenstone) of Salisbury Crags by Robert Kennedy, M.D., F.R.S., F.A.S. Edin., Trans. of the Royal Soc. of Edin, vol. v. p. 90.

Silex, . .	96
Argil, . .	19
Oxide of Iron,	17
Lime, .	8
Moistures and other volcanic matters,	4
Soda about, .	3.5
Muriatic acid about,	1
	98.5

Sp. gr. 2.802.

Analysis of the "Whin" (Porphyry) of the Calton Hill by the same, vol. v. p. 92.

Silex, . .	50
Argil, . .	18.50.
Oxide of Iron,	16.75.
Carbonate of Lime,	3
Moisture and other volcanic matters,	5
Soda about .	4
Muriatic Acid about	1
	98.25

Sp. gr. 2.663,

duced by chemical actions. The peat which occurs in the Lothians exhibits nothing remarkable; its modes of position and other aspects being the same as those which characterize it in other districts. The untransported soils or earths are interesting, both in an economical and chemical point of view; and that their study is of great importance, even in a geological sense, is well exemplified in the Lothians, since in many parts it is, in a considerable degree, by reference to their characters that the nature of the subjacent rocks can be ascertained. The soil originating from the decomposition of the greywacke country has its characters; that derived from rocks of mountain limestone and sandstone has also each its peculiar and marked appearance, while that produced from the disintegration of the trap series has its own distinct aspect. Though, however, all these rock-formations produce a peculiar soil, still he who from experience has been able to form a conjecture as to the nature of the inferior rocks, by observing the soil which covers them, will find himself unable to impart the knowledge he is in possession of. Of the alluvial transported class of soils there are many varieties; all the valleys through which the rivers and streams flow being covered to a greater or less extent with rolled fragments and sands, derived from the decomposition of the rocks which they run over in their progress; those portions of the country also which form the coasts are to a greater or less extent covered by an alluvium, which is generally to be considered as resulting from the more or less direct action of the waves on those rocks which come under their influences. The banks of the Tyne, of the Esk, and of the Almond, afford deep sections of gravels, sands, and clays; and all the coasts, especially where they are level and not surrounded by mural cliffs, present wide extents of marine sands of unknown depth, portions of which, travelling by prevailing winds, encroach on the land and form sandy soils or links. Alluvium produced by chemical agents is, in the Lothians, comparatively rare, and that which does occur is, in every instance, a deposition from water charged with calcareous matter.

On the shore of East Lothian, near Thornton Loch, there is a considerable mass of calcareous tufa and sinter, incrusting the white sandstone. Near Tantallon Castle there is another example of a similar deposition, coating the rocks of trap tufa; and, in several places throughout the Lothians, the sands and gravels which occur on the banks of the rivers and sea-beaches are more or less consolidated by calcareous and ferruginous matter. The animal and vegetable remains which are found in the alluvium belong all to existing species; bones and antlers of the stag are frequently found, and several years ago an almost perfect skeleton was discovered on Sir A. Hepburn's estate of Smeaton, in Haddingtonshire. In regard to the vegetables imbedded in alluvium, we may state that trunks of trees, many of which are of great size, are to be found in every peat moss of any extent.

Of the deposits of the second class—the diluvium—there exists in the Lothians several examples, but the study of these does not allow us to draw many inferences in regard to the circumstances which effected their distribution. In this district little extent of country can be passed without numerous rolled masses of rocks occurring, which are not found *in situ*, but in distant localities; or, if the fixed rocks from which these are derived are met with in the neighbourhood, there appear at least to be no causes in action capable of reproducing such a distribution. On the coasts of Linlithgowshire and Mid-Lothian, in the valleys of the Pentlands and on their acclivities, on the flanks of the Lammermuir and Moorfoot range, we may easily detect rolled fragments of granite, syenite, greenstone, porphyry, mica-slate, gneiss, quartz-rock, and varieties of greywacke, which are met with only in the central districts of Scotland, while an examination of them shews, that they decrease both in magnitude and frequency of occurrence as we advance southwards, a fact indicating that the aqueous currents (for to such only can they be referred) diminished in intensity as they were removed from the more central parts of the island. Scattered around Edinburgh, numerous masses of trap-rocks are met with, which appear to be derived from no great distance.

Near Ratho, there are diluvial clays in which rolled fragments of greenstones, identical with those which occur *in situ*, in the neighbouring hills, are abundant. Superimposed on the limestone of Bathgate, and skirting the flanks of the hills, which range onward to Linlithgow, diluvial deposits of great thickness appear; none of these, however, as far as we have observed, contain masses of the primary rocks; indeed, it is probable that these clays have not been produced by the same current which distributed the numerous boulders of old rocks over the Lothians.

Of the diluvial class of clays and sands, the country around Edinburgh exhibits several interesting examples. A formation of sand and clay containing imbedded fragments of older rocks covers up the country around Newhaven and Leith, and extends as far as Joppa, in some places forming high mural cliffs. In East Lothian, a very thick deposit of diluvium may be observed, covering the rocky strata between the Dunglass and Bilsdean Burns, and consisting entirely of rolled fragments of the various rocks of the district, arranged in a more or less stratified manner: and near the Siccar Point, lofty sandstone cliffs are surmounted by a diluvial conglomerate, formed of rolled masses of the same description, compactly held together by a basis of calcareous sinter.

In several places around the coast of the Lothians, sands, a considerable number of feet above the level of the Firth of Forth, have been found, containing shells of species at present existing, and the position of these has been explained by supposing that there has, in this district, been, within a very modern epoch, an elevation of the land. That some of these deposits of existing shells are in situations relative to the sea, which its present level and other circumstances seem inadequate to place them in, we may at once affirm; but there certainly seems to be no reason why such appearances should be referred to a rising of the land, rather than to a local recession of the sea; and if we consider the estuarial character of the firth, perhaps the latter may be most likely.

In all countries composed of several distinct rock-formations, it is invariably found, that each one exhibits on the great scale a certain range of characters;—the hills have a peculiar form, the cliffs a certain style of fracture, the valleys a particular mode of grouping with other characteristic features. In the transition or greywacke range, which forms the southern highland of this district, there is, in the outline of the mountains, an appearance perfectly distinct from that presented by any other elevated country in the Lothians. When viewed from a distance, the hills have a gently undulating contour; all are more or less round backed, and are generally covered to the summit with vegetable soil; while, in some instances, by the disintegration of the strata, they are strewed with an infinity of masses of greywacke and slate, affording a barren and uninteresting surface of light grey rocks. The valleys in the transition country are in general of limited dimensions, and are almost universally traversed by a stream, the magnitude of which depends on the angle which the valley forms. If a stream is on the side of a mountain, it is in general narrow, and cuts through a valley which increases in breadth as it approaches the one, into which other mountain streams discharge themselves. In regard to their physiognomy, the secondary rocks of the Lothians present appearances distinct from those of the greywacke group. The red sandstone, which is the oldest member of the secondary system of the Lothians, rises, at the western extremity of the Pentlands, and in the eastern part of the Lammermuirs, into mountain masses, of a table-shaped or round-backed form, and has, with the exception of some of the porphyry hills, an elevation next to that of the transition strata. In the conglomerate districts, the valleys through which rivers flow are almost entirely destitute of soil, and present a more or less extensive deposit of the rolled blocks which enter into their composition. The country formed of the white sandstone series, when viewed generally, affords a considerable contrast to that of the red; when it is not visibly affected by the ignigenous masses, with which it is so generally connected, its surface is that of a very gently undulating line, the depressions being trivial. At the western part of the Lothian coal-series, this comparatively level position is reversed, inasmuch as the white sandstone rises there, in the hills of Leaven Seat, Woodmuir Height, and Muldrondrum, to the heights of 1164 and 1106 feet.

The two great classes of unstratified masses which occur in the Lothians, exhibit, in a marked manner, the aspect which characterises them in other districts. The hills formed of the porphyry or felspathic class, differ from the other mountainous parts of the Lothians, in the fact of the eminences which are composed of this series approaching more or less to the conical shape; there are felspar mountains, however, having the round-backed form, but generally, it may be stated that they present an outline more or less acute. The trap series also affords those well marked characters of form, which have from their almost universal occurrence, awarded this descriptive title to the group. Large extended and more or less parallel ridges of dark-grey rock, having a face in general approaching to vertical, often perfectly or rudely columnar, and separated from each other by a slope covered with debris or vegetable soil, constitute the general aspect of a trap hill. In the trap valleys, also, there is a system of characteristic forms: they are most frequently of inconsiderable dimensions, and appear, in the generality of cases, to present no indications of any formation but one synchronous with that of the trap deposit in which they form depressions. They are almost always irregular in their levels, and not sufficiently extensive to be traversed by any bodies of water, which in size deserve to be raised to a higher rank than that of streams or rivulets, and it is from this circumstance that the lower parts of the trap valleys are frequently more or less in a marshy state.

Concerning the topographical distribution of the several formations which constitute the Lothians, the highly covered state of the country prevents us from being able to assign to each minute lines of boundary. The bounding line of the transition strata with the secondary deposits which skirt them, is somewhat irregular: it may be stated, however, that in Haddingtonshire, no rocks of this group occur to the east of a line running almost north and south through Crichness, Kist Hill, Dod, Watchlaw, and East Heartside; a little to the north of this, the line assumes, at the farm of

Pathhead, a westerly direction, and runs thus as far as Duchrie Dod, a hill near Presmennan. From the Dod hill of Duchrie, the greywacke country is then bounded by a line running N. E. and S. W. near Stoney Path, Castle Moffat, Ryestubble, and Danskin. After leaving Danskin, the boundary line assumes an east and westerly direction, passing near Quarryford Mill, Bog Hall, Cairny Haugh, and Newton Hall, when it turns to the S. W. running through Stob Shiels, Blegbie, Keith Hill, Pockbie, and Soutra Mains. In Mid-Lothian there is hardly any irregularity in the direction of the line which separates the transition from the secondary rocks; indeed, it may be said to stretch with little variation directly W. S., the hills of Cakemuir, Fala Hill, Ruther Law, Wullmuir, Turtichen, Huntly, and Mausely, forming a well defined boundary. In regard to the distribution of the secondary formations, they form, with the exception of numerous detached masses of trap rock, and the felspathic range of the Pentlands, the whole of the three Lothians, unoccupied by the transition series. In East Lothian a formation of red sandstone and variously coloured shales, forms a great extent of undulating country; this deposit, however, exhibits no exact line of boundary, as it passes always by an insensible gradation into the regular coal-formation. We may, however, affirm that by drawing a line from Cockburnspath through Thornton and Oxwellmains to Broxburn, we indicate, in a sufficiently exact manner, the district in which the transition of the one series of sandstone into the other takes place. Dunbar, the course of the Tyne from its confluence with the sea to Preston Kirk, Sunnyside, Pople, and Whitelaw Hill, may be stated as chief points, between which and the transition strata no other rocks but those of the red sandstone series occur.

The northern boundary of the red sandstone formation in East Lothian, after this, becomes more obscure, from the circumstance of a transition taking place into the white sandstone series: the line of gradation appears to run S. W. near Salton, Keith village, and Costerton, till at last in Mid-Lothian it is terminated by a very ill defined boundary, running more or less south from Crichton Dean to the base of the greywacke hills. On the sea coast, extending from Whitberry Point to Weaklaw, several minute masses of red sandstone appear, all of which are generally associated with rocks of igneous formation.

In Edinburghshire and Lanarkshire, red sandstone forms a considerable portion of the western division of the Pentland range. As in East Lothian, the northern boundary cannot be recognised, but the most natural line of distinction appears to be that, where the transition of the one formation into the other has been completed; and this line seems to run more or less in the neighbourhood of Wark Hill, Harlaw, Upper Buteland, Harper Rig, Easter Cairns, Wester Colzium, and Crosswood. The westerly part of the red sandstone may be said to be bounded by the felspar rocks of Black Hill, West Kip Hill, and Spittal Hill, while on the south it runs parallel with the new line of road from Nine Mile Burn to West Linton. Mountain limestone occurs in numerous points in the Lothians, forming bands which cross the country in different directions, and of these the most extensive is that which in Mid-Lothian skirts the base of the Moorfoot range. The most western point in Edinburghshire where this formation is exposed, is in the Hieflat quarry near Howgate; to the west of this, however, it is worked extensively at Rutherford and the Bents in Peeblesshire. Crossing the country in a north-easterly direction, mountain limestone forms much of high ground, running from Arniston to the neighbourhood of Tranent, and may be examined in numerous openings with facility.

At Crichton Dean, near the village of Fala, limestone is extensively worked; the same belt also crops out at the village of Salton and at the farm of Jerusalem, and several miles to the south a similar rock is quarried at Kidlaw, a point on the immediate confines of the greywacke strata. At Sunnyside a farm near Traprainlaw, a considerable deposit of limestone appears connected with the red sandstone series, and associated with trap rocks. Limestone again occurs near Balgone, forming, in all likelihood, a portion of that fetid limestone deposit which is worked at Rhodes, near North Berwick. Interstratified with the white sandstone which forms the coast of East Lothian from Broxburn to the Cove shore, there occur several strata of mountain limestone: the points where it is best seen are at Laurie's Den, Barness Point, and a little to the south of St Dennis' Chapel. To the north of the calcareous formation which we have described as forming a considerable extent of country, and skirting the base of the Moorfoot Hills, limestone has been extensively worked at the village of Burdie House, and can be traced to the neighbourhood of Gilmerton, where it disappears under the white sandstone. Near Tranent limestone is met with in one or two places; and it crops out also at several points on the shore between Aberlady and Red House.

In Linlithgowshire, though the great abundance of trap rocks, and the covered state of the surface, render the tracing of strata a matter of no small difficulty, and in many cases one of impossibility, still one band of limestone is found crossing the country in a N. N. E. and S. S. W. direction, in a well marked manner. The most southern point in the county where this limestone is visible is at

Blackburn, and around Bathgate it is completely exposed by the extensive workings of Kirkton, Petershill, Galla Braes, North and South Silver Mines, Wardlaw, and Hill House. In the neighbourhood of Linlithgow the limestone appears again at Bowden and Carruthers, and terminates in the sea near Borrowstownness. Near Dechmont Law, at Kirkliston, Newton, and Port Edgar, quarrying operations have exposed several other limestones, all of which are probably more or less connected. Concerning the distribution of the white sandstone series, little need be said, since, if we except the various ignigenous masses, it forms all that portion of the Lothians which is not occupied by the three formations, the boundaries of which we have endeavoured to assign. In regard to the localities of the igneous rocks of the Lothians, nothing here requires to be noticed, as these have been already detailed with sufficient minuteness, when considering their associations with the Neptunian strata.

We have given a more or less particular relation of the geognostical structure of the three Lothians, and shall now, by a short description, connect it with those parts of the county of Fife, which form the northern coast of the Firth of Forth.

The strata which are met with in Fifeshire may be referred to three series, viz. the red sandstone, the mountain limestone, and the white or carboniferous sandstone; all of which, however, in their modes of relative association, are precisely similar to the secondary stratified system of the Lothians. The lowest member of the stratified series of Fife is, as in the counties of Haddington and Edinburgh, the red sandstone; it passes insensibly into the white sandstone, with which it alternates both on the large and small scale. The mountain limestone is, it is needless to state, not a formation situated between the red and white sandstone systems, but, on the contrary, exists only as a subordinate alternating rock. Partial examination of this system may lead some into error, as a similar mode of investigating the structure of the Lothians and other districts has done; but thorough scrutiny will convince, that the sandstones and limestones of Fife constitute a group which cannot be geologically subdivided. The origin of all its members has been strictly contemporaneous, and the causes which have produced these strata, have, from their commencement to their termination, been of the same general nature.* As points where the connection of the red with the white sandstone can be well observed, we may notice, the sea-coast extending between Dysart and Wemyss, and that which stretches from Crail to Fifeness; the course of the river Eden, also, and the country in its immediate neighbourhood, exhibit, in a clear manner, the relations of the two series to each other. The ignigenous masses which rise through the stratified rocks of Fife, are of the same general description as those which occur in the Lothians, inasmuch as they consist of various porphyries, greenstones, basalts, and tufas, and the changes which these have produced on the Neptunian rocks with which they are associated, are in numerous places of a highly interesting nature.

* In their organic contents, the rocks of Fifeshire are highly important, and deserve, as those of the Lothians, diligent and minute examination. The coal mines of this quarter also afford to the geologist much that is interesting in the economical department of the science. These subjects at present we do not intend to investigate, but on a future occasion we hope to lay before the Wernerian Natural History Society, a somewhat detailed account of the mines in the coal-field of Fife and the Lothians, and also a more or less perfect list of the vegetable and animal relics found in the several strata of these districts.

We shall now describe the geological phenomena which are to be observed on that part of the coast of Fifeshire which lies immediately opposite to the county of Edinburgh. It is one of the interesting tracts annually visited and explained to his pupils by Professor Jameson.

The North Queensferry is situated on a promontory composed almost entirely of greenstone, the felspar of which sometimes becomes of a brick-red colour, and occurs in a quantity sufficient to produce the syenitic aspect. In structure, it very generally exhibits the globular concretionary arrangement; the concretions varying in size from an inch in diameter, to an irregularly formed mass of several feet in length and breadth. On the road between the North Ferry and Inverkeithing there are several fine displays of this structure, and the atmospherical agents having acted on the softer and more easily decomposed base of greenstone, cause the globular masses to stand out in strong relief. Contemporaneous veins of greenstone traverse in considerable numbers indiscriminately the globular concretions and the bases in which they are imbedded. Veins of calcareous spar also occur: these, however, never cross the globular concretions of greenstone. In regard to the connexion of this body of trap with the sandstone, there are no intimate relations exhibited; near the toll-house between Inverkeithing and the Ferry, sandstone strata, dipping N. N.W. at 20°, are visible in a small bay which is entirely surrounded by trap. On proceeding along the shore from Inverkeithing to St David's, a junction of the greenstone with the slate-clay and bituminous shale has been exposed in searching for coal; no induration is, however, evinced, but, on the contrary, the strata appear to have a greater tendency to decomposition when near the trap than in those parts farther removed from it.

Near the point which constitutes the eastern boundary of Inverkeithing bay, a tufa occurs which forms mural sea-cliffs for a considerable way, and in some parts differs in character from those tufas which are so frequently met with associated with the trap rocks of the Lothians. It is composed very generally of a yellowish-white claystone felspar, in which variously shaped and sized masses of felspar, greenstone, bituminous shale, and sandstone, are imbedded, and passes into a tufa, of which the basis is an earthy greenstone, containing greenstone fragments which are sometimes amygdaloidal. Throughout the whole extent of this tufa there are indications of a more or less perfectly bedded structure, the separations into strata being produced by a change in the size of the imbedded fragments. The connexion of the sandstone with the tufa is in two places exposed : at one of these, which is near St David's, it exhibits numerous marks of derangement ; and a series of strata, consisting of alternations of blackish and white slaty sandstone, which is shifted in one place for several inches, is thrust up amongst a completely compact white sandstone.

The other point where the junction of the two rocks is visible, is at the eastern extremity of the tufaceous mass ; there, a vertical stratum of sandstone, several yards in height, by about three feet in breadth, is completely enveloped in it, standing out from the strata of tufa which, on both sides of it, have a westerly inclination. In regard to position and structure, there are appearances in both which indicate, that in the tufa there had been a cause adequate for displacement, and also for producing a change in mineral structure; for masses of the sandstone are bent amongst the tufa, and, as sandstones in contact with the more crystalline trap aggregates, become intensely indurated, and make the usual transition into quartz rock.

From this junction of the sandstone with the tufa to

Downing Point, there occurs only an uninteresting similarity of trap; it rests upon a thin series of strata of sandstone, but their more intimate relations are, as is generally the case in this part of the coast, much obscured by a thick covering of debris and vegetable soil;—the sandstone abuts, however, against the trap of the Point. On the shore opposite the House of Dunibristle, the strata change their W. N.W. dip, for one to the E. S.E., and continue to plunge in this direction as far as the old church of Dalgety, where, after lying for a short distance in an undulatory horizontal position, they are again found to sink to the W. N.W., inclosing a parallel vein of greenstone, and abutting against the trap hill of Braefoot. On the east side of Braefoot strata of white sandstone are met with, having the same inclination, and continue to form the shore as far as Aberdour, a little to the west of which two dykes of trap occur, one of which appears to have risen through the strata and tilted them up on both sides.

At Aberdour, on the western side of the harbour, a greenstone cliff exhibits phenomena of a most satisfactory nature in regard to its connexion with Neptunian rocks. (Plate XIV.) The lowest visible rock on which the trap rests is a white sandstone, which is exposed only for a few feet, and is separated from another stratum of sandstone by a mass of greenstone about two feet in breadth; this second mass presents in one part a slight flexure, and, as all the other masses included in this cliff of trap, gradually thins out at its western extremity. Above these two included portions of sandstone another one occurs, and also three imbedded fragments of shale; they vary in breadth from half a foot to the most delicate thread, and are completely changed in character; the sandstone becoming quartzose, and the shales assuming a compact structure. On the other side of the harbour the same arrangement is visible; the sandstone again appears underneath the greenstone, and at the junction, and for a considerable distance from it, completely changes it into a characteristic hornstone. The greenstone which overlies these sandstone strata runs boldly into the sea, presenting vertical cliffs. On their eastern side the sandstone strata are again met with dipping to the N. N.E. at about 18°, almost throughout their whole extent altered, and presenting characters little differing from those exhibited by the quartz rocks of primitive districts. The strata between this point and Burntisland afford nothing deserving detail; as sandstone, which dips in general to the north, forms, with the exception of one or two greenstone masses, the whole of the exposed rocks on the shore. On advancing into the interior of the country, there is a continuation of the same general system of rocks as is visible on the shore. The Bin Hill rises immediately to the north of Burntisland, and exposes at its base, and for a considerable way up its acclivity, strata of white sandstone and limestone. The rock which forms the principal mass of the Bin Hill, is a coarse and easily disintegrated tufa, composed of variously sized masses of trap rocks, limestone, shale, and sandstone, imbedded in a base of earthy trap, and is traversed in one part by a dyke of basalt, containing numerous crystals of glassy felspar, and exhibiting an imperfectly columnar structure. Natrolite is found in the tufa in the form of imbedded amygdaloidal concretions. On the east side of the Bin Hill the same series of strata appears which is seen on the west, all dipping to the E. N.E. Basalt occurs, forming a vein running parallel with these, but the covered strata of the country prevents its relation to the sandstone or tufa from being made out. On advancing along the shore in the direction of Pettycur, no rocks are observed for a considerable way, the coast being entirely formed of a flat sandy beach. Near Whinny-hall, however, and a short distance from the shore, a range of greenstone cliffs exhibits some interesting appearances;—the trap rises through the slate and sandstone strata, and from the lower side of an overlying portion, a mass of greenstone issues. All the strata, when in contact with the plutonic rock, are highly indurated, the slates acquiring the compactness of jasper and Lydian stone, and the sandstone passing into granular quartz-rock. Masses also of the slate are entangled in the greenstone, some of which are so changed as almost to put on the appearance of striped Siberian jasper. In their position these slates evince much disturbance, and are convoluted to a considerable distance from the greenstone. (Plate XV., Fig. 1.) Near this, the extensive opening of Whinny Brae quarry has exposed some interesting phenomena. The strata are alternations of sandstone, limestone, slate-clay, bituminous shale, and clay-ironstone, with an included parallel vein of claystone, all of which sink to the E. N.E. at an angle of 25°. In their course the rocks exhibit two gentle undulations, and are shifted in one place to a considerable extent. Near the eastern extremity of the claystone, the mean breadth of which does not appear to be more than three feet, a vein of about a foot in breadth issues from its under surface; it crosses the shale strata at an angle of about 70°, and is probably connected with a lower mass of felspar, which the quarrying operations have exposed. In regard to the effects of this claystone on the strata, they are completely demonstrative of its violent protrusion and former highly heated state. Masses of the shale are imbedded in it in innumerable places, and it is traversed near the junction by an infinity of small felspar veins. In some places the slate appears to have been fractured into minute fragments, which have been subsequently agglutinated by the infusion of the felspar; and in other parts masses of the shale are bent up amongst the felspar, and made to assume the form of a vein; the structure is also completely changed, inasmuch as the perfectly fissile slate-clay assumes a hardness which, in some parts, is little inferior to that of Lydian stone. (Plate XV. Fig 2.)

Alexander's Craig, which forms a high traprange near this, is composed of irregular alternations of tufa and amygdaloid, surmounted by a range of an imperfectly prismatic basalt, which reposes on thin strata of slate-clay, ironstone, and sandstone; in one part it is in immediate contact with a bed of coal, a portion of which is entangled in the basalt and completely charred. Veins of fibrous calcareous spar abound, traversing both the tufa and the strata. From Alexander's Craig to Pettycur, the rocks are entirely composed of amygdaloid with tufa, in which numerous variously sized masses of slate are imbedded. Calcareous spar occurs in great quantities, forming large veins and amygdaloidal masses in the greenstone, and is in some places associated with groups of amethyst and quartz crystals. On the shore at Pettycur, the amygdaloid reposes immediately on much indurated strata of mountain limestone; and, at one point, both rocks have been shifted for several feet. Superimposed on the amygdaloid which lies on the limestone, there rests a thin series of ironstone and shale strata, above which amygdaloid again occurs. Immediately below the inn of Pettycur, there begins an alternating series of sandstone, limestone, shale, basalt, amygdaloid, greenstone, tufa, and wacke; all these rocks dip to the east, and continue with little interruption till within a short distance of Kirkaldy. Though the alternations of the neptunian and plutonic rocks are so numerous, still there are only a few places where their connections exhibit any thing interesting, and with a detail of two of the most conspicuous of these we shall conclude this short account of the southern coast of Fife. The first object of interest to be observed in proceeding along the coast, is at a short distance to the east of the village of Kinghorn, where a stratum of white sandstone is completely enveloped in the greenstone. It varies in breadth in different places, and in those parts which are thinnest becomes completely changed into quartz rock, while in the others there is a gradual transition made from a quartz rock at the junction with the trap, to a sandstone, forming the more central parts of the stratum. It exhibits a slightly undulating position, and splits easily into irregularly-shaped masses, in a direction more or less at right angles to the plane of the bed. The other point where interesting phenomena are displayed is at Tyrie Bleachfield, a point almost at the extremity of this series of rocks. Here a mass of greenstone, presenting the ordinary character, occurs, and having the same N. E. dip as the other rocks of the coast; it rests in one part on thin strata of black slaty sandstone, and in another on a white sandstone. Lying immediately below the white sandstone, and in contact with it, a vein of claystone-felspar appears, identical with that of Whinny Brae quarry; it traverses strata of black slaty sandstone and shale, and finally is seen to thin out between them and a stratum of white sandstone, inferior to that upon which the overlying greenstone mass rests. In its course, this vein of felspar gives off minute veins, and is also shifted in two places, a proof in addition to that which the Whinny Brae quarry exhibits, that disturbing influences had operated after the eruption and consolidation of these igneous rocks. Below the lowest series of black slaty sandstone and shale strata, a bed of limestone occurs, resting on one of coal, and the group of sandstone strata which forms the lowest of the rocks visible in this section. (Plate XVI.)

From this point to Kirkaldy, a flat sandy beach completely covers the subjacent rocks; to the east of the town, however, the sandstone-slate and shale again appear, and continue onwards for a long way.

In the more central parts of Fife, there are numerous points where the relations of the trap-rocks to the neptunian strata are interesting, and we shall conclude with a notice of the geological appearances exhibited in the Lomond hills. The Lomond hills consist of three eminences, Easter, Wester, and Mid Lomond, the two first rising to the heights of 1466 and 1721 feet. When viewed from a distance, these hills might, from their external appearance, be considered as entirely composed of trap-rocks; on examining them, however, it is found that a very considerable portion consists of the coal sandstone, and on the north side of the Wester and Mid Lomonds, a section, extending from the foot almost to the summit of the hills, exposes their structure in the most satisfactory manner. Red sandstone dipping S. W. at 8°, is the lowest rock visible, and forms the most of that comparatively level country which skirts their northern base, being succeeded by the coal series of white sandstone, slate-clay, and clay-ironstone, which is surmounted by the great overlying trap deposit of the hills. Wester Lomond rises immediately above Loch Leven, and presents a front of more or less regularly columnar trap. In several places the quarrying of the sandstone, for the purpose of building, has exposed immediate junctions of the two classes of rocks; but in no instance do the strata afford appearances of induration: near their contact with the greenstone, however, they in some places occur in positions which can only be considered as disturbed.

On crossing the trap ridge of Wester Lomond, horizontal strata of mountain limestone are found resting upon it. Quarrying operations have not as yet exposed the greenstone on which this limestone reposes, but its aspect throughout its whole visible extent is a sufficient proof that it has been influenced in no inconsiderable degree by the agency of the trap. The smooth conchoidal fracture, the earthy appearance, and uncrystalline arrangement, of the mountain limestone have all been removed, and a rock produced which in many places, is perfectly crystalline in its structure, and of various shades of grey and white. The usual corals and madrepores occur in this limestone, and, in their states of preservation, vary from one, which in the rock when little altered, is almost perfect, to that more or less obliterated appearance which they present when found in the completely altered limestone.

The trap forming the range of Wester Lomond, is a greenstone which varies from large to small granular; it is in general arranged in concretions having a tendency to the prismatic form; but, in some places, it displays, in the most marked manner, the globular appearance. Mid-Lomond, as we have before stated, is, in its lower part, composed of sandstone strata, and in the upper of trap. Induration is, however, in no instance to be observed. On the side of the valley which separates this hill from Wester Lomond the trap may be found alternating several times with the sandstone; the state of the surface, however, prevents us from examining the appearances exhibited at the junction of the two classes of rock. The trap-rock which forms the lower parts of Mid-Lomond, is an ordinary greenstone with somewhat of a prismatic structure; the summit, however, and a considerable part of the southern acclivity, is entirely composed of a well characterized greyish-black basalt, which is in one or two places arranged in an irregularly tabular manner. The structure of Easter Lomond is precisely similar to that of the two hills we have just described, and in no place are there any appearances which render a detailed description necessary. Throughout the whole extent of this highly picturesque and beautiful range of trap hills, no point can be fixed on as one through which the igneous matters which alternate with and cover the sandstones have been erupted : the almost perfect horizontality of the strata is, however, a sufficient indication that these trap-rocks are to be considered more or less as portions of plutonic streams, which, on being erupted, have flowed over horizontal surfaces. Separating the hills of Wester and Mid Lomond, there is a ravine which is interesting, inasmuch as it has evidently been produced by a great rent running through the parallel and horizontal beds of aqueous and igneous rocks, which form these hills: no one, however, when viewing them, and observing the perfect agreement of the beds of the one hill with those of the other, can ever consider this ravine as original, nor can any one, with any degree of propriety, refer it to the action of the rivulet. When describing the trap-rocks in the vicinity of Edinburgh, we have remarked that they, as well as the strata on which they repose, frequently present abrupt and broken fronts : of this the Lomond hills on their northern side exhibit an excellent example; and the horizontality of the beds renders it probable that this aspect has been produced contemporaneously with the protrusion of the ignigenous masses.

We have now described at considerable length the geology of the Lothians, having endeavoured to notice every locality which in our investigations appeared worthy of detail, and every rock which afforded to us any thing interesting, either in regard to its mineral characters or mode of connexion with others. Notwithstanding that an observer spends much time in investigating a given tract, and pursues his labour with much alacrity and diligence, still when he has completed his survey, though he has travelled through the country in every direction, having climbed its mountains and perambulated its valleys, coasts, and streams, some points, perhaps, even of considerable interest, may have been passed over by him unobserved. Aware of this, however, we sincerely hope, that though geologists, in examining the district which we have been considering, may find appearances which we have not described, they will not, when comparing our descriptions with phenomena in the field, discover that in any instance we have misunderstood what we saw. Throughout the whole of this paper, we have endeavoured to state, in the most concise manner, what we considered requisite to notice, doing this from a conviction, that in writing upon natural appearances, a multiplication of words is to be particularly guarded against. In conclusion we may only remark, that if we have endeavoured to advocate doctrines considered as erroneous by some observers of celebrity, and have differed from others in descriptive details, we have in the one case done so from no love of disputation, and in the other, from only finding in the district which we have examined appearances which seemed to us capable of being only seen in one way.

APPENDIX I.

SIR JAMES HALL'S EXPERIMENTS.

When describing the relations of the trap-rocks of the Lothians to the Neptunian strata, we have casually remarked, that it was from an examination of them that Dr Hutton first formed those theoretical opinions concerning their mode of formation, which are now universally adopted by the cultivators of geological science. From Salisbury Crags, Arthur Seat, and numerous other points in the district of the Lothians, that ingenious philosopher and acute observer drew conclusions in regard to the past history of the world which, even on their first proposal, were adopted by many, and zealously defended by not a few. In the present advanced state of geology, it may appear to some that the several phenomena which Dr Hutton first pointed out in regard to the trap-rocks, and the appearances which the individuals of the stratified systems exhibited, when near them, were of so clear a nature, that they could be explained only in one way; but it must be remembered that the plutonic origin which he awarded to the trap-rocks, and the changed state in which he said certain strata existed, were as yet to be considered as theoretical, and could not be proved by direct experiment. Compression under water or solid strata had been stated to be a cause sufficient for the production of a crystalline structure in masses cooling down from an original state of igneous fusion, but the chemist had not as yet demonstrated this by making a homogeneous vitreous mass acquire a granular arrangement.

If Hutton, however, proposed the theory of the unstratified rocks, it was left for Sir James Hall to establish its truth, by a series of original experiments which will make his name ever be respected by the scientific world, and ever have a prominent place in the page of geological history. To this distinguished examiner, the crystalline structure of granite, porphyry, and trap, appeared at first to contradict the hypothesis of Dr Hutton; but the experiments which he made with such success, convinced him that the effects of compression were of a gigantic character, and that differences in it might account for the dissimilarity of aspect which exists between a trap or a Plutonic rock, and a lava or a Volcanic rock As the experiments of Sir James Hall on "Whinstone" (Trans. of Royal Society of Edin. v. 5.) were made on several well known rocks in the neighbourhood of Edinburgh, which we have already described, we shall briefly extract, from his paper in the Transactions of the Royal Society, a few particulars in regard to this interesting subject.

The first trap-rock which was examined was the greenstone of Bell's Mills, a point which, in its proper place, we have already noticed. A black-lead crucible filled with fragments of this stone was introduced into the reverberating furnace of an iron foundry; having remained there a quarter of an hour, the greenstone became completely fused and was agitated with a violent ebullition, and on being removed from the furnace and allowed to cool rapidly, was found to have lost its crystalline arrangement, and to have assumed a vitreous aspect. It was thus found that fused greenstone when quickly cooled has not a granular structure.

In subsequent experiments, Sir James Hall endeavoured, by slow and gradual cooling, to cause the trap to assume its original characters. The first attempts which were made to effect this object were only partially successful; the product of the slow refrigeration was not in a vitreous state, but still it had not the crystalline appearance of the whinstone; sometimes it had a liver-like appearance, and at others was a dull vitreous mass, containing innumerable little spheroids and having a dull earthy fracture; at last, however, Sir James succeeded completely in the object which he had in view. A crucible, containing melted greenstone, was removed from the reverberatory, placed in a large open fire, and surrounded with burning coals. The fire "after being maintained for several hours was allowed to go out, and the crucible when cold was broken, and was found to contain a substance differing in all respects from glass, and in texture completely resembling whinstone. Its fracture was rough, stony, and crystalline; and a number of shining facettes were interspersed through the whole mass. The crystallization was still more apparent in cavities produced by air bubbles, the internal surface of which was lined with distinct crystals."—P. 48. The fragments of greenstone, however, which had been thus artificially crystallized had not been previously reduced to the state of glass, and therefore the experiment might be liable to rejection as inconclusive by those who advocated Neptunian principles. To obviate this, however, Sir James Hall determined, on the suggestion of Dr Hope, the Professor of Chemistry, to "reduce the stone first to glass, and to perform the crystallization after the second fusion."

We shall now notice the results which were obtained. The greenstone of Bell's Mills was fused and quickly cooled into a black glass, as in former experiments; "a crucible, filled with fragments of this glass, being then exposed to a heat, which from previous trials was judged to be more than sufficient to reduce its contents to fusion, the fire was very gradually lowered till all was cold."—P. 49. On the crucible being examined, Sir James was in no small degree surprised to find that "the fragments had never been in complete fusion, since they still, in a great measure, retained their original shape."

In another experiment the trap-glass was completely fused, the temperature of the fire was reduced to about 28° of Wedgwood's pyrometer, and allowed to remain so for six hours. "The result was a perfectly solid mass, crystallized to a certain depth from the outside, though still vitreous in the heart;" a similar mass of glass, however, being experimented on in the same manner, but being subjected to the heat for twelve hours, was on its consolidation "entirely crystalline and stony throughout."

On investigating the fusibility of the glass obtained by melting the greenstone of Bell's Mills, from experiment it occurred to Sir James Hall, that the fact of the trap-glass not thoroughly fusing on a former occasion, was to be explained by supposing that, on the first application of heat, it had partially softened, and then had crystallized so as to become again rigid, and that in the crystallizing process, "it had acquired such infusibility as to yield to no heat under 30°."

We shall quote from Sir James Hall's paper the experiment by which he confirmed this conjecture. "A piece of the same glass (the trap-glass), placed in a cup of clay, was introduced into a muffle, heated to 21°. In one minute it became quite soft, so as to yield readily to the pressure of an iron rod. After a second minute had elapsed, the fragment, being touched by the rod, was found to be quite hard, though the temperature had remained stationary. The substance, thus hardened, had undergone a change throughout; it had lost the vitreous character; when broken, it exhibited a fracture like that of porcelain, with little lustre; and its colour was changed from black to dark brown. Being exposed to heat, it was found to be fusible only at 31°; that is, it was less fusible than the glass by 13° or 14°.

"Numerous and varied experiments have since proved, in the clearest manner, that, in any temperature, from 21° to 28° inclusive, the glass of this whin passes from a soft, or liquid state, to a solid one, in consequence of crystallization; which is differently performed at different points of this range. In the lower points, as at 23, it is rapid and imperfect; in higher points, slower and more complete, every intermediate temperature affording an intermediate result. I likewise found, that crystallization takes place, not only when the heat is stationary, but likewise when rising or sinking, provided its progress through the range just mentioned is not too rapid. Thus, if the heat of the substance, after fusion, exceeds one minute in passing from 21° to 23°, or from 23° to 21°, the mass will infallibly crystallize, and lose its vitreous character. These facts enabled me to account for the production of the substance resembling the liver of an animal, which I obtained in my first attempts to crystallize the melted stone. Not being then aware of the temperature proper for complete crystallization, I had allowed it to be passed over rapidly by the descending heat, and I had begun the slow cooling in those lower points, at which the formation of this intermediate substance takes place.

"By the same means I was enabled to explain the unexpected result, which I obtained in endeavouring to convert the glass of this stone into crystallite.* The fire applied to the crucible, containing fragments of the glass, had been

* The crystallized substance, obtained from the slow cooling of trap-glass, was denominated crystallite by Sir James Hall.

raised very slowly, which I know to have been the case by some circumstances of the experiment. The glass had softened by the first application of heat, but had crystallized again as the heat gradually rose; so that the substance consolidated, while still so viscid as to retain the original shape of the fragments; at the same time it acquired such infusibility as to resist the application of higher degrees of heat during the rest of the process." (Trans. of Royal Soc. of Edin. vol. v. p. 5.) Besides the greenstone of Bell's Mills, Sir James Hall fused and recrystallized several other of the trap-rocks around Edinburgh. We shall note his observations in regard to these.

Whin (Basaltic Clinkstone) *of the rock of Edinburgh Castle.*

"The pure glass which this whin yielded, by rapid cooling after a moderate heat, was crystallized in three experiments, and produced masses greatly resembling the original. In one of these, formed on a large scale in the glass-house, the resemblance is so strong, both as to colour and texture, that it would be difficult, or perhaps impossible, to distinguish them, but for a few minute air-bubbles visible in the artificial crystallite. The glass is less fusible than that resulting from the greenstone of Bell's Mills, and seems not to possess the property of producing the liver crystallite." —p. 53.

Whin of the basaltic columns on Arthur's Seat, near Edinburgh.
(Basalt of the summit.)

"In the temperature of 100° or upwards, the whole was changed to pure black glass; but in a more moderate heat (about 60°), the felspar remained unchanged, while the hornblende disappeared and formed a glass along with the basis of the stone. Both kinds of glass yielded highly characterized crystallites, that last mentioned having its felspars entire, produced a substance like porphyry, in which the white felspars were imbedded in a black crystalline basis. The crystals formed in this basis are so complete in one example, that they are seen projecting into the cavities and standing erect on the external surface so as to make it sparkle all over. These black crystals seem to be hornblende of new formation. We have found by some late experiments that they are considerably more refractory than the crystallite in which they lie, and are equally infusible with some species of natural hornblende."—P. 53.

Whin (Basalt) *from the neighbourhood af Duddingston Loch.*

" Its glass yields a fine grained crystallite, like to that of the greenstone of Bell's Mills."—P. 54.

Whin (Greenstone) *of Salisbury Crags.*

" Its glass yielded a highly facetted crystallite, approaching to the structure of the unfused basalt of Duddingston Loch."—P. 54.

Whin (Syenitic Greenstone) *from the rolled masses in the bed of the Water of Leith.*

" In fusion and crystallization it resembled the other whins."—P. 55.

Whin (Basalt) *of the basaltic columns of Staffa.*

" It yielded a perfect and very hard glass, which, in a regulated heat, produced a uniform stony crystallite, greatly resembling the original."—P. 55.

Having performed the experiments on whinstone, the unerupted lava of the philosopher whose opinions he had adopted, Sir James Hall engaged in a series of experiments on mineral masses, the evident volcanic origin of which was admitted by all. From his original paper we shall extract the results to which this examination led.

Lava of Catania (Basaltic Lava).

"After strong heat, the whole was reduced by rapid cooling, to pure black glass; but, when the heat applied was moderate, the felspars remained unchanged. Being maintained, after a second fusion, in a temperature of 28° (Wedgwood) both these glasses yielded strong and crystallized substances somewhat less fusible than the original, and, when exposed to a temperature of 22°, they crystallized rapidly like most of the whins (trap-rocks) into the liver crystallite. This last property is common to all the lavas." —P. 60.

Lava of Sta. Venere.

"The pure black glass formed from this lava yielded, in the regulated heat, the most highly crystallized mass we have obtained from any lava or whin."—P. 61.

Lava of La Motta di Catania.

"Its glass yielded a dark grey crystallite of uniform texture."—P. 62.

Lava of Torre del Grecco.

"It was found to be less fusible than any of the others, yet its glass crystallized in a lower temperature."—P. 63.

Lava of Vesuvius, eruption 1785.

Sir James Hall, after examining with care a lava stream which flowed from Vesuvius, found that it completely resembled the glass obtained from the rapid cooling of an artificially fused mass of lava. "Besides all other properties," he remarks, "it possesses the fusibility of the glasses, since it softens completely at 18, that is 14 or 15 degrees below the softening point of any of the stony lavas. Being exposed to the process of regulated cooling, it gave the same result as all the other lava glasses. In the lower points it yielded a liver crystallite infusible under 30, and in the higher a stony substance like a common lava or whin, and fusible only at 35."

We here extract from Sir James Hall's paper the Table of the fusibilities of the traps and lavas which he examined, and from it "it may be observed that the original whins soften in a range from 38 to 55, the glasses from 15 to 24, and the artificial crystallite from 32 to 45."

SUBSTANCES.	Original softened.	Glass softened.	Crystallite softened.
Whin (Greenstone) of Bell's Mills Quarry,	40	15	32
Whin (Basaltic Clinkstone) of Castle Rock, ...	45	22	35
Whin of basaltic column, Arthur's Seat, ...	55	18	35
Whin (Basalt) near Duddingston Loch, ...	53	24	38
Whin (Greenstone) of Salisbury Crags, ...	55	24	38
Whin (Syenitic Greenstone) Water of Leith, ...	35	16	37
Whin (Basalt) of Staffa, . .	38	14½	35
Lava of Catania, ...	33	18	38
Lava of Sta. Venere, Piedmont, .	32	18	36
Lava of La Motta, ...	36	18	36
Lava ? of Iceland, ...	35	15	45
Lava of Torre del Grecco, . .	40	18	28
Lava of Vesuvius, 1785, . .	18	18	35

The other discoveries of Sir James Hall we need not here notice in detail. His experiments on limestone and coal are known to both the chemist and the geologist, having to the latter afforded explanations of appearances of no little complexity, and to the interest excited by his investigations are, in no small degree, to be traced many discoveries which have been made by Continental philosophers. To the geologist and chemist of the present day, the experiments of Hall tell that a vast field is open for investigation; and examinations, philosophically conducted on the grand principles which he chalked out, would, it may with certainty be stated, either corroborate the truth of certain, as yet, theoretical points in geology, or display their falsity. By furnace experiments knowledge could be gained, in all probability, on much which is now the "Terra Incognita" of geology. How is dolmitization effected? Are the granites, the porphyries, the trap-rocks, trachytes, and lavas to be considered only as links in a connected chain of igneous elaborations, of which the one extremity is granite and the other lava, the differences in mineral structure and composition being effected by differences in compression, and in the rocks with which they have come in contact? Do the various stratified deposits contribute to the formation of igneous rocks; and can sandstones, shales, and conglomerates be made to assume characters indicative that the formations of gneiss, mica-slate, hornblende rock, and the several strata denominated Primitive, are only to be considered as mechanical deposits, which have been completely altered? All these are questions which it is of the highest importance to solve, and solutions appear only to be got in experimenting on mineral masses, at very high temperatures, and under great compression.

APPENDIX II.

ON THE JUNCTIONS OF GREYWACKE AND SANDSTONE WITH GRANITE AND SYENITE.

In our memoir on the Geology of the Lothians, we have observed that the Transition strata are in few instances connected with the ignigenous rocks, and that even when such relations are observable, they are seldom of an interesting description. Other portions, however, of the great transition high land of the south of Scotland are related, in an interesting manner, with plutonic masses. Trap and porphyry rocks in several places occur associated with the strata, but a detail of the appearances exhibited by these is here inadmissible; we shall, however, shortly notice a few points where they are found connected with true granite and syenite.

The granitic rocks which rise through the greywacke strata form three distinct and isolated groups, viz. that of Criffel, Loch Ken, and Loch Doon.

I. *Criffel District.**

The first of these, near the village of New Abbey, rises through the greywacke and attains in the hill of Criffel to the height of 1830 feet. The granitic rocks of this district do not consist entirely of true granite; on the contrary, they vary much, some of the mountains being formed of granite, while others are composed of a characteristic syenite. None of these rocks, however, in their relations to each other, indicate a difference in age, but bear impressed upon them characters which prove a perfect synchronism

* Vide Professor Jameson's Memoir on the Geognosy of Criffel, Kirkbean, and the Needle's Eye in Galloway, in the 4th volume of the Memoirs of the Wernerian Society.

of formation. The felspar which enters into the composition of the granite and syenite varies in colour from white to grey and light brick-red, while the quartz is invariably of the usual grey colour; the mica is in general brown, and occurs only in minute scales. In several places, the granite assumes a porphyritic aspect, the crystals which produce this arrangement being invariably of felspar; but on the large scale there is no example of determinate structure,—that tabular appearance which is so often to be observed in extensive granite districts never occurring here. The syenite which is associated with the true granite is, like it, small granular, and from the hornblende varying in quantity, the rock assumes various aspects. Sphene occurs in minute crystals, and may be observed in the syenitic cliffs about two miles to the north of New Abbey. Contemporaneous veins occur in the granite and syenite, and appear to have been produced during a state of the rock capable of allowing the free motion of its constituent minerals; some of these veins are composed of quartz, while others consist of a granite of a smaller grain than that which they traverse. They run courses more or less tortuous, pass more or less into the bounding walls, and when well exposed may be found thinning completely out at both extremities. On examining any considerable tract of this country, numerous concretionary masses are to be observed in the syenite. They vary from a small size to one or two feet, being either of angular or ovoidal shapes, and in general are composed principally of hornblende; frequently all the constituents of the syenite, however, enter into the composition of these masses, and sometimes they become porphyritic by containing crystals of felspar. In regard to the appearance of the concretions at the planes of contact with the rock in which they occur, it may be remarked that they vary from a perfect distinct boundary line to one of the most indefinite character, one in which the minerals of the rock containing the concretions occur interlaminated with those of the concretion.

We shall now detail the relations of the granite to the greywacke, which are observable at two points. The Needle's Eye, a perforated rock which occurs near the mouth of the Southwick water, is a point where both rocks may be found in immediate connection, and the first appearance, which is most striking, is the intimate blending of the one with the other. The whole scene in this respect is one of the greatest confusion, and certainly if the igneous origin of granite were not supported by appearances more indicative of a plutonic formation than those observable here, its synchronism with the greywacke, and perfect similarity of formation, would be based on no insecure foundation.

To describe all the minute modes of junction of the greywacke and the granite at this point would, if the nature of the ground did not render it impossible, be an unnecessary labour; we shall, however, give a detailed account of their junction taken as a whole. When considered as a mass the granite of this point appears to be chiefly distributed through the greywacke in the form of veins, which occur of all magnitudes, and run courses which in some instances are almost straight, while in others they are highly tortuous. On examining the immediate planes of junction of the granite with the greywacke, these will be found to vary much in appearance, sometimes both rocks having a decided and well marked boundary, while at other times they make a gradual transition into each other. Throughout the same vein both of these appearances may sometimes be observed; one part, in some instances, affording a distinct separation, while in another there is so complete an intermixture, that it is almost impossible to tell where the one rock begins, and where the other ends. The size of the veins bears no relation to the degree of intermixture of them with the greywacke; on the contrary, a very large vein may pass into the rock, or it may not, or a small vein, in size perhaps not exceeding three or four lines, may be completely commingled with the greywacke which it traverses, or may have a determinate outline.

In its mineralogical structure, the rock which forms the veins frequently differs from that which constitutes the larger masses. The several components, the quartz, felspar, and mica, or the felspar, quartz, and hornblende, become intimately and obscurely intermixed with one another; and in many places the veins are composed of an intermixture of quartz and felspar, which is sometimes so perfect that the veins appear to be composed of a very compact felspar.

The appearances which the greywacke exhibits when in the neighbourhood of the granite and syenite, are expressive of indurating or altering causes: in every instance it becomes compact, the slaty varieties passing into a species of felspar, not unlike some clinkstones. In both the granite and the greywacke, shifts may in some places be observed; the sides of these shifts, however, are so intimately connected as to render it highly probable that they have taken place before the granite was in a perfectly consolidated state. In regard to the stratification of the greywacke, it varies in regularity; sometimes the rock being perfectly amorphous, while in other places it exhibits a more or less bedded structure, the strata then dipping to the S. S. E. at angles between 30° and 70°, and resting upon the principal mass of granite and syenite. In one or two places layers of quartz occur in the greywacke; in every instance, however, these are to be observed only near the granite; fibrous amethyst is also to be found at some points. Near an isolated rock called Lot's Wife, a vein of felspar-porphyry crosses the strata of greywacke, into which, at the planes of contact, it is gradually found to pass.

Having described the appearances at the Needle's Eye, we shall next notice some other localities where the greywacke is connected with granite.

On proceeding along the bank of the Ladyland burn, a streamlet which crosses the road about a mile and a half to the south of Kirkbean, the greywacke is found in various altered positions, dipping at high angles, and in some places also much contorted. In several parts veins of felspar porphyry cross the strata, but junctions are in no place visible. In mineralogical character these porphyry veins present a perfect similarity; they are composed of a compact light reddish-brown felspar with imbedded crystals of felspar, being identical, in every respect, with other porphyries associated with the same strata in other parts of this great transition district. As an examination of the bed of this burn appeared to afford a chance of again observing a junction of the syenite with the greywacke, we traced it through its whole extent, but unfortunately the desired contact was not visible. In the Kirkbean burn, however, almost at its source there is a distinct exhibition of the junctional relations between the granite and the greywacke. In the other parts of the bed of this stream there is nothing interesting exposed: there are a few porphyry and felspar veins, but beyond their presence little else can be made out; they cross the strata and are frequently many yards in breadth. As in the other points where the contact of the granite and greywacke is exposed, the strata are here found to abut against the unstratified rocks at high angles. Some of the varieties are highly quartzose, and approach almost to sandstone. Concerning the characters of the greywacke when next the granite they are interesting and completely different from those exhibited at the Needle's Eye, inasmuch as the slate invariably passes into a perfect slaty aggregate of brown micaceous scales. In regard to the positions of the two rocks to each other, they are rather remarkable: there is the most perfect intermixture, the one with the other; layers of granite, in many instances, not more than two or three lines in breadth occurring completely isolated in the strata, and without any visible connexion with the main mass of the rock. The very reverse of this is also, in many places to be observed, masses of the slate altered into brown mica, occurring imbedded in the granite. In their position these granitic masses enveloped in the slate agree with the greywacke, conforming in every instance with the contortions visible in it; a circumstance which very frequently attends junctions of granite with stratified rocks. At the planes of junction here there is never to be observed a well marked boundary line; on the contrary, there is a transition of both rocks into each other, of such a nature that, if a theory concerning the origin of granite were to be formed only from the phenomena of this point, it would incline any one to consider both mineral masses as merely modifications of each other, and the effect of one and the same cause or system of causes.

II. *Loch Ken District.**

Another group of granitic rocks is met with in the neighbourhood of Loch Ken in Kirkcudbright: as several junctions, however, of these rocks with the greywacke have been described in the Transactions of the Royal Society of Edinburgh, we shall here only notice a few localities shortly.

* The geognosy of this district is described by Dr Grierson in a memoir and map laid before the Wernerian Society, and published in the 3d volume of the Annals of Philosophy, and also in a memoir in the 2d volume of the Wernerian Memoirs, entitled "Mineralogical Observations on Galloway."

Proceeding from the village of New Galloway, down the western bank of Loch Ken, the greywacke strata are found ranging in a vertical position S. W. and N. E., a position which they preserve very generally over this country.

About a quarter of a mile to the south of the ancient castle of Kenmore we meet for the first time with the granite of the Ken district. It is here a compound of brick-red felspar, quartz, and mica, and for a considerable way the loch is skirted by a narrow band of the transition rocks. With the exception, however, of the junction of the Windy Shoulder, which has been described in the volume we have referred to, we only noticed one on the bank of the loch, and this is not traceable for more than a foot or a foot and a half. The greywacke, which, at a distance from the granite, is perfectly characteristic and similar to that of other quarters in the south of Scotland, acquires, on approaching it, the aspect of an indurated felspathic sandstone, containing a few very minute scales of mica; at the junctional planes it exhibits a tendency to pass into the granite, in a manner evincing, however, no greater or more remarkable changes than those which are often found attending junctions of trap-rocks with sandstones and shales.

The other point where we had an opportunity of examining junctional relations, was at the east end of Loch Stroan, and at this point the nature of the ground renders these more apparent. Near that part of the loch, from which the Black Water of Dee rushes, a vein of granite traverses the greywacke: it is not found in union with the principal mass, though its joining it near this is probable from the circumstance of the granite forming the bed of the loch here. The visible length of this granite vein is thirty feet, being at its greatest breadth one foot, from which it gradually diminishes until at last it terminates in a mere thread. Very generally a layer of massive quartz intervenes between the granite and the greywacke, and traverses the latter in numerous veins. The greywacke is intimately connected with the granite at the junction; but there is no transition into any rock which can with any degree of propriety be referred to the primitive series of the Wernerian geognosy. The granite which occurs here is a compound of a yellowish-white felspar with the accompanying minerals of quartz and mica. Another locality which we examined for the purpose of noticing the altering effects of granite was at the old bridge of Dee, about half a mile to the south of Clatteringshaws toll-bar. The greywacke here is indurated, but it is still greywacke, and abuts at a considerable angle against the granite which has upraised it.

III. *Loch Doon District.**

The third granite group, which is associated with the strata of the south of Scotland, is that of the district of Loch Doon; and as connected with that metamorphic theory, which supposes that the gneiss and mica-slate strata are only altered sandstones and shales, the junctions exhibited in this quarter are interesting. To trace the connections of granite with its associated strata, and to examine the appearances observable at their junctions, has long been an object of geological investigation. In the generality of cases, however, this examination can only be made in regard to the contact of granite with rocks which, though stratified, are nevertheless a complete crystalline aggregate, and bear impressed upon them characters as completely indicative of a consolidation from a state of fluidity as the unstratified granitic masses which occur among them. If we wish to discover, therefore, whether such rocks have lost their original mechanical characters by the action of the granite, it is evident that we must endeavour to find an indubitable mechanical rock so connected with

* Vide Dr Grierson's Memoir on the "Mineralogy of Galloway," in vol. ii. Mem. Wern. Soc., for his description of the granite and greywacke junctions in this district.

granite, that it is to be considered in circumstances which are fitted for its undergoing a metamorphosis. It is not enough to state that gneiss and mica-slate are metamorphic; but to prove that they are, it is necessary to find a mechanical deposit becoming a gneiss or mica-slate. If an object undergoes a metamorphosis, the fact of its having done so, is only to be believed from the evidence of the senses in witnessing the change, or from finding the original substance in all states between a complete and an incipient alteration.

The junction of granite and greywacke at Loch Doon, affords no support whatever to the doctrines to which we have alluded, and certainly if such a theory is tenable, this locality is one where we might expect to find appearances in favour of it. On both sides of the loch, a junction of the granite rocks with the greywacke is visible. On the west side, however, these appearances are best exposed, and we may remark that perhaps no part of Scotland exhibits, in a more clear or marked manner, the connections of granite with stratified rocks. For many yards the junctions of the two rocks are exposed in the most satisfactory manner, veins of granite traversing the vertical greywacke strata in all directions, and in some instances crossing them at various angles with the planes of stratification, while in others they run parallel with them. In breadth, the granite veins vary from six or seven feet to the smallest size, and at their planes of contact with the greywacke, there is in general an intimate commixture of both rocks, the larger granite veins containing numerous variously sized imbedded angular fragments of the greywacke. The rocks on the side of Loch Doon which exhibit the junction afford every facility for examination, and from the action of the water they are almost as smooth as if they had been polished by art: the veins even of the smallest size may, from their resisting the weather better than the greywacke, and standing out in strong relief, be investigated throughout their most minute ramifications. As an interesting circumstance in regard to this junction, we may state, that the granite does not disturb the direction of the strata in any instance. Thus, although they are traversed in every possible manner, still they preserve the same N. and S. direction which they had when at a distance from the granite. It is to be particularly noticed also, that the lines of direction, when visible in the imbedded masses, agree with those of the strata.

At a distance from the granite, the greywacke of this district, exhibits only the usual aspect, but when in contact with it, it affords a different series of characters, and is then generally composed of very minute crystalline grains of white felspar and mica, with a slight intermixture of quartz. It has a perfect granular structure, and exhibits nothing which approaches either to gneiss or mica-slate, but, on the contrary, is only to be considered as a greywacke which has lost its mechanical aspect through the influence of the granite rocks which rise through it.* The granite of Loch Doon is of two kinds, the one being a compound of red felspar, quartz, and mica, the other of white felspar, quartz, and mica; hornblende frequently enters into its composition, producing then a characteristic syenite. The only structure observable is the tabular, but of this even there are no very marked examples.

IV. *Junction of Granite and Sandstone in Arran.*

The details we have just given, it is needless to say, prove that in Scotland there is a granite formation newer than the transition strata. We shall, however, adduce an instance of true mineralogical granite being also newer than the old red conglomerate.

* Dr Grierson, in his "Mineralogical Observations in Galloway," describes this altered greywacke as a compact gneiss.

The junctional appearances of the granite and sandstone, to which we refer, occur in the island of Arran, and are only to be observed in a stream which enters the sea near the village of Corry. At this point, when at a distance from the granite, strata of slate-clay and red sandstone are found dipping S. S.E. at 30°, the sandstone frequently passing into conglomerate, and containing rolled masses of quartz-rock. On advancing from the sea to the mountain, however, the rocks progressively assume a greater inclination, till at last, near a mural escarpment of granite, they assume a nearly vertical position ; the stratified arrangement of the sandstone also, which is in general perfectly distinct, becomes then very much obliterated, and the red colour of the strata entirely disappears. At the immediate junction of the sandstone and granite, which is only visible for about four feet, the former passes into a perfect granular quartz-rock ; the granite also exhibits characters completely different from those which it has when at a distance from the sandstone, and instead of being a distinct crystalline aggregate of quartz, felspar, and mica, it becomes a rock composed entirely of the two first, which are not arranged in distinct granular concretions, but, on the contrary, are blended intimately the one with the other. From the great thickness of the series of clay and chlorite slates, which in every part of Arran, with the exception of a short distance along the base of the hills which rise above Corry, lies always between the granite and the secondary rocks, it is vain to seek for junctions of the granite and the sandstone in other parts of the island. The one, however, which we were fortunate enough to find, though of limited extent, renders the fact that the granite has been protruded after the deposition of the sandstone sufficiently evident. In a paper published by Messrs Sedgwick and Murchison, in the Transactions of the Geological Society of London, "On the Geological Relations of the Secondary Strata in the Island of Arran," it is stated " that the granite could not have been in a fluid state at the time of its elevation ; for, had that been the case, it could never have risen into lofty mountains, and mural precipices, overhanging the secondary strata, without ever flowing over their broken edges, or penetrating their mass in the form of dykes." These reasons appear, however, in no way sufficient to prove that the granite of Arran has been elevated in a solid state, after its fluid protrusion through the primitive rocks with which it is connected. In regard to its having, unless elevated in a solid state, been unable to form mountains and mural precipices, we have a statement which may as well be applied to all the granite and trap rocks of Scotland, as to the granite of Arran, and indeed to almost every igneous rock which does not occur in streams. Concerning the circumstances which have allowed the granite and trap to assume their existing forms, this is no place for a discussion ; and besides, they will suggest themselves on reflection to any geologist. Data are awanting also to prove, either that the granite does or does not penetrate the sandstone ; and besides, the sandstone is so related to the granite that it might be older than it, and still not be traversed by veins ; for, as we have just stated, the granite is, with one exception, always separated from the secondary rocks by a great formation of slate, consequently it might easily happen, that the plutonic rock might be newer than both, and still might have not sent out veins of a length sufficient to invade the secondary series. The nature of the ground, however, where a solitary instance of the sandstone being in contact with the granite may be observed, is such as to render it impossible to affirm whether the sandstone is crossed by granite dykes or not.

GEOLOGICAL MAP OF THE LOTHIANS.

In this map the several formations are laid down with an accuracy as perfect as the nature of the ground allowed us to do; the dotted lines which separate the formations being intended to express their limits in a general way.

In regard to the Red Sandstone deposits, we wish to state that several others occur in the Lothians, in addition to those which we have marked on the map; these, however, from being on a small scale, and existing only as deposits subordinate to the white sandstone series, we considered it unnecessary to exhibit; in many instances, also, their extent of distribution, when compared with the scale of the map, rendered this impossible. Several trap-dykes have, for the same reason, been excluded; a few, however, have been represented, though on a larger scale than that of the map.

The limestone which occurs in the Lothians we have only laid down on those parts where it is quarried or otherwise exposed at the surface. Without much chance of mistake, however, we might have connected many of these. When the covered state of the country, however, prevented us from being able to connect the limestones exposed by natural or artificial means, we have coloured the intervening portions, as the white sandstone series, from a knowledge that if limestone did not form the uppermost rock continuously, it was in almost every instance covered only by that group of strata.

By straight lines we have indicated the direction of the strata, and, by an arrow placed at right angles to these lines, the point of the compass to which they dip. In several instances we might perhaps have drawn lines shewing the outgoing of a stratum over a very considerable space: this, however, we refrained from doing, as the apparent accuracy might in many instances have been found by other observers to have no existence. Vertical strata are denoted by a line shewing the direction, and by this mark +.

PLATE Explanatory of the colours used in the sections.

PLATE I. Fig. 1.—Unconformable position of the red sandstone and transition strata. Heriot Water, Berwickshire.

Fig. 2.—Section near Red Heugh exhibiting the same appearances.

II. Fig. 1.—Sectional view of another junction of the transition and secondary rocks, near Red Heugh.

Fig. 2.—Ground plan affording the same appearances. Red Heugh.

III. Fig. 1.—Greenstone traversing and overlying sandstone. St Leonard's Hill.

Fig. 2.—Greenstone enveloping masses of sandstone and overlying arenaceous limestone. Salisbury Crags. (The masses of sandstone are on a larger scale than the rest of the section.)

Fig. 3.—Greenstone overlying and fracturing arenaceous limestone. Salisbury Crags.

IV. Section of the central part of Salisbury Crags. Here the greenstone is found to have both contorted and enveloped masses of the sandstone. Upraised strata of sandstone are also found overlying it.

V. Fig 1.—Shift in sandstone. Cat Nick, Salisbury Crags.

Fig. 2.—Vein of greenstone traversing the greenstone and sandstone of Salisbury Crags. This point is one of the few in the Lothians where there are indications that the trap-rocks of the district are the formation of more than one epoch.

VI. Fig. 1.—Sectional view of the northern part of Salisbury Crags.

Fig. 2.—Greenstone porphyry overlying and enveloping strata of white sandstone. Northern front of Arthur Seat.

VII. Fig. 1.—Sectional view of Arthur Seat, partly ideal.

Fig. 2.—Section shewing the probable relations of the basalt which forms the summit of Arthur Seat, to the greenstone and sandstone of Salisbury Crags.

Fig. 3.—Section from the Calton Hill to Leith. (The greenstone rocks of Lochend and Restalrig are on a larger scale than the rest of the section.)

VIII. Fig. 1.—Greenstone traversing shale. St George's Well, Water of Leith.

Fig. 2.—Ground plan of greenstone vein traversing shale. St George's Well, Water of Leith.

PLATE VIII. Fig. 3.—Greenstone traversing sandstone; Bell's Mills, Water of Leith. (Sir J. Hall made the first of his interesting experiments in regard to slow refrigeration on specimens of this rock.)

IX. Greenstone enveloping masses of slate and sandstone. Hound Point.

X. Fig. 1.—Felspar vein traversing sandstone and passing into greenstone. Inch Colm.

Fig. 2.—Vein of greenstone traversing sandstone conglomerate. Cairn Muir.

Fig. 3.—Greenstone traversing and overlying red sandstone. Sunnyside Quarry.

Fig. 4.—Junction of greenstone and red sandstone. Whitberry Point.

XI. Fig. 1.—Greenstone traversing aud enveloping masses of red sandstone. Dunbar Castle.

Fig. 2.—Greenstone dyke traversing sandstone; near Broxmouth.

XII. Fig. 1.—Trap-veins traversing sandstone conglomerate. Stotan Cleugh.

Fig. 2.—Felspar veins traversing greywacke. Fassney Water.

Fig. 3.—Trap overlying strata of mountain limestone and trap-tufa. Kirkton, Bathgate.

XIII. Fig. 1.—Greenstone traversing sandstone and enveloping slate-clay. Winchburgh.

Fig. 2.—Greenstone traversing and overlying sandstone. Winchburgh.

XIV. Greenstone cliff near the harbour of Aberdour, in which are enveloped masses of sandstone and slate-clay.

XV. Fig. 1.—Greenstone traversing sandstone and shale, near Alexander's Crag.

Fig. 2.—Felspar vein traversing the coal series. Whinny Hill.

XVI. Strata of sandstone and limestone traversed by a vein of felsparand overlaid by greenstone. Tyrie near Kirkaldy.

PRIZE ESSAY

ON THE

NATURAL AND ECONOMICAL HISTORY OF THE FISHES, MARINE, FLUVIATILE, AND LACUSTRINE, OF THE RIVER DISTRICT OF THE FIRTH OF FORTH.*

BY

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DESCRIPTION OF THE FIRTH OF FORTH.

In connection with the study of the species in Natural History which belong to any particular district of land and water, some consideration is due to the ascertainable circumstances by which its capabilities, as an abode of animated nature, can be determined. On this account, a short notice of the general character of the river Forth and its estuary, cannot be out of place as a preliminary to a paper on the Fishes to be found there. A notice of this kind must necessarily be imperfect, not less owing to the brief space that can be devoted to it, than to the investigation of the facts becoming difficult, nearly in proportion to their interest and immediate bearing on the subject. And, indeed, all that I can promise under this head is, rather to indicate

* The Wernerian Natural History Society's honorary Premium of a gold medal, value Ten Sovereigns, was adjudged to Dr Parnell for this essay, 1837.

than to investigate some of the most important points that deserve to be inquired into.

The physical geography of the German Ocean, of which the Firth of Forth is so large an estuary, should not be omitted in an extended investigation of such a kind; the shallow bottom of that sea, the peculiarity of its tides, and the immense banks that traverse it, one of which juts out from the entrance of the Firth of Forth to a distance of one hundred miles north-eastward, cannot but exert a decided influence on the determination of the kinds of Fishes that frequent its estuaries. A comparison also between the physical geography and natural productions of this Firth, with those of the other estuaries of the same sea, such as the Firth of Tay, the Humber, and the Wash, would prove a source of interesting investigation.

But to proceed to the Firth of Forth itself, which is more than enough for my limits at present. The breadth of this estuary, at its junction with the ocean, as measured from St Abb's Head on the south side, to Fifeness on the north, does not fall short of thirty-five or forty miles: it contracts rapidly from these points, so that, between Elie Point and Yellow Craig, though no more than ten miles above Fifeness, and owing to the trending eastward of the southern border not less than twenty-five miles of St Abb's Head, the breadth does not exceed seven miles. From there it expands into a wide basin, the greatest extent of which, between Musselburgh and Largo, is not much short of twenty miles; while its medium breadth, as between Guillon Point and Buckhaven, is about twelve miles in a straight line. Above, it contracts again to nine miles, and proceeds, gradually becoming narrower, through a course of nine or ten miles to Queensferry, where it is about two miles across. Here it expands again in a beautiful basin, varying in width from three to four miles, through an extent of thirteen or fourteen miles; above this it assumes more of the character of a river, and here, therefore, the estuary may be said to terminate.

The Islands of the Firth are important in its physical geography, as exerting an important influence on its currents, and thereby on the depositions from the water at the bottom, and on its encroachments on its banks. The Bass, distinguished as the abode of the Gannet (*Susa Bassana*); and the May, on which a light-house is situated, are the most conspicuous near its junction with the ocean. Higher up, Inchkeith occupies the middle space near the upper contraction of its greatest basin, and determines, by its influence on the tide, the banks, channels, and bays, through an extent of several miles. Between this island and Queensferry, Cramond Island, Inch Mickery, and Inchcolme, intersect the Firth nearly in a line across, being at the distance of three or four miles from Queensferry. Inchgarvey, the highest island that deserves notice, occupies the middle of the contraction between North and South Queensferry.

The Depth of the Forth, below the Isle of May, is upwards of thirty fathoms, declining to fourteen or fifteen fathoms, as the northern or southern border is approached. In the first contraction, between Elie point and Yellow Craig, the greatest depth is about twenty-eight fathoms; from which, in the middle of the channel up to Inchkeith, the depth varies to sixteen or seventeen fathoms. From Inchkeith a great bank, termed the Middle Bank, extends towards Hound Point: on the north of this bank runs a deep channel, named the North Channel, the depth of which varies from sixteen to twenty-five fathoms in its direct course. On the south side, in the neighbourhood of Leith, numerous rocks project, between which and the middle bank there is a channel, termed the South Channel or Leith Roads, which varies from three to sixteen fathoms in depth. Between South Queensferry and Inchgarvey the greatest depth is about nine fathoms; but between that island and North Queensferry the depth increases to thirty-seven fathoms, which is the greatest depth observed above the Isle of May. At a short distance above this point, the depth is still twenty-one fathoms; from thence the basin gradually shallows upwards.

Numerous streams pour themselves into these basins of the Firth, among the principal of which are the Tyne, the Esk, the Leith, the Almond, and Avon, on the south side; while the Leven, arising from Lochleven, is the only considerable stream which joins it on the north side.

The Forth itself, one of the largest rivers in Scotland, arises from the north side of Benlomond: it is first called the Avendow or the Black River, and receives the name of Forth on entering the parish of Port: it then expands into a lake (Lochard), and flows through the vale to Stirling. Here it is augmented by the addition of the Teith and the Allan, and, after taking a winding course of twenty-four miles, finishes by joining with the termination of the estuary.

The first part of the course of the river Forth is through deep clay; it then takes its course through a country containing extensive beds of coal, limestone, and ironstone, so that, under the lowest part of the river and the highest basin of the Firth, coal is dug on both sides from beneath the channel.

Thick beds of alluvial clay and copious depositions of sand are found on both sides of the Firth, wherever the solid rock does not appear. Between Musselburgh and Guillon Point, numerous patches of turfy beach, over which the tide rises, are met with. The Firth appears, on account of the large extensive sand-beds, and the immense quantity of algæ which it contains, to be favourable for the deposition of the spawn of fishes. How far the Firth is fitted to be a receptacle for fishes, by the kinds of food favourable to their increase which it supplies, is a question that can be but imperfectly answered at present. Molluscous animals, which certainly constitute the chief food of fishes, next at least to their own tribe, abound in the Firth; but, as yet, little is known as to the comparative favour in which the several species of these are held among fishes, nor have we any means of ascertaining the relative proportions in which the different molluscous animals found in it abound.

As might be anticipated, from the extent and irregularities of this estuary, the tide derived from the German Ocean exhibits some anomalies. The tide flows to a mile from Stirling Bridge, a distance of near eighty miles from the ocean in a straight line. It is there interrupted by a rock which crosses the river, and at stream tides the rise on that rock is five feet. The regular flow and ebb of the tide is twice in twenty-four hours, but both run about two hours longer in the middle of the channel than along the shore.

Above Queensferry some singular irregularities, termed Leakies, occur. Before high-water the tide begins to ebb, then, after a time, turns and continues to flow till high water; also before low water the tide begins to flow, then turns and ebbs till low water. This has been ascribed to the contraction at Queensferry;—enough of water cannot in consequence flow in to supply the level places of the shore; the tide therefore flows back from the river to serve this purpose. The velocity of the tide varies in different parts of the Firth, and this variation is connected with the place of the moon and the force of the winds.

FISHES OF THE FIRTH OF FORTH AND TRIBUTARIES.

CLASS PISCES.

Vertebrated animals with red blood respiring by gills or branchiæ, and moving in water by the aid of fins.

SUB-CLASS I.—PISCES OSSEI.

Bones fibrous; cranium divided by distinct sutures, branchiæ free, membrane furnished with rays.

ORDER I.—ACANTHOPTERYGII.

First portion of the dorsal-fin, or the entire first dorsal, when two are present, with simple spinous rays; first ray of the anal fin always spinous, and generally the first ray of the ventrals.

Family I. PERCIDÆ.—Operculum, or preoperculum, denticulated or spiny; scales generally ciliated; jaws, front of the vomer, and almost always the palatine bones, furnished with teeth.

Genus *PERCA*.—Dorsal-fins two; preoperculum notched below; operculum ending in a flattened point; tongue smooth, without teeth.

PERCA FLUVIATILIS.*—THE PERCH.

Specific Characters.—Back dusky green; sides with dusky bands.

Description.—From a specimen nine inches in length. Body rather deep; back arched; sides compressed, marked with about six dark brown bands passing from above downwards. Colour above the lateral line dusky green, below it rather lighter, with a tinge of red; belly white; dorsals and pectorals light brown; anal of a rich scarlet, as well as the ventral and caudal fins; posterior portion of the first dorsal occasionally black; irides bright yellow. Teeth small and fine in both jaws, as well as on the vomer, palatines, and pharyngeals. First dorsal fin commencing over the posterior half of the operculum, and ending within a short space of the origin of the second dorsal; all its spines sharp and stout; the third and fourth the longest; the remainder gradually decreasing. Second dorsal fin soft and flexible, with each ray, except the first, branched at the summit. Anal fin commencing in a line under the fourth ray of the second dorsal, and terminating under the last ray but three of the same fin; first two rays spinous, shorter than the third, which is soft and flexible, as well as the remaining rays in that fin. Pectoral fin taking its origin in a line under the second ray of the first dorsal, and terminating in a line under the ninth or tenth ray of the same fin. Anal fin placed rather behind the origin of the pectorals; first two rays spinous, much shorter than the others, which are branched and flexible. Tail forked; the middle ray rather more than half as long as the longest ray in the same fin. Margin of the preoperculum finely serrated, the teeth being stronger on the lower border; operculum triangular, terminating behind in a long flattened point. Body covered with hard scales, strongly ciliated at their free margins, rendering a roughness to the surface of the fish when the hand is passed from tail to head. Lateral line commencing over the operculum, taking a course nearly parallel with the line of the dorsal curve, and ending at the base of the middle caudal rays. Number of fin rays—

1st D. 14; 2d D. 16; P. 14; A. 10; C. 17; V. 6.

The only British fish it is likely to be mistaken for is the *Bass*, the tongue of which is covered with teeth; whereas that of the *Perch* is perfectly smooth.

* *Perca fluviatilis.* Cuvier et Valenciennes, *Hist. Nat. des Poiss.*—Yarrell, *Brit. Fishes.*—Pennant, *Brit. Zool.*—Donovan, *Brit. Fishes.*—Fleming, *Brit. Animals.*—Linnæus, *Syst. Nat.*—Bloch, *Ichth.*—Jenyns, *Brit. Vertebrate Animals.*

According to the arrangement of Baron Cuvier, Britain possesses but one species of the genus Perca, universally known by the name of Common Perch. In general it is a gregarious fish, found inhabiting most of the lakes in Scotland, as well as those in England and Ireland. According to Cuvier, it occurs over the whole of the temperate parts of Europe, as well as in most of the northern districts of Asia. In the neighbourhood of Edinburgh it is of common occurrence, particularly in the Union Canal, Duddingston Loch, and Lochend. It is met with in some of the rivers leading into the Forth, and, on some few occasions, specimens have been taken in the estuary itself; but when found in this latter situation, or in brackish water, it has been carried down, through the medium of high floods, from some distant pond. Pallas, it is said, found perch in the Caspian Sea.

The habits of the perch most persons are acquainted with. It prefers deep lochs or canals, or those slow-running waters, where the banks are shaded and covered with weeds, in preference to the more rapid running rivers, so favourable to the habits of most of the fresh-water fishes. Perch, on some occasions, attain to a large size. Bloch alludes to one, the head of which alone measured twelve inches in length. Pennant speaks of one taken in the Serpentine River, in Hyde Park, which weighed nine pounds. Colonel Montagu saw a perch of eight pounds weight taken in the Avon, in Wiltshire, by a line baited with a roach. In Loch Lomond it is not unfrequently taken of the weight of five pounds, but beyond that it is seldom met with.

The spawning season of the perch is about the end of April, when the ova, as noticed by Aristotle, are united together by a viscid matter in lengthened strings. Bloch has observed the same appearance while a fish was depositing its spawn in a vessel kept in a room. The number of eggs that are sometimes found in an ordinary-sized perch, is said to amount to nearly a million. The principal food is insects, worms, and small fishes. It is very tenacious of life, and will live several hours after it has been taken from the water. As an article of food it is very wholesome if in season, when the flesh is white, firm, and well-flavoured. It is out of condition in April, May, and June.

GENUS *LABRAX*.—Dorsal fins two; scaly operculum terminating behind in two spines; body covered with hard scales; tongue rough with teeth; preoperculum toothed.

LABRAX LUPUS.*—THE BASS.

Specific Characters.—Operculum with a dusky spot; ventrals whitish.

Description.—From a specimen fifteen inches in length. Body more elongated than that of the perch; colour of the back dusky grey; sides rather lighter; belly silvery-white; gill-covers tinged with yellow; operculum with a large dark spot on its upper and posterior border; dorsal, caudal, and pectoral fins dusky; ventrals whitish. First dorsal fin commencing over the middle of the pectorals, and ending in a line a little anterior to the vent; all the spines stout, taking a slight curve backwards; the first and last ray of equal length; the third, fourth, and fifth, the longest. Second dorsal fin commencing immediately behind the termination of the first; all the rays soft and flexible, except the first, which is sharp and spiny; the anterior rays longer than the terminating ones. Anal fin a little smaller than the second dorsal, and placed rather nearer the tail. Ventral fins commencing behind the origin of the pectorals. Tail lunated when expanded, twice and a half the length of the middle ray. Scales rather large and hard; ciliated at their free margins; suboperculum without serratures; preoperculum notched below, and serrated on its posterior edge; operculum ending in two points directed backwards; body, cheeks, operculum, and preoperculum, covered

* *Labrax lupus*, Cuv., Yar. *Perca labrax*, Lin., Pen., Flem., Don. *Bass, Sea Perch.*

with adherent scales. Lateral line taking the curve of the back to the commencement of the last dorsal fin, from thence straight to the tail; eyes moderate, placed half way between the point of the snout and the posterior margin of the preoperculum: under jaw longest when the mouth is opened half an inch. Teeth small and fine in both jaws, as well as on the vomer, palatines, and tongue; branchiostegous rays seven. The young fish, as stated by most authors, is marked above the lateral line with dark spots. Number of fin rays—
1st D. 9; 2d D. 14; A. 14; C. 17; P. 17; V. 6; Vertebræ 26.

This fish differs from the *Serranus* and the *Ruffe*, in having two dorsal fins; and from the *Perch* by the tongue being furnished with teeth.

The Bass sometimes attains the weight of fifteen, and, according to Duhamel, even of thirty pounds. It was known to the ancients, who, on account of its strength, activity, and voraciousness, gave it the appropriate name of Lupus. In the Mediterranean it is of common occurrence, where it is said to increase to a much larger size than on our coasts. It does not appear to exist in so great abundance on the coasts of Scotland as on those of England: now and then it makes its appearance in the Firth of Forth, more particularly in the months of July and August, when it is taken with lines on rocky parts, and occasionally in the salmon nets near Queensferry. The Bass, in general, appears to feed on small crustaceous animals. In the stomach of a specimen which I examined were found several specimens of *Astacus linearis*, and two of the *Cancer longicornis*, together with part of a *Blennius gunnellus*. Mr Yarrell states, on the authority of Mr Couch, that it is particularly fond of the *Onisci* which are washed from the rocks in stormy weather, when these fish are seen in pursuit of them. Dr Neill took from the stomach of one, the fry of the sand-launce, and two young specimens of the father-lasher.* The flesh of this fish is firm and well-flavoured,

* *Wernerian Memoirs*, vol. i.

particularly in the autumn months, and is said to be greatly improved when boiled in salt-water. "Several have been retained with success in Mr Arnold's fresh-water lake, in Guernsey, and Dr M'Culloch has vouched for the superiority of the flavour obtained by the change."* The Bass is brought occasionally to the Edinburgh market, and sold at a low rate.

GENUS *TRACHURUS*.—First dorsal fin very short, the second very long; operculum furnished with a strong sharp spine directed backwards; preoperculum notched below.

TRACHINUS VIPERA.†—THE STING-FISH.

Specific Characters.—Second dorsal-fin with twenty-four rays; no spine before the eye.

Description.—From a specimen five inches long. Body rather elongated; sides compressed, marked by a number of oblique lines forming an angle below the lateral line; back nearly straight; abdominal line slightly convex. Colour of the back, as far as a little below the lateral line, reddish-grey; sides and belly silvery-white; first dorsal-fin black; second dorsal and pectorals of the same colour as the back; anal and ventrals white; caudal-fin even at the extremity, and margined with black.‡ (Mr Jenyns says there is a black spot at the extremity of the caudal fin.) Scales small, thin, and entire; cheeks and operculum without scales; eyes moderate, without spines in front, situated high on the head, placed nearer the point of the jaw than to the posterior margin of the preoperculum; operculum with a long sharp spine directing backwards over the shoulder; lateral line nearly straight throughout its course; lower jaw longest, sloping greatly upwards. Teeth small and fine on the maxillaries, vomer, palatines and pharyngeans. First dorsal fin commencing over the base of the pectorals, and ending in a line with the second ray of the anal; all its spines simple and very sharp,

* *Yarrell's British Fishes.*

† *Trachinus vipera*, Cuv. Yar. Jen.; *T. draco*, Pen. Flem. Donov. *Sting-Fish, Otter-Pike, Lesser-Weever, Adder-Pile, Black-fin.*

‡ Dr Fleming states, in his work on British Animals, that the tail is rounded, and that there are two spines in front of the eyes.

three first nearly of equal length; second dorsal-fin commencing close behind the first, and ending near the tail, over the last ray but three of the anal fin; rays soft and flexible, branched at the summit, gradually decreasing in height from the fifth; ventral-fins placed before the pectorals, the tips of the rays reaching as far as the vent; number of fin rays—

1st D. 6; 2d D. 24; P. 15; V. 6; A. 25; C. 12.

It is distinguished from the Great Weever, *T. draco*, the only other British species in this genus, by having no spine before the eyes, and in the second dorsal fin being composed of twenty-four rays; whereas the *T. draco* has a strong hooked spine before each eye, and thirty rays on the second dorsal fin.

This fish is of common occurrence on the south western shores of Scotland, and more particularly in the Solway Firth, than on any other part of the British coast. I have seen it captured occasionally on the sand banks off Exmouth, on the coast of Devon, and more frequently at Brixham while drawing the drag-net. Mr Yarrell says it occurs in the bays of Dublin and Belfast. It is met with at the mouth of the Tay, but very seldom seen in the Firth of Forth. In the year 1831, Mr Stark took specimens on the sands of Portobello. It has been observed once in the sands above Queensferry; and in 1834, in the month of August, a very fine specimen six and a half inches long was sent me from Musselburgh, where it was taken with a hook baited for flounders. Since then two other instances of its capture have occurred from the same quarter. It approaches the shores only in the warm summer months, when it is found inhabiting water from two to three feet deep. During the day it conceals itself in the sands, leaving only its nose and eyes above the soil uncovered; when approached, it immediately erects the first dorsal-fin, and if trod on (as frequently happens while persons are bathing), its sharp spines inflict a severe and painful wound, causing the part affected to swell, and become almost immediately of a dark brown appearance, which remains for five or six hours and then gradually subsides. The best application for a wound of this description is hot water, which relieves the pain and diminishes the swelling in the space of half an hour. The most common size of this fish is from four to four and a half inches in length. Dr Fleming and other authors state that it grows to the length of a foot; while the oldest fishermen on the Solway Firth never saw or heard of one more than six inches long. As an article of food it is never made use of. It feeds on crustaceous animals and young gobies, and deposits its spawn about the middle of spring.

Family II. LORICATI.—Suborbital bone extending over the cheek, and articulating behind with the preoperculum; head mailed, or otherwise armed.

Genus *TRIGLA*.—Dorsal fins two; body scaly; three detached rays under the base of the pectorals.

Trigla cuculus.*—The Red Gurnard.

Specific Characters.—Lateral line crossed throughout its length by lines not reaching below the middle of the sides. (See Plate XVIII.)

Description.—From a specimen fourteen inches in length. Body rather elongated; sides rounded, particularly near the caudal extremity; back nearly straight; head of a square form, falling obliquely from the orbit to the point of the snout. Colour of the head, sides, back, dorsal and caudal fins, rose-red; belly, ventral, and anal fins, dull white, more or less tinged with red; pectorals bluish; scales of moderate size, ciliated at their free margins, rendering the body rough to the touch; cheeks and upper

* *Trigla cuculus*, Lin. Cuv.; *T. pini*, Bloch. Jen.; *T. lineata*, Mont. Flem. *Red Gurnard*, *Red Crooner*, *Cuckoo Gurnard.*

part of the head rough, without scales; eyes large, placed high on the head; four spines on the upper and front part of each orbit; operculum with two sharp spines on the upper and posterior border; scapular spines extending back as far as in a line under the third dorsal ray; lateral line commencing over the upper part of the operculum, taking a straight course to the base of the tail where it divides into two, and extends down the caudal fin, crossed throughout its length with lines half an inch long, placed one-eighth of an inch apart; upper jaw longest. Teeth small and fine in both jaws, and on front of the vomer; dorsal ridge strongly toothed. First dorsal fin commences over the base of the pectorals and ends in a line over a little in front of the vent; all its spines simple; the second the longest, the remainder gradually decreasing; second dorsal fin beginning a little behind the first, and ending over the last ray of the anal; all its rays, except the first, branched at their summits; anal fin corresponding with the last dorsal, but somewhat shorter; pectorals reaching as far as the first ray of the anal; ventrals commencing close under the base of the pectorals, the tips of the rays reaching a little anterior to the vent; three detached rays under the base of each pectoral fin, the last ray the longest; tail lunated. Number of fin rays—

1st D. 9; 2d D. 18; P. 11; C. 12; A. 17; V. 6. Branchial rays 7.

The principal character which distinguishes this species from the rest of the gurnards is the form of the *scale*, which crosses the lateral line. (See Plate XVIII.) There is, however, a British species (*T. lineata*) that has not, as yet, been noticed on the Scottish coast, in which the lateral line is also crossed by lines, but *these lines*, instead of reaching only a short way down the *sides*, pass round as far as the *anal fin*. (See Plate XIX.)

The Red Gurnard occurs, on the Devonshire coast, in great numbers; and, on some occasions, thousands of them may be seen exposed for sale daily, especially in those small towns where the trawl-boat fishing is carried on. Mr Yarrell states that "it is very common in Ireland, and is taken from Waterford on the south up the eastern shore to Londonderry in the north, but seldom found larger than twelve or fourteen inches in length." On the east coast of Scotland it is seldom seen in any numbers. In the Firth of Forth a few are taken occasionally with lines during the summer months, and a solitary specimen may sometimes be found entangled in the salmon nets at the lower part of the Firth. The flesh is firm and well flavoured, and held in high estimation as food. It spawns about the month of June, and continues out of season until August; from October till March it is in the greatest perfection for the table. It feeds principally on crustacea.

Trigla hirundo.*—The Sapphirine Gurnard.

Specific Characters.—Lateral line plain and smooth; scales entire at their free margins, not ciliated; pectorals reaching beyond the second ray of the anal. (See Pl. XX.)

Description.—From a specimen fifteen inches in length. Body rather elongated and rounded, tapering from the head to the base of the tail; head of a square form, falling obliquely from the forehead to the end of the nose. Colour of the head, sides, and back, brownish-red, tinged with green; pectorals on their inner surface bluish-green, edged and spotted with bright blue; on their outer surface brownish-red; dorsal and caudal fins reddish; ventrals, anal, and abdomen, whitish. Scales rather small, oval, and entire; head rough; cheeks granulated, radiating from different centres; eyes large, placed high on the head; two spines on the upper and anterior edge of each orbit; operculum with two short spines on the upper and posterior border; scapular spines extending a short way back, over the base of the pectorals. Lateral line straight, perfectly smooth, and slightly elevated, commencing over the base of the scapular spine, taking a straight course to the base of the tail, where it bifurcates and extends down the caudal fin; composed of a number of short straight lines slightly bent at the lower extremity; under jaw longer than the upper; teeth small and fine in both jaws, and on front of the vomer; dorsal ridge in young specimens strongly serrated; when two feet in length the serratures become crenated, and rough. First dorsal fin commencing over the base of the pectorals, of a triangular

* *Trigla hirundo*, Cuv., Yarr., Pen., Don., Linn. *T. lævis.* Mont., Flem. *Sapphirine Gurnard, Tub-fish, Smooth-sides.*

form, and terminating in a line over the end of the ventral rays; first ray shorter than the second, all sharp and spiny. Second dorsal fin commencing close behind the termination of the first, and ending over the last ray of the anal; tail lunated; anal fin corresponding with the second dorsal; pectorals large, reaching a little beyond the third ray of the anal; ventrals terminating in front of the anal aperture; three detached rays at the base of the pectorals, of which the last is the longest; number of fin rays—

1st D. 9; 2d D. 16; P. 10; V. 6; C. 11; A. 15.

Fleming, Pennant, and Donovan, have all very incorrectly adopted the characters of Linnæus, in considering the lateral line of this fish rough; but on close examination, it is found to be perfectly smooth, which misled Montagu in supposing he had obtained a new species, to which he gave the name of *Trigla lævis*.

The present fish can be readily distinguished from all the other species of gurnards, except the *T. lyra*, by the *lateral line* being *smooth* and simple, composed of a number of short lines bent at the lower end. (See Plate 20.)

It differs from *T. lyra* in many respects, in having the *scales* of the body *entire*, *scapular spines short*, and the *second ray* of the first dorsal fin the *longest*; whereas the *scales* of *lyra* are *ciliated*, scapular spines extending *half way* down the pectorals; the *third ray* of the first dorsal fin the *longest*, and the *short lines*, which form the lateral line, *straight*. (See Plate 21.)

This species is common in the Mediterranean, and also on the English coast, more particularly on that of Cornwall, where it is sometimes taken the length of two feet, although the more common length is from a foot to fourteen inches. On the west coast of Scotland it is of frequent occurrence, but not so on the east coast. In the Firth of

Forth it is very rare, the only instance I am aware of its capture in the estuary was during the month of August, near Queensferry, where it was found in a pool of water left by the receding of the tide; occasionally it is taken beyond the Isle of May and brought to the Edinburgh Market. The ova in the month of January appear to be in a fit state to be deposited. Its food is crustaceous animals and small fishes; its flesh is firm and wholesome, and is considered by some to be superior tothe last species, but in general more dry. In the north of Europe it is salted for keeping; it is out of season in December, January, and February.

TRIGLA GURNARDUS.*—THE GREY GURNARD.

Specific Characters.—Pectoral and ventral fins of equal length; not reaching to the first ray of the anal fin; lateral line crenated. (See Plate 22.)

Description.—From a specimen a foot in length. Body elongated and rounded, tapering from the nape to the base of the tail; back straight; head somewhat of a square form, falling obliquely from the forehead to the end of the snout. Colour of the head, back, and sides, as far as a little below the lateral line, brownish-grey, marked with irregular white spots and a few black ones; dorsal, caudal, and pectoral fins, dusky; abdomen, lateral line, ventral and anal fins, pure white. In young specimens, the head, back, and sides, are red, with a black spot on the first dorsal fin; scales small, ciliated at their free margins (Mr Yarrell says the scales are smooth); head and cheeks rough, with granulations disposed in lines radiating from different centres; eyes large, placed high on the head; two spines in front of each orbit; operculum on the upper and posterior edge ending in two spines, the lower one much the longest; scapular spine ending in a sharp point directing back over the base of the pectoral fin; lateral line straight, bifurcating at the caudal extremity, and extending down the caudal fin, composed, as far as the base of that fin, of a number of elevated scales (in young specimens these scales and

* *Trigla gurnardus*, Cuv., Yar., Penn., Jen., Flem., Lin., Bloch, Don. *Grey Gurnard*, *Crooner* in Scotland.

dorsal ridge are strongly serrated) which in old specimens, together with the dorsal ridge, become crenated,* allowing the finger to pass as easily from tail to head as in the contrary direction; under jaw shortest; teeth small and fine in each jaw and on front of the vomer; first dorsal fin commencing a little behind the base of the pectorals, first ray shorter than the second; second and third rays longer and stouter than the rest; second dorsal fin commencing at a short distance from the termination of the first, and ending in a line over the last anal ray; first rays longer than the succeeding ones; anal fin corresponding nearly with the second dorsal; pectoral and ventral fins of equal length not reaching to the vent; three detached rays under the base of the pectorals, of which the last is the longest.—Number of fin rays—

1st D. 8; 2d D. 20; P. 9; V. 6; A. 19; C. 11; air-bladder bilobed.

This species is one of the most common on the east coast of Scotland. "It is taken along the line of our southern coast generally; up the eastern coast going northwards, on the coast of Scotland, and at the Orkney Islands; it is found also in the Baltic, and on the west coast of Norway; it occurs in Ireland in all the localities which produce the red gurnard, namely from Waterford in the south, up the eastern coast to Londonderry in the north." †

It occurs frequently in the Firth of Forth during the summer months, seldom found higher up the estuary than a little above Queensferry. Off Burntisland it is occasionally taken, but not in such numbers as at the mouth of the Firth. Pennant states, "that it sometimes attains the length of two feet and a half;" although one half that size is con-

* Mr Jenyns, in his Manual of British Vertebrate Animals, page 342, states, that the lateral line is *sharply serrated.* Mr Yarrell says the lateral line is strongly marked with a *sharp crest.* Dr Fleming in his work, page 215, mentions, that the lateral line and dorsal ridge *are serrated.* This diversity of opinions will be accounted for in the sequel, when speaking of the characters at different ages of the fish.

† Yarrell's *British Fishes.*

sidered beyond the average length. It feeds on crustacea and small fishes, and is taken generally with hooks baited with muscles; it spawns in May and June, when it is out of season for the table. As food, it is considered by all fishermen to be richer and sweeter than most of the other gurnards, although in the market it is less sought after than the red gurnard, which is the drier and worse-flavoured of the two.

This fish when a foot in length is distinguished by having short pectoral fins *not* reaching beyond the vent; the dorsal ridge and lateral line *crenated* but not serrated, allowing the finger to pass as freely from tail to head as in the contrary direction; and in having the first three dorsal spines *granulated;* the pectoral fins in all the other species (except *T. Blochii* of Yar.) reach to or beyond the first ray of the anal fin. In a specimen nine inches in length the dorsal ridge is partly crenated and partly serrated, the granulations appearing first on the back of those scales nearest the tail; each scale forming the lateral line has a small sharp point directing backwards, with two or three granulations pointing outwards; the first dorsal fin with a faint dark spot. If a specimen seven inches in length be examined, we shall find the dorsal ridge and lateral line *strongly serrated*, allowing the finger to be readily passed down, but not in the opposite direction; the first dorsal spine granulated in front, the second on the right side, and the third on the left; a distinct *dark spot* on the first dorsal fin, and a dark band down the middle of the second dorsal. In a specimen six inches long, the base of the three first dorsal spines is but very faintly granulated; and in one five inches long the granulations are *not* apparent, and the pectoral fins reach to the vent.

TRIGLA BLOCHII.*—BLOCH'S GURNARD.

Specific Characters.—First dorsal fin with a black spot; dorsal ridge strongly serrated. (See Pl. 23.)

Description.—From a specimen five inches in length. Body elongated, tapering from the posterior part of the head to the tail; head somewhat of a square form, falling obliquely from the forehead to the tip of the nose; back straight. Colour of the head, back, sides, dorsal, and caudal fins, rose red; abdomen, lateral line, ventral and anal fins, dull white; first dorsal fin with a large black spot placed on the upper part of the membrane between the third, fourth, and fifth rays; pectorals dusky grey. Eyes large, placed high on the head; two spines in front of each orbit, directing backward. Head and cheeks hard and rough, with granulations disposed in lines radiating from different centres; operculum ending in two sharp spines, the upper not projecting beyond the membrane; the lower one extending half way over the scapular spine; scapular spine rather long, ending in a sharp point directing backwards over the base of the pectorals. Lateral line straight, slightly turned at its origin, much raised and bifurcated at the caudal extremity; each scale composing it has two teeth of unequal length, the lower one pointing towards the tail, the other directing slightly upwards; the finger can be passed with ease down the scales, but not in the contrary direction. Dorsal ridge strongly serrated, each scale or plate ending in a sharp point directing backward. Teeth small and fine in each jaw, and on front of the vomer. First dorsal fin commencing a little behind the base of the pectorals; first ray shorter than the second,† second and third rays the longest; the remainder gradually decreasing; second dorsal commencing at a short distance from the termination of the first, and ending nearly in a line over the base of the last anal ray; first rays longer than the rest. Anal fin corresponding with the second dorsal; pectorals reaching to the vent and longer than the ventrals; three detached rays under the base of the pectorals, the first shorter than the succeeding ones; tail lunated. Number of fin rays—

1st D. 8; 2d D. 20; V. 6; A. 18; P. 9; C. 11; Branchiostegous rays 7.

This fish, according to the statements of authors, is found in the Channel of Boulogne, and is very abundant in the Mediterranean. It is equally common with the grey gur-

* *Trigla Blochii*, Yarr. *T. cuculus*, Cuv., Penn., Jen., Bloch, Montagu.

† Mr Yarrell has represented the first ray as being *longer* than the second.

nard throughout the whole of the British coast, although it is said to be of less common occurrence. Colonel Montagu, as well as myself, have seen many of these taken on the Devonshire coast, by small drag-nets, and returned again to the water, the fishermen considering them as the young of some of the other species of gurnards.

In the Firth of Forth, in the month of August, I procured several specimens about three inches in length, above North Queensferry, in a pool of water which had been left by the tide, where there were at least two dozen; they remained in the same station for five weeks, although the tide covered them daily with three feet of water; they did not appear in the least shy but swam about in shoals, one always taking the lead; when they were suddenly approached they became stationary, and erected their first dorsal fin, which, with the black spot on the upper part of each, gave the shoal a beautiful appearance; when they were unmolested this fin became deflexed. In those I examined, their stomachs were filled with small shrimps and star-fish.

The spawning season of this species is not known, as no ova has yet been found in it of any size, although specimens can be obtained all the year through.

From a close examination of several specimens of this fish, of all sizes, I am induced to consider it as nothing else than the young of the *Trigla gurnardus* or grey gurnard, notwithstanding the high authorities of Cuvier, Jenyns, Montagu, and others, who, from personal examination, consider it as a distinct species.

The characters by which this fish is said to be distinguished from the grey gurnard, are, first dorsal fin with a black spot; dorsal ridge strongly serrated, and the first three dorsal rays smooth, not granulated. These characters depend on the age of the fish, as shewn when treating of the last species, *Trigla gurnardus.* Mr Yarrell, in speaking of this fish, says, "The spot on the first dorsal fin, however, must not be considered as sufficient alone to identify this species; the two specimens under comparison, both having this black spot, are in reality only varieties of the grey gurnard." Certainly if we examine a specimen of *T. Blochii* and a full grown one of *T. gurnardus*, we shall find them to differ widely from one another; but if a specimen of either, nine inches in length, be examined, it will be found to possess the characters of both, namely, the first dorsal fin will have the rudiments of a dark spot; the dorsal ridge partly crenated and partly serrated, the lateral line rough and serrated, and the body of a reddish-grey appearance. Mr Jenyns states that it never attains the size of the grey gurnard. In no instance have I ever found the young of the grey gurnard possessing the characters of an adult, but bearing always those which are assigned to *T. Blochii.**

GENUS *COTTUS.*—Dorsal fins two; body without scales; teeth in front of the vomer, but none on the palatines.

COTTUS SCORPIUS.†—THE SHORT-SPINED COTTUS.

Specific Characters.—Preoperculum with three spines, the longest not extending beyond the operculum.

Description.—From a specimen a foot in length. Body rounded, without scales, tapering gradually to the base of the tail; head large,

* Plate 24. is here added to make the number of the British gurnards complete, and to serve as a comparison should the fish be found to occur on the Scottish coast. It has recently been added to the British Fauna.—*See Magazine of Zoology and Botany*, vol. i.

† *Cottus scorpius*, Cuv., Yar., Jen., Bloch. *Short-spined Cottus, Sea Scorpion, Sea Bullhead*, Scotland.

armed with spines. Colour of the head, back, and sides reddish-brown; belly whitish, with large spots of light brown; all the fins beautifully marbled with black and white. The colours are very variable, depending greatly on the time of the year in which they are examined; in July and August they are the most vivid, when I have found the roe far advanced. Lateral line smooth, rather prominent, commencing over the upper part of the operculum, taking a slight curve to the end of the first dorsal fin, from thence straight to the base of the tail where it terminates; occasionally there are a number of small rough tubercles scattered over the body, sometimes arranged in rows presenting an appearance as if there were a second lateral line. (Mr Yarrell has well represented this second line in his figure of this fish.) Eyes moderate, situated rather high, placed nearer the point of the nose than to the operculum. In front of each orbit is placed a short, stout, sharp spine, and a small tubercle on the upper and posterior margin. Operculum with a stout, sharp spine directing over the base of the pectorals; suboperculum with two short spines, one pointing down towards the base of the ventral fin, the other directing to the first ray of the pectoral fin. Preoperculum with three spines; the first, which is the longest, points towards the base of the first ray of the pectorals, and does not extend beyond the posterior border of the operculum; the second, which arises at the base of the former, is about one-half its length, and points towards the base of the tenth ray of the pectoral; the third, which scarcely projects beyond the membrane, points towards the base of the lower jaw. First dorsal fin commencing over the middle of the base of the pectorals, and terminating in a line over the anterior part of the vent; all its rays spinous and slender; the middle ones the longest. Second dorsal commencing close behind the first, and ending rather behind the termination of the anal fin; its middle rays the longest. Anal corresponding with the second dorsal, but somewhat shorter; pectorals broad and rounded, extending rather under the throat, the seventh, eighth, and ninth ray the longest; ventrals placed under the base of the lower part of the pectorals. Teeth small and fine in both jaws, and on front of the vomer; under jaw the shortest; a conical elevation between the nasal spines; tail rounded at the end; occipital spine short; scapular spine directing backwards and slightly upwards. Number of fin rays—

1st D. 9; 2d D. 16; P. 16; V. 4; A. 11; C. 12; Branchiostegous rays 6.

It is distinguished from the *Cottus bubalis* in the lateral line being *smooth*; the long spine of the preoperculum *not* *extending* beyond the posterior margin of the *operculum* ; and in having *a conical elevation* between the nasal spines. Whereas the lateral line in *Cottus bubalis* is *rough* ; the spine of the preoperculum *extends* beyond the posterior margin of the *operculum* ; and *no elevation* between the nasal spines.

We have reason to suppose that this fish does not exist in the Mediterranean, since Risso makes no mention of it in his Ichthyologie de Nice, nor is it found so plentiful on the southern coast of England as on the east and west coasts of Scotland. It is common in the Firth of Forth in the months of July and August, and is found as far up as opposite Kincardine, where a few are occasionally taken. The flesh is eaten on some parts of the coast, but is by no means considered a delicate morsel. It feeds on crustacea generally, and small fishes, keeps not far from shore, and is frequently found in small pools left by the receding tide. The common length is from seven to nine inches, although occasionally specimens are found to exceed a foot.

Cottus bubalis.*—The Long-spined Cottus.

Specific Characters.—Preoperculum with four spines ; the longest extending beyond the operculum.

Description.—From a specimen five inches in length. Body rounded, without scales, tapering gradually to the base of the tail. Head large, armed with spines, some directing backwards, others downwards. Colour of the head, back, and sides, reddish-brown ; belly dull white ; fins more or less mottled with dark-brown, with a shade of orange, but very variable ; more brilliant in the spawning season. Lateral line elevated, rough, more so behind the pectorals, taking a slight bend at its origin and passing straight to the tail. Eyes nearer the nose than to the posterior margin of the operculum ;

* *Cottus bubalus*, Cuv., Yar., Jen. *Long-spined Cottus, Father Lasher, Lucky Proach*, Scotland.

in front of each orbit a small sharp spine, and on the upper and posterior margin a small tubercle, whence proceeds an elevated ridge passing backwards, terminating in a sharp point. Operculum with a strong granulated spine directing over the base of the pectorals, and inclining a little upwards; suboperculum with two spines, one pointing backwards, and the other downwards towards the base of the ventrals. Preoperculum with four spines, the first the longest, directing backwards, over the base of the pectorals and inclining a little upwards; the second very short, about one-fifth the length of the first, commencing at its base, directing backwards and outwards; the third similar to the last; the fourth pointing downwards to the base of the lower jaw. First dorsal fin commencing over the base of the pectorals, and terminating in a line over the anterior part of the vent; all its rays spinous and slender, the middle ones the longest, the last shortest; second dorsal fin commencing at a short distance from the termination of the first, and ending a little behind the last ray of the anal, its middle rays rather the longest. Tail rounded; anal fin corresponding with the second dorsal, but shorter; pectorals broad and rounded, extending rather under the throat; sixth, seventh, and eighth rays the longest, the remainder on the lower border gradually decreasing; ventrals short, commencing under the base of the lower part of the pectorals. Teeth small and fine in both jaws and in front of the vomer, lower jaw shortest; scapular spine directing backwards and inclining a little upwards. Number of fin rays—

1st D. 8; 2d D. 12; P. 16; V. 4; A. 9; C. 10; Branchiostegous rays 6.

This species is distinguished from *Cottus scorpius* in the lateral line being *rough*, the spine of the operculum *granulated*; preoperculum with *four spines*, the longest *reaching* to the base of the pectorals. Whereas the lateral line and spine of the operculum in *C. scorpius* are *smooth*, preoperculum with *three spines*, the longest *not* reaching to the base of the pectorals.

It was not until after the appearance of Mr Yarrell's valuable work on the British Fishes, that naturalists in this country could distinguish the difference between this and the last species, being constantly confounded under one synonym, the Father Lasher.

It is now well known that two species, equally common, are found to inhabit the coasts of Britain, which are not only distinguished from one another by certain specific characters, but differ likewise in their habits and peculiarities.

Mr Yarrell, who was the first naturalist to discover the *Cottus bubalis* as British, says that the "Father Lasher is immediately recognised by its well-armed head and long spines, but seldom measures more than from six to ten inches in length on our shores. During the greater part of the year it is to be found on the coast from Cornwall to the Orkneys, and is frequently left by the receding of the tide in small pools among rocks. The general appearance of the fish is forbidding; when touched it distends its gill-covers, and sets out its numerous spines, assuming a most threatening appearance. It spawns in January, and the ova at that time are very large, and of a fine orange-yellow colour. These are deposited near the sea-shore, frequently in the estuaries and sometimes even in rivers; the fish having prepared itself for this change by its previous residence in the brackish water, after which it appears to be able to bear either extreme. Its food is small crustaceous animals, and it is said to be particularly partial to feeding on the fry of the blennies. In Greenland it is in such great request, that Pallas tells us it forms the principal food of the natives, and the soup made of it is said to be agreeable as well as wholesome." This fish is as frequently met with in the Firth of Forth as the *Cottus scorpius*, and is common throughout the Firth, but seldom found higher up the estuary than a little above Queensferry. Near North Berwick, as many as nine were taken from a small pool that had been left by the tide. The most favourable locality for this fish appears to be rocky situations, or where there are large stones covered with fuci, among which it secures itself by crawling a far way underneath; it takes the bait eagerly, and a number are taken off the pier-head at Leith with hooks baited with muscle. In the stomachs of many I found small shells and the remains of star-fish.

GENUS *ASPIDOPHORUS*.—Dorsal fins two; body covered with scaly plates; vomer and palatines without teeth.

ASPIDOPHORUS EUROPÆUS.*—THE ARMED BULLHEAD.

Specific Characters.—Chin with thread-like filaments; vent under the middle of the pectorals.

Description.—From a specimen four inches in length. Body angular, tapering to the tail; covered with a number of hard scaly plates; head depressed; dorsal, pectoral, and caudal fins rounded; the body behind the pectorals hexagonal; from the termination of the pectorals to the end of the second dorsal octagonal; from thence to the tail hexagonal. Colour of the head, back, dorsal, and caudal fins, light brown; belly and anal fin white; pectorals slightly mottled with brown; body with three, or sometimes more, broad, transverse dark bands. Lateral line commencing over the base of the pectorals, making a slight bend to the end of the pectoral rays, thence straight to the tail, composed of a series of small elevated dots, placed a little apart from each other. Operculum rounded, entire, without spines; preoperculum with a stout curved spine on its lower margin, extending back nearly to the posterior border of the operculum. A little before this is another spine, much smaller, pointing outwards and upwards; infra-orbitals with three or four small tubercles on the inferior margin; snout with four strong erect spines, two on each side; eyes moderate, placed nearer the point of the nose than to the posterior margin of the operculum; from the posterior border of the orbit extends an elevated bony ridge, which terminates at the nape; jaws furnished with a number of small fine teeth, but none on the vomer or palatines; under jaw the shortest. First dorsal fin commencing over the middle of the pectorals, and ending a very little beyond them;† second dorsal fin commencing close behind the first,

* *Aspidophorus Europæus*, Cuv., Yar., Jen. *Cottus cataphractus*, Linn., Pen., Don. *Cataphractus Schoneveldii*, Flem. *Armed Bullhead*, *Pogge*, *Lyre*, *Sea-poacher*, *Pluck*, *Noble*, *Shell-backed Bullhead*, Scotland.

† The position of the dorsal fins is liable to vary a little according to the size of the fish; in a specimen six inches in length the first dorsal fin commences over the lower third of the pectorals.

and terminating behind the last ray of the anal; anal fin placed under the second dorsal, with its last rays the longest; pectorals rather large; ventrals commencing under the base of the pectorals, and extending to a little behind the vent, which is situated under the middle of the pectorals; chin and branchiostegous membrane furnished with a number of thread-like appendages. Number of fin rays—

1st D. 5; 2d D. 6; P. 16; V. 3; A. 7; C. 11; Branchiostegous rays 6.

This species is readily distinguished from its congeners, by the body being covered with osseous plates, and the chin fringed with thread-like appendages.

Mr Yarrell says, on the authority of Mr Couch, that "this species is not very common in Cornwall, and that, when found, it is most frequently near the mouths of rivers, but occasionally taken far out at sea." In the county of Devon, in the sandy bays of Exmouth, I have frequently met with it, although Colonel Montagu considers it rare on the south coast of Devon. Mr Yarrell states that it is well known along the line of our southern coast; and the young of small size are frequently taken by the shrimpers in most of the sandy bays in the mouth of the Thames, and of other rivers. In the Firth of Forth it is very commonly taken in the oyster dredges off Newhaven, as well as in the cruives at Kincardine. It occurs on the coast of Norway, and in all the northern seas as far as Greenland. Mr Jenyns states that it conceals itself in the sand, and feeds on small crustacea and marine insects. According to Bloch, it spawns in May: its flesh is said to be firm and good. Average length about four inches.

Genus *GASTEROSTEUS*.—Dorsal fin one, with from three to fifteen spines in front; teeth in both jaws; none on the vomer or palatines.

Gasterosteus leiurus.*—The Quarter-armed Stickleback.

Specific Characters.—Back armed with three spines; lateral plates not extending beyond the second dorsal spine. (See Plate 25.)

Description.—From a specimen two inches in length. Body rather elongated of an oval form; sides compressed; head granulated; cheeks smooth; colour of the back and sides yellowish-brown; thorax and belly silvery-white; male individuals, especially in the spawning season, are red under the throat and breast, and shaded with bright green on the sides, but liable to great variation. Lateral line commencing over the scapular plate, and taking the curve of the back to the base of the tail; sides, over the pectorals, armed with three or four scaly plates, which terminate under the second dorsal spine, and not extending beyond the end of the pectoral rays; from the second dorsal spine to the tail, the sides are smooth without scales, marked with transverse linear depressions, forming an angle at the junction with the lateral line. Scapular plate and operculum rounded; preoperculum slightly produced at its inferior posterior margin; ascending portion of the pelvic plate passing behind the pectorals, and ending in two points a little under the lateral line. First dorsal spine placed over the base of the pectorals; the second, which is the longest, over the last lateral plate; the third, which is much the smallest, over the termination of the pelvic plate. Dorsal fin commencing close behind the last spine, and ending nearly in a line over the termination of the anal fin; tail fin slightly concave at the end; anal fin corresponding with the dorsal, but commencing farther back; a small bent spine in front of the first ray; each ventral fin composed of a strong serrated spine; pectorals not reaching beyond the membrane of the second dorsal spine; eyes large; jaws furnished with small fine teeth; none on the vomer or palatines; under jaw the longest; base of the tail never keeled. Number of fin rays—

D. 11; P. 10; V. 2; A. 8; C. 12; Branchial rays 3.

It is distinguished from *G. trachurus* and *G. semiarmatus* by the lateral plates not extending beyond the second dorsal spine; but in what respect it differs from *G. brachycentrus*, both of equal length, I am not prepared to say.

* *Gasterosteus leiurus*, Cuv., Yar. *G. aculeatus*, Penn. (p. lxi.) *Quarter-armed Stickleback*, *Smooth-tailed Stickleback*, *Banstickle*, Scotland.

This species is said to be extremely common in all the fresh waters of Europe. It is known throughout England by the name of Stickleback, and in Scotland is denominated Banstickle. It is far more common in the districts of the Firth than *G. trachurus*, and is found in Lochend, Duddingston Loch, and in most of the pools and ditches in the neighbourhood. "It is an active and greedy little fish, extremely destructive to the fry of other species, and consequently injurious in ponds where these are sought to be preserved." We are informed by Mr Baker, that it will spring not less than a foot perpendicularly out of the water, and to a much greater distance in an oblique direction, when it desires to overcome any opposing obstacle. It is scarcely to be conceived what damage these little fish do, and how greatly detrimental they are to the increase of all the fish in general among which they live; for it is with the utmost industry, sagacity, and greediness that they seek out and destroy all the young fry that come in their way, which are pursued with the utmost eagerness, and swallowed down without distinction, provided they are not too large; and in proof of this I must assert, that a banstickle which I kept for some time, did, on the 4th of May, devour in five hours' time, seventy-four young dace, which were about a quarter of an inch long, and of the thickness of a horse-hair. Two days after, it swallowed sixty-two; and would, I am persuaded, have eat as many every day could I have procured them for it.* It spawns in May; its flesh, although wholesome and palatable, is seldom made use of as food.

* *Encyclopædia Britannica*, article *Ichthyology*. J. Wilson, Esq., Edinburgh.

Gasterosteus semiarmatus.*—The Half-armed Stickleback.

12, *Specific Characters.*—Back armed with three spines; lateral plates not extending beyond the line of the vent. (See Plate XXV.)

Description.—From a specimen two inches in length. Body rather elongated of an oval form; scapular plate, operculum, and preoperculum, rounded at their posterior margin; under jaw the longest; dorsal and anal fins gradually diminishing in height from the anterior rays; caudal fin even at the end, or very slightly concave; second dorsal spine the longest; the third very small, not half the size of the first. Colour of the head, back, and sides, yellowish-brown, with a shade of green; cheeks, thorax, and belly, silvery-white. Lateral line commencing over the upper part of the operculum, following the curve of the back, and terminates at the base of the tail; sides armed by a number of scaly plates, which do not extend beyond the line of the vent, from thence to the tail the sides are naked, marked with transverse linear depressions, forming an angle at their junction with the lateral line. First dorsal spine placed over the base of the pectorals; the second over the ventral spine; the third over the termination of the pelvic plate. Dorsal fin commencing close behind the last dorsal spine; anal fin commencing behind the vent, and both fins terminating in the same line; each ventral fin composed of a strong serrated spine, commencing at the base of the ascending portion of the pelvic plate; pectorals small, even at the end; eyes large; teeth fine and sharp in both jaws; none of the vomer or palatines; base of the tail smooth, never keeled; a small curved spine at the base of the first anal ray. Number of fin rays—

D. 10; P. 10; V. 2; A. 9; C. 12; Branchial rays 3.

This fish is of much less frequent occurrence than *G. biurus*, or *G. trachurus*, although found to inhabit the same places. It seldom exceeds two inches and a half in length, and is supposed by Jenyns to be only a variety of the *leiurus*. They certainly are very much alike, but the fact of the lateral plates extending beyond the end of the pectorals and not passing the vent, is considered by Cuvier and Yarrell as a sufficient character to constitute it a distinct species. It is found occasionally in the marshes below Kincardine, and in the ditches in Guillon Links.

* *Gasterosteus semiarmatus*, Cuv., Yarr.

Mr Jenyns, who appears to have paid much attention to the characters of these fish, says, that "*G. leiurus*, *G. semiarmatus*, *G. trachurus*, and *G. brachycentrus*, are mere varieties, subject to great variation, not only in the number of the lateral plates, but in several other less obvious respects. The former may occasionally be found of every intermediate number, down to that which characterizes *G. trachurus*. This number, moreover, is sometimes found constant in specimens which differ remarkably in other respects; at other times varying, when all other characters remain the same." Mr Yarrell states, that "he has taken specimens of *G. semiarmatus* of all sizes, which were uniform in the number of lateral plates, and close examination by a friend who has paid particular attention to this subject, has shewn that no point of ossification or induration is to be found posterior to the last perfect lateral plate which seldom passes beyond the line of the vent."

Gasterosteus trachurus.*—The Full-armed Stickleback.

Specific Characters.—Back armed with three spines; lateral plates extending to the base of the tail. (Plate XXV.)

Description.—From a specimen two inches and a half in length. Body rather elongated of an oval form; sides compressed; scapular plate, operculum, and preoperculum, rounded at the posterior border; under jaw the longest; dorsal and anal fins diminishing in height from before backwards, and ending in the same line; tail fin slightly concave at the end; second dorsal spine the longest; the third the shortest, not half as long as the first; lateral line commencing over the base of the scapular plate, taking the curve of the line of the back to the base of the tail; first dorsal spine placed over the base of the pectorals; second over the ascending portion of the pelvic plate;

* *Gasterosteus trachurus*, Cuv., Yarr. *G. aculeatus*, Bloch, Don., Flem., Jen. *Full-armed Stickleback*, *Rough-tailed Stickleback*, *Banstickle*, *Sharplin.*

the third over the point of the ventral spine; dorsal fin commencing close behind the last dorsal spine; anal fin commencing behind the vent, with a small bent spine placed in front of the base of its anterior ray; ventral fin composed of a strong serrated spine, placed at the base of the ascending portion of the pelvic plate; eyes large; teeth small and fine in both jaws; none on the vomer or palatines; base of the tail square; formed by a horizontal expansion of skin placed on both sides. Colour of the head, back, and sides, brownish-grey, shaded with green; cheeks, thorax, and abdomen, silvery-white. Number of fin rays—

D. 10; P. 10; V. 2; A. 9; C. 12; Branchial rays 3.

It is readily distinguished by two constant characters, namely, the sides armed with plates extending from the base of the pectorals to the tail; and the base of the tail being square, formed by a horizontal expansion of skin on both sides.

Mr Jenyns considers this stickleback as a mere variety of the preceding ones; but, as far as my observations have led me, I agree with Cuvier and Yarrell, in considering it a constant and well-marked species. I have examined carefully several hundred, from half an inch to two inches and a half in length, and in all the specimens the lateral plates were constant; nor does the square tail exist in the other species, however variable the characters may be in other respects.

This species is known throughout the whole of the British coast, but is found more plentiful in some situations than in others. Pennant states that at Spalding, in Lincolnshire, there are, once in seven years, amazing shoals which appear in the Welland, coming up the river in the form of a vast column. This concourse is supposed to arise from the multitudes which have been washed out of the fens by the floods of several years, and which collect in deep holes, till, overcharged with numbers, they are obliged to attempt a change of place. The quantity may, perhaps, be conceived from the fact, that a man employed in collecting them gained, for a considerable time, four shillings a-day by selling them at the rate of a halfpenny a bushel.* The habits of these fish, when observed while under confinement, are extremely pugnacious. "When a few were placed in a wooden vessel, they swam about in a shoal, apparently exploring their new habitation ; suddenly, one will take possession of a particular corner of the tub, or, as it will sometimes happen, of the bottom, and will instantly commence an attack upon his companions ; and if any one of them ventures to oppose his sway, a regular and most furious battle ensues. The two combatants swim round and round each other with the greatest rapidity, biting and endeavouring to pierce each other with their spines, which on these occasions are projected. I have witnessed a battle of this sort which lasted several minutes before either would give way ; and when one does submit, imagination can hardly conceive the vindictive fury of the conqueror, who, in the most persevering and unrelenting way, chases his rival from one part of the tub to another, until fairly exhausted with fatigue. They also use their spines with such fatal effect that, incredible as it may appear, I have seen one during a battle absolutely rip his opponent quite open, so that he sunk to the bottom and died. I have occasionally known three or four parts of the tub taken possession of by as many other little tyrants, who guard their territories with the strictest vigilance. These are the habits of the male fish alone ; the females are quite pacific, appear fat, as full of roe, and never assume the brilliant colours of the male, by whom, as far as I have observed, they are unmolested."†

However plentiful this species may be on some parts of

* *Encyclopædia Britannica*, article *Ichthyology*.
† *Yarrell's British Fishes.*

the coast, it is by no means common in the Firth of Forth. The only places I know of its occurrence are between Bo'-ness and South Queensferry, and in the vicinity of Aberlady, and then seldom more than five or six are found together. Further south on the same coast, in the neighbourhood of Berwick-upon-Tweed, it is more frequently met with, inhabiting brackish water in preference to either fresh or salt water. The young when disturbed are remarkably active, darting about in every direction, and will often, to avoid the pursuer, bury themselves an inch or more under the surface of the mud. They are of little or no use except as manure for the land. They spawn in spring, and feed on insects, worms, and the fry of other fishes.

Gasterosteus spinulosus.*—The Four-spined Stickleback.

Specific Characters.—Back armed with four spines. (See Plate XXV.)

Description.—From a specimen one inch and a half in length. Body of an oval form; sides compressed; operculum, preoperculum, and scapular plate rounded at the posterior margin; under jaw the longest; dorsal and anal fins of the same form, gradually decreasing from before backwards; caudal fin slightly concave; second and third dorsal spines the longest, the fourth the shortest, not half the length of the first. Lateral line commencing over the base of the scapular plate, following the line of the curve of the back to the base of the tail. First dorsal spine placed over the base of the pectorals; second over the ascending portion of the pelvic plate; the third over the end of the ventral spine; dorsal fin commencing close behind the last dorsal spine, and ending over the last ray of the anal; anal fin commencing under the third dorsal ray. Lateral plates about three in number, extending down as far as the end of the pectoral rays; from thence to the tail the sides are naked, marked like *G. leiurus* with linear transverse depressions; ventral fin composed of a strong serrated spine, attached behind to a small ray, placed at the base of the ascending portion of the pelvic plate. Eyes large; teeth small and fine in both jaws, none on the vomer or palatines;

* *Gasterosteus spinulosus*, Yar., Jen.

at the base of the first ray of the anal fin, a small curved spine. Colour of the head, back, and sides, brownish-green; cheeks thorax, and abdomen, silvery-white. Number of fin rays—

D. 9; P. 9; A. 8; C. 12; Branchial rays 3.

Dr Stark was the first naturalist who noticed a four-spined species of stickleback, inhabiting the waters of Britain; several specimens, about an inch and a quarter in length, were found by him in a ditch in the neighbourhood of Edinburgh, and exhibited at a meeting of the Wernerian Natural History Society in 1831. Since then I have met with it in several localities; in a stream about a mile above South Queensferry; in ditches at Guillon Links; in a ditch on the west side of Duddingston Loch, and in the neighbourhood of Berwick-upon-Tweed. In this last-named locality I found three specimens with the third spine much shorter than the fourth, which deserves to rank higher than as a mere variety. (See Plate XXV.)

Gasterosteus pungitius.*—The Ten-spined Stickleback.

Specific Characters.—Back armed with ten spines. (Plate XXVI.)

Description.—From a specimen one inch and a half in length. Body rather elongated, of an oval form; sides compressed, naked, without lateral plates; operculum, preoperculum, and scapular plate, rounded at the posterior margin; eyes large; under jaw the longest. Colour of the head, back, and sides, of a yellowish-brown, occasionally dark brown, and in a few instances nearly black; cheeks, thorax, and abdomen, dull white, minutely frecked with dark olive, liable to great variation in colour. Back with ten spines, the first placed over the middle of the shoulder plate, the last, which is the longest and stoutest, placed in a line over the anterior part of the anal spine. Dorsal fin commencing close behind the last dorsal spine, and ending in a line with the last ray of the anal fin; its anterior rays the longest, gradually decreasing from before backwards; anal fin corresponding with thê dorsal: tail even at the end, or very

* *Gasterosteus pungitius*, Cuv., Yar., Jen., Don., Pen., Flem.

slightly concave; ventral spine placed under the middle of the pectorals, not as long as the abdominal plate; lateral line commencing over the scapular plate, and taking a straight course to the base of the tail; ascending portion of the pelvic plate rather narrow, not extending so high as to meet the lateral line; sides marked by a number of linear transverse depressions, forming an angle at their junction with the lateral line. Teeth small and fine in both jaws, none on the vomer or palatines; number of fin rays—

D. 10; P. 11; A. 10; V. 2; C. 12; Branchial rays 3.

This fish is said to be equally abundant with the three-spine species of stickleback, and is found in salt, as well as in fresh water pools. In the district of the Firth of Forth, I have met with but four specimens, and those were taken in a small stream west of Prestonpans; two of them differed in the number of dorsal spines, the one possessing eleven spines and the other nine,—but in other respects they were similar to those with ten spines. (See Plate XXVI.)

Gasterosteus spinachia.*—The Fifteen-spined Stickleback.

Specific Characters.—Back armed with fifteen spines. (Pl. XXVI.)

Description.—From a specimen five inches in length. Body much elongated, rounded in front of the dorsal fin, behind it depressed; base of the tail compressed; dorsal and anal fins of equal size, of a triangular form, slightly rounded at their free margins; caudal fin, when expanded, slightly rounded at the end; scapular plate, operculum, and preoperculum, also rounded. Colour of the head, back, and sides, brownish-yellow, occasionally bright-green; cheeks, thorax, and abdomen silvery-white; anterior part of the dorsal and anal fins black, the remainder transparent; sides spotted and marked with irregular brown bands, passing across the lateral line in the region of the dorsal and anal fins; a bright silvery band extending from the angle of the mouth, round the inferior margin of the orbit, to the upper half of the preoperculum. Lateral line strongly marked, much elevated, commencing over the operculum, and passing nearly in a straight line to the base of the tail, composed of a number of imbricated

* *Gasterosteus spinachia*, Cuv., Yarr., Jen., Linn., Bloch, Don. *Spinachia vulgaris*, Flem. *Fifteen-spined Stickleback*, *Great Sea-adder*, *Bismore*, *Duckins* at Berwick.

scales, slightly carinated on the outer surface, marked by a few granulated and striated lines; dorsal spines commencing over the middle of the scapular plate, fifteen in number, all of equal length, the last excepted, which is rather longer and more curved than the preceding ones. Dorsal fin commencing immediately over the vent, and ending in a line a little before the termination of the anal fin; ventral fin commencing close behind the end of the pectorals, composed of two rays, the first strong and spiny, the other, which is placed behind, soft and flexible; under jaw the longest, both jaws furnished with a number of small teeth, none on the vomer or palatines, those in front are placed in a row about four in number, stouter and more bent than the others. Eyes large, situated nearer the posterior margin of the operculum than to the point of the snout; a strong bent spine close behind the vent corresponding in size to the last dorsal spine. Number of fin rays—

D 7; P 11; V 2; A 7; C 12; Branchial rays 3.

This species of stickleback is considered by Mr Couch to be common on the coast of Cornwall, where, in the summer months, considerable numbers of fry are seen swimming about at the margin of the sea. I have observed it on the coast of Devon as well as in many places on the west and east coasts of Scotland, and according to Mr Low it is found very frequent in the Orkneys. Perhaps, in no part of the British coast do they exist in greater numbers than on the coast of Berwick-upon-Tweed; there have I seen in the month of June, in some of the pools which had been left by the tide, as many as a hundred young ones together, taking refuge under the large blades of *fuci* which they delight to frequent. At this time the fry are from an inch to an inch and a half in length, the parent fish which grows to the length of five inches or more keeping far in the deep. On the return of the tide specimens of large size are occasionally taken in the salmon nets at the mouth of the Tweed; but are never found to ascend the river higher than brackish water. These fish are not common in the Firth of Forth, although it seems a place well calculated for their habits, in containing large quantities of *fuci*, more particularly the *Chordaria flagelliformis.* They are found in pools near Aberlady, but seldom more than three or four together. While undisturbed, they remain apparently motionless, moving the pectorals only, and occasionally giving a dart with such velocity as almost to escape observation. Specimens have occasionally been taken at Queensferry, but they are rarely seen as high up as Alloa.

They feed on small insects, and the fry of other fishes, and spawn in the early part of spring. Their flesh is never made use of as food.

FAMILY III. SCIÆNIDÆ. Preoperculum denticulated, operculum with spines; no teeth on the vomer or palatine.

GENUS *SCIÆNA*. Dorsal fins two; head and body covered with scales.

SCIÆNA AQUILA.*—THE MAIGRE.

Specific Character.—Anal fin with only one spine; chin without a barbule.

Description.—Body elongated, resembling the *Perca labrax* in form; sides rather compressed, covered with scales; first dorsal fin short; the anterior rays the longest; second dorsal, with the terminating rays, the shortest; tail even at the end; preoperculum very slightly notched at its posterior and inferior margin; operculum ending in two flattened points directing over the base of the pectorals; jaws nearly of equal length; cheeks covered with scales. First dorsal fin commencing over the base of the pectorals, and ending at a short distance below the termination of the rays; second dorsal commencing close behind the first, and ending near the base of the tail; anal fin short, placed rather behind the middle of the second dorsal; ventrals situated a little behind the base of the pectorals. Colour of the head and back brownish-grey; cheeks and sides silvery-grey; belly dull white. Lateral line commencing over the upper part of the oper-

* *Sciæna aquila*, Cuv., Yar., Jen., Flem.

culum; taking a slight bent over the pectorals, from thence falling gradually to the tail; jaws furnished with a number of sharp teeth, none in the vomer, tongue, or palatines. Number of fin rays—

1st D. 9; 2d D. 28; P. 16; V. 6; A. 9; C. 17; Branchial rays 7.

The maigre is extremely common in many parts of the Mediterranean, especially along the Roman States. It has occurred several times on the English coasts, as well as once in Zetland. A specimen about three feet and a half in length was taken a short time since in the Firth of Forth, and is now in the College Museum of Edinburgh, from which the above description was taken. It was found entangled in a salmon net at the mouth of the Esk, a short distance from Musselburgh. Paul Jovius mentions, that many are taken at the mouth of rivers, along with sturgeons. They swim in troops, and are said to utter at times a singular low bellowing beneath the waters. The noise may be heard at a depth of twenty fathoms, and is often very perceptible when the ear is placed upon the gunnel of the boat. Its tone seems to vary, as some have compared it to a dull buzzing, others to a sharp whistle. Some of the fishermen allege, that the males alone are musical during spawning time, and that it is quite possible to capture them without any bait, merely by imitating this peculiar sound.* It is recorded that three fishermen, guided by this grunting sound, dropt their net on one occasion so successfully as to secure twenty-five of these fish at a single throw. One alluded to by Cuvier as having been entangled in a net spread along the shore at Dieppe, was at first found sleeping; but on being handled, it roused itself so suddenly, and with such violence, as to precipitate the fisherman into the water and force him to call for assistance before he could

* *Encyclopædia Britannica*, article *Ichthyology.*

become its master. High, though of course imaginary, virtues were formerly attributed to the bones which occur in the ear of this, as of other osseous fishes. They were worn on the neck set in gold; and Belon says they were called *colic-stones*, being renowned for the cure, and even prevention of that complaint. It was necessary, however, that they should be received as a gift,—such as were purchased being found to lose their virtue. As an article of food this fish is considered good as well as wholesome. Mr Yarrell states, that a specimen some time since was brought to the London market; part of the flesh was eaten by several persons, and by all reported to be good, particularly by those who prepared their portions by stewing; when boiled, it was rather dry and tasteless.

This fish very much resembles the *bass* in appearance, but is readily distinguished from it in having *no teeth* on the *vomer* or *tongue*; these parts in the *bass* being well furnished with teeth.

Although I have affixed the name of *aquila* to the present fish, yet I am doubtful whether it be the *aquila* of Cuvier or a different species. The fish described by Cuvier has the preoperculum strongly serrated; the middle rays of the first dorsal fin the longest, and the anterior rays of the second dorsal fin shorter than the terminating ones. In the present example the preoperculum is nearly entire, very slightly notched on the inferior border; the second, third, and fourth rays of the first dorsal the longest; and the anterior rays of the second dorsal longer than those succeeding.

FAMILY IV. SPARIDÆ.—Preoperculum and operculum without denticulations or spines; palate without teeth; vertical fins without scales.

GENUS *PAGRUS*.—Front teeth conical, sharp and numerous; molars rounded.

Pagrus vulgaris (Yarrell)

PAGELLUS ERYTHRINUS.*—THE SPANISH BREAM.

Specific Character.—Origin of the lateral line slightly bent. (See Plate XXVII.)

Description.—From a specimen nineteen inches in length. Body rather deep, of an oval form; sides compressed, covered with large scales finely ciliated at their margins; under jaw the longest; operculum and preoperculum entire, without denticulations or spines. Colour of the body, pale silvery red; dorsal and caudal fin rose-red; ventral and anal fins paler; in front of the eye and on the lower half of the preoperculum, metallic grey; space between the eyes reddish-brown. Dorsal fin commencing over the base of the pectorals, and ending in a line over the last ray but two of the anal fin; first eleven rays strong and spiny, the remaining ones soft and flexible. Anal fin commencing in a line under the last ray but seven of the dorsal, and terminating a little behind the same fin; ventrals situated a little behind the base of the pectorals. Lateral line commencing over the upper and posterior margin of the operculum, taking a slight bend upwards, following the line of the back to the base of the tail; composed of sixty-seven scales. Pectoral fin long, the fourth ray reaching to the first ray of the anal. Eyes small, placed nearer the posterior margin of the operculum than to the point of the upper jaw; anterior part of the orbit situated considerably behind the angle of the mouth; cheeks covered with scales; no scales before the eyes or on the posterior-inferior part of the preoperculum. First three rays of the anal fin spinous, the second spine much the stoutest and shorter than the third; the rest branched and flexible. Caudal fin deeply forked, the middle ray about one-third the length of the longest ray; the intervening membrane covered with small scales, to the end of the rays. Teeth numerous in both jaws, rather more so on the lower; those in the first row in front, sharp and conical, those behind, fine and thickly set; the molars rounded, arranged in two rows in the lower jaw, and in three or more rows in the upper. Number of fin rays—

D. 23; P. 15; A. 12; V. 6; C. 17; Branchial rays 6.

This fish is said to be very abundant in the Mediterranean, and even enters the Atlantic, advancing pretty far north. It

* *Pagellus erythrinus*, Cuv., Yar., Jen.

is, however, very rare along the British shores. Mr Yarrell states that " Mr Couch, with the exception of Mr Walcott, seems to have been the only British naturalist acquainted with its appearance on the English coast." The former gentleman has noticed it in two or three instances on the coast of Cornwall; the latter, occasionally on the coast of Devon. In the Firth of Forth I have seen it once, where a fine specimen, nineteen inches in length, was captured in a salmon-net near Musselburgh. As food for the table, this species is considered excellent. It feeds on crustaceous and testaceous animals, and occasionally small fishes.

The characters which distinguish this bream from others, are—eyes rather small; the anterior margin of the *orbit* placed *behind* the angle of the *maxillary bone*. *Lateral line* at its origin slightly *bent*, first taking a horizontal course for *half an inch*, an oblique course *for an inch*, from thence following the line of the dorsal curve to the tail; *origin* of the lateral line and base of the pectorals *without* a large black spot.

In *Pagellus acarne* and *Pagellus centrodontus* the anterior part of the orbit is placed in a line *immediately over* the posterior angle of the maxillary bone, and the lateral line from its *commencement* takes the curve of the line of the back. In *P. centrodontus* there is a *large black spot* at the origin of the lateral line, and in *P. acarne a dark violet coloured one*, at the base of the upper part of the pectorals.

erythrinus. (Gmelin) Spanish Sea bream.

PAGELLUS ~~ACARNE.*~~—THE AXILLARY BREAM.

Specific Character.—Dark violet-coloured spot at the base of the upper part of each pectoral fin. (See Plate XXVII.)

* *Pagellus acarne*, Cuv., Parnell. *Proceedings of the Royal Society of Edinburgh.*

Description.—From a specimen thirteen inches in length. Body of an oval form; depth in the region of the pectorals four inches; sides compressed, covered with large ciliated scales, producing a roughness on the surface when the finger is passed from tail to head. General form resembling that of the sea-bream, but not so deep in proportion to its length. Dorsal line rounded, descending obliquely from the nape to the nostrils, from thence more suddenly to the lips. Colour of the body pale silvery-red; dorsal and caudal fins rose-red; ventral and anal fins paler; space between the eyes reddish-brown; in front of the eyes, and on the lower half of the preoperculum, metallic grey; on the upper part of the base of the pectorals a dark violet-coloured spot, very conspicuous even in the dried fish. Eye large, placed half-way between the tip of the upper jaw and the posterior margin of the operculum; its diameter one-fourth the length of the head. Operculum and preoperculum entire, without spines or denticulations. Lateral line commencing over the upper part of the operculum, following the line of the dorsal curve to the base of the tail; composed of seventy scales. Dorsal fin commencing over the posterior margin of the operculum, and ending in a line with the last ray of the anal fin, its spiny rays twelve in number, sharp and stout; the first spine short, about half the length of the second; the fourth the longest; the remainder gradually decreasing in height, to the commencement of the flexible rays, which are longer than the terminating spiny rays. Anal fin commencing under the third flexible ray of the dorsal, the three first rays spiny, the rest soft. Pectorals and ventrals commencing in the same line; the sixth ray of the pectoral the longest, reaching to the first ray of the anal. Tail forked, the middle ray not half as long as the longest ray in the same fin. Jaws nearly of equal length, the under rather the shorter; anterior teeth small and numerous, disposed in many rows; the outer row composed of thirty teeth, longer and more bent than those within; molars large, disposed in three rows in each jaw. (In one of the specimens under examination but two rows are perceptible and the teeth irregularly placed.) The intervening membranes of the caudal, and the last two rays of the dorsal and anal fins, covered with small thin scales, diminishing in size as they approach the summit of the rays. Number of fin rays—

D. 24; P. 16; V. 8; A. 14; C. 20; Branchial rays 6.

The above description is taken from a specimen captured in the Firth of Forth, in a salmon-net near Musselburgh, in the early part of July. A few days after, a second specimen was taken from the same place, and brought to the Edinburgh market, where it was called a bream. It appears to be an addition to the British Fauna, since no instance has been hitherto recorded of its occurrence on the coast of Britain. It is an inhabitant of the Mediterranean Sea, and I have reason to suppose that it has been found more than once on the English coast, but mistaken for the *Pagrus vulgaris*, which it greatly resembles; for Mr Yarrell, in his description of that fish, says, "the pectoral fins have *occasionally* a violet-coloured spot at their origin," a character which is constant in the *acarne*, and which has not been noticed by any other author as occurring in the *Pagrus vulgaris*.

This species is at once distinguished from the rest of the British breams, by the dark spot at the base of the pectorals; besides that character it is discriminated from *Pagrus vulgaris*, *Pagellus erythrinus*, and *Pagellus centrodontus* in other respects. The *Pagrus* has never more than six teeth in the first row, in front of each jaw, the *acarne* having thirty in the first row on the upper jaw.

The *Pagellus erythrinus* has the origin of the lateral line *slightly bent*, and the anterior part of the orbit placed *behind* the posterior angle of the maxillary bone; while the *acarne* has the lateral line taking its course at once, parallel to the curvature of the back, and the anterior margin of the orbit in a line *over* the angle of the maxillary.

The *Pagellus centrodontus* has a large black spot at the origin of the lateral line; while the *acarne* has the commencement of the lateral line perfectly plain.

PAGELLUS CENTRODONTUS.*—THE SEA-BREAM.

Specific Characters.—Origin of the lateral line with a large black spot. (See Plate XXVII.)

Description.—From a specimen fifteen inches in length. Body of

* *Pagellus centrodontus*, Cuv., Yar.; *Sparus centrodontus*, Jen. *Sea-Bream, Red Gilthead, Lunated Gilthead.*

an oval form, deep in proportion to its length; sides compressed, covered with large ciliated scales, producing a roughness on the surface; operculum and preoperculum entire, without spines or denticulations. Colour of the body reddish-grey; dorsal and caudal fins brownish-red; ventrals and anal paler; belly dull white; space between the eyes reddish-brown, in front of the eyes and on the lower border of the preoperculum metallic grey. Eye large, placed half way between the tip of the upper jaw and the origin of the lateral line; lateral line commencing over the upper part of the operculum, taking its course parallel to the curvature of the back to the base of the tail, composed of about seventy-two scales. Dorsal fin commencing over the posterior margin of the operculum, and ending in a line with the last ray of the anal fin; its spiny rays twelve in number, sharp and stout; the first spine shortest, about half the length of the second; the fourth, fifth, and sixth the longest, the remainder gradually decreasing in height to the commencement of the flexible rays, which are longer than the terminating spiny rays; anal fin corresponding with the flexible portion of the dorsal; its three first rays spiny, the rest soft; pectorals and ventrals commencing in the same line. (In Mr Yarrell's figure of this fish, the ventrals are placed considerably before the base of the pectorals.) The fifth and sixth rays of the pectorals the longest, reaching beyond the vent. Tail forked, the middle ray not half as long as the longest ray in that fin; jaws nearly of equal length, the under rather the shorter; teeth fine and sharp in both jaws, smaller than in the two preceding species, disposed in two or three rows in front; molars small and rounded, placed far back, not easily seen, unless the jaws be widely expanded. The intervening membranes of the caudal fin covered with small thin scales. Number of fin rays—

D. 24; P. 17; V. 6; A. 15; C. 17; Branchial rays 6.

The sea-bream is one of the most common species in the Mediterranean, and has been found to exist as far north as off the coast of Denmark On the authority of Mr Couch, "it is found on the west coast of England throughout the year, but it is most abundant in the summer and autumn months, and retreats altogether in severely cold weather. The spawn is shed in the beginning of winter in deep water; and in January the chads, about an inch in length, are found in the stomachs of large fish, taken at two or three leagues from land. In summer, when from four to six inches long, they abound in innumerable multitudes, and are taken by anglers in harbours and from the rocks, for they bite with great eagerness at any bait, even of the flesh of their own species." "On the Irish coast it may be traced from Waterford Bay and the north coast of Antrim, where it is called Murranroe and Barwin."* On the Devonshire coast I have noticed it in abundance, taken in the trawl-nets, as well as with lines, at Brixham. On the coast of Sussex it is said to be by no means uncommon, but as we advance further north on the east coast of Scotland, it seems to become scarcer. In the Firth of Forth very little is known regarding this fish, as its appearance there is of rare occurrence. Two specimens, however, have been noticed in the Firth; the one was taken with a line baited for cod near Inchcolm in the month of July, and the other was found in a salmon-net above Queensferry. Their stomachs were crammed with shells and sea-weed. They feed also on crustaceous animals and small fish.

The sea-bream is generally considered to be of little value for the table, but this seems to depend greatly on the period of the year at which it is eaten and the mode in which it is cooked. Mr Yarrell says that he will venture to suggest a mode of preparing a sea-bream, which materially improves its more ordinary flavour. "When thoroughly cleaned the fish should be wiped dry, but none of the scales should be taken off; in this state it should be boiled, turning it often, and if the skin crack, flour it a little, to keep the outer case entire. When on table, the whole skin and scales turn off without difficulty; and the muscle beneath, saturated with its own natural juices which the outer covering has retained, will be found of good flavour." The

* *Yarrell's British Fishes.*

flesh is white, solid, and sweet, having much the taste of boiled lobster.

This fish is considered full grown when fifteen inches long, at which time the origin of the lateral line is furnished with a large black spot nearly an inch in length. When the fish is young this spot is not perceptible. The characters in which it differs from its congeners were noticed when treating of the two preceding species.

FAMILY V. SQUAMIPINNATI.—Dorsal and anal fins, or at least their soft portions, closely covered with scales.

GENUS *BRAMA*.—Both jaws, as well as the palatine bones, with fine teeth.

BRAMA RAII.*—RAY'S BREAM.

Specific Character.—Base of the dorsal and anal fins, long.

Description.—From a specimen eighteen inches in length. Body of an oval form, deep in the region of the pectorals, tapering gradually towards the caudal extremity; snout obtuse; dorsal line rounded, descending obliquely from the fin to the forehead, from thence suddenly to the upper lip. Sides compressed, covered with large strong scales; in front of the eyes and on the posterior part of the preoperculum without scales; colour of the back and sides silvery-grey, between and in front of the eyes reddish-brown; dorsal and caudal fins brownish; ventral and anal fin paler, tinged with light yellow; lower parts of the sides and belly dull silvery; operculum and preoperculum entire, without spines or denticulations. Eyes large, placed nearer the nose than to the origin of the lateral line; dorsal fin commencing over the base of the pectorals, and ending over the last ray of the anal; the fourth ray the longest, rapidly decreasing in height to the ninth, the remainder of equal length; anal fin similar in form to the dorsal, commencing under the sixth ray; caudal fin lunate, each extremity greatly produced; ventral fins

* *Brama Raii*, Cuv., Yar., Jen.; *Sparus Raii*, Bloch; *Toothed Gilthead*, Pen.

rather small, placed under the base of the pectorals. Under jaw the longest; each jaw furnished with a number of sharp slender teeth, those on the outer row longer than those behind; palatines also furnished with small card-like teeth. Lateral line commencing over the upper part of the operculum, taking its course parallel to the dorsal curve to the base of the tail; nearly the whole surface of the vertical fins covered with small scales. Number of fin rays—

D. 36; P. 19; V. 7; A. 29; C. 26; Branchial rays 7.

Cuvier supposed that this fish was peculiar to the Mediterranean, and never found to enter the Atlantic. It has, however, not only been captured several times on the British coast, but has been observed as far north as on the coast of Denmark. Mr Couch has obtained two or more specimens on the coast of Cornwall. Colonel Montagu has recorded it as taken in Devonshire, and another at Swansea. It is known at Belfast and said to be not uncommon on the western shores of Scotland. In the Firth of Forth it has occurred frequently, and two or three specimens are now in the College Museum of Edinburgh taken from that locality. This bream seldom exceeds the length of eighteen inches. According to Cuvier it spawns in summer. Its flesh is said to be good and wholesome, particularly in the winter months, when in season.

Family VI., SCOMBRIDÆ.—Vertical fins without scales; operculum and preoperculum without spines or denticulations; scales small, entire.

Genus *SCOMBER*.—Dorsal fins two, widely separate; sides of the tail raised into two small cutaneous crests; finlets behind the second dorsal and anal fins.

Scomber scomber.*—The Mackerel.

Specific Character.—First dorsal fin with twelve rays.

* *Scomber scomber*, Linn., Yar., Jen.; *Scomber vulgaris*, Flem.

Description.—From a specimen fifteen inches in length. Body fusiform; sides a little compressed; slender and slightly angular towards the tail. Colour of the back of a fine green varied with blue, marked with dark undulated lines placed vertically throughout its length; sides and belly silvery-white; occasionally the back is of a dark green, without marks of any description. Head sharp; nose pointed; first dorsal fin commencing behind the base of the pectorals, of a triangular form; the second ray the longest; the remainder gradually decreasing; second dorsal commencing a little in advance of the anal; not half the size of the first; its length twice its height; between it and the caudal fin are five spurious finlets, placed at equal distances from each other; anal fin corresponding to the second dorsal, with the same number of finlets behind it; tail deeply forked; ventral fins situated a little behind the base of the pectorals. Teeth small and sharp, placed in a single row in each jaw, as well on each side of the vomer; operculum rather small; rounded at its upper and posterior border; extending to a point below, at its junction with the posterior margin of the preoperculum; suboperculum large; preoperculum much produced; lateral line commencing over the base of the pectorals, taking a slight curve at its origin, from thence passing nearly in a straight line to the base of the tail; pectoral and ventral fins small, nearly of equal form and size; first dorsal fin when unexpanded, scarcely perceptible, placed in a groove; scales small, entire. On each side of the base of the tail, are two small cutaneous crests giving a square form to that part. Number of fin rays—

1st D. 12; 2d D. 12; P. 18; V. 6; A. 12; C. 17; Branchial rays 7.

The Mackerel, although taken in the Firth of Forth with lines, in sufficient numbers to supply the different markets in the neighbourhood, cannot be considered plentiful when compared with the vast quantity caught on the English coast at various periods of the year. They are first observed in the Firth of Forth about the beginning of June, confining themselves for the first month principally to the neighbourhood of the Bass. In July they are taken off Prestonpans, but more frequently at Largo, Buckhaven, and Wemyss on the opposite coast. A few straggling individuals have occasionally been found as high up the estuary as Queensferry, and on one occasion I saw a small specimen taken in the spirling nets near Alloa. After October they are seldom seen in the Firth, but are supposed to retire, like the other gregarious fishes, to the deep sea until the following summer. "On the coast of Ireland the mackerel is taken from the county of Kerry in the west, along the southern shore eastward to Cork and Waterford; from thence northward to Antrim, and north-west to Londonderry and Donegal. Dr MacCulloch says, it visits some of the lochs of the Western Islands, but is not considered very abundant. On the Cornish coast, this fish, in some seasons, occurs as early as the month of March, and appears to be pursuing a course from west to east. They are plentiful on the Devonshire coast, and swarm in West Bay about June. On the Hampshire and Sussex coast, particularly the latter, they arrive as early as March, and sometimes even in February, and the earlier in the year the fishermen go to look for them, the farther from the shore do they seek for and find them. Duhamel says, the mackerel are caught earlier at Dunkirk, than at Dieppe or Havre; up our eastern coast, however, the fishing is later. The fishermen of Lowestoffe and Yarmouth gain their great harvest from the mackerel in May and June, and Mr Low in his Fauna Orcadensis, states, that they do not make their appearance there till the last week in July, or the first week in August."*

The mackerel, it is said, can be taken on the coast of Cornwall every month in the year, but in much greater plenty in the summer season than at any other time. It spawns in June, and the young are seen from four to six inches in length in the month of August, in great numbers,

* Yarrell's *British Fishes*.

along the Devonshire coast. Mr Couch considers them as half grown in November, when they retire to deep water, and are seen no more that winter. Whether the young that are seen, of four or more inches in length, in the month of August, be the production of the spawn shed in June of the same or the preceding year, remains involved in considerable doubt, and it would prove an object of interesting research to discover the true growth.

The food of the mackerel is fry of other fish. Its flesh is held in high estimation for the table, and should be eaten when perfectly fresh. In the months of May and June it is considered to be in best season.

At Dover, in the year 1808, mackerel were so plentiful that they were sold at sixty for a shilling, and in the year 1821 the catch of sixteen boats from Lowestoffe amounted to the value of L. 5252, and it is supposed that there was no less an amount than L.14,000 altogether realized by the owners and men concerned in the fishery of the Suffolk coast.*

This species is distinguished from *Scomber maculatus* of Couch, in having five more rays in the first dorsal fin, and the sides being without spots.

GENUS *THYNNUS*.—Dorsal fins two; the first reaching nearly to the second; finlets behind the second dorsal and anal fins.

THYNNUS PELAMYS.†—THE BONITO.

Specific Character.—Behind the second dorsal fin eight finlets; behind the anal seven; sides of the abdomen with four longitudinal dusky bands. 23,

* Paget, *Nat. Hist. of Yarmouth.*

† *Thunnus pelamys*, Cuv., Yar. *Scomber pelamys*, Linn., Couch. *Bonito, Striped-bellied Tunny.*

Description.—Length twenty-nine inches; round; close behind the pectoral fin twenty inches; head conical, ending in a point at the nose; under jaw projecting; teeth few and small; tongue flat and thin; nostrils obscure, not in a depression; from the nose to the eye two and a half inches; gill-covers of two plates; body round to the vent; from thence tapering to the tail; near the tail depressed; lateral line at first descending and waved, becoming straight opposite the anal fin, from thence ascending and terminating in an elevated ridge, with another above and below the lateral line near the tail. Eye elevated; round; iris silvery; from the nose to the pectoral fin eight and three-quarter inches; the fin pointed; four inches long; received into a depression; first dorsal fin seven inches long, four inches high, lodged in a groove; the first two rays stout; the others low; the body is most solid opposite the second dorsal, which fin and the anal are falcate; tail divided and slender; ventral fins in a depression: colour, a fine steel-blue, darker on the back; sides dusky; whitish below. Behind the pectoral fins is a bright triangular section of the surface, from which begin four dark lines, that extend along each side of the belly to the tail; scales few like the mackerel. Number of fin rays—

D. 15 — 1 + 12, VIII.; P. 27; V. 1 + 5; A. 2 + 12, VII; C. 35.

This fish was taken in a drift-net off the coast of Cornwall in July, at which time the roe was abundant. It had no air-bladder; intestines simple; the muscle the colour of beef, greatly charged with blood. It rarely takes a bait, and is too wary to be often taken in a net. The above description is taken from Mr Yarrell's work, on the authority of Mr Couch, in consequence of not possessing myself a specimen of this fish. It has been found once in the Firth of Forth, on the authority of Mr Charles Stewart, Elem. Nat. Hist., vol. i. p. 363. Dr Scouler states that a specimen was found in the Firth of Clyde in July 1832, and which is now in the Andersonian Museum in Glasgow. "The food of the bonito is fish, small cuttles, testaceous animals, and marine vegetables. Its flesh is considered dry, and by some even disagreeable."

The *Thynnus vulgaris* differs from the present fish in having nine finlets above and below, and no abdominal bands.

GENUS *XIPHIAS*.—Dorsal fin one; ventral fins wanting; snout produced into a long sword-like process.

XIPHIAS GLADIUS.*—THE SWORD-FISH.

Description.—"Body elongated, nearly round posteriorly, a little compressed in front; depth increasing with the age, from one-tenth to one-sixth of the entire length, reckoning this last from the end of the sword to the extremity of the lobes of the tail; sword three-tenths; upper part of the head vertical; eye round; its diameter nearly two-thirds of the breadth of the cranium above it; sword terminating in a sharp point; the edges cutting, and finely denticulated; lower jaw likewise pointed, extending to where the upper surface of the sword becomes horizontal; no teeth in either of the jaws; pharyngeans only with fine teeth, like shorn velvet; no true tongue; gill-opening large; the branchiostegous membrane with seven rays; pectorals inserted very low down, sickle-shaped, one-seventh of the entire length, this last being reckoned as before; ventrals none. Dorsal commencing over the gill-opening, and extending in young subjects to within a short distance of the caudal, its anterior portion very much elevated and pointed; rays rapidly decreasing from the fifth to the eleventh, continuing low beyond that point to the thirty-ninth or fortieth; last three or four again elevated; all the intermediate or low portion of the fin extremely delicate, and with the rays more slender than those at the two extremities; in adult individuals often found very much torn, or even entirely destroyed, causing the two elevated ends which are left to appear like two distinct fins; anal somewhat similar in shape to the dorsal, but much shorter, only commencing in a line with its last third portion; caudal crescent-shaped; the whole head and body covered with a somewhat rough skin, the roughness arising from very minute scales; opercule smooth; lateral line scarcely visible; on each side of the tail a projecting horizontal keel; number of vertebræ, twenty-five. Colour of all the under parts, fine silvery white; upper parts tinged with dusky blue. Young individuals, from twelve to eighteen inches in length, have the whole body covered with little tubercles, disposed in longitudinal rows; these disappear first on the back, and afterwards on the belly; they

* *Xiphias gladius*, Cuv., Yar., Jen., Linn., Pen., Flem.

are no longer visible in individuals of three feet in length. Number of fin rays—

"D. 3–40; A. 2–15; C. 17; P. 16; B. 7."*

The sword-fish sometimes frequents our coasts, and specimens have occasionally been seen in the Firth of Forth, at a considerable distance from the mouth of the estuary. In the year 1826, an individual that measured seven feet in length was found stranded on the banks between Stirling and Alloa, and is now in the College Museum of Edinburgh. The sword-fish is well known in almost every part of the Mediterranean, especially in that part of the sea which separates Italy from Sicily. It has been seen off the coast of Denmark, and several have been taken in various parts of the Baltic of an enormous size. Mr Yarrell states that "this fish is supposed to entertain great hostility to the whale, and accounts of conflicts that have been witnessed are recorded by mariners." Captain Crow, in a work lately published, relates the following as having occurred on a voyage to Memel:—"One morning during a calm, when near the Hebrides, all hands were called up at three A.M., to witness a battle between several of the fish called thrashers, or fox-sharks (*Carcharias vulpes*), and some sword-fish on one side, and an enormous whale on the other. It was in the middle of summer, and the weather being clear, and the fish close to the vessel, we had a fine opportunity of witnessing the contest. As soon as the whale's back appeared above the water, the thrashers springing several yards into the air, descended with great violence upon the object of their rancour, and inflicted upon him the most severe slaps with their long tails, the sound of which resembled the reports of muskets fired at a distance. The

* Jenyn's *Vertebrate Animals* (a most accurate description).

sword-fish, in their turn, attacked the distressed whale, stabbing from below, and thus beset on all sides and wounded, when the poor creature appeared, the water around him was dyed with blood. In this manner they continued tormenting and wounding him for many hours, until we lost sight of him; and I have no doubt they in the end completed his destruction."

"Their mode of capture in the Mediterranean may be likened to whale-fishing in miniature, and is said to be a very amusing and exciting sport. A watchman placed upon a mark, or standing on the summit of a neighbouring rock, gives warning by signal when he sees a fish approach. The fishermen then row towards it, and, being very skilful, frequently strike the fish from a great distance, by throwing into it a harpoon attached to a long line. An arduous struggle then commences, during which the aggressors are sometimes pulled about by the fish for many hours before they can get it into the boat.

"This fish is not only the largest species of the European seas, attaining sometimes to a length of fifteen feet, but it is also much esteemed as an article of diet, when young especially; the flesh is white, firm, and of excellent flavour."*

GENUS *CARANX*. Dorsal fins two, nearly contiguous; no finlets behind the second dorsal or anal fins.

CARANX TRACHURUS.†—THE HORSE-MACKEREL.

Specific Character.—Lateral line with from seventy to seventy-five large scaly laminæ.

Description.—From a specimen eleven inches long. Head one-

* *Encyclopædia Britannica*, article *Ichthyology*.

† *Caranx trachurus*, Cuv., Yarr.; *Scomber trachurus*, Linn., Penn.; *Horse-Mackerel. Scad.*

fourth of the whole length, including the caudal fin ; body fusiform, of a quadrangular shape at the base of the tail; eye large, placed half-way between the point of the upper jaw, and the origin of the lateral line, equal nearly to one-half the depth of the head ; preoperculum rounded, entire ; operculum rather small, tapering to a point below, half-way down the inner margin of the suboperculum. Colour of the body above the lateral line dark-olive, with a greenish gloss; below silvery, with waved reflections ; on the posterior margin of the operculum above the base of the pectoral fin, a large black mark. First dorsal fin of a triangular form, commencing in a line a little behind the origin of the pectorals, all its rays spiny and slender; when unexpanded scarcely perceptible, being lodged in a groove ; the third ray the longest, the last extremely short; the base of the fin about equal to its height ; at the base of the first ray a short strong horizontal spine, placed in a depression, with the point directed towards the nose; second dorsal fin commencing immediately at the termination of the last, and ends at a short distance from the base of the caudal fin ; the anterior rays longer than the terminating ones, all soft and branched, except the first which is short and spiny ; anal fins similar to the last in form but somewhat shorter, commencing in a line under the end of the pectoral rays and terminating in a line with the last ray of the second dorsal ; the first ray strong and spiny, not half the length of the second which is soft and flexible, as well as the remaining rays in that fin ; in front of the anal fin are two stout spines, connected together by a fine membrane, concealed in a depression when laid down ; ventrals placed under the base of the pectorals ; the sixth ray of the pectorals the longest, reaching as far as in a line under the seventh ray of the second dorsal, and nearly twice the length of the ventrals. Under jaw the longest ; both jaws, furnished with very fine and slender teeth, as well as the vomer and palatines ; the teeth are distinctly seen in the dried specimen, particularly on the lower jaw. Lateral line commencing behind the upper and posterior margin of the operculum taking its course parallel to the curvature of the back to the commencement of the second dorsal fin, then taking an oblique line downwards until in a line over the first ray of the anal fin, from thence passing straight to the base of the tail ; composed of seventy-four scaly laminæ closely compacted ; the greater part of the anterior scales are neither keeled nor pointed ; the last thirty-eight are strongly keeled, and ending in sharp points directed towards the tail ; those in a line with the last rays of the anal fin, to the base of the long rays of the caudal fin are the highest and strongest, becoming smaller as they approach the base of the middle caudal rays, where they terminate. Body covered with small, oval, entire, scales, very deciduous ; tail deeply forked, the middle ray not half as long as the longest ray in that fin. Number of fin rays—

1st D. 8 ; 2d D. 31 ; P. 21 ; V. 6 ; A. 27 ; C. 18 ; Branchial rays 7.

In the Firth of Forth, seldom more than a dozen or a dozen and a half of these fish are taken throughout the year, and these are found in the salmon nets at Musselburgh and Queensferry, during the months of July, August, and September. They are very uncertain visitants, for in the year 1833 and 1834 scarcely a single specimen was observed in the Firth, while on the English coast, they were seen and taken in prodigious numbers. Mr Yarrell states, that in July 1834 immense shoals were seen off the coast of Glamorganshire. They were first observed in the evening, and the whole sea, as far as one could command it with the eye, seemed to be in a state of fermentation with their numbers. Every net was immediately put in requisition, so that they were taken by cart-loads. Their feeding time appeared to be morning and evening, when they were seen pursuing the herring fry. According to Mr Couch, "they regularly visit the coast of Cornwall and Devon, commonly in scattered numbers, but occasionally in considerable shoals. The first appearance of these fish is not until the end of April, and are not abundant before the warm months, when some may be found on board of every fishing boat. They are rarely brought to market, and in many places even the fishermen are not in the habit of eating them ; in the west of Cornwall, however, they are salted in the same way as mackerel, and in this state meet with a ready sale in winter. The usual habit of these fish is to keep near the ground ; but when they assemble in pursuit of sandlaunce or other favourite food, as they sometimes do in innumerable multitudes, they become so eager as to thrust each other in heaps on the sand." "On Tuesday evening, in the month of August, upwards of ten thousand of these fish were taken by a foot sean near Marazion. They frequently come so near the shore as to enable persons to take them by hand. On Wednesday evening another shoal appeared, when a number of men, women, and children, went into the water to catch them, while others stood on the sand to see them throw the fish on shore; and by this means a vast quantity were obtained. The young keep near the shore after the larger fish have retired to deep water."

The horse-mackerel is said to spawn in the month of June, and has been found as far north as off the coast of Denmark. The flesh is considered by some as inferior food, by others, as far superior to that of the mackerel; it is firm, of good flavour, and wholesome, and is in best season in March and April.

The large imbricated spinous plates forming the lateral line, will distinguish this species from the rest of the British fishes.

GENUS *ZEUS*. Dorsal fin one; ventrals thoracic; body oval, compressed.

ZEUS FABER.*—THE DORY.

Description.—From a specimen a foot in length. Body oval, much contracted at the base of the tail; sides and cheeks greatly compressed; head large, one-third of the entire length including the caudal fin. Colour of the body olive grey, tinged with yellow; in the middle of the side a large black spot with a whitish circle; ventrals darker than the other fins; dorsal fin divided in the middle by a deep notch, appearing at first as if it were two fins; the anterior part spinous and the rest soft, commencing in a line over the base of the pectorals, and ending within a short distance of the base of the caudal fin; the first ray shorter than the second; the third, fourth, and fifth, nearly of equal height; the intervening membranes of the spiny rays about

* *Zeus faber*, Linn., Cuv., Yarr., Jen., Penn., Don., Flem., Bloch; *Dory*, *John Dory*.

twice as long as the rays themselves; the first rays of the soft portion very short, gradually increasing to the seventh, the remainder of equal length, not half as high as the spinous rays; the soft part of the anal fin answering to that of the dorsal; the spinous portion with four stout rays commencing in a line under the sixth ray of the dorsal; the intervening membrane not twice as long as the rays; ventral fins placed before the base of the pectorals, the rays extending as far as to the second ray of the anal; pectorals small not reaching beyond the middle of the lateral spot. Eyes moderate, rather remote from the snout, situated half-way between the point of the upper jaw and the fourth ray of the dorsal fin. Operculum small, entire, of a triangular form; two spines occasionally behind the eye directed backwards, and one on each side of the occiput; a row of sharp spines on each side of the base of the dorsal and anal fins, at first simple, afterwards forked; between the ventrals and anal a double row of large, strongly-serrated scales, the serratures pointing towards the tail; pectoral ridge before the ventrals, with three rows of the same serratures; lateral line commencing in a line with the upper margin of the orbit, descending gradually down till opposite the middle of the soft portion of the dorsal fin, from thence passing straight to the tail. Scales of the body small and adherent, deeply impressed; mouth very protractile, under jaw the longest; teeth, in both jaws, arranged in two or three rows, with their points directed inwards (Mr Yarrell states, that the teeth are placed in a *single row* in each jaw); tail rounded at the end. Number of fin rays—

D. 33; P. 13; V. 8; A. 27; C. 12; Branchial rays 7.

The Dory, or John Dory as it is sometimes named, is said to be a common fish in the Mediterranean. It enters the Atlantic and is taken of large size in the Bay of Biscay off the French coast. On the south coast of England, particularly off that of Cornwall, these fish are in great abundance; but the farther north we proceed on the eastern shores, they become of less frequent occurrence. In the Firth of Forth seldom more than one or two are seen in the course of the year, generally at the mouth of the Firth, or on the sandy banks in Guillon Bay.

Among the superstitious, the Dory disputes with the Haddock the honour of having been the fish out of whose mouth St Peter took the tribute-money, on which occasion he is said to have left the mark of his finger and thumb on their sides, as both of these fishes possess this characteristic marking. But another version of the legend will enable the lover of such stories to leave each in possession of an equal honour, for St Christopher, in wading through an arm of the sea, having caught up a Dory, is reported to have perpetuated the circumstance by impressing on it the mark of his finger and thumb. A long time elapsed before this fish was used as food in Britain. Quin the actor and bon vivant established its edible reputation. "It is now, adds Colonel Montagu, about sixty years since (from 1814) the celebrated Mr Quin, of epicurean notoriety, first discovered the real merit of the dory, and we believe from him originated the familiar, and we may say national epithet of John Dory, as a special mark of his esteem for this fish; a name by which it is usually known in some parts, especially at Bath, where Quin's celebrity as the prince of epicures was well known, and where his palate finished its voluptuous career."

"Mr Couch considers the Dory as rather a wandering than a migratory fish, and its motions are chiefly regulated by those of the smaller kinds on which it preys. When the Pilchards approach the shores, the Dory is often taken in considerable numbers. In the autumn of 1829, more than sixty were hauled on shore at once in a net, some of them of large size, and yet the whole sold together for nine shillings. It continues common until the end of winter, after which it is more rare, but never scarce. The form of the Dory would seem to render it incapable of much activity, and it is sometimes seen floating along with the current rather than swimming, yet some circumstances favour the idea that it is able to make its way with considerable activity. It keeps pace with schulls of Pilchards, so that some are usually enclosed in the sean with them; it also devours the common cuttle, a creature of vigilance and celerity, and I have seen a cuttle of a few inches long taken from the stomach of a Dory that measured only four inches. It takes the hook, but gives the preference to a living bait, and a chad hooked through the back, with the prickly dorsal fin cut off, is sure to entice it."*

Pennant speaks of a Dory which weighed twelve pounds. One of half that weight is considered above the average size.

GENUS *LAMPRIS.*—Dorsal fin one; teeth wanting; ventrals abdominal.

LAMPRIS GUTTATUS.†—THE OPAH.
(See Plate XXVII.)

Description.—From a specimen three feet in length. Body deep; of an oval form; sides compressed; head about one-third the length of the body, not including the caudal fin; eyes large, placed nearer the point of the upper jaw than to the posterior margin of the operculum. Colour of the back a deep greenish blue; sides rich green, reflecting in different lights purple and gold, with a number of yellowish-white spots; belly pale yellowish-green; all the fins rich scarlet, as well as the irides; dorsal fin commencing in a line over the anterior part of the base of the pectorals, and ending at a short distance from the caudal fin; first two rays spiny; the five succeeding ones the highest, gradually decreasing to the seventeenth, which is not one-fourth the height of the third; the remainder nearly equal, becoming rather longer towards the last ray; anal fin about half the length of the dorsal; the anterior rays longer than the terminating ones; ventrals, placed some distance behind the base of the pectorals, and reaching beyond the twelfth ray of the anal; pectorals not as long as the ven-

* Yarrell's *British Fishes.*

† *Lampris guttatus*, Cuv., Yarr.; *Lampris luna*, Flem.; *Zeus luna*, Pen., Don. *Opah*, *King-fish.*

trals, but of the same falcated forms; tail lunated; lateral line commencing over the operculum, taking a high curve under the first ray of the dorsal, from thence passing obliquely down for half its length, then straight to the base of the tail; jaws without teeth; tongue rough; preoperculum produced behind, smooth, and entire. Number of fin rays—

D. 53; P. 26; V. 10; A. 24; C. 30.

Examples of this fish have been recorded, as taken at several different periods on the British coast. The first was found by some fishermen at Leith, and described by Dr Mortimer in the *Philosophical Transactions* in 1750, and the specimen was exhibited at a meeting of the Royal Society of Edinburgh. Since then it has been seen in the Firth of Forth at six different times. The last was found in July 1835, washed ashore on some rocks to the west of North Queensferry; its length was five feet, weighing, as nearly as the men could compute, eleven stones. The head of it I preserved; the body was cut up, taken away, and eaten by the fishermen, who stated that the flesh was red, remarkably good, equal to that of the salmon, and very much of the same flavour. They said they only wished they had more of them. Another was seen at the same time and place, but, in consequence of the weather being very stormy, they were unable to procure it.

Mr Yarrell states, on the authority of Professor Reinhardt, that within the last thirty years three specimens have been taken on the coast of Denmark, and, what is remarkable, they were all caught very near the same spot.

Family VII. MUGILIDÆ.—Body covered with large scales; dorsals two, widely separate; ventrals placed behind the pectorals; branchiostegous membrane with six rays; tail forked or lunated; cæca two; intestine long and folded.

Genus *MUGIL.*—Body possessing no broad silvery band along each side; first dorsal fin with four spiny rays.

Mugil capito.*—The Grey Mullet.

Specific Characters.—Maxillary visible when the mouth is closed; orifices of the nostril near together; the skin at the margin of the orbit not advancing upon the eye; scale above the pectoral short and obtuse. (See Plate XXVIII.)

Description.—Back but little elevated; ventral line more convex than the dorsal; greatest depth beneath the first dorsal about one-fourth of the whole length, excluding caudal; greatest thickness nearly two-thirds of the depth. Head broad and depressed; snout short, transversely blunt and rounded, but vertically sharp; mouth very protractile, transverse angular. Teeth in the jaws scarcely perceptible; on the tongue, vomer, and palatines, more developed; maxillary visible when the mouth is closed, and not retiring beneath the infra orbital; upper lip rather thick and fleshy, margined with a number of close-set minute pectinations. Eyes rather high up; the skin at the anterior and posterior margins of the orbit not advancing over any portion of the iride; nostrils double on each side: the two orifices placed near together, the anterior one round, the posterior one oblong; head smooth, all the upper part covered with large polygonal scales. Scales on the body large, but smaller than the above, deciduous; first dorsal commencing about the middle, its height twice its length; spines strong; the first two equal and longest; second dorsal considerably behind the first, its height and length the same as in that fin; all the rays, except the first, branched; caudal forked; anal rather in advance of the second dorsal, somewhat longer than that fin, but of the same height; pectorals about three-fourths of the length of the head; second, third, and fourth rays longest; all the rays, except the first, branched; ventrals a little behind the pectorals, close together, somewhat shorter; first ray strongly spinous; second soft ray longest. Number of fin rays—

D. 4–9; A. 3–9; C. 14; P. 17; V. 1–5; B. 6.

Colours.—Back dusky blue; sides and belly silvery, the former marked with several parallel longitudinal dark lines.

The above description is taken from Jenyns's *Vertebrate Animals.*

* *Mugil capito*, Cuv., Yar., Jen. *Mugil cephalus*, Penn., Don., Flem.

This fish, on the authority of Dr Neill, is occasionally found in the Firth of Forth, as recorded in the *Wernerian Transactions*, vol. i. p. 544, under the name of *Mugil cephalus*, which is now supposed to be the *M. capito* of Cuvier.

The following is from the work of Mr Yarrell :—“ Baron Cuvier, in the last edition of his *Règne Animal*, states, in a note at the foot of page 231, that Linnæus and several of his successors have confounded all the European Grey Mullets under one common name, that of *Mugil cephalus*. He has, however, distinguished among them several species, and, according to him, the description of the *cephalus* of Willoughby and the figure of the *cephalus* of Pennant both appear to belong to the *M. capito* of the *Règne Animal*.

“ *Mugil cephalus* of Cuvier is distinguished by having its eyes partly covered with a semi-transparent membrane, adhering to the anterior and posterior edges of the orbit, and also by a larger elongated triangular scale pointing backwards, placed just over the origin of the pectoral fin on each side. (See Plate XXVIII.)

“ Our most common Grey Mullet may, therefore, be considered as the *M. capito* of Cuvier, an inhabitant not only of the Mediterranean, but also of all the western shores of the more temperate part of Europe. In Ireland this fish occurs on the coast of the northern counties of Londonderry and Antrim ; in the south, on those of Cork and Waterford, and, probably, at many intermediate points. It is found plentifully in Cornwall and Devonshire, and along the whole line of our south coast. It occurs constantly on the Kentish and Essex coast, is taken at Yarmouth, and it has been traced to the Baltic and the west coast of Norway.”

It is a singular fact, although common as this fish appears from the above description, that not a single specimen has fallen under my notice ; those which I have examined being the *M. chelo* of Cuvier (the next fish to be described), and not *M. capito*, which, according to my observation, is by far the rarer fish of the two.

" The Grey Mullet never goes to a great distance from land, but delights in shallow water, when the weather is warm and fine, at which time it is seen prowling near the margin in search of food, and imprinting a dimple on the placid surface, as it snatches beneath any oily substance that may chance to be swimming. It selects food that is soft and fat, or such as has begun to suffer decomposition, in search of which it is often seen thrusting its mouth into soft mud ; and, for selecting it, the lips appear to be furnished with exquisite sensibility of taste.

" The Grey Mullets shed their spawn about Midsummer ; and the young in August, then an inch long, are seen entering the fresh water, keeping at some distance above the tide, but retiring as it recedes. Mr Arnould put a number of the fry of the grey mullet about the size of a finger into his pond at Guernsey, which is about three acres area, and after a few years, mullets of four pounds weight were caught, which proved to be fatter, deeper, and heavier for their length, than others obtained from the sea. Of all the various salt-water fishes introduced, the Grey Mullet appeared to be the most improved. A slight change in the external colour is said to be visible."

These fish are with some difficulty taken in the sean, except by those who are familiar with their habits, for when they find themselves enclosed, and danger at hand, they escape by leaping over the body of the net, and, as soon as one takes the lead, the rest follow immediately in succession.

Mugil chelo.*—The Thick-lipped Grey Mullet.

Specific Characters.—Upper lip thick and fleshy; base of the last ray of the first dorsal half-way between the point of the snout and the base of the middle caudal ray; maxillary visible when the mouth is closed. (See Plate XXVIII.)

Description.—From a specimen fourteen inches and a half in length. Back but little elevated; ventral line more convex than the dorsal; greatest depth beneath the first dorsal, about one-fourth of the whole length, excluding caudal; greatest thickness nearly two-thirds of the depth. Head broad and depressed; snout short, transversely blunt and rounded, but vertically sharp; mouth very protractile, transverse, angular; lower jaw divided in the middle by an ascending angular point, which, when the mouth is closed, passes within the upper jaw. Teeth in the jaws, scarcely perceptible; on the tongue, vomer, and palatines, more developed; maxillary at its lower edge sinuous and entire, visible when the mouth is closed, and not retiring beneath the infra orbital. (In Mr Couch's description of this fish, the posterior edge of the superior maxillary bone is said to be minutely notched.) Upper lip thick and fleshy, margined with a number of close set minute pectinations; suborbital plate finely toothed on its lower margin; eyes rather high up; the skin at the anterior and posterior margins of the orbit not advancing over any portion of the iride, as it is observed to do in *M. cephalus.* Nostrils double on each side; the two orifices placed near together, the anterior one round, the posterior one oblong; head smooth; all the upper part covered with large polygonal scales, as well as the cheeks and operculum; scales of the body large, deciduous; First dorsal commencing above the middle; the base of the fourth or last ray, exactly midway between the point of the upper jaw and the base of the middle caudal ray; the base of the first ray, half-way between the posterior border of the operculum and the third ray of the second dorsal; second dorsal remote from the first, commencing in a line over the third ray of the anal, and terminating a little behind the last ray, situated nearer the point of the long caudal rays than to the base of the pectorals; the last ray exactly midway between the base of the first dorsal ray and the tip of the middle ray of the tail. Ventrals placed half-way between the tip of the jaw and the first ray of the anal, and behind the base of the pectorals; first three rays of the first dorsal commencing very close together, the fourth remote, much shorter and smaller than the two first, which are of equal length, longer than the base of the fin; first two rays of the second dorsal fin spiny, shorter

* *Mugil chelo*, Cuv., Jen., Yar., Couch.

than the third, which is the longest, and like the remainder soft and flexible; the sixth ray as long as the base of the fin; anal fin concave, with the last ray but two the shortest, of the same form as the second dorsal but rather larger. Caudal forked or lunate, depending on the width of expansion; pectorals about three-fourths of the length of the head, the second, third, and fourth rays longest; all the rays except the first branched; ventrals somewhat shorter, all the rays soft and branched, except the first which is spiny; last ray connected to the body by a fine membrane passing off from half way up its length. Intervening membranes of the caudal fin covered with small scales, which diminish in size as they approach the summits. Colour of the back dusky blue; sides and belly silvery; the former marked with seven or eight longitudinal dark lines. Number of fin rays—

1st D. 4; 2d D. 10; P. 15; V. 6; A. 11; C. 14; B. 6.

According to Mr Yarrell, Mr Couch is the only naturalist who has noticed the appearance of *Mugil chelo* on the British coast. "This fish," says Mr Couch, "is gregarious, frequenting harbours and the mouths of rivers, in the winter months, in large numbers, all of which are just of one size."

It is singular that this fish, as common as it is on many parts of the British coast, should have been so long mistaken for the *Mugil cephalus* of Cuvier, and still is by many confounded with the *Mugil capito*. Dr Hancock appears to have been the first of our own naturalists to remark that the grey mullet of the British coast was not the true *Mugil cephalus*. He named it *M. Britannicus*.*

This fish I have observed to be excessively common in the months of September and October on the Devonshire coast, particularly off Exmouth, Teignmouth, and Brixham. I have found it common on the west coast of Scotland, and occasionally large shoals of them appear on the east coast. Dr Johnston has noticed it off Berwick, and in

* *Lond. Quart. Journ. of Science*, 1830, p. 129, on the authority of Jenyns.

some seasons numbers are taken off Dunbar, and sent to the different markets for sale.

Scarcely a summer passes but that a few are found at the different fishing stations in the Firth of Forth, and occasionally of large size. A specimen was taken in the Hopetoun salmon nets, in June 1835, which measured twenty-three inches in length, although the common size is about a foot.

Mugil chelo is distinguished from *M. capito*, in the operculum being smaller; the upper lip thicker; the suborbital larger, and nearly even at its inferior margin; which in *M. capito* is small and rounded at the end.

If we refer to Mr Yarrell's figure of *M. capito*, we shall find *M. chelo* to differ in other respects. The base of the fourth ray of the first dorsal fin in *M. chelo* is placed exactly half-way between the point of the lip and the *base* of the middle caudal ray; whereas the base of the same ray in *M. capito*, is placed exactly mid-way between the point of the lip, and the *end* of the middle caudal ray.

The fish from which the above description is taken, agrees in every respect with the figure Mr Yarrell has given of *Mugil chelo*.

Genus *ATHERINA*.—Body with a broad silvery band along each side; first dorsal fin with four rays.

Atherina presbyter.*—The Sand-Smelt.

Description.—From a specimen five inches in length. Body rather elongated; sides slightly compressed; head, from the point of the upper jaw to the posterior border of the operculum, one-fifth of the whole length, caudal fin not included. Colour of the back and sides pellucid greyish-white; belly yellowish-white; sides marked

* *Atherina presbyter*, Cuv., Yar., Jen. *Atherina hepsetus*, Pen., Flem., Don. *Sand-smelt*, *Atherine*.

with a broad silvery band, with a tinge of blue, extending from the operculum to the base of the tail. Snout short and blunt, very protractile; under jaw the longest, when the mouth is open; teeth small and sharp in each jaw, as well as on the vomer and posterior part of the palatines; eyes large, extending below the middle of the cheeks; operculum rounded and entire; preoperculum angular; between the eyes, a small elevated ridge, extending back nearly to the nape. First dorsal fin with slender spinous rays, commencing over the middle of the ventrals; third and fourth rays the longest; the last the shortest, not half the length of the first. Second dorsal remote from the first, commencing in a line over the third ray of the anal, and ending over the last ray; the first ray spiny; the rest flexible and branched; the second and third the longest; the ninth the shortest. Anal fin corresponding with the second dorsal, but rather longer; ventrals commencing in a vertical line with the tips of the long pectoral rays, and ending in a line with the base of the last ray of the first dorsal; pectorals as long as from the point of the lower jaw, when open, to the posterior margin of the orbit; the second and third rays the longest; the first simple, the rest branched. Scales along the lateral silvery band, about fifty-six in number, becoming very small at the base of the caudal fin. Head and fins more or less freckled with small black spots; tail forked. Number of fin rays—
1st D. 8; 2d D. 13; P. 15; V. 6; A. 15; C. 17; B. 6.

Mr Yarrell was the first British naturalist to notice that the atherine, which is found so common on the southern shores of England, was not the *Atherina hepsetus* of Linnæus, as Pennant, Donovan, Fleming, and other authors supposed it; but the *Atherina presbyter* of Cuvier, which is quite a different species. The atherine, says Colonel Montagu, is as plentiful on some parts of the southern coast of England as the smelt is on the eastern coast, and each appears to have its limits, so that the one does not intrude upon the other; at least, as far as our observation has gone, where one is the other is not. We have traced the smelt along the coast of Lincolnshire, and southwards into Kent, where the atherine appears to be unknown; but in Hampshire the atherine is extremely plentiful, especially about Southampton, where, for want of knowing the true smelt, this is sold under that denomination. On the south coast of Devon they are caught in great abundance in the creeks and estuaries, but never in rivers above the flow of the tide; and they appear to continue near shore through the months from autumn to spring, being caught for the table more or less during the whole of that time, but are greatly superior in the spring, when the males are full of milt as the females are of roe. The atherine is a well-flavoured fish, but, in our opinion, not so good as the smelt—it is more dry ; but when in season, and fried without being embowelled, the liver and roe make it a delicious fish.

Mr Couch says it is found in Cornwall at all seasons, and sometimes in such numbers that three small boat-loads have been enclosed in a sean at once.

Dr Neill states, in vol. i. of the *Wernerian Transactions*, that " he has frequently found the atherine washed ashore about Figget Whins in the Firth of Forth after easterly winds." Of late years they have been undoubtedly scarce. Two instances only have occurred to me, in which the atherine was found in the Firth of Forth; the first was taken at Kincardine in company with sprats and other small fish; the second was drawn ashore in a net, about two miles west of Newhaven. The fishermen said it was more frequently met with in Guillon Bay, and that they considered the fish was nothing else than a *sort of mongrel spirling*.*

Family VIII., GOBI~~A~~DÆ.—Dorsal rays slender and flexible, excepting the species ***Murænoides** guttata*, where they are short, stout, and sharp-pointed; scales small or entirely wanting; tail rounded at the end; body more or less elongated, with one or two dorsal fins. The genus *Zoarces* is destitute of spiny rays, but has an anal tubercle.

* *Spirling*, *Salmo eperlanus*, very common in the Forth.

The viscera of all the fishes pertaining to this family are nearly of the same conformation; the intestinal canal is equal, ample, and without cæca, and there is no swimming-bladder.

GENUS *BLENNIUS*.—Body rather elongated, with a single dorsal fin, composed almost entirely of simple and flexible rays; ventral fins placed before the pectorals and formed of two or three rays in each; teeth on the vomer, and in one row in each jaw; dorsal and caudal fins separate.

BLENNIUS PHOLIS.*—THE SMOOTH BLENNY.

Specific Characters.—Dorsal fin abbreviated in the middle; head smooth and destitute of appendages; last tooth in each jaw slightly curved and longer than the rest.

Description.—From a specimen five inches in length. Body behind, rather compressed; head one-fourth of the entire length, tail fin not included; sides smooth, covered with a mucous secretion; gill-opening large; the membrane continued across the throat. Colour very variable, some specimens quite black, others of a deep olive-green, occasionally variegated like marble. Head sloping from the nape to the orbit, from thence suddenly to the lip; snout short and obtuse; eye moderate, placed high up; dorsal fin extending the whole length of the back, commencing in a line over the origin of the ventrals, and ending within a short distance of the base of the caudal rays; all the rays simple, the first shorter than the second; fifth, sixth and seventh, slightly the longest; eighth and following ones decreasing to the twelfth, which is the shortest and finest in the whole fin, from the fourteenth to the twenty-eighth nearly even, the remainder a very little shorter; the last connected to the base of the tail by a membrane which passes off from the summit as not to allow the ray to take an erect position. Anal fin commencing in a line under the thirteenth ray of the dorsal, and ending in a line under the last ray of that fin; first ray shorter than the second, the rest increasing very gradually to the last, which is somewhat shorter and connected to the base of the tail by a membrane similar to that of the last ray of the dorsal, but not extending quite so far towards the short rays

* *Blennius pholis*, Yarr., Linn., Cuv., Jen., Pen., Don.; *Pholis levis*, Flem.; *Smooth Blenny*, *Smooth Shan*, *Shanny*, *Stone-fish*.

of the caudal. Pectoral fin large and rounded ; the middle rays the longest, extending as far as in a line under the eleventh ray of the dorsal ; ventral fins small and stout, placed before the base of the pectorals, the longest ray as long as the third ray of the pectorals. Caudal fin rounded at the end, the middle rays branched. Teeth, twenty-one in the lower jaw, and twenty-four on the upper ; anterior ones longest, the last stoutest and slightly curved inwards ; on the vomer four, two on each side, short, stout, and very strong. Lateral line commencing over the operculum running straight for a short course, taking a curve over the pectorals, as far as under the ninth ray of the dorsal, from thence passing straight to the base of the middle caudal ray. Number of fin rays—

D. 30 ; P. 13 ; V. 2 or 3 ; A. 19 ; C. 12 ; B. 6.

This species of Blenny is common on most of the rocky parts of our coast, and nowhere more so than in the Firth of Forth, where it is found in great numbers under rocks and stones. In almost every pool left by the receding of the tide they abound particularly in the neighbourhood of North Berwick. Though so common, however, yet specimens are with difficulty procured, not only on account of their activity, but also because the large stones under which they conceal themselves are with difficulty removed ; and unless that be accomplished, it will be almost impossible to obtain a single specimen. In the month of August I observed many of these fish in a small pool of water which had been left by the tide, and after dipping the place dry, to my astonishment, they had all disappeared, and taken refuge under some sea-weed a foot and a half distant from the pool. By means of their strong ventral fins they are enabled to crawl several feet on dry land, and will remain six hours under stones or sea-weed, awaiting the return of the tide. The Blenny is remarkably tenacious of life, and has been known to live out of water for many days in a damp situation ; but, if put into fresh water, it soon expires.

These fish will take eagerly a baited hook, and are often captured off the pier-head at Leith. Their principal food is small shells and young crabs; and I have also found their stomachs distended with sea-weed. They spawn in the month of June, and possess no swimming-bladder. They are never brought to market or used as food.

All the British species of Blennius, excepting the present one, are furnished with one or more appendages placed on the head in the region of the orbits.

GENUS *MURÆNOIDES*.—Body elongated, sword-shaped, with a single dorsal fin composed of short stout rays; ventral fins placed before the pectorals, reduced nearly to a single ray; teeth on the vomer, and in two rows in each jaw; dorsal and caudal fins continuous.

MURÆNOIDES GUTTATA.*—THE SPOTTED GUNNEL.

Description.—From a specimen five inches in length. Body elongated, compressed, similar to the blade of a sword in form; head small, one-ninth of the length of the body, caudal not included, and about equal to the depth. Colour of the body olive, with a mixture of yellow; on each side of the dorsal fin, from twelve to thirteen large dark spots, bordered by a whitish circle, placed at equal distances from each other down the back; anal fin with whitish spots from eleven to twelve in number, arranged similar to those of the back; pectoral and caudal fins deep orange; irides above red, below white. Dorsal fin commencing in a line over the base of the pectorals, extending down the back to be continuous with the caudal fin, to which it is connected by a membrane; the rays of the dorsal short and stout, with very sharp points, all of equal length, projecting beyond the membrane. Anal fin commencing in a line under the thirty-fifth dorsal ray; the first ray spinous, the rest soft and flexible, branched at their summits; the last ray connected to the caudal fin by the intervening membrane; the last three or four rays longer than those preceding; ventral fin very small, composed of one short stout spine, very sharp, with a small ray immediately behind

* *Murænoides guttata*, Yarr. *Blennius gunnellus*, Don., Pen., Jen. *Gunnellus vulgaris*, Flem. *Spotted Gunnel, Butterfish, Stane-checker.*

it; pectorals rounded like the caudal, about one-half its size. Jaws furnished with a number of small teeth arranged in two rows on the anterior part. (Mr Yarrell states, they are placed in a *single row* in each jaw.) Teeth on the front of the vomer, none on the palatines or tongue; under jaw the longest when the mouth is opened; head narrow, much more compressed than the nape. Lips thin and folded back, giving an appearance as if thick and fleshy; each operculum ends in a point directed over the base of the pectorals; membrane continuous under the throat. Number of fin rays—

D. 78; P. 11; V. 2; A. 45; C. 15.

This fish which I have frequently met with on the coast of Devon, has been observed as far north as the shores of Norway. It is common in every part of the estuary of the Firth of Forth; more so in those situations where sea-weed grows in the greatest abundance, under which it will seek refuge for many hours after the tide has ebbed. Above North Queensferry, about a mile, I found, in the month of July, as many as from nine to twelve in number collected together under a tuft of sea-weed. These fish when first taken in the hand, are with difficulty retained, owing to the slimy secretion with which the whole surface of the body is covered. When found in large pools of water, they are observed to swim with great rapidity, and are caught with the greatest difficulty in consequence of their moving from one place to another with extreme quickness, and creeping into every small crevice they can find.

The common length of the spotted Gunnel, or, as it is named in Scotland, *Stane-checker*, is from four to five inches. On one occasion, I found a specimen to measure eleven inches in length, when the whole of the dorsal spots were obliterated except the first, which was scarcely perceptible. As the fish increases in size, the spots become less defined. We are told, that in Greenland the flesh of this fish, though hard, is dried and eaten. In this country it is seldom if ever made use of except to bait lines with. It feeds on minute crustacea and small fry, and is said to be destructive to the eggs of other fishes.

This fish might probably be confounded with *Blennius Yarrellii* of Cuvier, a rare British species, but the want of appendages on the head will sufficiently distinguish it.

GENUS *ZOARCES*.—Body elongated, eel-shaped, with a single dorsal fin, composed of flexible branched rays; ventral fins of three rays, placed before the pectorals; teeth in two rows in front of each jaw; none on the vomer or palatines; dorsal and caudal fins continuous.

ZOARCES VIVIPARUS.*—THE VIVIPAROUS BLENNY.

Specific Character.—Dorsal fin abbreviated near the caudal extremity.

Description.—From a specimen six inches in length. Body compressed behind, gradually tapering from the nape to the tip of the tail; sides smooth, covered with a mucous secretion; head one-sixth of the whole length, and about twice the depth of the body, not including fins. Colour of the back and sides yellowish-brown, mottled with dark olive; when young, lateral line, and below it, spotted with white, which is not visible in the adult. Dorsal fin composed of flexible rays, branched at their summits, commencing over the base of the pectorals, extending down the back to be continuous with the caudal rays, when it becomes suddenly depressed, giving an appearance as if a piece had been cut out; from this part to the nape the rays gradually increase in height. Anal fin commencing in a line under the twenty-sixth dorsal ray, and extending down to be continuous with the caudal rays; the rays gradually diminishing in height from the third. Pectorals large and rounded; ventrals small, composed of only three rays, placed before the base of the pectorals. Lips long and thin, the upper one entire, the lower one bilobed; when folded back, having the appearance as if thick and fleshy. Operculum triangular ending in a point, directing over the base of the first ray of the pectorals. Teeth small, conical, and blunt; placed a little apart from each other; situated in two rows in

* *Zoarces viviparus*, Cuv., Jen. *Zoarcus viviparus*, Yarr. *Blennius viviparus*, Pen., Don. *Eelpout, Guffer, Greenbone, Bards, Maruna Eel.*

front of each jaw; none on the vomer, tongue, or palatines. (Mr Yarrell in mentioning the generic characters of this fish, states the teeth to be conical, placed in a *single row*. In the description he says the teeth are short, conical, sharp, with a *second row* round the *front only* of the *lower jaw*; the *lips fleshy*.) It is probable that Mr Yarrell drew his characters from a young specimen, in which the teeth were not completely developed; for when the fish is less than three inches in length, only one row of teeth in each jaw is visible, the second row commencing first on the lower jaw. Number of fin rays—

D. 90; P. 19; V. 3; A. 70; C. 40; B. 6.

This fish is scarce on the coast of Devon, but appears more common as we approach the north. In the Firth of Forth it exists in great plenty, hiding under sea-weed in rocky situations. They are often taken with lines in the winter months, and brought to market, where they fetch a ready sale at the rate of three a penny. Some people consider the flesh as very fine and wholesome; while others, again, announce it as dry and of a disagreeable flavour. Dr Neill, in the month of February 1807, saw a female fish fifteen inches long, from which several dozen of young escaped alive: these fry were from four to five inches in length. A short time since, in the month of March, I had a specimen sent me which measured six inches in length, from which I took fifty-six young, all alive, although the parent fish had been dead for nearly two days. Each was an inch and a quarter in length, and on being put into a glass of fresh water, they at first appeared remarkably active, but in less than half an hour after they all expired.

The general length of this fish is about eight inches, although at Berwick, at the mouth of the Tweed, specimens have been taken which measured nearly two feet in length. They are there named *Maruna eels*, and at Edinburgh *Bards*.

The bones of this fish when boiled assume a green appearance, from which circumstance the fish often times receives the name of green-bone.

GENUS *ANARRHICHAS*.—Dorsal fine on; ventral fins wanting; mouth armed with conical incisors and flat grinders.

ANARRHICHAS LUPUS.*—THE WOLF-FISH.

Specific character.—Last rays of the dorsal fin abbreviated.

Description.—From a specimen two feet in length. Body elongated; sides compressed, covered with a mucous secretion; forehead sloping; face wrinkled. Colour of the back and sides light grey, marked with seven or eight broad vertical bands of a bluish-grey tinge. Dorsal fin commencing at the nape, extending down the back, to be connected to the first caudal ray by a short membrane; first ray shorter than the second, the rest, as far as the sixty-third, of equal length, the remainder gradually decreasing to the base of the first short caudal ray. Anal fin commencing in a line under the thirtieth ray of the dorsal, and ending at a short interval from the caudal; all the rays of equal length; no ventral fins; pectorals broad, the rays strong and branched, the fifth, sixth, and seventh the longest, reaching in a line under the seventeenth ray of the dorsal; caudal fin rounded, rather small, about one-third the size of the pectorals, composed of branched flexible rays. Teeth remarkably strong, of two kinds in each jaw, those in front long and conical, those behind, and on the vomer, closely paved, short, and truncated; eyes rather small, placed high on the head, on a line over the vomerine teeth. Number of fin rays—

D. 72; P. 20; A. 45; C. 17: B. 7.

The Wolf-fish sometimes grows to the length of six feet, and is a rare visitant on the southern coast of England. It is found on the coasts of Norfolk and Yorkshire, and is well known along the northern shores of Europe. This large and ferocious species is the most savage and powerful of all our British fishes. It feeds on crustaceous and testaceous animals, and by the power of its large and strong

* *Anarrhichas lupus*, Cuv., Yarr., Jen., Pen., Don. *Sea-wolf*, *Sea-cat*, *Swine-fish*, *Cat-fish*.

temporal and masseter muscles, and broad and short molars, is enabled to grind to pieces the largest crab with the greatest facility. It is common in all the rocky parts of the Firth of Forth, is often found on the haddock lines, and occasionally taken in the salmon-nets above Queensferry. About June the young are two feet in length, and are sold in the market for sixpence each. The appearance of this fish is not very prepossessing in the sight of those who are not aware of its quality as food; but if properly dressed and disguised by the head being cut off, it is considered equal to many of the marine fishes. The stomach is remarkably thin and transparent like that of most fish which are furnished with strong and powerful grinders.

GENUS *GOBIUS*.—Dorsal fins two; ventrals joined together forming a hollow disk, placed under the thorax; body with scales.

GOBIUS NIGER.*—THE BLACK GOBY.

Specific Characters.—Dorsal fins contiguous; first fin with six rays, the third and fourth rays the longest; second fin with all the rays equal. (See Pl. XXIX.)

Description.—From a specimen four inches and a half in length. Head one-fourth of the length as far as half way down the caudal rays; dorsal line straight; profile rounded; abdomen prominent; sides behind slightly compressed. Colour of the whole fish dusky-brown, darker on the dorsal region, more or less mixed with spots and streaks; the summit of the first dorsal fin darker than the rest of the membrane. Preoperculum rounded; operculum slightly produced at its upper and posterior margin. First dorsal fin commencing in a line a little behind the origin of the pectorals, and terminating in a line over the vent; the third and fourth rays the longest; like the rest of the rays in that fin, spiny and extremely flexible. Second dorsal commencing close behind the first, slightly connected to it by a fine membrane, ending in a line over the last ray of the anal fin; all the rays except the first branched and flexible, and nearly of equal

* *Gobius niger*, Cuv., Yarr., Jen., Mont. *Black Goby*, *Rock-fish*.

height. Anal fin commencing under the third ray of the second dorsal, ending under the last ray of the same fin, leaving a wide space between it and the base of the caudal fin; ventrals united; the middle rays the longest, about the length of the pectorals, placed under the chest in a line with the origin of the pectorals; middle rays of the pectoral fin the longest, equalling the length of the caudal rays; behind the vent a small tubercle. Teeth small and fine, placed in two or three rows in front of each jaw, those composing the first row longer and farther apart from each other than those within; no teeth on the tongue, vomer, or palatines. Eyes high on the head, approximating, placed in a line over the angle of the jaw; lateral line scarcely perceptible, straight throughout its course. Scales large, ciliated at their free margins, about forty in the course of the lateral line; much smaller on the nape, placed on a reddish-brown patch; tail rounded at the end; the first rays of the anal fin shorter than the terminating ones. Number of fin rays—

1st D. 6; 2d D. 14; P. 19; V. 10; A. 12; C. 13; B. 5.

This species of goby, on account of its inhabiting rocky situations, has received the name of rock-fish, differing greatly in habits from the rest of the gobies. Mr Couch has met with it on the coast of Cornwall, and has observed a peculiarity in its habits, in which it resembles the shanny,—that of carrying off its prey in its mouth to a resting-place, and there struggling with it. Colonel Montagu has frequently taken it on the south coast of Devon, in the estuary of Kingsbridge. Off Brixham I myself have seen it captured of large size, measuring from six to six and a half inches in length. It can be traced as far north as the Orkneys. In the Firth of Forth I find this fish rather scarce, having seen but three specimens, and those were taken at the Joppa Rocks east of Portobello. They spawn in June. Their flesh is of little value, serving only as food for other fishes.

Before the appearance of Mr Yarrell's very valuable work on fishes, all previous authors described the whole of the British gobies under two synonyms, that of *G. niger*, and

G. minutus ; but now, instead of having only two species, we can identify six as inhabiting the British shores.

The *Gobius niger* is distinguished from the rest of the British gobies in its growing to three or four times the size, and in having the two dorsals contiguous, which in all the other species are more or less remote.

Gobius minutus.*—The Freckled Goby.

Specific Characters.—Dorsal fins remote ; anterior rays of the second dorsal fin longer than the succeeding ones ; caudal fin rounded ; first dorsal with six rays. (See Pl. XXIX.)

Description.—From a specimen two and a quarter inches in length. Dorsal line nearly straight, slightly elevated over the pectorals ; profile falling from the orbit to the lip ; body rounded in the abdominal region ; nape depressed ; tail compressed. Colour of the head, back, and sides reddish-brown, freckled and streaked with dark brown ; throat and belly whitish ; dorsal and caudal fins mottled with brown ; ventral and anal fins plain. Operculum and preoperculum rounded ; cheeks prominent ; under jaw longest ; on the nape a sulcus extending from the orbit to the dorsal fin. Eyes approximate, situated high on the head, and in a line over the angle of the jaw. First dorsal fin commencing behind the base of the pectorals, and ending in a line over the end of the pectoral rays ; all the rays spiny and very flexible ; the second and third rays longer than the fourth. Second dorsal fin taking its origin in a line over the vent, and terminating over the last ray of the anal ; the anterior rays longer than the terminating ones, all branched except the first, which is simple, and a little more than half the length of the second. Anal fin commencing in a line under the third ray of the second dorsal, and corresponding in form to that fin ; ventrals united together so as to form but one fin, placed under the chest a little behind the base of the pectorals ; the middle rays the longest, reaching nearly to the vent ; pectorals when reflected reach as far as the middle of the orbit ; the centre ray the longest ; tail rounded at the end ; behind the vent a small tubercle. Scales large for the size of the fish, and finely ciliated at their free margins ; lateral line straight, crossed throughout by ten or twelve dark spots ; the one at the base of the tail the most conspicuous. Number of fin rays—

1st D. 6 ; 2d D. 10 ; P. 16 ; V. 8 ; A. 9 ; C. 15 ; B. 5.

* *Gobius minutus*, Cuv., Yarr., Jen., Penn., Don. *Freckled Goby, Spotted Goby, Polewig.*

The freckled goby seems to be a common fish in sandy bays throughout the British coast. I have met with it repeatedly on the west coast of Scotland, as well as in England, on the south coast of Devon. In the Firth of Forth it is taken on the Musselburgh and Portobello sands in shrimping-nets; and on one occasion I met with it as high up as Alloa, where it was found in a spirling-net in the early part of November. Those gobies when young delight in small shallow pools to bask more immediately under the rays of the sun, when they fall a prey to aquatic birds. When disturbed they are remarkably active, darting about in all directions; and, in consequence of their backs being precisely of the same colour as the sand on which they repose, will, when stationary, evade the eye of the most patient observer. Their food is small marine insects. They spawn in the month of June. The flesh, although sweet and well-flavoured, is never used as food.

Gobius minutus is more nearly allied to *Gracilis* and *Unipunctatus* than to any of the rest. In *Gracilis* the last rays of the second dorsal fin are *longer* than the preceding ones; in *Minutus* they are *shorter*. *Unipunctatus* has a large *black spot* on the membrane of the two last rays of the first dorsal fin; *Minutus* has *no spot* in that part.

GOBIUS UNIPUNCTATUS.—THE ONE-SPOTTED GOBY. *Par.*

Specific Characters.—Dorsal fins remote; anterior rays of the second dorsal fin longer than the succeeding ones; caudal fin even; first dorsal with six rays; a large black spot on the summit of the membrane between the last two rays of the first dorsal fin. (See Plate XXIX.)

Description.—From a specimen two inches and a half in length. Body rather elongated, rounded in front, compressed at the tail; flattened on the nape; head long in proportion to its depth, one fourth of the length, including half the caudal rays; operculum and preoperculum rounded. Colour of the head, back, and sides, pale brownish-yellow; throat and belly white; dorsal and caudal fins freckled and barred with pale brown; first dorsal fin with a black spot between the two last rays, which assumes a beautiful appearance when newly taken from the water; lateral line crossed by six or seven dark spots, the one at the base of the tail the most conspicuous. First dorsal fin with fine, flexible, spiny rays, of which the second and third rather the longest, commencing behind the base of the pectorals, and ending in a line over the end of the pectoral rays; second dorsal fin remote from the first, commencing in a line over the vent, and ending over the last ray of the anal, the anterior rays longer than the terminating ones, all flexible and branched, except the first which is simple; anal fin similar to the second dorsal, leaving a wide space between its termination and the base of the caudal rays; ventral fins united so as to form but one fin, the middle rays the longest, extending to the vent; each ray is branched except the first and last, which is very short and simple, between each is stretched a membrane forming the base of the ventral disk. Pectorals, when turned back reaching to the middle of the orbit; the middle rays the longest; tail even at the end. Eyes rather large, placed high on the head, approximating; cheeks tumid; under jaw the longest; teeth small and sharp placed in two rows in each jaw, none in the tongue, palatines, or vomer; a small tubercle in front of the anal fin. Number of fin rays—

1st D. 6; 2d D. 11; P. 16; V. 10; A. 11; C. 15; B. 5.

This fish does not appear to have been noticed by previous authors. I have observed it in most of the sandy bays in the Firth of Forth, but in greater numbers and of larger size in the neighbourhood of the salmon nets above South Queensferry, where it may be found throughout the summer months in water from two to three feet deep. I found it on the south coast of England, equally common with the *G. minutus*. I have also found it in many situations where the *minutus* was not seen; and the *minutus* has been taken in many places where the *G. unipunctatus* did not exist. The most northern locality in which it has yet been observed appears to be the Moray Frith, where James Wilson, Esq., obtained a fine specimen of three and a half inches in length.

This fish, although closely allied to the other species of the same genus, is undoubtedly quite distinct from them; the black spot on the first dorsal fin being far more constant and conspicuous than any character which distinguishes the rest of the British gobies. The only species it can well be mistaken for is the *G. minutus*; but differs from it in having a black spot between the fifth and sixth ray of the first dorsal fin; the second dorsal with eleven rays, and the tail fin even at the extremity. Whereas the *G. minutus* has no black spot between the fifth and sixth ray of the first dorsal fin; the rays of the second dorsal ten in number, and the tail fin rounded at the end.

Gobius gracilis.—The Slender Goby. *Jen.*

Specific Characters.—Dorsal fins remote; anterior rays of the second dorsal fin shorter than the succeeding ones; first dorsal fin with six rays. (See Plate XXIX.)

Description.—From a specimen two and a quarter inches in length. Dorsal line nearly straight; profile falling gradually from the forehead; body rather elongated, rounded, compressed at the base of the tail; flattened on the nape; operculum and preoperculum rounded; cheeks tumid; under jaw the longest. Colour of the back and sides reddish-brown; freckled and streaked with a dark brown; dorsal and caudal fins barred with the same; lateral line crossed with seven or eight dark spots, occasionally the middle one extending nearly the depth of the side; ventral and anal fins dusky, sometimes nearly black. Eyes approximating, situated high on the head, in a line over the angle of the jaw; first dorsal fin commencing in a line over the upper third of the pectorals, and ending over the end of the pectoral rays; all the rays spiny and flexible; the second, third, and fourth, of equal length. Second dorsal fin taking its origin in a line over the vent and terminating over the last ray of the anal; the anterior rays shorter than the terminating ones, all branched except the first; anal fin corresponding to the second dorsal, but commencing a little further back; in front of the first ray a small adipose tubercle; ventrals united so as to form but one fin, placed under the thorax, a little behind the base of the pectorals, the middle rays the longest, reaching to the vent; pectorals on being reflected reach back as far as the middle of the orbit; the central rays the longest; tail slightly rounded at the end. Scales large for the size of the fish; finely ciliated at their free margins and beautifully situated within. Number of fin rays—

1st D. 6; 2d D. 11; P. 18; V. 10; A. 10; C. 12; B. 5.

This fish was first described by Jenyns from specimens which were supposed to have been taken somewhere off the Essex coast. Mr Jenyns remarks, that it closely resembles the *G. minutus,* but is more elongated and slender throughout; greatest depth barely one seventh of the whole length; snout rather longer; opercule approaching more to triangular, the lower angle being more cut away, and the ascending margin more oblique; a larger space between it and the pectorals; the two dorsals farther asunder; rays of the second dorsal longer; these rays also gradually *increasing* in length, instead of *decreasing;* the posterior ones being the longest in the fin, and rather more than equalling the whole depth; rays of the anal, in like manner, longer than in the *G. minutus;* anal and ventral fins dusky, approaching to black in some places, instead of plain white as in *G. minutus.* Jenyns' *British Vertebrate Animals.*

This well marked species of goby is occasionally found in the Firth of Forth, but is not common; it inhabits similar situations as the *minutus,* and they are frequently taken together. I have found it in the Solway Firth, and in much greater plenty on the southern coast of England. It spawns in June, and is of little value except as food for other fishes and aquatic birds.

Gobius bipunctatus.—The Doubly-spotted Goby. *Yarrell.*

Specific Characters.—Dorsal fins nearly contiguous; first fin with seven rays; a black spot behind the pectorals, and a similar one on the base of the caudal fin. (See Plate XXIX.)

Description.—From a specimen two inches and a half in length. Body rounded, compressed towards the base of the tail; flattened on the summit of the head; dorsal line nearly straight, slightly raised over the pectorals; operculum and preoperculum rounded; under jaw the longest. Colour of the back and sides dark reddish-brown, crossed with dark lines taking opposite directions; dorsal and caudal fins barred with light reddish-brown; ventral and anal fins white; lateral line marked by nine or ten light blue spots, placed at equal distances from each other; a large black spot under the second and third rays of the first dorsal fin, partly concealed by the upper rays of the pectorals; a similar spot at the base of the caudal rays. First dorsal fin commencing in a line over the upper thirds of the pectorals, and ending in a line over the vent; the second, third, and fourth rays the longest, all simple and flexible; second dorsal fin commences in a line over the anal tubercle, and ends over the last ray of the anal fin; the second ray the longest, the rest gradually decreasing in height; all the rays branched except the first; tail rounded at the end; anal fin corresponding with the second dorsal, but commencing rather further back; ventrals united together, forming but one fin, all the rays branched except the two first; the middle rays the longest, reaching to the vent; pectorals not as long as the ventrals, reaching as far as in a line under the sixth ray of the dorsal. Eyes placed high on the head; teeth small and sharp, placed in two rows in each jaw, none on the tongue, vomer, or palatines. Scales large for the size of the fish, finely ciliated at their free margin. Number of fin rays—

1st D. 7; 2d D. 11; P. 18; V. 12; A. 11; C. 12; B. 5.

This fish was considered by Donovan to be identical with the *G. niger* of Linnæus, and he figured it as such in his work on the British Fishes; but Mr Yarrell has since very clearly proved it to be a distinct species, differing widely from those found on the British coast, and from the fact of its possessing two conspicuous black spots on each side of the body, suggested to him the characteristic name of *bipunctatus*. It appears to have an extensive range, and has been found on the Belfast, Cornish, Devonshire, and Dorsetshire coasts. Dr Johnston has observed it at Berwick, and I have repeatedly taken it at the mouth of the Firth of Forth as well as at Largo, on the opposite shore. The *bipunctatus*, independent of external characters, differs widely in habits from the rest of the gobies. It frequents the most rocky situations, where *fuci* grows in the greatest abundance, and is never found reposing on the sandy bottoms, like the rest of its congeners. It keeps but a short distance from below the surface of the water, apparently in a motionless position, assuming, in this respect, much the habits of the Stickleback; when approached, it gradually lowers itself in the deep, and soon disappears, by making short, though rapid, darts among the *fuci* which it delights to frequent.

This species is easily recognised by having more rays in the first dorsal fin than the other British gobies possess. The *G. niger*, *G. minutus*, *G. unipunctatus*, and *G. gracilis*, have six rays in the first fin. *G. albus** has but five, whereas the *G. bipunctatus* has seven in that fin.

GENUS *CALLIONYMUS*.—Dorsal fins two; ventrals separate, placed under the throat; body without scales.

CALLIONYMUS LYRA†.—THE GEMMEOUS DRAGONET.

Specific Characters.—First ray of the first dorsal fin elongated, reaching beyond the last ray of the second dorsal fin.

Description.—From a specimen seven inches and a half in length. Head depressed, elongated; snout sharp, very protractile; body elongated, smooth, without scales; sides rounded. Colour of the head and sides pale yellow, striped and spotted with blue and white of different shades, assuming a sappharine appearance; ventrals dark purple; anal and caudal fins bluish-black; pectorals pellucid white; first dorsal fin beautifully variegated with blue, black, and pale yellow, intermixed with lines of white; throat dark; belly cream colour. First dorsal fin commencing a little in advance of the base of

* *Gobius albus*, a new species of British Goby.—*Proceedings of the Royal Society of Edinburgh*, 1837.

† *Callionymus lyra*, Linn., Cuv., Jen., Yarr., Penn., *Gemmeous Dragonet, Yellow Skulpin, Goudie, Chanticleer.*

the pectorals ; the first ray very much produced, reaching when folded down to the base of the caudal fin. In some specimens this ray does not reach quite so far, but invariably extends beyond the base of the last ray of the second dorsal. The second ray about half as long as the first, the other two rays in that fin rapidly decreasing ; second dorsal fin commencing close behind the first, and ending in a line over the last ray but three of the anal ; the first ray equalling the height of the third ray of the first dorsal ; the last ray the longest, branched at the summit ; the rest simple. Anal fin commencing in a line under the third ray of the second dorsal ; the last ray twice as long as the first, and reaching when folded down to the base of the caudal rays ; pectorals pointed, the middle rays the longest, extending to the third ray of the anal ; all branched except the first ; ventrals placed before the pectorals ; the first ray about half the length of the last, which is the longest, reaching to the first ray of the anal ; the four first rays branched on one side only, presenting a feather-like appearance. Head one-third the length of the body, caudal not included ; operculum rounded, covered by a membrane which nearly closes the branchial aperture, leaving only a small hole on each side of the nape, close by the origin of the lateral line ; posterior border of the preoperculum greatly produced, ending in *four* strong short spines, two of which are directed upwards, the third points towards the base of the pectorals, and the fourth, which is placed underneath, points towards the snout. Most authors state the preoperculum to have but three spines. Eyes rather large, placed high on the head, approximating ; under jaw the shortest. Teeth small and fine, placed in many rows in front of each jaw, none on the tongue, vomer, or palatines ; lateral line prominent, commencing immediately above the branchial aperture, taking a slight curve over the base of the pectorals, from thence passing straight to the tail ; both lines unite at the nape by extending across the occiput to meet with its fellow on the opposite side ; caudal fin rounded at the end ; all the rays branched except the two lateral ones. Number of fin rays—
1st D. 4 ; 2d D. 9 ; P. 20 ; V. 5 ; A. 9 ; C. 9.

The Gemmeous Dragonet is an inhabitant of the Mediterranean, and, according to authors, has been found as far north as off the coast of Norway. Mr Yarrell considers it as not a common fish on our coast. It has been taken on the coast of Cumberland and Belfast, and occasionally in Cornwall. Colonel Montagu considers it rare at Salcombe, on the coast of Devon ; yet at Exmouth I found it not unfrequent. At one haul of a sean I procured five specimens, and have often seen them taken in shrimping-nets, though of small size. It has been obtained at Weymouth and Hastings, and Pennant says it is not unfrequent on the Scarborough coast, where it is taken by the hook in thirty or forty fathoms of water. Dr Neill records it as common in the Firth of Forth, and often found on Haddock lines. In this latter locality I find them not so plentiful as they formerly appear to have been; they are principally confined to the mouth of the Firth, in deep water, especially near the Isle of May; seldom found high up the Firth, although one or two solitary instances have occurred in which specimens were taken at Alloa and Kincardine, after strong easterly winds. This fish is said to grow to the length of a foot. Its food, according to Mr Yarrell, is testaceous animals, which are swallowed whole, molluscous animals, and worms. The flesh is said to be white, firm, and of good flavour. Cod, it is recorded, occasionally feed on the young.

CALLIONYMUS DRACUNCULUS.*—THE SORDID DRAGONET.

Specific Characters.—First ray of the first dorsal fin moderate; not extending beyond the sixth ray of the second dorsal.

Description.—From a specimen seven inches and a half in length. Body rather elongated, depressed, sides rounded; head triangular, broader than the body, rather more than one-fourth of the whole length, caudal excepted; snout protractile. Operculum rounded, covered by a membrane which nearly closes the branchial opening, leaving only a small hole, on each side of the nape, close by the origin of the lateral line; preoperculum greatly prolonged behind, terminating in *four* strong, short, spines, which are said to be capable of inflicting a severe wound; two of the spines are directed upwards, the third towards the base of the pectorals, and the fourth placed below pointing towards the snout. Colour of the back and

* *Callionymus dracunculus* Linn., Jen., Yarr., Penn., Cuv. *Sordid Dragonet, Fox, Skulpin.*

sides, reddish brown, mottled with dark-brown; belly dull white; ventrals dusky; pectoral and anal fins white; dorsals pale uniform brown; irides yellowish. First dorsal fin commencing over the base of the pectorals; the first ray the longest, reaching to the third ray of the second dorsal fin; the second ray nearly of the same length as the first; the third and fourth much shorter; second dorsal fin commencing close behind the termination of the first, and ending in a line over the last anal ray but three; the first ray of the same height as the second ray of the first dorsal, the seventh and eighth ray the shortest, the last not longer than the first; all simple except the terminating one which is branched. Anal fin commencing in a line under the third ray of the second dorsal; the last ray the longest; pectorals pointed, middle ray the longest, extending to the third ray of the anal, all branched except the first; ventrals placed before the pectorals, the first ray not half the length of the last, which is the longest, reaching to the first ray of the anal; the first four rays branched on one side only. Caudal fin rounded at the end, all the rays branched except the first on each side. Eyes rather large, placed high on the head, approximating; under jaw the shortest. Teeth small and fine, placed in many rows in front of each jaw, none on the tongue, vomer, or palatines; lateral line prominent, commencing immediately over the branchial aperture, taking a slight bend over the base of the pectorals, from thence passing straight to the tail; on the nape it joins with its fellow on the opposite side, by extending across the occiput; body smooth without scales. Number of fin rays—

1st D. 4; 2d D. 9; P. 20; V. 5; A. 9; C. 10.

This species like the last appears to be widely distributed, and is found frequenting the same places. According to Dr Neill it is rather common near the mouth of the Firth of Forth, where it inhabits water from twelve to twenty fathoms deep, and is often taken on haddock lines baited with mussels. I have occasionally seen specimens taken myself from this locality, and off North Berwick and Largo, but it is seldom found higher up the estuary than Inchcolm. Dr Neill, after dissecting some dozens of specimens of *Callionymus lyra* and *C. dracunculus*, and finding the former all milters, and the latter all spawners, came to a conclusion that they were male and female of the same species.

This also is the opinion of M. Valenciennes. Dr George Johnson of Berwick, has, on the other hand, recorded in the third volume of the Zoological Journal, page 336, that he had found a Sordid Dragonet with a milt. Mr Yarrell also considers them as distinct. Mr Couch has observed a certain difference in their habits. "The Yellow Skulpin," says Mr Couch, "prefers deeper water; whereas the other will often approach the margin of the tide, where I have watched its actions with great interest. They keep at the bottom, among sand or stones, and never rise but to pass from one situation to another, which is done with great suddenness and rapidity. They possess great quickness of sight, and dart with swiftness when alarmed, though not to a great distance: and I have seen the Sordid Skulpin repeatedly mount after prey, and invariably return to the same spot again. This motion is chiefly performed by the ventral fins; and the eye is well adapted to the habit, the muscles of that organ being fitted to direct the sight upward but not downwards. They sometimes take the hook, though rarely; and are much devoured by the larger fish, in the stomachs of which they are often found. They feed on shell-fish, worms, and molluscous animals."

Mr Yarrell says that, "in proof of the distinction of the species, it may be stated that the colours of the body and fins are decidedly different; that in *C. lyra* the head is to the whole length as one to four; the eyes removed two diameters from the end of the nose; the head elongated and elevated; the distance from the point of the nose to the posterior edge of the orbit, and thence to the origin of the first dorsal fin ray, equal; the mouth large; the lateral line prominent. In *C. dracunculus*, the head is to the whole fish as one to five; the eyes but one diameter above the snout; the head depressed, strictly triangular; the distance from the eye to the first dorsal fin ray double that of the distance from the point of the nose to the eye; the lateral line much less distinct, and the mouth only half as deeply divided." In addition to these characters I may add, that in *C. lyra* the first ray of the first dorsal fin always reaches beyond the last ray of the second dorsal fin; and the last ray of the second dorsal fin is twice as long as the first ray in the same fin; whereas in *C. dracunculus* the first ray never reaches beyond the sixth ray of the second dorsal and the last ray of the second dorsal is seldom longer than the first ray in the same fin.

FAMILY IX. LOPHIADÆ.—Carpal bone elongated in order to form a kind of arm, which supports the pectorals; body without scales; skeleton semi-cartilaginous.

GENUS *LOPHIUS*.—Head broad, depressed; excessively large in proportion to the rest of the body; dorsal fins two; ventrals placed before the pectorals, and of a glove-like form.

LOPHIUS PISCATORIUS.*—THE SEA-DEVIL.

Specific Characters.—Head with three long filaments, two of which are placed close behind the upper lip.

Description.—From a specimen two feet in length. Head large, broad, depressed, about one-third of the entire length, caudal fin included; body tapering rapidly from behind the pectorals, becoming rounded towards the base of the tail; covered with a thin loose skin, very smooth, without scales. Colour of the head, back, and dorsal fins uniform brown, pectoral and caudal darker; under the throat and belly pure white; anal fin dusky; occasionally the whole body is marked with large white spots very much resembling white paint. First dorsal fin small, placed in a line with the base of the pectorals; the last ray about one-third the length of the first. Second dorsal

* *Lophius piscatorius*, Linn., Cuv., Yarr., Jen., Penn. *Fishing-frog, Angler, Wide Gape, Devil-fish, Mirring.*

remote from the first, and much more conspicuous; of a rounded form, the middle rays being rather the longest; the last ray connected to the base of the tail by a membrane which passes off from its whole length; anal fin corresponding in form to the second dorsal, but rather smaller, commencing under the fourth ray, and ending a little behind the last ray of the second dorsal; tail rather small, rounded at the end; ventrals small, very much resembling a glove in form, placed a little in advance of the pectorals. In front of the eyes, a little behind the upper lip, are two long slender filaments nearly the length of the head, the anterior one is furnished on the summit with a small triangular piece of skin, often of a sappharine appearance, which the fish uses as a bait for its prey; on the occiput is another filament nearly of the same length, connected at the base with a small membrane, which greatly limits its freedom. Eyes rather small, placed high on the head; orbits on the upper and posterior borders with four or five bony tubercles, having in front of the two first a number of small bony granulations; snout in front of each eye, also with two bony tubercles; occiput and cheeks with scattered processes of a similar kind. Teeth long and slender, capable of easy flexion inwards, but not outwards, placed in two rows in each jaw, those in the outer row being about half the length of the inner ones; palate and tongue also furnished with teeth with their points directing inwards. Mouth large, allowing of great expansion; under jaw the longest; chin, under the cheeks, down the sides to the base of the tail, furnished with a row of short prolongations of the cuticle. Branchial opening under the pectorals, in which situation there is a large sack or pouch from twelve to fourteen inches deep, where the young are supposed by some writers to take refuge in time of danger. Number of fin rays—

1st D. 3; 2d D. 11; P. 23; V. 5; A. 10; C. 8; B 6.

This fish, or the Angler, as it was first named by Pennant, is sometimes taken the length of five feet, but the more common size is from two feet and a half to three in length. The great resemblance it bears to a frog in the tadpole state, and the peculiar mode in which it procures its food, had suggested the name of Fishing-frog to the earliest writers. It is said by authors to be found in all the seas in Europe; it is, however, a common fish all round the British coasts, and has been found as far north as off the coast of Norway. According to Mr Couch, " it is very voracious, making little difference what the prey is, either in respect to size or quality. A fisherman had hooked a cod fish, and, while drawing it up, he felt a heavier weight attach itself to his line; this proved to be an angler of large size, which he compelled to quit its hold by a heavy blow on its head. In another instance an angler seized a conger eel that had taken the hook, but after the latter had been engulphed in the enormous jaws, and perhaps stomach, it struggled through the gill aperture of the angler, and in that situation both were drawn up together. It has been known to swallow the large ball of cork employed as a buoy to a deep-sea line. They are very common in Cornwall, and we are informed that it is not an unfrequent occurrence to take in a trawl-net a dozen at once.*"

The long filaments on the upper and anterior part of the head of the angler are supposed to be of service in procuring it subsistence. The first filament, according to Mr Bailly, is supplied with twenty-two muscles, so that it has the power of being moved in all directions; "The uses to which they are applied are singular. While couching close to the ground, the fish, by the action of its ventrals, tail, and pectorals, stirs up the mud; hidden by the obscurity thus produced, it elevates these appendages, moves them in various directions by way of attraction as a bait, and the small fishes approaching either to examine or to seize them immediately fall a prey to the invidious angler."

In the Firth of Forth the angler is frequently taken both with the hook and net, and is common in almost every part of the estuary. Occasionally specimens have been taken in the spirling-nets as far up as Alloa, but beyond that they are scarcely ever met with. The flesh is considered good, particularly that near the tail.

* Yarrell's *British Fishes.*

A short time since some fishermen at Queensferry observing the water very much discoloured at a particular spot near the shore, proceeded to discover the cause, and on poking the bottom a few seconds with a long handled mop, found that a *sea-devil* had taken hold of it with an intent of making it a mouthful, and the fish not being able to extricate its teeth in sufficient time from the woolly substance of the mop, it was hauled into the boat by the fishermen. It measured four feet nine inches in length.

Family X. LABRIDÆ.—Body oblong, covered with large scales; dorsal fin one, with the greater part of the rays spinous, and the intervening membrane extending a little beyond their point; lips thin and doubled back, giving an appearance as if thick and fleshy; pharyngeal bone armed with blunt teeth; the tail fin of all those inhabiting the British waters is rounded at the extremity.

Genus *LABRUS*.—Preoperculum without dentations; cheeks and operculum scaly.

Labrus maculatus.*—The Ballan Wrasse.

Specific Character.—Last ray but five of the dorsal fin more than twice the length of the third ray of the same fin.

Description.—From a specimen fifteen inches in length. Head one-fourth of the entire length, caudal fin included; body of an oblong oval form; dorsal line from the soft part of the dorsal fin to the nape nearly straight, from thence falling gradually to the upper lip; sides but slightly compressed; covered with large thin scales, about fifty forming the lateral line. Colour of the head, back, and sides, bluish-green, with an obscure white spot on each scale, presenting a mottled appearance; belly orange-red; cheeks greenish, striped with pale red; dorsal, caudal, and anal fins bluish-green, with pale light blue spots; pectoral and ventrals orange-red; in some specimens the whole body, fins included, of a uniform reddish-brown, but liable to great variation in colour. Dorsal fin commencing in a line over the

* *Labrus maculatus*, Yarr., Jen., Penn., Bloch. *Labrus tinca*, Don.

base of the pectorals, extending down nearly the whole length of the back, to within a short distance of the base of the tail; the first twenty rays short and spiny, nearly all of equal length, with the intervening membranes extending beyond their points, in the form of fine filaments; the remaining portion of the fin, soft and flexible, the rays, which are branched on their summits, being much longer than the spinous ones. Anal fin commencing in a line under the eighteenth ray of the dorsal, and ending in a line beneath the last ray but four of the same fin; the first three rays spiny, of which the first is the shortest; the rest of the rays soft and flexible, branched at their summits; the last but four the longest: ventrals shorter than the pectorals, and placed behind the base: pectorals rounded at the end with the middle rays the longest; operculum rounded; preoperculum smooth not denticulated, the ascending margin rather oblique; cheeks and operculum scaly, compressed. Nose pointed; under jaw the shortest; lips long and thin, rugose on the under surface and, wh n folded back, having the appearance as if thick and fleshy. Eyes rather small, placed half way between the point of the upper jaw and the posterior margin of the operculum. Teeth stout and conically arranged in two rows in front of each jaw; the front row in the upper jaw has eighteen teeth; the same row in the lower jaw has twenty; in the second row they are small and few, not exceeding eight in number; pharyngeals armed with short blunt teeth; none on the tongue, vomer, or palatines; lateral line commencing over the operculum, taking a slight bend over the base of the pectorals, running parallel with the dorsal line as far as the last ray but four, where it makes a short bend down, from thence passes straight to the tail; scales six in number in an oblique row between the middle of the dorsal fin and lateral line; between it and the vent twelve; between the rays of the caudal fin, half way down, a number of small imbricated scales; preoperculum without scales; corners of the tail rounded. Number of fin rays—

D. 31; P. 15; V. 6; A. 12; C. 13.

The Ballan Wrasse is a rare fish in the Firth of Forth, although found in tolerable numbers in most of the rocky places round the British coast. A fine specimen was sent me by Mr M'Queen, which was taken in the salmon nets at Hopetoun in the month of August; it measured seventeen inches in length, and six in depth. I feel myself indebted to that gentleman for his uniform kindness in sending me many fish of value and interest; the specimen was full of roe apparently in a fit state to be deposited; perhaps the spawning time of this species is later in the north than on the more southern parts of the coast, since it is stated by Mr Couch of Cornwall, that "the spawn is shed in April, and the young, scarcely more than an inch in length, are seen about the margin of the rocks in shallow water throughout the summer."

This fish is occasionally taken at North Berwick with the hook and brought to the Edinburgh market for sale, but the flesh is little sought after, being white, soft, and very insipid. It feeds on crustaceous and testaceous animals.

The Wrasses greatly resemble each other in their external form, and their colours being liable to great variation, have created much confusion in the identification of the species. This fish is distinguished by having the soft rays of the dorsal fin about twice the length of the spiny rays; whereas in the rest of the British *Labri* the soft rays in that fin are scarcely longer than the spiny ones, and frequently of equal length.

Labrus carneus.*—The Red Wrasse.

Specific Character.—Posterior rays of the dorsal fin very little longer than the spiny rays; body red, with three dark spots on each side; two at the base of the dorsal fin, and one between the dorsal and caudal.

Description.—Not possessing a specimen of this fish, the following is from the work of Mr Yarrell. Prevailing colour a fine orange-red over all the upper part of the body, becoming lighter as it descends the sides; all the fins a rich yellow, with a tinge of dark at the edges of the membranes; part of the spinous portion of the dorsal fin, a fine rich purple, with two spots at the base of the hinder soft-rayed

* *Labrus carneus*, Cuv., Yar., Bloch. *Labrus trimaculatus*, Jen., Penn., Don. *Red Wrasse, Three-spotted Wrasse, Double-spotted Wrasse.*

part of the same fin, and one of the same deep purple colour still farther back at the upper part of the fleshy portion of the tail. Alternating with the last three dark spots, are four lighter coloured ones, of a delicate rose colour, which appears to have given origin to the name of Double-Spotted Wrasse. There are occasionally but two dark spots at the hinder part of the body. The length of the head measuring from the teeth to the backward projecting angle of the operculum, is, to the head and body taken together, without including the caudal rays, as one to three; the depth of the body and dorsal fin, equal to the length of the head; the depth of the body alone in a line with the origin of the ventral fins, is, to the whole length of the fish, as one to four; the scales small. Number of fin rays—

D. 30; P. 15; V. 6; A. 14; C. 14.

The red wrasse, or trimaculated wrasse as it is occasionally named, has been noticed by naturalists on the coasts of Cornwall and Devonshire, as well as in the Baltic and on the coast of Norway. Dr Neill has recorded it in the Wernerian Transactions, as found in the Firth of Forth. In this locality it is undoubtedly a rare fish, as not a single specimen has yet occurred to me from that quarter. The flesh is said to be good food.

Genus CRENILABRUS. Margin of the preoperculum dentated.

Crenilabrus tinca*.—The Connor.

Specific Character.—Base of the tail under the lateral line without a black spot; depth less than one-third of the length; intervening membranes of the dorsal fin without scales.

Description.—From a specimen five inches in length. Dorsal line slightly curved, falling gradually from the first ray to the snout; head compressed, more than one fourth of the whole length; in a specimen seven inches long, the head is not one fourth of the entire length. Colour of the upper parts, in the region of the back, bluish-green, tinged with brownish-red; side lighter, with longitudinal lines of

* *Crenilabrus tinca*, Yar., Flem. *Labrus tinca*, Linn., Jen. *Ancient Wrasse*, Penn. *Gilt-head*, *Connor*, *Golden maid.*

dusky blue; cheeks bluish-green with longitudinal lines of red; belly pale; dorsal, caudal, and anal fins, blue, spotted and streaked with red; pectorals yellowish-blue without spots or marks. Dorsal fin commencing in a line over the posterior margin of the operculum and ending, the length of the ventral fin rays, from the base of the tail; the first ray the shortest about one third the length of the pectorals, the rest gradually increasing to the last ray but three of the soft portion, the first seventeen rays sharp and spiny, the rest soft and flexible. Anal fin commencing in a line under the fourteenth ray of the dorsal and terminating immediately under the last ray of the same fin; the first three rays strong and spiny, the rest branched and flexible; the terminating rays, except the last ray, rather the longest; ventrals placed behind the base of the pectorals, the rays not reaching to the vent; pectorals rounded at the end, the upper rays the longest, reaching as far as in a line under the ninth ray of the dorsal fin; tail rounded at the end, with all the rays branched except the two or three lateral ones. Eyes placed high on the head, the upper margin of the orbit in a line with the ascending extremity of the preoperculum. Teeth stout and conical, arranged in two rows in each jaw, the second row very indistinct, confined to the anterior part, about six above and four below, those in the first row, ten above and fourteen below, the front ones longer and stouter than the rest, no teeth on the tongue, vomer, or palatines: operculum smooth, ending in two soft points, directing back over the base of the pectorals; preoperculum angular, margined with a number of sharp minute points, scarcely perceptible except in the dried state. Scales on the body large and thin, those on the operculum and cheeks smaller; preoperculum without scales. Lateral line commencing over the middle of the upperpart of the operculum, taking a slight bend at its origin, following the dorsal curve as far as the posterior part of the flexible rays, where it makes an oblique turn down for a short course, from thence passing straight to the base of the middle caudal ray. Number of fin rays—

D. 24; P. 14; V. 6; A. 13; C. 13.

This fish has no particular name in the Firth of Forth further than that of wrasse or old wife, and is not distinguished by the fishermen from the last species, with which they always confound it. On the rocky parts of Prestonpans, North Berwick, Largo, and Burntisland, they are not unfrequently met with, and, what is singular, they are scarcely ever taken with the hook, but mostly found in crab-cages and lobster-pots. The largest specimen I have met with does not exceed the length of seven inches and a half, and the stomach of most of those that were examined was filled with shrimps and small star-fish. The flesh when boiled has a bluish-white appearance with a very disagreeable tarry flavour. They are said to spawn in the month of April.

We are informed by Mr Yarrell that this species has much the habits of the goldsinny, and is not uncommon on the Sussex, Hampshire, and Devonshire coasts, and that it has been taken at Londonderry, Dublin, and in Belfast Bay.

This fish is distinguished from the last in having the preoperculum denticulated, and from the following one in the base of the tail below the lateral line being without a black spot. There are, however, three other British Wrasses that have dentations on the preoperculum, closely resembling the present one, viz., *Crenilabrus gibbus*, *C. luscus*, and *C. rupestris*, which, I have no doubt, have occasionally occurred on the west coast of Scotland, but have been confounded with *C. tinca*. *C. gibbus* is distinguished from *C. tinca* in being much deeper in proportion to its length, the depth being considerably more than one-third the length of the whole fish; in *C. tinca* the depth is not more than one third of the length, if so much. *C. luscus* has the intervening membranes of the dorsal rays furnished with imbricated scales; in *C. tinca* there are no scales on that part. *C. rupestris* is recognised by having a conspicuous dark spot on the base of the upper part of the tail, and no spot below the caudal extremity of the lateral line; in *C. tinca* there is no dark spot on the base of the tail either above or below the lateral line. *Crenilabrus rupestris* i the same as *Lutjanus rupestris* of Bloch, and *Labrus Cornubicus* of Pennant's description, but not the *Labrus Cornubicus* of Jenyns or *Crenilabrus Cornubicus* of Yarrell, or the *Corkwing* of Couch.

Crenilabrus Cornubicus.*—The Goldsinny.

Specific Characters.—Base of the tail, with a black spot, below the lateral line.

Description.—From a specimen four inches in length. Dorsal line more rounded than in the last species; head rather more than one-fourth the length of the whole fish; depth greater than the length of the head. Colour of the back and sides reddish-brown, tinged with greenish-blue, marked with twelve or fifteen longitudinal lines of a darker shade; belly pale orange-red; dorsal, caudal, and anal fins, bluish green, with spots and stripes of orange-red. Dorsal fin commencing in a line over the margin of the operculum, and ending the distance of the length of the ventral fin rays from the base of the tail; the first ray the shortest, the rest very gradually increase in length to the last ray but one; the seventeen first rays spiny; the remainder soft and flexible: anal fin commencing in a line under the twelfth ray of the dorsal, and ending under the last ray but one of the same fin; the first three rays spiny, the rest rather longer and flexible; ventrals behind the base of the pectorals; upper rays of the pectorals the longest, reaching down as far as in a line under the ninth ray of the dorsal fin; tail rounded at the end, all the rays branched except the short lateral ones. Eyes placed high on the head and rather remote from the point of the snout. Operculum smooth, ending in a soft flattened point, over the base of the pectorals; preoperculum angular, finely dentated at the free margin. Teeth rather small in both jaws, pointing slightly outwards; scales large and thin, those on the cheeks smaller than the rest; preoperculum without scales. Lateral line commencing over the operculum, following the curve of the back to the end of the dorsal rays, there taking a short oblique bend down, from thence passing straight to the base of the tail, a large black spot a little below the caudal extremity of the lateral line. Number of fin rays—

D. 24; P. 14; V. 6; A. 13; C. 14.

The habits of this species are similar to those of the Wrasses generally, that of frequenting deep and rocky

* *Crenilabrus Cornubicus*, Yar. *Labrus Cornubicus*, Jen., but not of Penn. *Lutjanus Geoffry*, Risso. *Corkwing*, *Goldsinny*.

recesses in preference to more open and sandy situations. They feed on small shells and crustacea, which are found in the greatest abundance in those places they inhabit, and on some occasions I have noticed their stomachs filled with vegetable matter, and apparently the roe of other fishes. At Brixham, one of the principal fishing ports on the south coast of Devon, I had an opportunity of witnessing several of these fish taken at the mouth of the harbour, in company with the *Labrus maculatus* and *Crenilabrus tinca*, which were in equal plenty. All the specimens were nearly of equal dimensions, not exceeding four inches and a half in length, which appears to be the average size, although on two occasions I observed them considerably larger, one measuring seven, and the other eight inches in length, with the tail-spot well developed in each. Mr Jenyns has observed this fish at Weymouth, and I have occasionally met with it in the Firth of Forth, which is the most northern locality in which it has yet been noticed. In the month of August I obtained three specimens in a pool of water at Inchkeith, and at Prestonpans they are now and then taken by small hooks baited with pieces of mussel, their mouths being too small to admit of being taken by the ordinary sized hook used for sea-fishing. Although I have followed Mr Yarrell in the synonyms of this fish, yet there is little doubt but that it has been confounded by him and other authors with the *Goldsinny* of Jago, which is the *Lutjanus rupestris* of Bloch, and *Labrus Cornubicus* of Pennant. Perhaps the mistake first originated with Pennant, who has described the *Goldsinny* of Jago, and figured the *Goldsinny* of Yarrell, but forgotten to delineate the tail-spot. Although his description is laconic, yet it is certain it refers to the *Goldsinny* of Jago, for he says, " near the tail is a remarkable black spot ; the *first rays* of the dorsal fin are tinged with *black*," this last mark decides it, as being one of the characters peculiar to that fish. The *Crenilabrus Cornubicus* of Yarrell is the *Labrus Cornubicus* of Jenyns and of Donovan; the *Corkwing* of Couch, and the *Lutjanus Geoffroy* of Risso.

This species is readily distinguished by having a black spot at the base of the tail *below* the lateral line, a character which none of the other British Wrasses possess.

Crenilabrus rupestris.*—Jago's Goldsinny.

Specific Characters.—Anterior part of the dorsal fin, as far as the fifth ray, black; a large black spot at the base of the upper caudal rays.

Description.—From a specimen five inches in length. Head one-fourth of the whole length, caudal rays included; depth of the body less than the length of the head; dorsal line nearly straight, falling gradually in front from the nape to the point of the snout; sides rather compressed. Colour of the head and back yellowish-brown; sides somewhat lighter; belly dull white; the membranes between the first four dorsal spines deep black; a large conspicuous black spot at the base of the upper part of the caudal fin; dorsal fin commencing in a line over the base of the pectorals and running down the back to within a short distance of the base of the caudal, leaving a space between, about equalling the length of the pectoral rays; the anterior seventeen rays, strong and spiny, nearly all of equal length, except the first two or three which are rather the shortest; the posterior rays soft and branched, and longer than those preceding, the middle flexible rays being half as long again as the spiny rays, presenting a rounded form to that portion of the fin; the membrane between each dorsal spine terminating in a fine pointed filament; caudal fin rounded, all the rays branched except two or three of the lateral ones, which are simple; the middle ray as long as the base of the nine first dorsal spines; pectorals rounded, the fifth and sixth rays the longest, equalling the length of the base of the anal fin; all the rays, except the first, soft and branched; ventrals taking their origin rather behind the base of the pectorals; the first ray stout and spiny, the rest soft; the longest ray about half the length of the

* *Labrus Cornubicus*, Penn. (Description, not figure.) *Lutjanus rupestris*, Bloch.

head; anal fin commencing in a line under the fourteenth ray of the dorsal, and terminating immediately under the last ray but one of the same fin; all the rays nearly of equal length, except the three first, which are stout and spiny, and somewhat shorter, the rest soft and flexible, the longest rays being as long as the base of the first six dorsal spines, and equalling the length of the middle flexible rays of the same fin; head in front of the ascending margin of the preoperculum somewhat of a triangular form; snout pointed; mouth small; jaws of equal length. Teeth, on the anterior part of each jaw, long and sharp, with their points bending slightly inwards; those behind much smaller and more numerous; eyes moderate, placed high on the head and half-way between the point of the upper jaw and the posterior margin of the operculum; cheeks, gill-covers, and body, covered with scales, as well as the intervening membranes of the caudal fin, those on the sides being much larger than elsewhere. Preoperculum angular, the posterior margin finely serrated, the lower border entire; operculum terminating over the base of the pectoral in a small flattened point, the lower margin somewhat sinuous; lateral line placed high up, commencing at the upper part of the operculum, running parallel with the dorsal line as far as in a line under the last ray of the dorsal fin where it takes a sudden bend, thence passing straight to the base of the middle caudal ray; four scales in an oblique row between the middle of the dorsal fin and lateral line; along the course of the lateral line, as far as the base of the caudal fin, thirty-seven scales. Number of fin rays—

D. 25; P. 15; V. 6; A. 11; C. 14.

This species, which was first observed by Mr Jago, on the Cornish coast, has been obtained by Mr Couch from the same quarter, and a specimen of three inches in length is figured in Mr Yarrell's work on the British Fish, vol. i. page 301, under the name of the Scale-rayed Wrasse. Several examples have since been observed on the Northumberland and Berwickshire coasts, and specimens are occasionally found in the Firth of Forth, washed ashore after strong easterly gales. It is a fish of little value for the table, its flesh, like most of the species in this genus, being soft and insipid.

ORDER II.—MALACOPTERYGII.

All the fin rays soft and flexible, except sometimes the first of the dorsal or pectoral fins.

I. ABDOMINALES.

Ventral fins placed on the lower part of the abdomen, under the first dorsal fin, or nearly so.

Family I. CYPRINIDÆ.—Dorsal fin one; mouth small, mostly without teeth; belly not compressed, never serrated; intestinal canal short, destitute of cæca. Inhabitants of fresh waters; swimming bladder generally divided into two lobes.

Genus *LEUCISCUS*.—Dorsal and anal fins short; nose without cirri, tail forked.

Leuciscus rutilus.*—The Roach.

Specific Characters.—Body deep, scales large; anal fin red; base of the tail without a black spot.

Description.—From a specimen six inches and a half in length. Dorsal line more convex than that of the abdomen; head one-fifth the length of the whole fish, caudal fin included; depth of the body at the commencement of the dorsal fin one-fourth the length, as far as to the end of the middle caudal rays. Colour of the back dusky-blue, sides lighter, cheeks and abdomen silvery, irides yellowish; dorsal and caudal fins pale red; ventrals and anal bright red; pectorals pale orange, sometimes dusky red. First ray of the dorsal fin commencing exactly half-way between the point of the nose and the

* *Leuciscus rutilus*, Cuv., Yarr.; *Cyprinus rutilus*, Linn., Penn., Jen.

base of the middle caudal ray; the first ray short, not half the length of the second; the third ray the longest in that fin; the rest gradually diminishing in height; the last ray about the length of the first; the sixth ray equalling the length of the base of the fin; first two rays simple, the rest branched. Anal fin commencing in a vertical line under the tip of the last ray but one of the dorsal fin, when folded down; the first ray short, not half the length of the second, both simple; the remainder branched; the third ray the longest, the sixth as long as the base of the fin. Ventral fins of the same length as the pectorals, arising in a vertical line under the base of the first ray of the dorsal. Pectorals as long as from the tip of the nose to the base of the occiput, the first ray simple, the second the longest in that fin, and, like the remainder, branched at the summit. Eye rather large, the lower margin of the orbit extending below the middle of the cheek; operculum and suboperculum, taken together, rounded at their free margins; preoperculum more angular; mouth small; the jaws nearly equal; teeth wanting. Scales large, each marked with three or four radiating lines beside concentric ones; the number of scales forming the lateral line forty-three; in an oblique row between the dorsal fin and lateral line, seven and a half; between the lateral line and ventral fin, three and a half. Lateral line commencing over the upper part of the operculum, and taking a descending course below the middle to the base of the tail; caudal fin deeply forked; the middle ray one-third the length of the longest ray in the same fin; the longest ray equalling the length of the head. Number of fin rays—

D. 11; P. 16; V. 9; A. 12; C. 19; B. 3.

The Roach is a gregarious fish, keeping in large shoals, and is said to be abundant in all the rivers throughout the temperate parts of Europe. It seldom grows to a large size; one of three pound weight is considered uncommon, although it is recorded by Pennant to weigh occasionally five pounds. Every summer in the early part of May, immense shoals of Roach are observed to leave Loch Lomond, to ascend the different tributary streams for the purpose of depositing their spawn. During this period, which seldom lasts more than three days, the rivers are literally swarming with their numbers, giving a fine green appearance to the whole surface of the water. On this occasion, every basket and net in the neighbouring villages are immediately put in requisition, and the thousands thus taken afford food to the villagers for a short period. It is remarked by anglers, that during the time these fish are in the streams, and for a week after their departure, not a trout can be taken either with the minnow, worm, or fly, in consequence of the favourite food being at that time the roe of the Roach, with which the trout gorge themselves to a considerable extent. By Donovan it is supposed, that Roach come up in large shoals from the sea to deposit their spawn, and Montagu expresses his belief, that the Roach could not exist in sea-water at all. To this I may add, that, although the sea is not the natural abode of the Roach, yet, sometimes it is found there, being carried down from rivers or lakes after high floods. In the Solway Firth, I saw in the month of June five examples taken in the salmon-nets, and, I was informed by the fishermen there, that in the early part of the season they frequently captured them after a flood. This fish as food, is little sought after, but is in the best condition for the table in the month of October. It feeds on worms and small insects. The only locality known for the Roach in the neighbourhood of Edinburgh, is the Union Canal, where it was first noticed by James Wilson, Esq.

Leuciscus phoxinus.*—The Minnow.

Specific Characters.—Body elongated; scales small; base of the tail with a black spot.

Description.—From a specimen two inches and a half in length. Dorsal and ventral line but slightly convex; head one-fifth of the whole length, caudal fin included; depth rather less than the length of the head. Colour of the back and sides as far as the lateral line, in those which inhabit deep and slow running waters, olive-brown; belly silvery white, often tinged with yellow; head dark olive with a

* *Leuciscus phoxinus.* Cuv., Yar., Flem. *Cyprinus phoxinus.* Jen., Penn., Don. *Minnow, Bagies,* Cumberland.

dark line extending from the nape to the dorsal fin, from thence to the tail; dorsal and caudal fins light brown; ventrals and anal fin, pale yellow; sides marked by a broad olive band extending from the eye to the base of the tail. In those which frequent rapid and shallow streams the back is of a deep olive; sides of a lighter shade, beautifully mottled with black, yellow, green, and white; belly white, tinged with red; under part of the throat black; base of the pectorals, ventrals and anal fin, deep crimson; head dark olive, marked with a number of white elevated portions of the cuticle; the whole fish is liable to much variation in colour, depending on the period of the season and the places in which it inhabits. First ray of the dorsal fin commencing exactly half-way between the point of the snout and the tip of the long caudal rays; the first ray short, not half as long as the second; the third the longest in the fin; the sixth as long as the base of the fin, the last about the length of the first; the first and second rays simple, the rest branched. Caudal fin deeply forked, the middle ray half the length of the longest ray; a black spot at the base of the tail. Anal fin commencing in a vertical line under the last ray but one of the dorsal fin, and answering in every other respect to that of the dorsal. Ventrals arising a little in advance of the dorsal, and extending to the vent; pectorals as long as from the tip of the nose to the posterior margin of the preoperculum; the first ray simple, the remainder branched, the second longest in the fin. Eyes moderate, placed nearer the point of the snout than to the posterior margin of the operculum; mouth small; jaws of equal length. Lateral line scarcely perceptible, commencing over the operculum, and taking a descending course below the middle to the base of the tail; scales small, none on the head or cheeks. Number of fin rays—

D. 9; P. 16; V. 8; A. 9; C. 19.

In the north of Scotland the Minnow does not seem to exist, as not a single specimen was observed by a party of Ichthyologists who lately visited the different lakes and rivers in the county of Sutherland. It is however found in some of the tributaries of the Dee, appearing more plentiful as we advance south. It inhabits all the rivers entering the Firth of Forth, but in the Teith, about fifteen miles above Stirling, it becomes very scarce, although of a larger size than usual, measuring from three to three and a half inches in length. The Minnow abounds in great numbers in some of the rivers in England, particularly in those in the county of Devon, where it is not an uncommon occurrence, by making small bays, and by the aid of a net, to procure from a peck to a peck and a half of these beautiful little fish in the space of an hour. After the month of June when most of them have finished spawning, the males ascend the shallows in large shoals, occupying sometimes the space of several feet in circumference, and giving the water an appearance, with their little white spotted heads, of a bed of *Ranunculus aquatilis* before the buds have fully expanded.

These fish are considered good, being sweet and well flavoured, equalling any of the fresh-water fish as food. When a sufficient number can be obtained for a fry, they are in general cooked without being scraped or embowelled, which adds greatly to their richness. Worms and aquatic insects appear to be their principal food, although they are sometimes observed to feed on dead animal matter.

GENUS *COBITIS*.—Dorsal and anal fins short; nose with cirri; tail even.

COBITIS BARBATULA.*—THE LOACH.

Specific Characters.—Snout with six cirri; nose without spines.

Description.—From a specimen three inches in length. Body elongated; dorsal and ventral outline similar; head one-sixth of the whole length. caudal included; depth less than the length of the head. Colour of the back and sides, yellowish-white, beautifully mottled with dark brown; dorsal, caudal, and pectorals of the same appearance; ventrals and anal nearly plain. First ray of the dorsal fin commencing exactly midway between the point of the nose and base of

* *Cobitis barbatula*, Linn., Yarr., Jen., Penn. *Loach*, *Beardie.*

middle caudal rays; the third and fourth rays the longest, the last the shortest, equalling the length of the base of the fin; the first two simple, the remainder branched; caudal fin even at the end, the rays equalling the length of the head. Anal fin far behind the dorsal, the first ray commencing half way between the base of the ventral fin and the base of the middle caudal rays; the third ray the longest, the last the shortest, as long as the base of the fin, the first two rays simple, the rest branched. Ventrals the length of the anal, placed in a vertical line under the fourth ray of the dorsal, the third ray the longest; pectorals equalling the length of the dorsal, the third and fourth rays the longest. Snout blunt; lips fleshy; under jaw the shortest; eyes small, placed high on the head; barbules six in number, one at each corner of the mouth; two in front of the upper lip, and two immediately behind it. Scales small and adherent; lateral line commencing over the upper part of the operculum, and running straight to the base of the middle caudal ray; body invested with a mucous secretion. Number of fin rays—

D. 9; P. 11; V. 7; A. 7; C. 18; B. 3.

The Loach is found in most of our rivers in England, as well as in many streams in the north of Scotland, and in all the rivers entering the Firth of Forth. It prefers inhabiting streams where the bottom is gravelly and covered with large stones, under which it lurks, and so being often overlooked is sometimes considered scarce.

When the rivers become muddy and much increased in size by heavy falls of rain, these fish are found to leave the middle of the streams, and seek refuge under banks and small tufts of grass, where they are taken in nets by anglers and greatly prized as bait for trout. The food of the Loach is aquatic insects and worms; and it seldom moves three inches out of its way to take a bait, however tempting, but seizes it with great eagerness when placed at its nose. This fish is often eaten as a dainty morsel, and by some is said to rival the Minnow as food. It is occasionally preserved in the same manner as Anchovies, and considered superior both in flavour and richness.

Cobitis barbatula is very much allied to *Betia tænia*, differing from it in having no spines in front of the nose; whereas *B. tænia* has a large spine just behind each nostril.

In September last, I rather think that a specimen of *Betia tænia* came under my observation in the river Teith, as far as I was able to judge through the dense medium in which it was placed, but failed in obtaining it, in consequence of the wind being high, and the water discoloured.

FAMILY II. ESOCIDÆ.—Dorsal fin one; mouth large, with sharp teeth; intestinal canal short, destitute of cæca; body shaped like the Pike; nearly all possess a swimming bladder.

GENUS *ESOX*.—Snout rounded, broad, and depressed; teeth in both jaws, as well as on the vomer, palatines, tongue and pharyngeans.

ESOX LUCIUS.*—THE PIKE.

Specific Characters.—Eye placed half-way between the tip of the snout and the posterior margin of the operculum.

Description.—From a specimen two feet in length. Body rather elongated; greatest depth less than the length of the head; head one-fourth of the whole length, caudal fin included. Colour liable to much variation. " During the earliest stage of its life it is of a greenish hue; in the second year it becomes grey with pale spots, the latter ultimately acquiring a yellowish colour. Instances have occurred of its being perfectly white." Dorsal fin placed near the tail, the first ray commencing a little in advance of the vent, the last ray in a line over the eleventh ray of the anal; the middle rays the longest, as long as the base of the fin; anal fin arising in a vertical line under the seventh ray of the dorsal; the middle rays the longest, more than equalling the base of the fin; caudal fin forked, the

* *Esox lucius*, Linn., Cuv., Yar., Jen., Penn., Don. *Pike, Jack, Pickerell, Luce, Gedd.*

middle ray half the length of the longest ray in the same fin; ventral fins situated half-way between the point of the lower jaw and the tip of the long caudal ray, about equalling the length of the pectorals; pectorals as long as from the point of the upper jaw to the middle of the eye; the fifth and sixth ray the longest; operculum and preoperculum rounded; eyes moderate, placed high on the head, half-way between the point of the snout, and the posterior margin of the operculum; mouth large, under jaw the longest; vomer, palatines, tongue, intermaxillaries, pharyngeans, and branchial arches, furnished with sharp teeth; also a row of teeth on the lower jaw, those on the sides much the longest; cheeks, upper part of the operculum, and body, covered with small adherent scales, invested in a mucous secretion; lateral line nearly straight, very indistinct. Number of fin rays—

D. 18; P. 14; V. 10; A. 17; C. 19; B. 14.

This fish is said to grow with great rapidity. "In the first year it is often from eight to ten inches long; the second year from twelve to fourteen, and in the third year from eighteen to twenty inches in length." Individuals are recorded as measuring from five to nine feet in length. They frequently weigh above thirty pounds in the lakes of the north of England; and Dr Grierson mentions one taken in Loch Ken in Galloway, which weighed sixty-one pounds. The most remarkable pike, however, of which we have any authentic account, is that caught at Kaiserslautern, near Manheim, in 1497, which was nearly nineteen feet in length, and weighed 340 pounds. It was supposed to have been upwards of 235 years old."

The pike occurs in great abundance in Asia and North America, and inhabits almost all the fresh-waters of Europe, but seems to flourish most in the northern and middle counties It is one of the most voracious and destructive fish in existence; there seems indeed to be no bounds to its gluttony, for it devours indiscriminately whatever edible substance falls in its way, and almost every animal it is able to subdue. This fish is not only gifted with strength, and size, but is also adorned with great richness and variety of colour. It is in rivers, lakes, and ponds, that this formidable species is to be found. It is never seen but accidentally in the sea, and Rondelet informs us that such as are taken by chance in the mouth of the Rhine, or in salt pools which border the Mediterranean, are dry, and without flavour. In the Forth they are frequently seen in the brackish water ; and are often observed off Stirling Bridge basking in the shallows. They are also found in Duddingston Loch and Lochend, but few in number and of small size. The pike spawns in February and March, and deposits its ova on stones and plants; more than one hundred and forty-eight thousand eggs have been counted in a female of the middle size. "The flesh of the pike is white, firm, savoury, and easy of digestion. It is never very fat, and is, therefore, a suitable aliment for convalescents and other persons who have a weak stomach, especially if it be the flesh of a young fish. Its liver is very good, but its eggs excite nausea, and even violent purging. In some places, it is said, indeed, that their eggs are used as a cathartic."*

GENUS *BELONE.*—Snout attenuated, greatly prolonged ; teeth in both jaws, none on the palatines or tongue ; dorsal and anal fins entire.

BELONE VULGARIS.†—THE GAR-FISH.

Specific Characters.—Dorsal fin with seventeen or eighteen rays.

Description.—From a specimen two feet in length. Body elongated, tapering behind the dorsal and anal fins ; from the tip of the jaws to the posterior margin of the operculum, one-fourth of the whole

* *Encyclopædia Britannica.*

† *Belone vulgaris*, Cuv., Yarr., Flem. *Esox belone*, Linn., Jen., Penn., Don. *Gar-fish, Sea-pike, Mackerell-guide, Green-bone, Long-nose, Gorebill.*

length; abdomen bounded on each side by a longitudinal series of large imbricated scales; cheeks compressed; head flat on the summit, marked by a number of radiating lines; snout very much produced, ending in a sharp point, slightly raised in front of the nostrils. Operculum and preoperculum rounded; eyes large, extending below the middle of the cheek, placed nearer the angle of the mouth than to the posterior border of the preoperculum. Colour of the head, back, and sides, bluish-green; gill-covers and belly silvery-white; pectorals, ventrals, and anal, pale straw colour; dorsal and caudal dusky; dorsal fin situated near the tail, commencing in a line over the second ray of the anal, and terminating in a vertical line over the last ray but one of the same fin; the third ray the longest, the fourth, fifth, and sixth, suddenly diminishing in height, the seventh as long as the base of the five first rays, the remainder of the rays of equal length; anal fin commencing a little in advance of the dorsal, and ending a little behind the last ray of that fin; the first and second rays simple, the rest branched, the third the longest, fourth, fifth, sixth, seventh, and eighth, suddenly diminishing in height, the remainder of equal length; caudal fin deeply forked, the middle ray one-third the length of the longest ray; ventral fins shorter than the pectorals, situated about the length of the upper jaw from the commencement of the anal; the first ray broad and simple, the rest branched, the second the longest in the fin; pectorals of the same form as the ventrals. Body covered with large deciduous scales; cheeks, head, and opercle, also with scales; teeth small and fine in both jaws, as well as on the vomer.* Number of fin rays—
D. 18; P. 13; V. 6; A. 22; C. 16.

The Gar-fish has been noticed on the coast of Cornwall, on the Essex coast, and as far north as on the shores of Norway and Sweden. It has also been observed on the coast of Ireland, from Cork to Londonderry. It enters the Firth of Forth in large shoals about the beginning of July, in company with the Mackerel, and remains till the end of August; but is seldom found to ascend the Firth to any distance, but confining itself principally to the neighbourhood of the Bass and the May. These fish are caught both with the

* Mr Jenyns, in his *Manual of British Vertebrate Animals*, states that the head and opercle are without scales, and the vomer without teeth.

net and hook, and are sometimes found on haddock lines, which had been baited with mussels. They are occasionally brought to market, and considered by many persons to be superior to the mackerel as food, being firmer and whiter in the flesh, and possessing much of the same flavour. The bones, which are always green, frequently create disgust.

This species is distinguished from the *Scomberesox sauris*, in having the dorsal and anal fins entire, which in the *S. sauris* are divided behind into five or more finlets as in the mackerel.

GENUS *SCOMBERESOX*.—Snout attenuated, greatly prolonged; teeth in both jaws, more on the palatines or tongues; dorsal and anal fins divided behind into finlets.

SCOMBERESOX SAURIS.*—THE SAURY PIKE.

Specific Character.—Dorsal fin with five, and anal with eight spurious fins.

Description.—" From a specimen fourteen inches and three-quarters in length. Body elongated, considerably deeper for its length than that of the gar-fish; length of the jaws and head, compared to the whole length of the fish, as one to four; the depth of the body two inches, or, as compared to the whole, as two to seven. Pectoral fins small; a keel-like edge, commencing on each side in a line with the low edge of the gill-covers, passes the whole length of the body; the space between these lines not wider than one quarter of an inch, except where they dilate a little to include or pass outside of the ventral fins; the dorsal and anal fins placed far back, and commence on the same plane; the dorsal fin with five finlets behind it; anal with seven finlets behind it; tail deeply forked; the two portions divided as far as the posterior edge of a scale-like appendage with which the fleshy portion terminates. Cheeks and gill-covers silvery-white; irides golden-yellow; pupil rather elongated vertically; upper part of the head and back, of a fine dark blue, lighter on the sides, and tinged with green; lower part of the sides and

* *Scomberesox saurus*, Cuv., Yarr. *Esox sauris*, Penn., Don., Jen. *Saury Pike*, *Skipper*, *Gowdnook*, *Gofnick*.

belly silvery-white; all the fins dusky-brown. Number of fin rays—"D. 9, V; P. 13; V. 6; A. 11, VII; C. 19."—Yarrell.

Mr Couch says, that the Saury Pike is common in Cornwall, and is more strictly a migratory fish than the gar-pike, never being seen in the channel until the month of June, and commonly departs before the end of autumn. "It is gregarious, and is sometimes seen to rise to the surface in large shoals, and flit over a considerable space. When closely pursued by the porpoises, tunny, and bonito, which are their greatest enemies, they will singly spring to the height of several feet, leap over each other in singular confusion, and again sink beneath. Still further urged, they rise again, and rush along the surface by repeated starts for more than a hundred feet, without once dipping beneath, or scarcely seeming to touch the water. More than twenty thousand, by computation, have been seen out of the water at one time." They have been observed as far north as the Orkneys. According to Dr Neill it is not an uncommon fish in the Firth of Forth, where it is found as high up as Kincardine; but of late years, not a single specimen has been observed in the Firth. In November 1768, great numbers of these fish were thrown ashore on the sands of Leith after a great storm from the east. It is considered a stupid inactive fish, and is said to be frequently found in the shallows when the tide retires, with its long nose imbedded in the mud.

Family III. SALMONIDÆ.—Dorsal fins two; the first with rays; second adipose without rays.

Genus *SALMO*.—Branchiostegous membrane with more than eight rays; anal fin with less than twelve rays; gape wide; teeth sharp and stout; intestinal canal provided with numerous cæca.

SALMO SALAR.*—THE SALMON.

Specific Characters.—Lower third of the pectorals, as well as the membranes between the three first rays of the ventral fins, black; middle ray of the caudal fin not exceeding half the length of the longest ray in the same fin; vomerine teeth confined to the anterior extremity. (See Plate XXXII. Fig. 1.)

Description.—From a female specimen three feet and a half in length. The whole fish of an elongated oval form; greatest depth in front of the dorsal fin; head one-fifth of the whole length, caudal fin not included; snout rather sharp; jaws nearly equal; posterior margin of the gill-cover rounded; preoperculum rather angular; lower margin of the operculum directed obliquely upwards and backwards, in a line with the base of the first ray of the dorsal fin. Colour of the back and sides, as far as a little above the lateral line, bluish-grey; below the line silvery-white, occasionally with blue reflections; summit of the head dark olive-green; dorsal and caudal fins dusky black; ventrals and anal whitish, with the membranes, between the first three rays of the former, tinged with black; pectorals behind dusk; the lower third black; above the lateral line a number of black scattered spots; below it, in the region of the pectorals, three spots (few individuals exceed six spots below the line); operculum with a round black spot (occasionally there are three spots). First dorsal fin placed exactly half-way between the point of the upper jaw and the base of the middle caudal rays; the first ray short and simple, not half the length of the second ray, which is also simple; the rest branched; the third the longest, not quite equalling the length of the base of the fin; the last two rays of equal height, exactly half the length of the sixth ray. Second dorsal fin adipose, without rays, placed nearer the dorsal fin than to the end of the caudal rays, and situated in a vertical line over the base of the last anal ray. Tail fin lunated, the middle ray not quite half the length of the longest ray in the same fin. The sixth ray of the anal fin equalling the length of the base of that fin; the first two rays simple, the rest branched; the third the longest, the last the shortest, about half the length of the sixth. Ventral fin arising in a vertical line under the base of the last ray but four of the dorsal; the first ray simple, the rest branched; the second the longest, equalling the length of the fifth dorsal ray; the last ray the shortest, rather more than half the length of the longest ray. Pectorals as long as the base of the dorsal fin; the first ray simple, the rest branched; the second and third rays the longest,

* *Salmo salar*, Cuv., Linn., Yarr., Jen., Penn., Flem.

the last the shortest, about half the length of the fourth. Eye placed half way between the point of the snout and the upper corner of the gill-cover; mouth large; maxillaries extending back, as far as in a vertical line with the posterior margin of the orbit. Teeth sharp and stout in both jaws, as well as on the tongue, vomer, and palatines; those on the vomer but two in number, confined to the most anterior part; those on the tongue four (never exceeding six, sometimes only one). Scales on the body large and thin, about 120 forming the lateral line; in an oblique backward row, between the middle of the dorsal fin and lateral line twenty-one scales; between the middle of the anal fin and lateral line in an oblique row fourteen scales. Lateral line straight throughout its course, dividing the body, in the region of the dorsal and ventral fins, into two equal parts; cæcal appendages sixty-two, seldom or never less than fifty-eight. Number of fin rays—

1st D. 12; P. 13; V. 9; A. 10; C. 19; "Vertebræ 60."

The *Salmo salar* is the largest species of the Salmonidæ, and is said to attain sometimes the weight of eighty pounds or more, but one of half that size in the present age is considered worthy of notice, the average size being from eighteen to twenty pounds in weight. "The common salmon inhabits the seas around Great Britain, and extends to the north of Europe and to Asia, but it is not properly ascertained that those found in North America are identical. There is no doubt that the true abode of the salmon is the sea, for as soon as it has entered the rivers, it begins to deteriorate in condition, the scales lose their brilliant silvery lustre, and the flesh becomes soft and pale; and that they are drawn to the fresh waters by a natural instinct widely implanted by Almighty power, for the purpose of reproduction, an instinct which enables them to stem the current of the most rapid waters, to ascend precipitous falls, and to pass through weirs and other obstacles of human art, which no other power could overcome. The necessity of a suitable place being found, in which to deposit their ova, together with the advantage of destroying the marine insects, which infest and torment them, is the principal purpose of their being made to seek the rivers. Salmon generally delay entering fresh water in great numbers, until the streams become somewhat swollen by rain, although in the large rivers there may be said to be a limited daily run. When the flood has fairly mingled with, and to a certain extent saturated, the estuaries, the run of fish is often very great, especially if there has been a continued tract of dry weather. In the latter case they collect at the mouths of rivers and are often taken in vast numbers; but they do not then attempt an ascent, deterred perhaps by the clearness of the stream, or by some instinctive feeling that the waters would yet be deficient to carry them through.*" During the continuation of the floods, when the waters become discoloured, the fish rush up with the greatest velocity, and make wonderful efforts to surmount cascades and other impediments, by leaping elevations of from eight to ten feet, so as to gain the waters above and pursue their course. The rate at which they travel is supposed to be from fifteen to twenty-five miles daily, and probably at a much greater speed where the waters are deeper and the interruptions less frequent. Having ascended the river to a considerable distance they proceed more slowly, resting for a time in pools by the way, or in some chosen spot where they remain until called forth by that law of nature which compels them to seek the shallows to deposit their spawn. "As the spawn advances the symmetry of the form is disfigured; the female becomes disproportionately large, the colours lose the brightness of their silvery tints, and become dull and grey. The male becomes thin upon the back, the nose elongates, and the under jaw turns up in a large and strong hook, which enters a hollow in the nose before the inter-maxillary bone. The colours and markings become brown and

* *Encyclopædia Britannica.*

red, those on the head and gill-covers being particularly brilliant, and disposed in lines almost like the markings of a *Labrus*. In this full breeding dress, the male and female seek some ford or shallow streams, and commence to excavate a trench or furrow. In this the spawn is deposited and impregnated at the same time, and finally covered with gravel by the exertions of the fish. The furrow is generally from six to nine inches in depth, and when the spawn has appeared to be covered beyond that depth, this has occurred from some other circumstances, such as the stream or floods having carried downwards additional masses of gravel, &c. After this great effort has been accomplished, both sexes are reduced to a state of remarkable emaciation. The elongated nose, and hooked jaw, and the brilliant colours, are almost immediately lost, the old scales are cast, and the fish retire to some pool to regain their strength. They finally redescend to the sea by easy stages, where their former condition and silvery lustre are regained,* their strength invigorated, and all their functions so repaired as to enable them ere long to renew their visit to the flowing streams, again to multiply their race."†

The spawn is shed in different rivers, sooner or later, between the month of October and the end of April, and continues covered by the gravel from about a hundred to a hundred and fourteen days, after which it begins to vivify; and it is probable, under certain circumstances, such as the temperature of the water and the mildness of the season, that the ova may become developed much sooner, or within a few weeks after their deposition. The spawn, if deposited in the commencement of October, will exclude the young dur-

* Their silvery lustre is frequently regained before they reach the sea.

† *Encyclopædia Britannica.*

ing some part of January or perhaps earlier, when the fry may be observed a little more than half an inch in length, with a part of the ovum adhering to the abdominal region, which remains about a month attached and then becomes absorbed. At this age the fry are of a translucent, shapeless appearance, the head small and rounded; the eyes large; the dorsal, caudal, and anal fins continuous, and the tail rounded at the end. In February they are found one inch in length, assuming more the appearance of a fish; the head one-fourth the whole length, caudal not included; all the fins separate, with the caudal slightly notched at the extremity; along the course of the depressed lateral line, are placed from nine to eleven transverse dusky bars, which are as yet obscurely visible. In March they are about two inches in length with the lateral bars more conspicuous, and the tail-fin deeper notched. In April they are seen in the Tweed from three to four inches in length, with the back of a dark blue and slightly spotted; belly and under the throat pure white; lateral bars very conspicuous, having a bright red spot placed between each; the sides below the bars are frequently tinged with yellowish-green; pectorals dusky; ventrals and anal pale straw colour; operculum with one or two large black spots, tinged occasionally with red; caudal deeply forked. In May they are observed the length of from four to five inches or more, and at the end of that month they perform their first migration to the sea; they are now of a fine silvery appearance, the back of a deep glossy blue, the cheeks, sides, and belly of a pure silvery-white; the ends of the pectorals black; the dorsal and caudal dusky; ventrals and anal, and the last two rays of the dorsal, white; the spots on the gill-covers rather obscure; the scales very deciduous, which when removed from along the sides, bring the lateral bars and the bright vermilion-coloured spots more distinctly into view; the mouth small; the maxillary reaching back to beneath the middle of the pupil; teeth in the jaws small and slender; those on the vomer about twelve in number, extending the whole way. (See Plate XXX.) The spawn deposited in the months of November and December produces fry sooner or later according to circumstances, as before mentioned, and in May following they will be found of various sizes, their growth depending principally on the quantity and quality of food they receive. The spawn shed in February, March, and April, does not appear to produce fry of sufficient size to migrate the following May, but they remain in the river all the summer, autumn, and winter, and depart for the sea in about the first week of the May following, with a size of from six to eight and a half inches in length. (See Plate XXXII.) The bright silvery appearance which they assume in this month is caused by the casting off their old dusky scales, and by having them replaced with a new clear set, which change is very apparent in the second or third week of April, when specimens may be obtained of every intermediate stage; the same change takes place in the fry of all the migratory trout. This fact, which is well known to many practical fishermen, seems to have escaped the notice of naturalists generally. After the fry or smolts reach the sea, we lose sight of them for two months or ten weeks, and can only infer their growth from the fact that, after the lapse of that period, we find them again returning to the rivers with a weight of from two and a half to four pounds. They are then known under the name of the grilse or salmon-peal. The body is now long, narrow, and elegantly shaped; the head small; the nose sharp; the gill-covers rounded; the teeth sharp and slender in both jaws, four teeth usually on the tongue, and from two to five on the anterior part of the vomer; the colour of the head is of a greenish-blue; the cheeks, gill-covers, and the whole of the body below the lateral line, of a fine silvery-white; the back, as far as a little above that line, dusky with metallic blue reflections; the pectoral, dorsal, and caudal fins, black; ventral and anal white; the caudal acutely forked. After they have remained a short period in fresh water, they lose their silvery lustre, and the ventral and anal fins assume a dusky appearance. During the ensuing winter the most of them spawn, after which they return to the sea, and are taken in the following year from ten to fifteen pounds weight, when they receive the name of salmon.

It is the opinion entertained by all naturalists who have hitherto written on this subject, that the fry of the salmon grow to the length of seven inches or more, in less than *two months*, and that *all* of them emigrate to the sea the same spring in which they are excluded from the ova; but this theory, I have little doubt, would no longer be found tenable, were naturalists to direct their attention to the natural growth of these animals, and to examine the young at different periods and stages of growth for themselves, since I have repeatedly ascertained, from personal observation, that a certain number of salmon fry (probably of a late brood) remain in the rivers during the autumn months in company with their congeners,—and being at that period of the year very similar in their external appearance to the fry of the Bull-Trout, the Salmon-Trout, and Parr, have given rise to such divided opinions as to what these small fish really are,—some persons supposing them to be all Parrs, while others again announce them as being the young of the Salmon.

Mr Shaw (who has performed some interesting experiments on the ova of the Salmon), by keeping salmon fry in small artificial ponds, and observing their growth, is led to surmise that none of the salmon fry leave the river in which they are hatched until they have acquired the age of two years, and during the whole of that period he believes their growth to be not more than six inches in length, or three inches for the first twelve months.* Under this head, I may here remark that all animals while placed under confinement, and deprived of their natural food, are found to make but little progress in their growth; in proof of which, it is recorded in the second volume of Mr Yarrell's British Fishes, that a trout about a pound weight had lived for twenty-eight years in a well at Dumbarton Castle, and had never increased in size from the time of its being put in. The kind of food exerts a material influence on the growth of fishes, as mentioned by Mr Stodart in his interesting work on the Art of Angling. "Trout were placed in three separate tanks, one of which was supplied daily with worms, another with live minnows, and the third with those small dark coloured water-flies which are to be found moving about on the surface under banks and sheltered places. The trout fed with worms grew slowly, and had a lean appearance; those nourished on minnows, which, it was observed, they darted at with great voracity, became much larger; while such as were fattened upon flies only, attained in a short time prodigious dimensions, weighing twice as much as both the others together, although the quantity of food swallowed was in nowise so great." The natural and most nutritious food of the salmon fry during the months of March, April, and May, is, there is no doubt, flies and the larva of insects, which, in small and recent artificial ponds, are comparatively scarce.

* *Edin. Phil. Jour.* for 1836 and 1838.

The Salmon, although a common fish in the Firth of Forth, is not accounted plentiful when compared with the number that are occasionally taken in the Tweed and in other fishing districts of the north. In some seasons they make their appearance in the Forth in much greater plenty than at others; and when that is the case, it is said, there is generally a diminished proportion observed in the rivers of the south. It seems certain that Salmon rove to a considerable distance when at sea, and that they do not universally return to the same stream in which they were excluded from the ova, since numbers are taken in the Firth of Forth which had been previously marked when fry in the Tweed; and it is probable that, on certain occasions, depending perhaps on the disturbed state of the ocean, they enter the first stream they meet with which seems best to suit their purpose. The Firth of Forth is bordered on both sides with stake-nets, besides other nets and snares of different descriptions used for the purpose of capturing salmon. July is the principal month for the run of salmon, when it is not an uncommon occurrence for some of the nets to take from fifty to eighty at each tide successively for a fortnight. Pennant states that a boat-load of Salmon, and sometimes nearly double that quantity, are often taken in the Tweed in a tide, and that some years before he wrote, above seven hundred were taken at one haul of a net.

The Edinburgh market is supplied with Salmon from the Firth of Forth until the early part of August, after which they are sent from the Tweed, and, in some seasons, sold at the rate of sixpence a pound.

Few persons have been able to agree as to the precise food of the Salmon, for on opening the stomach seldom any thing but thick mucus is observed to line it. Dr Knox states, that the food of the salmon, while in the sea, consists solely of the ova of various kinds *Echinodermata* and some of the *Crustacea*.* But, if we consider the strength of the jaws, the temporal and masseter muscles, and examine the arrangement and size of the teeth, we should be inclined to infer that it exists on something more solid than the food which Dr Knox supposes; besides, the ova of the *Echinodermata* and *Crustacea* are shed at a period when most of the Salmon have entered the rivers. Mr Yarrell, on opening the stomach of a Salmon, found the remains of a *Sand-lance*. Faber, in his Natural History of the Fishes of Iceland, remarks, that the common salmon feeds on small fish and various small marine animals. Dr Fleming says their favourite food is the *Sand-eel*. Sir William Jardine says, in the north of Sutherland, they are often taken by a hook baited with *Sand-eels*. At North Queensferry, the Salmon is said to have been occasionally taken with a fly. In the county of Devon, as well as in Loch Lomond in the north, I have taken grilse with the minnow, and the common earth-worm is a deadly bait for the clean salmon. On dissecting the alimentary canal of several dozen of salmon that were taken in salt water, I seldom failed in discovering the remains of some kind of food in the lower intestine, the stomach itself being almost invariably empty. In one out of five I found the remains of crustacea and bones, apparently of the *Sand-eel* and other small fish. I have repeatedly found the remains of worms and aquatic insects in the intestines of these salmon that were taken in rivers and lakes; but, in those fish which were far advanced in roe, both stomach and intestine were observed to be almost invariably empty.

It is mentioned by Mr Yarrell, on the authority of Sir

* *Trans. Royal Soc. Edin.*

William Jardine, that an angler, whilst fishing in the Tweed, hooked a Salmon that carried away his tackle; after putting on a new set, baited as before with a worm, in ten minutes after he hooked and killed the same fish with the former hook in its mouth. This, adds Mr Yarrell, will either prove extreme voracity, or little sensibility in the parts of the mouth.

Salmon, as food, are in the best season from March till August, after which the generality of them become pale in the flesh, soft, and very unwholesome.

There is occasionally taken in the Firth of Forth, a small species of Salmon, or rather a variety, which is said to occur more frequently in some of the large rivers further north, where it is commonly known by the name of Norway Salmon. Plate XXXII. Fig. 2. It is seldom found to exceed the length of two feet, and much resembles the common Salmon in miniature. The characters agree in every respect with those I have given of *Salmo salar*, excepting that it is of much smaller size; the dorsal fin rather nearer the head than to the base of the tail; the pectorals and ventrals rounded at the end; the fifth, sixth, and seventh rays being longer in proportion; the pectoral, dorsal, and caudal fins, dark grey, instead of dusky black; twenty scales in an oblique row between the dorsal fin and the lateral line, and the flesh is not so red or so well flavoured as that of the *Salmo salar*. Number of fin rays—

1st D. 13; P. 14; V. 9; A. 10; C. 20.*

SALMO ERIOX.†—THE BULL-TROUT.

Specific Characters.—Lower end of the pectorals dusky; membranes between the rays of the ventral fins, plain; middle ray of the caudal

* Sir William Jardine and Dr Johnston have also observed the same variety of Salmon in the Tweed.

† *Salmo eriox* of Yarrell and Jenyns; descriptions of other authors be-

fin more than half the length of the longest ray in the same fin; vomerine teeth confined to the anterior extremity. (Plate XXXII. Fig. 3.)

Description.—From a female specimen two feet six inches in length. Dorsal line straighter and higher over the shoulders than in a salmon of equal size; head larger, of a more clumsy make, and the caudal extremity of the body thicker; snout rather blunt; jaws nearly equal; head one-fifth of the whole length, caudal fin included. In male specimens the head is much longer, especially in the spawning season; the elongation takes place in front of the nostrils, and not in the gill-covers. Mr Yarrell's figure of the Bull-Trout was taken from a male individual, in which the length of the head, compared to that of the body only, is as one to four. Posterior margin of the operculum but slightly rounded, that of the suboperculum rather more so at its inferior part; preoperculum sinuous, and rather curved at its posterior border; the line of union between the subopercle and preopercle is not so oblique as in the salmon. Colour of the back dark grey; sides lighter; belly white; dorsal and caudal fins light grey; pectorals dusky grey at the lower half; ventrals and anal dull white; spots above the lateral line numerous, of various forms, extending to the base of the tail, those below the line about thirty, rather smaller, and not extending to the anal fin; no spots over the shoulders or on the dorsal line; opercle with three round spots, and one on the preopercle. During the spawning season the male fish assumes a reddish-brown appearance, and if it remains any length of time in fresh water the ventral and anal fins become dusky, and the whole fish of a darker colour. First dorsal fin situated half-way between the point of the snout and the base of the middle caudal rays; the first ray short and simple, not half the length of the second, which is also simple, the rest of the rays branched, the third the longest, as long as the base of the fin, the last two of equal length, exactly half the length of the fourth; second dorsal fin adipose, without rays, situated in a vertical line over the base of the last anal ray; caudal fin even at the end, the middle ray considerably more than half as long as the longest ray in the same fin; the sixth ray of the anal fin equalling the length of the base of that fin, the first two rays simple, the rest branched, the third the longest, the last the shortest, about half the length of the fifth; ventral fins arising in a vertical line under the last ray but six of the dorsal; the first ray simple, the rest branched, the second

ing too short to form any idea as to what species or variety they allude. In the Firth of Forth the young of this fish is named Sea-Trout; at Kelso, far up the Tweed, it is called Whitling, which is not the Whitling at Berwick.

and third of equal length, as long as the third dorsal ray, the last the shortest, considerably more than half the length of the longest ray; pectorals much longer than the base of the dorsal fin, and of the same length as the long caudal ray; the first ray simple, the rest branched, the second and third the longest, the last the shortest, about half the length of the seventh ray. Eye placed half-way between the point of the snout, and the upper corner of the gill-cover; mouth large; jaws nearly equal; maxillaries extending back as far as in a line with the posterior margin of the orbit. Teeth stout and sharp in both jaws, as well as on the tongue, vomer, and palatines; those on the vomer four in number, confined to the most anterior part; those on the tongue four, never exceeding eight. The vomerine teeth in young fish less than nine inches in length, are from nine to twelve in number, extending far back (See Plate XXX), and which disappear as the fish increases in age. Scales large and strong, twenty-two in an oblique row backward, between the base of the middle ray of the dorsal fin and the lateral line; lateral line straight, passing down the middle of the side to the base of the tail; cæcal appendages fifty-four; flesh pale yellow. Number of fin rays—

1st D. 10; P. 13; V. 8; A. 10; C. 19.

This migratory species of trout, when fully grown, leaves the sea about the end of July to enter the fresh-water streams, where it deposits its spawn in the months of October, November, and December, and after this law of Nature is fulfilled, it, like the salmon, returns again to the sea. During the spawning season, the males become of a brownish-red colour on the back, the spots shew themselves more vividly, and the vertical elongation of the lower jaw becomes developed similar to that observed in the male salmon at the same period, but not to such an extent. The weight that this fish attains to, is from twenty to five-and-twenty pounds, and sometimes more, as a fine example was taken a few years since in the Newby stake-net in the Solway Firth, that exceeded the weight of twenty-eight pounds. It was sent to the Carlisle market, where it received an indifferent sale, as the flesh when cut exhibited a coarse chalk-white appearance; the red fleshed trout, as food, receiving at all times the preference. Of the Bull Trout of Yarrell there appear to be numerous varieties, differing, however, not sufficiently from one another to be considered by ichthyologists as deserving to rank as distinct species. The Bull-Trout, when about nine inches in length, has the caudal fin acutely forked ; the middle rays elongating with the growth of the fish, and the fin ultimately becoming even at the end. When the fish reaches the length of twenty inches, the middle ray of the tail is *more* than half the length of the longest ray of the same fin, whereas the same ray in the salmon is *never* half as long as the longest ray of that fin at any age, a character that may be strictly depended on. Mr Yarrell places much dependence, as a character, on the formation of the suboperculum, and its line of union with the operculum compared to the axis of the body of the fish. In some examples I have recognised this character, but in others I have found it to vary too much to form a uniform mark of distinction. In the Firth of Forth I have met with the following varieties of Salmo Eriox :—

(Plate XXXII. Fig. 4.—*Salmon-spotted Bull-Trout.*)—Length twenty-seven inches ; female ; four teeth on the anterior part of the vomer ; basal margin of the operculum very oblique ; tail even at the end, six spots below the lateral line, twenty-eight above it ; flesh red ; cæca fifty-four. *Salmon-Trout* of the Firth of Forth, Solway Firth, and at Berwick-upon-Tweed ; in the latter locality it is frequently named Whitling.

(Plate XXXIII. Fig. 5.—*Few-spotted Bull-Trout.*—Length twenty-five inches ; female ; two teeth on the anterior part of the vomer ; suboperculum very narrow ; basal margin of the operculum oblique, in a line with the summit of the first dorsal ray ; preoperculum sinuous ; tail slightly forked ; no spots below the lateral line, and only four obscure ones above it ; flesh deep red, cæca fifty-five. *Salmon-Trout* of the Firth of Forth, Solway Firth, and Tweed, rather rare.

(Plate XXXIII. Fig. 6.—*Thickly-spotted Bull-Trout.*—Length twenty-four inches ; female ; one tooth on the vomer ; suboperculum narrow, produced at its upper and posterior margin ; preoperculum slightly sinuous; basal margin of the operculum oblique, in a line with the base of the first dorsal ray; tail even at the end; spots large, irregular, many of a square form; forty-two below the lateral line, about one hundred and eighty above it; flesh pale yellow; cæca forty-eight. *Bull-Trout* of the Firth of Forth, Solway Firth, and Tweed, not common.

(Plate XXXIII. Fig. 7.—*Large-headed Bull-Trout.*)—Length twenty-six inches; male; three teeth on the anterior part of the vomer; tail even at the end; suboperculum large; basal margin of the operculum very oblique; preoperculum sinuous; spots large, many of a square form, eighteen below the lateral line, and ninety above it; flesh pale yellow; cæca fifty. *Bull-Trout* of the Firth of Forth, Solway Firth, and Tweed, frequent.

(Plate XXXIII. Fig. 8.—*Curved-spotted Bull-Trout.*)—Length twenty-seven inches; female; three teeth on the anterior part of the vomer; tail even at the end; operculum and suboperculum narrow; preoperculum slightly sinuous; basal margin of the operculum very oblique; flesh deep salmon colour, rich, and well flavoured. Rare in the Firth of Forth, scarcely known in the Solway Firth, but common in the Tweed at Berwick, where it is named Whitling, and is seldom found to ascend more than five miles up the river; beyond that the fishermen call the young of the Bull-Trout, *Whitling,* for want of knowing the true *Whitling.* It is supposed that these fish deposit their spawn not far from brackish water, and that the young enter the sea a week or more before their congeners. One of two feet in length is of a very unusual size, the average length being about eighteen inches. A specimen now before me of seventeen inches in length, presents the following description. Shape much resembling the salmon; greatest depth a little in front of the dorsal fin; head one-fifth the whole length, caudal fin not included. Colour of the back, dark glossy blue; sides lighter; belly silvery-white; dorsal and caudal fins dark; ventrals and anal white; pectorals at their free ends nearly black, the base smoky blue; spots of the form of an Italic *x*; ten below the lateral line and about seventy above it. Basal margin of the operculum oblique; preoperculum rather sinuous; three teeth in front of the vomer, four on the tongue, thirty on the upper jaw, eighteen on the lower, and nine on each of the palatines. First dorsal fin placed half-way between the point of the snout and the base of the tail; adipose fin nearer the end of the tail than to the first dorsal; caudal fin sinuous, the middle ray rather more than half the length of the longest ray in the same fin. Ventrals placed in a vertical line under the last ray but four of the first dorsal. Pectorals rather more than the length of the base of the dorsal. Scales twenty-two in an oblique row between the base of the middle dorsal ray and lateral line; cæca fifty-four. Number of fin rays—1st D. 12; P. 12; V. 9; A. 10; C. 18.

(Plate XXXIII.*—*Salmon Bull-Trout.*)—Length eighteen inches; female; three teeth on the anterior part of vomer; operculum rounded; suboperculum rather large, its line of union with the operculum, oblique; back bluish-black; pectorals dusky; caudal dark at the margin; spots having the form of ✕; flesh deep red; cæca fifty-four. Number of fin rays—D. 11; P. 13; V. 9; A. 10; C. 20. *Salmon-Trout* of Firth of Forth, Solway Firth, and Tweed, frequent; at Berwick it is occasionally named *Whitling.*

(Plate XXXIV. Fig. 9.—*Crescent-tailed Bull-Trout.*)—Length twenty-two inches; female; one tooth in front of the vomer; tail *lunate;* gill-cover rounded; suboperculum narrow; the basal margin of the operculum very oblique and much curved; preoperculum slightly sinuous; spots large and distinct, of various forms, thirty-seven below the line, and about eighty above it; third ray of the dorsal fin as long as the base of that fin; all the fins as long in proportion; flesh red; twenty-six scales in an oblique row between the base of the middle ray of the dorsal fin and lateral line; cæca fifty. *Bull-Trout* of the Firth of Forth rare.

(Plate XXXIV. Fig. 10.—*Norway Bull-Trout.*)—Length twenty-two inches; female; body much elongated; five teeth in front of the vomer; caudal fin slightly forked; operculum and suboperculum very large, slightly produced behind; basal margin of the operculum rather oblique, in a line with the middle of the dorsal fin; preoperculum rounded, not sinuous; spots large and round; seven below the line, and twenty-two above it; flesh yellow; cæca fifty-two. *Norway-Trout* of the Firth of Forth, very rare.

Salmo trutta.*—Salmon-Trout.

Specific Characters.—Vomerine teeth not confined to the anterior extremity, but extending far back; sides with X-shaped spots; tail more or less forked. (See Plate XXXIV. Fig. 11.)

Description.—From a female specimen twenty-five inches in length. Form resembling more the salmon than that of the bull-trout; nose rather pointed; head one-sixth of the whole length; caudal fin included; greatest depth a little in front of the first dorsal. Colour of the back bluish-black; sides lighter, of a fine glossy blue; belly, anal, and ventral fins white; head dark greenish-blue; cheeks and gill-covers light steel-blue; spots on the sides numerous, having the form of the letter X; about a hundred below the line, and about one hundred and twenty above it; nine spots on the gill-cover, of a rounded

* *Salmo trutta,* Yarr., Jen.

form; dorsal and caudal dusky, as well as the inner surface of the pectorals. First dorsal fin placed half-way between the point of the nose and the base of the long caudal ray; the first and second rays simple, the rest branched; the third the longest, as long as the base of the fin; the last ray exactly one-half the length of the fifth; adipose fin situated in a vertical line over the base of the last anal ray, and mid-way between the last dorsal ray and the tip of the tail. Caudal fin slightly forked, the middle ray a very little more than half the length of the longest ray in the same fin. The third ray of the anal fin the longest, equalling the length of the same ray in the first dorsal fin; the last ray one-half the length of the fifth; the sixth as long as the base of the fin. Origin of the ventrals in a vertical line with the last ray but six of the first dorsal; the second ray the longest, equalling the length of the base of the dorsal. Pectorals pointed, the second and third rays the longest, nearly equalling the length of the long caudal ray; the last ray one-half the length of the eighth. Gill-cover slightly produced behind; suboperculum rather narrow; basal margin of the operculum oblique, in a line with the base of the first ray of the dorsal; preoperculum slightly sinuous. Jaws nearly equal; the end of the maxillary in a vertical line with the posterior margin of the orbit. Teeth stout and sharp; forty-four in the upper jaw, twenty-four in the lower, twelve on each palatine, and eight on the vomer. Scales thin, twenty-two in an oblique row between the base of the middle dorsal ray, and the lateral line; flesh red; cæca fifty-one. Number of fin rays—

1st D. 12; P. 13; V. 10; A. 10; C. 19.

The migratory species of trout (not including the salmon), when *young*, as far as I have been able to ascertain, cannot be distinguished with certainty one from another; therefore, in speaking of their habits, they must necessarily be described together. The spawn, which is shed in October, November, and December, begins to vivify in March and April, or sometimes sooner, depending greatly on the mildness of the spring, and the period in which the eggs are deposited. In June, we observe the young sporting about in the shallows, from two to three inches in length. In August, September, and October, they are taken by anglers, from four to five inches long, under the name of *hep-*

pers or *parrs*.* At this age they assume a beautiful appearance; the back and sides, as far as the lateral line, are of a dusky brown colour, marked with a number of small dark spots; the lateral line crossed with from eight to nine, and sometimes ten, transverse bluish bands, with an orange-coloured spot placed between each; the head brownish-green; the gill-covers with one or two large dark spots tinged with red; belly white; ventrals and anal fins inclining to yellow, as well as the pectorals which are rather darker; dorsal fin slightly spotted, with the summit of the anterior part dusky; vomerine teeth about twelve in number, extending far back; caudal fin deeply forked. In December, these fish are seen somewhat larger, and about the end of May or the early part of June following, the greater part make their first migration to the sea, when they are observed, on an average, from five and a half to eight inches in length, assuming a silvery appearance, with their anal and ventral fins white, and the pectorals dusky at their tips. (See Plate XXXI.) Those fry which remain in the river after the month of June, soon become in excellent condition.

After they have remained in the sea for about two months, we find them, on their return to the rivers, measuring from ten to twelve inches in length, when they are known under the name of *Herlings* or *Whitlings* (*Salmo albus* of Dr Fleming). At this period they assume a different aspect; the back becomes of a dusky blue; the sides silvery, marked with a few obscure dark spots, principally in the region of the pectorals. Some examples are without spots, presenting at the same time a fine silvery appearance, from

* These fish are not the Parrs (*S. salmulus*) of ichthyologists, although closely resembling them. Dr Fleming, however, considers them identical; probably owing to his never having had an opportunity of examining an adult specimen of *S. salmulus*.

which circumstance they seem to have received the name of *Whitling*. The lateral bands and orange-coloured spots are no longer visible; the gill-cover spot is almost obliterated; the tail still remains deeply forked; the pectorals become dusky, and in some specimens assume a yellow appearance, when they are named *orange fins*. The vomerine teeth are from nine to twelve in number, and in about one example out of twenty, only three of these teeth are perceptible, and then confined to the most anterior part (probably the young of some of the varieties of Eriox); the head is small; the nose sharp; the back, over the shoulders, thick; and the form of the body elegantly shaped. After they enter the rivers, and have remained there a short time, they lose their silvery appearance, the spots become more apparent, the ventral and anal fins become dusky; the flesh, which previously had a reddish tinge and a delicate flavour, now becomes white and insipid, and the whole fish soon assumes a lank and unwholesome appearance. In this condition, on their return again to the sea, in the months of January and February, numbers are taken in the Forth above Stirling, as well as in the Tay, and sent to the Edinburgh market, where they are named *Lammasmens*, and are sold at the rate of about sevenpence per pound. When they have recruited themselves by a short absence at sea, and regained their former symmetry and silvery hue, they visit us again in June on their return to the rivers as before, with a length, on an average, of eighteen inches. They now receive the provincial names of *Sea-Trout*, *Salmon-Trout*, *White-Trout*, and *Whitlings*, according to their form, or their external markings. The caudal fin at this period becomes less forked, the middle rays more lengthened in proportion, and in some examples nearly even at the end. The number of vomerine teeth at this age are also uncertain, varying from three to nine; nor is it possible to distinguish *S. trutta* by the teeth only, from some of the varieties of *Eriox*, at least not before the fish has reached the length of twenty inches, when it will be found that *S. trutta* has retained from seven to nine of these teeth, and that *S. eriox* and varieties have lost all except a few, and those confined to the most anterior extremity. They have now arrived at that age to reproduce their species in the months before mentioned, although it is said by fishermen that they spawn on their first visit to the rivers, but I have not as yet been able to detect in them roe of sufficient size to lead me to that conjecture.

Independent of the statements of naturalists of high authority, who assert that the *Herling* (*Salmo albus* of Dr Fleming) is a distinct species, I cannot but agree with Mr Yarrell and Mr Jenyns, in supposing it as nothing more than the young of some of the migratory trout. With a view of ascertaining this fact, I remained several weeks on the banks of the Solway Firth, where I had an opportunity of inspecting several hundred specimens as soon as they were taken from the nets. After carefully dissecting two hundred specimens, and finding them to differ exceedingly from one another in their anatomical structure, in the number of scales, in the colour of the flesh, and in the form and arrangement of the lateral spots, I came to the conclusion that they were not a distinct species, but the young of different species or varieties of trout, which, if allowed to remain uncaught, would ultimately increase to six, seven, or even eight pounds in weight.

Salmo salmulus.*—The Parr.

Specific Characters.—Teeth extending the whole length of the vomer; middle ray of the caudal fin not half the length of the longest ray of the same fin; fifth ray of the pectorals the longest. (See Plate XXX.

Description.—From a specimen eight inches in length. Head more than one-fifth of the whole length, caudal included; depth between the dorsal and ventrals, less than the length of the head; gill-covers slightly produced at the posterior margin; basal line of union of the operculum oblique; preoperculum rounded at its inferior border. Jaws nearly equal; posterior extremity of the maxillary bone in a line under the middle of the pupil. Colour of the back and sides olive-brown, marked by a number of round dark spots; pectoral, dorsal, and caudal fins dusky; ventrals and anal rather lighter; operculum with a large dark spot placed in the centre, and another at the posterior inferior angle; sides with eight or nine broad transverse bands, with an orange-coloured spot between each. First dorsal fin placed half-way between the point of the upper jaw, and a little beyond the base of the centre caudal ray; the first and second rays simple, the remainder branched, the fourth the longest, rather more than equalling the base of the fin; the last ray about one-half the length of the fifth; adipose fin situated in a line over the base of the last ray of the anal fin, and half-way between the dorsal, and the centre of the middle caudal ray. Caudal fin deeply forked, the middle ray not half the length of the longest ray in the same fin; the fourth ray of the anal fin the longest, equalling the length of the sixth ray in the dorsal fin; the last ray one-half the length of the fifth, the seventh ray as long as the base of the fin. Origin of the ventral fins in a vertical line under the last ray but six of the dorsal, the fourth ray the longest, more than equalling the base of the dorsal fin. Pectorals rounded at the end, the fifth ray the longest, more than equalling the longest ray of the caudal fin, and as long as the space between the base of the ventral fin and the origin of the first ray of the anal. Teeth small and sharp, forty-eight in the upper jaw; and twenty in the lower; twelve on each palatine; six on the tongue, and twelve on the vomer; scales small and adherent: flesh white. Number of fin rays—

1st D. 12; P. 13; V. 8; A. 10; C. 19; cæca 42, but liable to great variation in their number.

* *Salmo salmulus*, Penn., Jen., Yarr., Jar. The largest specimen I have met with, measures nine inches and a quarter in length. It was taken in the North Esk, Forfarshire, September 1835, by James Wilson, Esq.

If we compare a young *Salmon* of eight inches in length with a *Parr* of equal size, both taken from the same river in the month of May, we shall find them to differ in the following respects. (See Plate XXX.) The form of the *Salmon* is long and narrow, the snout pointed, and the caudal fin acutely forked; the body of the *Parr* is thick and clumsy, the snout broad and blunt, and the caudal fin much less forked. The operculum of the *Salmon* is beautifully rounded at its posterior margin, with the basal line of union with the suboperculum much curved; in the *Parr* this part is rather produced, with the line of union nearly straight. In the *Salmon* the maxillary is short and narrow; in the *Parr* it is longer and broader, particularly at the posterior free extremity. The teeth of the *Salmon* are long and fine, when recent, easily bent; those of the *Parr* are shorter and stouter, and resist much greater pressure. In the *Salmon* the pectoral fin is short, not quite one-*seventh* part the length of the whole fish, with the fourth ray the longest; the same fin in the *Parr* is very long, not quite one-*sixth* part the length of the whole fish, with the fifth ray the longest, giving a form to the fin totally different from that of the *Salmon*. (See Plate XXXIV.) The pectoral, dorsal, and caudal fins in the *Salmon* are black; those fins in the parr are dusky. The flesh of the *Salmon* is delicate and pinkish, the bones rather soft, and the coats of the stomach thin and tender; the flesh of the *Parr* is white and firm, the bones stout and hard, and the coats of the stomach and intestines thick and tough.

It is generally supposed that those small fish from four to five inches in length, which are found so plentiful in many rivers during the autumn months, and which are marked on the sides with from ten to eleven transverse dusky bands, and a black spot on each gill-cover, are either all parrs or the young of the salmon. But from a minute examination of several hundred of these fish taken in various rivers in England and Scotland, I am induced to consider them as not all of one species, but the young of various species or varieties of migratory trout, in company with the young of the salmon, with the *Salmo salmulus* or parr, and with different varieties of the common fresh-water trout; all of which have received the names of *Heppers, Brandlings, Samlets, Fingerlings, Gravellings, Laspings, Skirlings,* and *Sparlings.*

The parr is said to be an abundant species in all the clear running streams in England, Wales, and the north of Scotland; but in the last-named country it begins to decrease, so as to become comparatively rare towards the north. Sir William Jardine, whose authority stands high as a naturalist, and who is known to have devoted much attention to the natural history of the fresh-water fishes, states "that the difference of opinion among ichthyologists, or rather the difficulty which they appear to have in forming one, whether this fish is distinct, or only the young of some others, has rendered the solution of it interesting. The greatest uncertainty, however, has latterly resolved itself into whether the parr was distinct, or a variety, or young, of the trout, *S. fario;* with the migratory salmon it has no connection whatever."

"Among the British *Salmonidæ,* there is no fish whose habits are so regular, or the colours and markings so constant. It frequents the clearest streams, delighting in the shallower fords or heads of the streams, having a fine gravelly bottom, and hanging there in shoals, in constant activity, apparently day and night. It takes any bait at any time with the greatest freedom; and hundreds may be taken when no trout, either large or small, will rise, though abundant among them. That part of its history only which is yet unknown is the breeding. Males are found so far advanced as to have the milt flow on being handled; but at that time, and indeed all those females which I have examined, had the roe in a backward state: and they have not been discovered spawning in any of the shallow streams or lesser rivulets, like the trout.

"In the markings they are so distinct as to be at once separated from the trout by any observer. The row of blue marks which is also found in the young trout, and in the young of several *Salmonidæ*, in the parr are narrower and more lengthened. The general spotting seldom extends below the lateral line, and two dark spots on the gill-cover are a very constant mark. On a still closer comparison between the young trout and parr of similar size, the following distinctions present themselves:—The parr is altogether more delicately formed; the nose is blunter; the tail more forked, but the chief external distinction is in the immense comparative power of the pectoral fin; it is larger, much more muscular, and nearly one-third broader; and we at once see the necessity for this great power, when we consider that they serve to assist in almost constantly suspending this little fish in the most rapid streams. Scales of the parr, taken from the lateral line below the dorsal fin, were altogether larger, the length greater by nearly one-third, the furrowing more delicate, and the form of the canal not so apparent, or so strongly marked, towards the basal end of the scale. The greater delicacy of the bones of the parr is still kept up very distinctly. The operculum forming the posterior edge of the gill-cover is much more rounded than in the trout, approaching in this respect to the salmon; in the trout the lower part is decidedly angular. The interoperculum in the parr is longer and narrower. The maxillary bone is broader at the posterior corner, but much shorter in the parr ; the vomer is much weaker ; the bones or rays of the gill-covers are longer and much narrower than those of the trout. The teeth of the parr are smaller ; the bone of the tongue longer, weaker, and not so broad ; the under jaw much weaker, and the distance between the two sides of the under jaw, in the parr, about one-third less. These are the most conspicuous distinctions, but every bone varies ; and not in one only, but in many specimens which I have lately examined, the distinctions were the same, and at once to be perceived. In this state, therefore, I have no hesitation in considering the parr not only distinct, but one of the best and most constantly marked species we have, and that it ought to remain in our systems as the *Salmo Salmulus* of Ray."*

"Dr Heysham, at different times and seasons opened and examined three hundred and ninety-five parrs, or samlets as they are called at Carlisle, and found one hundred and ninety-nine males, and one hundred and ninety-six females ;" and J. C. Heysham, Esq. sent Mr Yarrell a specimen measuring seven inches in length, having both lobes of roe in a forward state.

"It is the opinion of Dr Heysham of Carlisle, that the old samlets begin to deposit their spawn in December, and continue spawning the whole of that month, and perhaps some part of January. As this season of the year is not favourable to angling, few or no observations are made during these months. As soon as they have spawned, they retire, like the salmon, to the sea, where they remain till the Autumn, when they again return to the rivers. The spawn deposited by the old samlets in the sand, begins to exclude the young or fry according to the temperature of the season, either in April or May. The young samlets

* Sir William Jardine, Bart., *Edin. New Phil. Jour.* Jan. 1835.

remain in the rivers where they were spawned during the whole of the spring, summer, and autumn, and do not acquire their full size till the autumn, about which time the old ones return from the sea. Hence it is evident that, although there are samlets of various sizes in the spring and fore part of the summer, there will be no very large ones till the autumn, when the young ones have nearly acquired their full size, and the old ones have returned to associate with their offspring. If the weather be mild and open in January and February, samlets are taken when retiring to the sea with empty bellies, and in a weak emaciated condition. In short, we see samlets of various sizes; we see them with milt and roe in various stages, and we see them perfectly empty; all which circumstances clearly prove that they are a distinct species."*

It has often been asserted, in corroboration of the parr being the young of the salmon, that numbers are to be taken below the falls of the Clyde, but none above it. Last summer I had an opportunity of examining several dozen of these fishes, which were taken below the falls, in the month of July, and not a parr (*S. salmulus*) was among them; all proved to be the young of the migratory trout, with the exception of three which were the young of the salmon.

Practical fishermen, from not being acquainted with the characters by which the *parr* is distinguished from its congeners, have frequently confounded it with the young of the *salmon*, the *bull-trout*, the *salmon-trout*, and the common *fresh-water trout*; all of which, during the autumn months, very much resemble each other in their external markings.

There is still great doubts as to the *parr* being a migra-

* Yarrell's *British Fishes.*

tory species, since no instance has been recorded of its capture in the sea. Nor does it appear to me to be so common a fish as is generally considered. Its habits require further investigation.

Salmo fario.*—The Common Trout.

Specific Characters.—Vomerine teeth extending the whole way; middle ray of the tail more than half the length of the longest ray in the same fin; body marked more or less with red spots. (See Plate XXX.)

Description.—From a specimen one foot in length. Head one-fifth of the whole length, caudal fin included; depth under the dorsal less than the length of the head. Colour of the back dusky inclining to olive, sides lighter; belly yellowish; sides above the lateral line marked with about fifty dark round spots; below the line about ten, surrounded by a pale circle; lateral line with eight red spots, which are more conspicuous on the caudal half of the body; pectorals yellowish, the remaining fins dusky; dorsal spotted, with the summits of the second, third, fourth, and fifth rays white, and an oblique black band beneath; the first ray of the anal fin white, with the four following ones, marked like those of the dorsal; gill-cover marked with five or six dark round spots (colour and spots very variable). First dorsal fin placed half-way between the point of the snout and a little beyond the fleshy portion of the tail; the first two rays simple (there are generally three simple rays in the trout and salmon, but the first being so very small is not taken into consideration), the rest branched; the fourth the longest, equalling the length of the long ray of the caudal fin; the last considerably more than half the length of the fourth; the eighth as long as the base of the fin. Adipose fin in a line immediately over the base of the last ray of the anal, and nearer the last ray of the dorsal than to the tip of the tail; caudal fin nearly even at the end (in young specimens more or less forked); the fourth ray of the anal fin the longest, nearly twice the length of the base of the fin; the last ray half the length of the fifth; all the rays branch except the two first which are simple; fourth ray of the ventral fin the longest, equalling the length of the seventh ray of the dorsal; base of the ventrals in a line under the last ray but five of the dorsal. Pectorals rounded, the fourth ray the longest, a very little longer than the long ray of the caudal fin; the last ray but one half the length of the third. Basal line of the operculum oblique; suboperculum slightly produced behind (in some individuals

* *Salmo fario* Auctorum.

it is very marked); jaws nearly equal; the posterior extremity of the maxillary reaching beyond the orbit. Teeth sharp and stout, slightly curved inwards; about thirty in the upper jaw, twenty-four in the lower, twelve on each palatine, ten on the vomer, and eight on the tongue. Scales small and adherent; flesh white; cæca forty-two.* Number of fin rays—

1st D. 14; P. 13; V. 9; A. 11; C. 18; "Vertebræ 56."

Trout are liable to much variation as to colour,† which seems greatly to depend on the situation and the waters they are accustomed to inhabit. Thus if one of these fish be taken from a small burn, running over a peaty soil, shaded by high banks, or overhanging trees, it will be found almost invariably of small size, seldom exceeding the weight of half a pound; with the head large in proportion, the belly, back, and sides, of a dark colour, and in some instances assuming a perfect black. If taken from a river overgrown with weeds, and flowing through a mossy district, it will be found marked with large black spots, placed in a pale circle, the back dark, and the sides shaded with green. But when newly taken from a translucent stream, which glides over a sandy or gravelly soil, it is found to be exquisitely beautiful; the head and back of an olive brown, the spots clearly displayed, and the sides tinged with the most brilliant orange and gold. It is perhaps owing to these variations in colour, that many species of trout are said to exist. "One cause of the variation is the difference of food, and, according to every information we possess, those which

* In those trout which inhabit highland streams, I have never found the number of cæca to exceed forty-six, the average number being forty-two.

† See *Observations and Experiments on the Colour of Fishes*, by Dr Stark, in Edin. New Phil. Jour. Oct. 1830, p. 327.

In the Tweed I have frequently observed a singular variety of trout, which is considered by the fishermen as the young of the bull-trout. General length about eight inches; vomerine teeth nine; pectorals of an orange colour; anal pure white; anterior part of the dorsal with a dark band (as in *S. fario*); and the extremity of the caudal fin is margined with black. It is found in the month of May in company with the young of the migratory species.

feed on fresh-water shells, *Gammari* (screws, or fresh-water shrimps as they are sometimes called), are of the most brilliant tint, and also of the finest flavour, with a decided pinkness in their flesh. Those feeding on the ordinary water insects are next in brilliancy and flavour, while such as live chiefly upon aquatic vegetables, are dull in colour, and of soft consistence."

The average growth of trout found in lowland streams, is from half to three-quarters of a pound; occasionally they may be taken weighing a pound, but one a pound and a half, and from that to two pounds, is considered a prize to the angler. We sometimes hear of trout being taken the weight of fifteen, twenty, and even five and twenty pounds, but these are of rare occurrence.

Trout deposit their ova in the shallows in the early part of November, and when that operation is completed, they retire to deep water, where they conceal themselves during the colder months.

This fish is found in every burn and river entering the Firth of Forth, and is extensively distributed over the whole of northern Europe.

SALMO CÆCIFER.*—THE LOCHLEVEN TROUT.

Specific Characters.—Vomerine teeth extending the whole way; caudal fin lunate; body without red spots. (See Plate XXX.)

Description.—From a specimen a foot in length. Head rather more than one-fifth of the whole length; caudal fin included; depth between the dorsal and ventral fins less than the length of the head. Gill-cover produced behind; basal margin of the operculum oblique; preoperculum rounded; end of the maxillary extending back as far as the posterior margin of the orbit. Colour of the back deep olive-green; sides lighter; belly inclining to yellow; pectorals orange, tipped with grey; dorsal and caudal fins dusky; ventral and anal fins

* *Salmo Levenensis*, Walker; *Salmo cæcifer*, Parnell. The cæca being more numerous in this species than in any of its congeners.

lighter; gill-cover with nine round dark spots; body above the lateral line with seventy spots; below it ten; dorsal fin thickly marked with spots of a similar kind; anterior extremities of the anal and dorsal fins without the oblique dark bands which are so conspicuous and constant in many individuals of *S. Fario.* First dorsal fin placed half-way between the point of the upper jaw and a little beyond the fleshy portion of the caudal extremity of the body; all the rays branched except the two first; the third ray the longest, equalling the length of the long caudal ray; the seventh as long as the base of the fin; the last considerably more than half the length of the third, equalling the length of the middle caudal ray; fin even at the end (in many specimens it is concave, with the last ray longer than the preceding one.) Caudal fin crescent shaped, the middle ray rather more than half the length of the longest ray; third ray of the anal fin the longest, equalling the length of the fifth dorsal ray; the last ray as long as the base of the fin, ventral fin equalling the length of the fifth ray of the anal; the third ray the longest; third ray of the pectorals equalling the length of the long caudal ray; the last ray half the length of the fin. Teeth stout and sharp, curved slightly inwards; thirty-two in the upper jaw, eighteen on the lower; twelve on each palatine; thirteen on the vomer; and eight on the tongue. Scales small and adherent, twenty-four in an oblique row between the middle dorsal ray and the lateral line; flesh deep red; cæca eighty. Number of fin rays—

1st D. 12; P. 12; V. 9; A. 10; C. 19.

This fish is considered by most writers on British ichthyology to be identical with *Salmo fario* or common trout, differing from it only in the colour of the flesh, and in having no red spots on the sides. It is true that food and season may have a great share in diminishing or increasing the external markings and colour of the flesh;* but they can have no effect in shortening or lengthening the rays of the fins, or in adding numbers to the cæcal appendages.

The differences that exist between *S. cæcifer* and *S. fario* are very striking. The pectorals in *S. cæcifer* when expanded

* James Stuart Menteath, Esq. of Closeburn, caught a number of small river trout, and transferred them to a lake (Loch Ettrick) where they grew rapidly; their flesh, which previously exhibited a white chalky appearance, became in a short time of a deep red, while their external appearance remained the same from the time they were first put in.

are pointed, in *S. fario* they are rounded. The caudal fin in *S. cæcifer* is lunated at the end; in *S. fario* it is sinuous or even. *S. cæcifer* has never any red spots; *S. fario* is scarcely ever without them. The caudal rays are much longer in *cæcifer* than in *fario*, in fish of equal length. In *S. cæcifer* the tail-fin is pointed at the upper and lower extremities; in *S. fario* they are rounded. The flesh of *S. cæcifer* is of a deep red, that of *S. fario* is pinkish and often white. The cæcal appendages in *S. cæcifer* are from sixty to eighty in number; in *S. fario*, I have never found them to exceed forty-six.

"Lochleven (of which the barren isle and now dismantled castle are famous in history as the prison-place of the beautiful Queen Mary) has long been celebrated for its breed of trout. These, however, have fallen off of late considerably in their general flavour and condition, owing, it is said, to the partial drainage of the Loch having destroyed their best feeding ground, by exposing the beds of fresh-water shells, which form the greater portion of their food."* They spawn in January, February, and March. The fish described does not appear to be peculiar to this loch, as I have seen specimens that were taken in some of the lakes in the county of Sutherland with several other trout, which were too hastily considered as mere varieties of *S. fario*. It is more than probable that the Scottish lakes produce several species of trout known at present by the name of *S. fario*, and which remain to be further investigated.

Salmo umbla.†—The Northern Charr.

Specific Characters.—Vomerine teeth confined to the anterior part; body spotted with white or red; axillary scale more than one-third the length of the ventrals.

* *Encyc. Brit.* There are two or three varieties of *S. fario* in Lochleven with white and pinkish flesh, which are much inferior in flavour to *S. cæcifer*.

† *Salmo umbla*, Cuv., Yarr., Jen., *S. alpinus*, Penn., *Alpine Charr*, *Case Charr*.

Description.—From a specimen fifteen inches and a half in length. Head one-sixth of the whole length, caudal fin included; depth of the body under the dorsal, equalling the length of the head; basal line of the operculum oblique; suboperculum very broad, slightly produced at its inferior posterior margin; preoperculum sinuous; jaws nearly equal. Colour of the back dark olive; sides bluish-grey; belly inclining to yellow; dorsal and caudal fins dusky; ventrals reddish; pectorals tinged with grey; sides spotted with white, more conspicuous above the lateral line. (During the spawning season the back is umber-brown; the sides greyish; the belly, pectoral, ventral, and anal fins, bright crimson-red; the first ray of the ventral and anal fins white; the sides above and below the lateral line marked with red spots.) Dorsal fin situated half-way between the point of the upper jaw and the base of the middle caudal ray; third ray the longest, equalling the length of the pectorals; the sixth as long as the base of the fin; the last one-half the length of the fourth; adipose fin rather small; placed nearer the last ray of the dorsal than to the tip of the caudal fin. Tail forked, the middle ray one-half the length of the longest ray of the same fin; anal fin shorter than the dorsal, the last ray the shortest, one-third the length of the fourth; the sixth ray as long as the base of the fin; ventrals equalling in length the longest ray of the anal; axillary scale not half the length of the fin; pectorals pointed, the last ray about one third the length of the second. Teeth small and sharp in both jaws and on the palatines; those on the vomer few in number and confined to the most anterior extremity; tongue with six teeth rather stouter than the others; lateral line straight throughout its course; scales small and adherent; flesh red. Number of fin rays—

1st D. 12; P. 12; V. 9; A. 12; C. 19.

The usual weight of this species of Charr is about three quarters of a pound, although specimens have been occasionally taken weighing beyond two pounds. It is found in many of the lakes of England, Wales, and Scotland, and has received various names according to the intensity of the colours it presents at different periods of the year; and even individuals taken at the same period are often found to vary excessively in this respect. Thus, "six specimens of Charr were selected from a hawl of a net taken in Windermere on the 12th December a few seasons ago, exhibiting the following variations as to colour:—No. 1, ground-colour of the body pale ashy-brown, somewhat lighter beneath the lateral line; sides richly marked with scarlet spots of different sizes; the whole of the under surface from the pectorals to the tail brilliant scarlet; fins margined anteriorly with an opaque white stripe followed by a blackish-brown portion passing posteriorly into deep crimson; tail blackish-brown; nose and front part of the head marked by a black spot; dorsal fin of the same pale brown colour as the back, slightly inclining to blue. Apparently a male. No. 2, back brown, becoming gradually paler beneath; abdomen and lower parts dingy white, tinged with bluish colour; ventral and anal fins margined with white, the remaining parts flesh colour; pectorals reddish-brown; dorsal and caudal fins blackish-brown; sides marked with obscure pale yellowish-red spots. A male specimen, which apparently had spawned. No. 3, of a blackish-brown colour, somewhat silvery, paler beneath the lateral line, and passing into yellowish-white on the belly; pectoral, ventral, and anal fins brown, tinged with red; dorsal and caudal fins brownish-black; upper part of the head of the same colour; sides marked with numerous, very pale, almost colourless spots. No. 4 resembles the last described, but smaller in size; these the fishermen named Geld-fish, full-grown and half-grown. No. 5 very dark, brownish-black upon the back and sides, becoming gradually paler beneath the lateral line; pectoral, ventral, and anal fins distinctly margined anteriorly with opaque white; the central portion of these fins brownish-black, and their interior margins flesh colour; upper part of the head dark; belly dingy red. No. 6 resembles the preceding, except that the under surface instead of being dingy red, is pale reddish-white; ventral and anal fins reddish-brown, margined anteriorly with white; pectorals reddish-brown; dorsal brownish-black;

both these specimens are marked on the sides with obscure, pale reddish spots. These two fish were what the fishermen called *Case Charr* (*Salmo alpinus*) male and female, yet the pectoral, ventral, and anal fins of the former, and the ventral and anal fins of the latter sex were conspicuously margined with white, although that character is usually regarded as distinctive of the torgoch or *Red Charr*."*

It is the opinion of M. Agassiz that the *Salmo umbla*, *S. alpinus*, *S. salvelinus*, and *S. salmarinus* of Linnæus, are all the same fish, differing only as regards colour; and Pennant states that, on the closest examination, he could find no specific differences between the Red Charr, the Case Charr, the Gelt Charr, and Silver Charr of the northern lakes.

The Northern Charr, in the months of November and December, leaves the deep waters and ascends the tributary streams to deposit its spawn in the shallows, when numbers are taken with the net at the very time when their preservation ought to be the most strictly attended to, and when, in truth, they begin to fall off in their condition. From their great unwillingness to take a fly, they offer but little diversion to the angler, except to those who are in the habit of skilfully using the minnow, when as many as two dozen have been taken in a day by a single rod. According to Sir William Jardine their food seems to be minute *Entomostraca*. A few specimens are occasionally taken in Lochleven when dragging the net for trout.

Salmo umbla is distinguished from *S. fario*, *S. cæcifer*, *S. salmulus*, and *S. trutta*, by having the anterior part of the vomer only armed with teeth; and from *S. eriox* and *S. salar*, by the body being marked with red or white spots. There are many other distinguishing characters, but these

* Art. *Ichthyology*, Encyc. Brit.

are the most prominent. In what specific characters the *S. umbla* differs from the Welsh Charr of Yarrell I am not at present prepared to state. Mr Jenyns appears to have placed reliance on the position of the dorsal fin as a character in the Welsh Charr. He states that it is situated exactly in the middle of the entire length; but, judging from Mr Yarrell's figure of the fish, the dorsal fin is placed halfway between the tip of the upper jaw and the base of the middle caudal ray, like that observed in the Northern Charr. According to Mr Yarrell the chief differences which exist between the two Charrs are these, that "the Northern Charr is an elegantly-shaped slender-bodied fish, with fins of small comparative size; whereas the Welsh Charr is a short fish, considerably deeper for its length, with very large fins, the eye and gape are also much larger than in the Northern Charr."

GENUS *OSMERUS*.—Branchiostegous membrane with eight rays only; anal fin with more than fourteen rays; gape large; teeth long and sharp; intestinal canal without cæca.

OSMERUS EPERLANUS.*—THE SPERLING.

Specific Characters.—Vomerine teeth confined to the anterior extremity; under jaw longest.

Description.—From a specimen eight inches in length. Head one-fifth of the whole length, caudal included; depth of the body under the dorsal fin less than the length of the head; basal line of the operculum rather oblique; suboperculum slightly produced behind at its superior posterior margin; preoperculum approaching to angular; under jaw the longest; the extremity of the maxillary extending back as far as the posterior margin of the orbit. Colour of the back as far as the lateral line, dusky green; sides marked with a metallic grey band, extending from the upper part of the gill-cover to the

* *Osmerus eperlanus*, Cuv., Flem., Yarr., Jen. *Salmo eperlanus*, Linn., Penn., Don. *Smelt, Sperling.*

base of the tail; belly, cheeks, and gill-covers, silvery-white; pectoral, ventral, and anal fins light straw-colour; dorsal and caudal pale ash-green. First ray of the dorsal fin arises exactly half-way between the point of the upper jaw and the base of the middle caudal ray; the first two rays simple, the rest branched, the third the longest, equalling the length of the long caudal ray; the last ray the shortest, one-half the length of the fourth; the last but three equalling the length of the base of the fin; adipose fin situated in a line over the last ray but three of the anal, and half-way between the base of the last ray of the dorsal and end of the middle caudal ray; tail-fin deeply forked, the middle ray not half the length of the longest ray of the same fin; third ray of the anal the longest, being as long as the base of the fin; the last ray half the length of the fourth; ventrals commencing in a line under the second ray of the dorsal, the second and third rays the longest, being as long as the fourth ray of the dorsal; pectorals equalling the length of the ventrals; teeth small and sharp in both jaws, those in the upper jaw much the finest; two rows of teeth on each of the palatines, but none on the vomer, except two or three very long ones placed on the most anterior extremity; tongue furnished with a number of teeth, those in front large, and slightly bent inwards, those behind small and fine; eyes moderate, situated nearer the posterior margin of the preoperculum than to the point of the upper jaw; scales large (Jenyns states they are minute), sixty-four forming the lateral line, and six in an oblique row between it and the base of the dorsal fin. Intestinal canal without cæcal appendages. The fish emits the smell of green rushes. Number of fin rays—

1st D. 10; P. 12; V. 8; A. 15; C. 19.

It is stated by Pennant that the Smelt inhabits the seas of the northern parts of Europe, and that it is found as far south as in the Seine. As a British fish, Mr Yarrell says, "it appears to be almost exclusively confined to the eastern and western coast of Great Britain, and that he is not aware of any good authority for the appearance of the true Smelt between Dover and the Land's End. The fish called Smelt and Sand-smelt along the extended line of our southern coast, is, in reality, the Atherine."

"On the eastern side of our island the Smelt occurs in the Tay, in the Firth of Forth, in the Ure on the Yorkshire coast; it is taken in abundance in the Humber, and on the Lincolnshire coast, in the Thames, and the Medway. On the western side, the Smelt is taken in the Solway Firth, and may be traced as far south as the parallel line formed by the Mersey, the Dee, the Conway, and Dublin Bay."

In the Firth of Forth, in the neighbourhood of Alloa, the Smelt, or Sperling as it is there named, is taken in great numbers, especially towards the fall of the year. From November till January, those then taken are generally of small size, seldom measuring more than from four to six inches in length, but after that time to the end of March, the larger ones make their appearance and the young ones disappear; and it is from this circumstance that two species are said to exist, which, in reality, are the same, differing only in size. It is very seldom that specimens are found more than ten inches in length, although Pennant mentions having seen one thirteen inches long, and which weighed half a pound. In the month of March these fish ascend the Forth in large shoals to deposit their spawn in the fresh water; this they shed in immense quantity about two miles below Stirling Bridge, when at that time every stone, plank, and post, appear to be covered with their yellowish-coloured ova. The young, from three to five inches in length, can be taken at Alloa throughout the summer months, but the larger specimens are only met with during the season of spawning. The Sperling is much esteemed as a luxury for the table, and numbers are sent to the Edinburgh market where they receive a ready sale. Their favourite food seems to be small shrimps.

The most important character which distinguishes *Osmerus eperlanus* from the genus *Salmo*, is in having no cæcal appendages, whereas the cæca in that genus are very numerous.

Family IV. CLUPEIDÆ.—Dorsal fin one; no adipose fin; intestinal canal with cæca.

Genus *CLUPEA*.—Vomer and tongue furnished with teeth; under jaw longest.

Clupea harengus.*—The Herring.

Specific Characters.—Dorsal fin placed exactly half-way between the point of the upper jaw, and the tip of the long caudal rays; ventrals situated under the dorsal. (See Plate XXXV.)

Description.—From a specimen eleven inches in length. Head, measuring from the point of the lower jaw, when opened, to the posterior margin of the gill-cover, nearly one-fifth of the whole length, caudal fin included; depth of the body under the dorsal equalling the length of the head. Dorsal fin placed exactly in the middle of the fish; the base of the first ray situated half-way between the point of the upper jaw and the end of the scaly portion of the body; the fourth ray the longest, not quite equalling the length of the base of the fin; the last ray exactly one-half the length of the eighth; all the rays branched except the three first which are simple; caudal fin deeply forked, the middle ray about one-third the length of the longest ray. First ray of the anal fin arises mid-way between the origin of the ventrals and the base of the middle caudal ray; the third ray the longest, about half the length of the base of the fin; ventrals equalling the length of the sixth ray of the dorsal, and placed in a vertical line under the base of that ray; pectorals pointed, of a triangular form, and about twice as long as the tenth ray of the dorsal. Colour of the back, glossy blue; sides and belly silvery-white; dorsal and caudal fins, dusky; ventrals and anal, white; under jaw tipped with black. Eyes large, placed nearer the point of the upper jaw than to the posterior margin of the operculum. Teeth very minute (Pennant states that the whole mouth is void of teeth) six or eight in a row on the most anterior part of each jaw, those on the lower jaw being longer and more perceptible; vomer with a double row about sixteen in number; each palatine with a single row somewhat smaller than those on the vomer; tongue also armed with a number of teeth arranged in three or four rows, with their points directed inwards. Maxillary large, broad, and thin, extending as far back as in a line under the middle of the eye; basal line of the operculum oblique

* *Clupea harengus*, Auctorum. *Zool. Bot. Mag.* vol. i. *Parnell.*

and sinuous; suboperculum slightly angular at its inferior posterior margin. Scales large, thin, and very deciduous, placed in fifteen rows between the dorsal and ventral fins; lateral line not perceptible; cæcal appendages about twenty in number. Most authors suppose that the belly of the herring is never serrated, at any stage of its growth, and which is said to form a good specific distinction between it and the sprat; but it will be found that this is not the case, for a herring less than six inches in length is as distinctly serrated on the belly, between the ventral and anal fins, as a sprat of equal size; and as the herring increases in size so the serratures become obliterated, and by the time the fish reaches to the length of eight inches, the belly will be found to be no longer serrated, but carinated. The serratures can be more evidently perceived when the abdominal scales are removed, which often project beyond the teeth, and prevent their points from being felt when the finger is passed from the anal, towards the pectorals. Number of fin rays—

D. 17; P. 16; V. 9; A. 15; C. 20; Vert. 56.

The Herring is distinguished from the Sprat, in the dorsal fin being placed exactly in the centre of the fish, that is, half-way between the point of the upper jaw and the end of the long caudal rays; and in the base of the ventrals being in a vertical line under the sixth ray of the dorsal fin; in the Sprat the dorsal fin is situated nearer the tip of the tail-fin, than to the point of the snout; and the origin of the ventrals is placed a little anterior to the first ray of the dorsal fin. The Herring has fifty-six vertebræ; the Sprat has but forty-eight. The scales in the Herring are arranged in fifteen rows between the dorsal and ventral fins; in the Sprat there are but seven rows in that position.

The Herring is readily known from the Pilchard in the position of the dorsal fin. If the Herring be held up by the anterior rays of the dorsal fin, the head will be observed to dip considerably; whereas if the Pilchard be held up by the same part, the body preserves an equilibrium. The Herring very strikingly differs from the Whitebait, in colour; the back of the Herring is of a dark glossy blue;

in the Whitebait that part is of a pale greenish ash colour; the origin of the first ray of the dorsal fin in the Herring is situated exactly half-way between the point of the upper jaw and the base of the middle caudal ray; in the Whitebait the same fin is placed mid-way between the point of the upper jaw and the end of the middle caudal ray.

Herrings enter the Firth of Forth about the end of December or the beginning of January, and remain two or three weeks at the mouth of the estuary, before they attempt to ascend. This delay seems greatly to depend on the state of the weather, for in some seasons when it is mild and fine, they have been observed to swarm in the Firth off Musselburgh in the early part of January; whilst in the rough and stormy seasons they do not make their appearance on that part of the coast before the middle of February, and always disappear before the end of March. They seem to visit the Firth regularly every winter, and a season very seldom passes without a few being captured, and sent to the Edinburgh market. Some years they appear in much larger shoals than in others, the reason of which is not accounted for. In the year 1816, pilchards were taken in the Firth of Forth, in great abundance, when not a dozen herrings were seen during the whole winter. Since that time not a single Pilchard has been known to enter the estuary.

"The herring is in truth a most capricious fish," says Dr MacCulloch, "seldom remaining long in one place; and there is scarcely a fishing station round the British Islands, that has not experienced in the visits of this fish the greatest variations, both as to time and quantity, without any accountable reason. In Long Island, one of the Hebrides, it was asserted that the fish had been driven away by the manufactory of kelp, some imaginary coincidence having been found between their disappearance and the establishment of that business. But the kelp fires did not drive them away from other shores, which they frequent and abandon indifferently without regard to this work. It has been a still favourite and popular fancy, that they were driven away by firing of guns; and hence this is not allowed during the fishing season. A gun has scarcely been fired in the Western Islands, or on the west coast, since the days of Cromwell; yet they have changed their places many times in that interval. In a similar manner, and with equal truth, it was said that they had been driven from the Baltic by the battle of Copenhagen. Before the days of guns and gunpowder, the Highlanders held that they quitted coasts where blood had been shed: and thus ancient philosophy is renovated. Steam-boats are now supposed to be the culprits, since a reason must be found. To prove their effect, Loch Fine, visited by a steam-boat daily, is now their favourite haunt, and they have deserted other lochs where steam-boats have never yet smoked. A member of the House of Commons, in a debate on a tithe bill lately stated, that a clergyman having obtained a living on the coast of Ireland, signified his intention of taking the tithe of fish, which was, however, considered to be so utterly repugnant to the privileges and feelings of the finny race, that not a single herring has ever since visited that part of the shore."

In June, July, and August, herrings are taken off the Dunbar and Berwick coasts in considerable number, from whence the Edinburgh market is abundantly supplied, when scarcely a single herring is to be seen higher in the Firth of a size worth the notice of the fishermen.

Herrings are said to deposit their spawn towards the end of October, and it is nearly three months previous to this operation that they are found to appear on our shores, when they become of so great national importance.

The spawning of these fish in October only does not appear to me to account for the number of small fry, two inches in length, that are found in the Firth of Forth during the month of July; and the young herrings that are taken from six to seven inches long in the month of February, mixed also with fry from two to three inches in length. When herrings are brought to the market in the first two months of the year, I have always found them full of spawn, and in the middle of March I have observed many very lank, with not a single ovum to be seen in them. Hence it is not improbable that the same species of herring may spawn twice in the year, early in the month of March, and also towards the end of October.

Pennant supposes that the herring migrates to a considerable distance; that they begin to appear first off the Shetland Islands, in April and May, and to divide into distinct columns from four to six miles in length, and three to four in breadth; and that, after they have taken their circuit, they return again to the Arctic Circle, where they recruit themselves after the fatigue of spawning. But it is more consistent to suppose, that the herrings approach our shores for the purpose of depositing their spawn like other fishes, and when this is accomplished, return again to the deep sea. Dr Knox considers the food of the Herring, while inhabiting the depths of the ocean, to consist principally of minute entomostracous animals; but it is certainly less choice (adds Mr Yarrell) in its selection when near the shore. Dr Neill found five young herrings in the stomach of a large female herring; he has also known them to be taken by the fishermen on their lines, the hooks of which were baited with limpets. Herrings feed on the roe of their own species and of other fishes. I have often found the young of the whitebait with small shrimps in the stomach of herrings when they were not in roe; but when they are about to spawn, their stomachs (as is observed in most other fishes at that period) appear as if empty, and destitute of any perceptible food. On the authority of Dr Fleming, the fry have been caught with a trout-fly. Sir William Jardine states, "that, on the coasts of the West Highlands, herrings for many years past have been taken with the rod, the hook dressed with a white feather (generally from some of the gulls). Near Oban, and upon the shores of Mull and Jura, twelve dozen are sometimes taken by a single boat during the evening."

Clupea pilchardus.*—The Pilchard.

Specific Characters.—Dorsal fin exactly in the centre of gravity; ventrals under the dorsal.

Description.—"From a specimen nine inches in length. Much resembles the herring, but rather smaller and thicker; length of the head, to the whole length of the fish, as one to five; depth of the body equal to the length of the head; transverse thickness of the body equal to half its depth; form of the head triangular, the upper surface flat; dorsal and abdominal lines slightly and equally convex; no perceptible lateral line; body across the back obtusely rounded; line of the abdomen smooth; the edges of the scales of the two sides having a longitudinal groove from the branchiostegous rays to the vent, along which groove extends a row of scales of a peculiar shape; the two long, narrow, lateral arms extending up each side under the scales, the shortest projection pointing backwards; the scales of the body very large, deciduous, and ciliated at the free edge. The distance from the point of the nose to the base of the last ray of the dorsal fin, and from thence half-way along the caudal rays, nearly equal; the commencement of the dorsal fin is therefore anterior to the middle of the fish by the whole length of the base of the fin; the first and second rays shorter than the third, which is equal to the length

* *Clupea pilchardus*, Auctorum. *Pilchard, Gipsy Herring.*

of the base of the fin ; these first three rays articulated, but simple ; all the other rays branched ; pectoral and ventral fins small, the latter commencing in a line under the middle of the dorsal fin ; the axillary scales very long ; anal fin commencing half-way between the origin of the ventral fins and the end of the flesh portion of the tail ; the first ray short, the second and the last two rays the longest ; tail deeply forked ; the scales at the end of the fleshy portion of the body extending far over the bases of the caudal rays, particularly two elongated scales above and below the middle line. Mouth small, without teeth, under jaw the longest ; the breadth of the eye one-fourth of the length of the head, and placed at rather more than its own breadth from the point of the nose ; irides yellowish-white ; cheeks and all the parts of the gill-covers tinged with golden-yellow, and marked with various radiating striæ ; posterior edge of the operculum nearly vertical and straight ; upper part of the body bluish-green ; sides and belly silvery-white ; dorsal fin and tail dusky. The fin rays in number are—

D. 18 ; P. 16 ; V. 8 ; A. 18 ; C. 19 ; Vert. 55." (*Yarrell.*)

The Pilchard is become of late a very rare fish in the Firth of Forth, as well as along the whole eastern line of the Scottish shores ; yet, about thirty years ago, it was found in equal abundance in certain localities as the common herring. A few are taken occasionally in the summer months on the Berwick and Dunbar coasts, but since the year 1816, no appearance of a Pilchard has been observed in the Firth of Forth.

" The older naturalists considered the Pilchard, like the herring, as a visitor from a distant region ; and they assigned to it also the same place of resort as that fish, with which, indeed, the Pilchard has been sometimes confounded. To this it will be a sufficient reply, that the Pilchard is never seen in the Northern Ocean, and the few that sometimes wander through the Straits of Dover, or the British Channel, have evidently suffered from passing so far out of their accustomed limits. They frequent the French coasts, and are seen on those of Spain ; but on neither in considerable numbers, or with much regularity, so that few fishes confine themselves within such narrow bounds. On the coast of Cornwall, they are found through all the seasons of the year, and even there their habits vary in the different months. In January, they keep near the bottom, and are chiefly seen in the stomachs of ravenous fishes; in March, they sometimes assemble in schulls, and thousands of hogsheads have in some years been taken in seans; but this union is only partial, and not permanent; and it is not until July that they regularly and permanently congregate, so as to be sought after by the fishermen."* Mr Couch says, " In some years, at least, a considerable body of Pilchards shed spawn in the month of May, perhaps in the middle of the Channel, where I have known them taken heavy with roe, in drift-nets shot for mackerel; yet it seems certain that they do not breed twice in the year, and that the larger body do not perform this function until October, and then at no great distance from the shore. I have known an equally great variation to occur in other fishes, which have in consequence visited us, and been in season, at a time not expected by the fishermen." They feed on small crustaceous animals, and the roe of their own and of other species of fishes.

The Pilchard is easily distinguished from the *herring*, *sprat*, and *whitebait*, by the position of the dorsal fin. If either of the three latter fish be suspended by the anterior dorsal rays, the head will be observed to dip considerably, whereas if the Pilchard be suspended by the same part, the body will preserve an equilibrium.

Clupea spratta.†—The Sprat.

Specific Character.—Base of the ventral fin placed a little anterior to the first ray of the dorsal. (See Plate XXXV.)

* Yarrell's *British Fishes*.

† *Clupea sprattus*, Cuv., Yarr., Jen. *Sprat, Garvey Herring*.

Description.—From a specimen five inches and a half in length. Head nearly one-fifth the whole length of the fish, tail-fin included; depth of the body under the dorsal fin equal to the length of the head; ventral line rather more convex than that of the dorsal, especially in front of the ventrals; gill-cover rounder at its posterior-inferior margin and slightly notched at its upper border; eyes large and round, occupying one-half the depth of the head, and situated half-way between the point of the lower jaw and the posterior margin of the operculum; head on the summit flat, smooth and transparent, with a triangular reddish-coloured spot placed in a line over the posterior half of the orbit. Colour of the back greenish with a shade of grey; sides and belly silvery-white; pectoral, ventral, and anal fins pure white; dorsal and caudal slightly dusky; jaws tipped with black. Dorsal fin placed nearer the end of the caudal rays than to the point of the upper jaw; the first ray very short, the second, third, and fourth gradually increasing in length, the fifth the longest in the fin, reaching, when folded down, to the base of the last ray, all the rays branched except the first five, which are simple; caudal fin deeply forked, the middle ray not one-half the length of the longest ray. Third ray of the anal fin the longest, about one-third the length of the base of the fin, all the rays branched except the two first; ventrals small, equal in length to the eighth ray of the dorsal, arising in a line a little in advance of the dorsal fin; pectorals as long as the base of the anal fin. Teeth small and fine in both jaws, and few in number, situated on the most anterior part, more perceptible on the lower than on the upper jaw; tongue furnished with fine teeth as well as the roof of the mouth; under jaw the longest; maxillary extending back as far as in a line under the middle of the eye. Belly strongly serrated as far as the anal aperture, with thirty-three teeth, their points directing backwards. Scales large and very deciduous, placed in seven or eight rows between the dorsal and ventral fins; axillary scales nearly half as long as the fin. (Mr Yarrell states, they have no axillary scales.) Number of fin rays—

D. 17; P. 15; V. 7; A. 18; C. 19; Vert. 48; Cæca about 12.

Sprats are found to frequent the whole of the British coasts, but are observed to exist in much greater numbers on the central part of the eastern coast than elsewhere. They are found in the Firth of Forth throughout the whole of the year, and, like many small animals, appear very susceptible of cold. During the warm summer months, they are seen sporting about in large shoals, in every part of the Forth, occupying a considerable extent of water, and causing a ripple on the surface with their fins, while they become the principal food of many marine birds, which assail them in the water or prey on them from above. As the cold weather advances, these little fish are no longer seen in the lower part of the estuary, but are found to ascend the Firth to a considerable distance, and to select that part of the river where the fresh and salt waters mingle together: "for it is a well-known law in chemistry, that when two fluids of different densities come in contact, the temperature of the mixture is elevated for a time in proportion to the difference in density of the two fluids; owing to mutual penetration and condensation; such a mixture is constantly taking place in the rivers that run into the sea, and the temperature of the mixed water is accordingly elevated." In the year 1830, Sprats were remarkably abundant all over the British coasts, but more particularly on the coast of Kent and Essex, where they were taken in immense quantities, so that they were sold at sixpence a bushel as manure for the land. The Sprat is generally considered as a delicious, well-flavoured, and wholesome fish, and is eaten in considerable quantity in this country, both fresh and salted. Prior to the year 1836, it was of rare occurrence to see Sprats brought to the Edinburgh market, and when they did appear they were sold at the rate of twelve a-penny; but now, owing to the immense numbers that are taken in the Firth of Forth, they are enabled to be sold in the Edinburgh markets at a low price, and consequently form a cheap and agreeable food to many of the inhabitants. The most common size of a Sprat is from four to five inches in length; yet it is observed occasionally to exceed six inches and a half, when it is named in the neighbourhood of Alloa the King of Garvies. Sprats spawn early in the month of March, and feed on small crustaceous animals.

The Sprat is easily distinguished from the herring, pilchard, and whitebait, by the position of the ventral fins; in the Sprat, if a vertical line be dropped from the origin of the first dorsal ray, it will fall behind the base of the ventral fin; whereas in the herring, pilchard, and whitebait, the ventrals are under the dorsal.

Clupea alba.*—The Whitebait.

Specific Characters.—Dorsal fin placed nearer the tip of the caudal fin than to the point of the upper jaw; ventral fins under the dorsal. (See Plate XXXV.)

Description.—From a specimen two inches and a half in length. Occasionally specimens are found to measure the length of five inches. Shape of the body resembles that of the young herring, but rather more compressed, and of a deeper form. The head, in a specimen five inches long, not quite one-fourth the length of the whole fish; in a fish four inches long, the head measures one-fourth of the entire length; in one two inches long, the head is more than one-fourth of the whole length. Colour of the upper part of the back, from the nape to the tail, of a pale greenish-ash; sides, gill-covers, pectoral, ventral, and anal fins of a beautiful pure white; dorsal and caudal fins straw-colour, minutely spotted with dark brown; head, on the summit, in young specimens, marked with a large brown spot, which is divided anteriorly by a white line; each orbit on the superior margin tinged with black, as well as the posterior-inferior margin, but in a less degree. First ray of the dorsal fin commences exactly midway between the point of the upper jaw and the end of the middle caudal rays; ventrals placed behind the third ray of the dorsal; tail fin deeply forked, the middle ray being not quite half the length of the longest ray of the same fin; pectorals pointed, much longer than the base of the anal fin. Scales thin, very deciduous, not so large as those of the sprat; under jaw the longest; each jaw, on the anterior part, furnished with a few small slender teeth, about six in number, placed in one row, which are more perceptible on the lower than on the upper jaw; on the roof of the mouth, as well as on the tongue, are placed three or more rows of teeth, which can be easily felt by the assistance of the point of a fine needle. Mr Yarrell says, the tongue of the whitebait has an elevated central ridge without teeth; it is probable that a dried specimen was not examined, for, until in that state, it is almost impossible to perceive the teeth, in

* *Clupea alba*, Yarr.

consequence of their extreme minuteness. This is a most important character, which at once removes it from the *shad*, which has the tongue and roof of the mouth destitute of teeth. Number of fin rays—

D. 17; P. 15; V. 9; A. 15; C. 20; Vert. 56; Cæca about 15.

The Whitebait which is found so plentifully in the Thames, and is so well known in the neighbourhood of London, as a delicate and well-flavoured fish, was supposed by naturalists to be the young of the *shad*, until Mr Yarrell, in the Magazine of Natural History, proved it to be a distinct species. In many respects it differs materially from all the other British species of *clupea*, not only in specific characters, but also in its habits, and is one as distinctly marked as any of its congeners. From the beginning of April to the end of September, this fish, according to Mr Yarrell, may be caught in the Thames as high up as Woolwich or Blackwall every flood tide in considerable quantity; while during the first three months of this period, neither species of the genus *Clupea* of any age or size except occasionally a young sprat can be found.

"About the end of March, or early in April, whitebait begin to make their appearance in the Thames, and remain till the end of September, when they are no longer to be found in the river. In the months of June, July, and August, provided the weather be fine, immense quantities are consumed by visitors to Greenwich and Blackwall, where epicures of all orders assemble for a whitebait feast. The fishery for these fish is continued in the Thames frequently so late as September, and specimens of young fish of the year, from four to five inches long, are then not uncommon, but mixed, even at this late period of the season, with others of very small size, as if the roe had continued to be deposited throughout the summer."

The Whitebait is not, as it was formerly considered to be, peculiar to the Thames, as I have found it to inhabit the Firth of Forth in considerable numbers during the summer months. From the beginning of July to the end of September they are found in great abundance in the neighbourhood of Queensferry, and opposite Hopetoun House, where I captured, in one dip of a small net of about a foot and a half square, between two and three hundred fish, the greater part of which were whitebait of small size, not more than two inches in length; the remainder were sprats, young herring, and fry of other fishes.

In their habits they appear to be similar to the young of the herring, always keeping in shoals, and swimming occasionally near the surface of the water, where they often fall a prey to aquatic birds.

I have no doubt that the Whitebait will be found to exist in the Firth of Forth, throughout the whole year, in considerable quantity, and that the fishermen would find it a new source of income, equal or superior to the sperling fishery, did they use the mode of fishing for whitebait that is practised in the Thames. But, in consequence of the large extent of the estuary, and of no means being used exclusively for the capture of these fish, we can form but a faint idea of the number that may exist there.

"The whitebait net which is used in the Thames, is not large; the mouth of it measures only about three feet across, but the mesh of the hose, or bag end of the net, is very small. A boat is moored in the tide-way, where the water is from twenty to thirty feet deep; the tail of the hose, swimming loose, is from time to time brought into the boat, the end untied, and its contents shaken out. The wooden frame forming the mouth of the net does not dip more than four feet below the surface of the water." In the Solway Firth, the whitebait is also found in great quantities in the months of June and July, but remain there disregarded, as their value as a dainty morsel does not appear to be known in that quarter. The principal food of the whitebait seems to be a very minute species of shrimp, which is scarcely larger than a moderate sized flea.

The Whitebait, four inches long, differs from the herring, sprat, and pilchard, of the same length, in the following characters:—

The herring has the dorsal fin placed half-way between the point of the upper jaw and the end of the long caudal rays, with the head nearly one-fifth the entire length of the fish. The whitebait has the dorsal fin much nearer the tip of the tail than to the point of the upper jaw, with the head exactly one-fourth the length of the whole fish; the body is more compressed, of a much lighter colour, and the belly much rougher under the pectorals, than is observed in the herring.

The sprat has the origin of the ventral fins situated anterior to a vertical line dropped from the first dorsal ray, with forty-eight vertebræ; the whitebait has fifty-six vertebræ, with the origin of the ventrals placed behind the third ray of the dorsal. In the pilchard, the dorsal fin is placed exactly in the centre of gravity; in the whitebait it is much behind that point.

The following is the mode adopted at Greenwich in the cooking of whitebait:—Take a quantity of whitebait, put them on a napkin and throw a handful of fine flour with a little salt over them; roll them about, by laying hold of opposite sides of the cloth, until they become well covered with the flour. A capacious pot of boiling hot lard being ready, the fish are to be taken up in successive portions by a skellet and thrown into the lard, from which they are to be removed to the dish for the table the instant they have acquired a pale straw colour.

GENUS *ALOSA*.—Tongue and roof of the mouth destitute of teeth; upper jaw with a deep notch in the centre.

ALOSA FINTA.*—THE TWAITE SHAD.

Specific Characters.—Distinct teeth in the upper jaw; a row of dark spots along each side of the body.

Description.—From a specimen thirteen inches and a half long. The length of the head, that is, from the tip of the upper jaw to the posterior margin of the gill-cover, exactly one-fifth the whole length of the fish, caudal fin included; depth of the body under the dorsal, rather more than the length of the head; operculum rounded at its upper border, and nearly straight at its lower and posterior margin; basal line rather oblique, directing towards the last ray of the dorsal; suboperculum rather broad, slightly angular about the middle of the posterior border. Colour of the back dusky blue; sides lighter, with green reflections; belly silvery-white; ventral and anal fins white; pectorals, dorsal, and caudal fins, dusky, the two latter minutely spotted with dark brown; upper part of the gill-covers and head with beautiful yellowish-green reflections. Base of the first ray of the dorsal fin exactly half-way between the point of the upper jaw and the last ray of the anal fin; the fourth and fifth rays the longest, equalling the length of the base of the fin; the last ray one-half the length of the seventh, and rather longer than the two preceding ones, giving the fin at the free margin a slight concave appearance; all the rays branched, except the first three or four, which are simple; caudal fin deeply forked, the longest ray equal to the length of the head; rays of the anal fin very short, the second and third the longest, considerably less than than one-half the length of the base of the fin, the last two or three rays longer than the centre ones; ventrals commencing in a line under the sixth ray of the dorsal; pectorals rather small, and acutely pointed, the second ray the longest, equal to the length of the base of the dorsal fin; under jaw the longest; upper jaw with a deep notch in the centre; end of the maxillary extending back as far as in a line with the posterior margin of the orbit. Eyes rather small, the diameter of which is rather more than one-fifth the length of the head; teeth very small, placed on the margin of the upper jaw only; none on the vomer, palatines, or tongue; lower margin of the maxillaries slightly roughened, but not a vestige of a tooth on the lower jaw in the specimens now before me; scales large, very deciduous, extending half-way down the caudal rays;

* *Alosa finta*, Cuv., Yarr. *Clupea alosa*, Linn., Penn., Don., Jen. *Shad*, *Twaite Shad*.

lateral line not perceptible; a row of six round dark spots along each side, in a line with the upper part of the gill-covers; belly strongly serrated, with forty strong, sharp, teeth, extending from the interoperculum to the vent; each ventral fin with an axillary scale, more than half as long as the fin itself. (Mr Yarrell says the ventral fins are without axillary scales.) Number of fin rays—

D. 19; P. 16; V. 9; A. 21; C. 19; "Vert. 55."

Shads inhabit the North Atlantic, the Mediterranean, and Caspian Seas. They form numerous troops in spring, ascend the large rivers to deposit their spawn, and, after this law of nature is accomplished, they return about the end of July again to the sea. The Severn is one of the rivers that affords this fish in great plenty; it makes its first appearance there in May, and in some seasons much earlier. It is common in the Thames, in the months of June and July, when great numbers are taken by the fishermen below Greenwich. It is in general considered a coarse, dry, and insipid fish. On the coast of Scotland, the Twaite shad receives the name of Rock Herring. We observe this fish enter the Firth of Forth in tolerable abundance towards the end of July, and dozens are then taken in the salmon-nets, at almost every tide; but after August we lose sight of them until the following season. These fish are occasionally salted and dried, and used as food when nothing better can be obtained. They are very seldom brought to market.

Alosa communis.*—The Allice Shad.

Specific Characters.—Jaws without teeth; sides without spots; a large dusky spot behind the upper part of the operculum.

Description.—From a specimen eighteen inches in length. Head one-fifth the whole length of the fish, caudal fin included; greatest depth of the body anterior to the dorsal fin, rather more than equalling the length of the head. Colour of the back and sides,

* *Alosa communis*, Cuv., Yarr. *Clupea Alosa*, Jen.

bluish-grey: belly silvery-white; dorsal and caudal fins dusky; ventrals, anal, and pectorals, pure white; gill-covers with yellowish-green reflections when viewed in a particular light. First ray of the dorsal fin commencing exactly half-way between the point of the upper jaw and the base of the last ray of the anal fin, the third and fourth rays the longest, not quite as long as the base of the fin, the third ray when folded down reaches to the base of the last ray, the three first rays simple, all the rest branched, the last ray exactly half the length of the eighth; the summit of the fin slightly concave. Caudal fin very much forked; base of the anal fin about equal in length to that of the dorsal; all the rays short, the third the longest, as long as the twelfth ray of the dorsal, the middle rays shorter than the lateral ones. Origin of the ventrals placed under the fifth ray of the dorsal; pectorals pointed, the second ray the longest, equal to the length of the base of the dorsal fin. Operculum rounded at its upper margin, and nearly straight at its posterior border; suboperculum broad and angular. Eye rather small, the diameter one-fifth the length of the head; under jaw the longest, no teeth in either jaw, on the vomer, tongue, or palatines. Scales large, thin, and very deciduous, extending half-way down the caudal rays; ventral fin with a long axillary scale; lateral line very indistinct; belly strongly serrated, with a number of strong teeth, extending from under the interoperculum to the anal aperture; head flattened on its upper surface; a large dusky spot behind the upper margin of each gill-cover; operculum roughened with a number of raised lines placed obliquely; suboperculum perfectly smooth. Number of fin rays—

D. 19; V. 9; P. 15; A. 23; C. 19.

This species of Shad is noticed by Pennant as sometimes to be taken the weight of eight pounds, but its more general size is from four to five pounds, whereas the Twaite shad is never found to exceed the weight of two pounds. The Allice Shad is said to be found in the Severn in greater numbers and in higher perfection than in any other river in Great Britain, and is esteemed a very delicate fish about the time of its first appearance, especially in that part of the river that flows by Gloucester, where they are taken by nets and usually sold dearer than salmon. Dr Hastings says, " they generally make their appearance there in May, though sometimes in April. This, however, depends a good deal upon the quality of the water; if it is clear, they ascend early in spring, but if there happens to be a flood, they wait till the waters are restored to their former purity; and if they meet with a flood in their progress upwards, they immediately return and keep below Gloucester." In the Thames this fish is seldom met with; and seems to be of equally rare occurrence in the Firth of Forth. Two specimens only have fallen under my notice, one of which was taken in the salmon nets in the month of June at Musselburgh, and the other was captured in a net along with herrings, at the mouth of the Firth, in the early part of January. It is frequently reported that herrings of large size, measuring from twenty to twenty-four inches in length, are occasionally taken off the Dunbar and Berwickshire coasts, and which the fishermen name the Queen Herrings, but it is probable that the fish they allude to is the Allice Shad. Mr Yarrell states, that "both species of shads have great resemblance, except in size, to the herrings, and have been frequently called the mother of herrings. The large herrings of two feet in length, so called by Anderson and others, and said to occur in the Northern Seas, and among our Northern Islands, are no doubt to be considered as referring to our shads."

The principal food of the shad seems to be small fishes such as sprats, whitebait, and young of the herring.

The Allice Shad is distinguished from the Twaite Shad, by having a large dusky spot placed behind the upper part of each gill-cover, and by the sides being without spots, and the jaws without teeth. The Twaite shad has from four to seven large dark spots on each side of the body, arranged in a row parallel to the lateral line, and a number of minute teeth on the anterior margin of the upper jaw.

II. SUBBRACHIALES.

Ventral fins placed beneath the pectorals or nearly so.

FAMILY V. GADIDÆ.—Eyes placed one on each side of the head; ventrals separate, jugular; jaws and front of the vomer armed with teeth.*

GENUS *GADUS*.—Dorsal fins three; one barbule at the extremity of the lower jaw.

MORRHUA VULGARIS.†—THE COMMON COD.

Specific Characters.—Lower half of the lateral line white; first anal fin commencing under the second dorsal.

Description.—Common size from a foot and a half to two feet in length; said sometimes to reach five, and to weigh seventy-eight pounds. Head in large specimens, rather more than one-fourth of the entire length; depth of the body under the first dorsal frequently more than equal the length of the head. Colours liable to much variation; the most common appearance, back and sides yellowish-grey spotted with greenish-ash; lower half of the lateral line broad and white; all the fins dusky; belly pure white. First dorsal fin commencing in a vertical line a little behind the base of the pectorals; its form somewhat triangular; fourth ray the longest, not quite as long as the base of the fin; the rest rapidly diminishing in height; the last very short, scarcely perceptible. Second dorsal commencing at a short interval from the termination of the first; the fourth ray the longest, rather less than half the length of the base of the fin, and equalling the length of the seventh ray of the first dorsal; the remaining rays gradually diminishing, the last three more suddenly so. Third dorsal arises at a short distance from the last ray of the second dorsal, and ends near the short rays of the caudal; fifth ray the longest, as long as, from the base of the first ray, to that of the eleventh of the same fin; the last three rays very short, diminishing rapidly from the one preceding. Caudal fin nearly even at the end; last anal fin corresponding to the last dorsal, and placed precisely under it; first

* Cuvier, says, "the teeth in this family are card-like and the cæca are numerous." But these characters do not seem to hold good throughout the family, and, therefore, they are here omitted, the teeth in the *hake* are very long; and the *tadpole-fish* has no cæca.

† *Morrhua vulgaris*, Cuv., Yarr. *Gadus Morrhua* Linn., (Jen. ?)

anal fin commencing in a line under the fifth ray of the second dorsal, and terminating under the last ray of the same fin; the fifth ray the longest, being as long as the seventh ray of the first dorsal. Ventrals rather small and pointed, commencing a little in advance of the base of the pectorals; the second ray much the longest; pectorals nearly as long as the base of the first dorsal, and rounded at the inferior margin; the fourth ray the longest; both jaws, as well as the anterior part of the vomer, furnished with small sharp teeth, arranged in several rows; under jaw rather the shortest, with a barbule placed on the under surface of the anterior extremity. Gape large; the maxillary extending back as far as in a line with the middle of the eye; gill-opening large; branchial rays seven; lateral line commencing at the upper part of the operculum, taking a gentle curve parallel to the line of the back as far as the commencement of the second dorsal fin, where it runs for a short distance in an oblique direction as far as the tenth ray of the first anal, from thence proceeding straight to the base of the middle caudal ray. Scales small and adherent; cæcal appendages numerous. Number of fin rays—

1st D. 13; 2d 19; 3d 18; P. 20; V. 6; 1st A. 19; 2d 16; C. 28; "Vert. 50."

The Cod is an inhabitant of cold or temperate climates. It is particularly met with in that part of the northern Atlantic comprehended between the fortieth and sixty-sixth degree of latitude. It does not exist in the Mediterranean or other interior seas whose entrance is nearer to the equator than the fortieth degree. It appears to be almost entirely confined to the northern parts of the world. Few, however, are taken north of Iceland, but on the south and west coasts they abound, and they are found to swarm on the coast of Norway, and off the Orkneys and Western Isles, after which they decrease in numbers in proportion as we advance towards the south. Cod are never found but in salt water, and remain habitually in the depth of the sea. They never ascend rivers, or even, generally, approach the shores except for the purpose of depositing their spawn.

The Cod is very voracious, feeds on small fish of all kinds, more especially on herrings, and sprats, as well as on mollusca, worms, and crustacea. Mr Couch has taken thirty-five crabs, none less than the size of a half-crown piece, from the stomach of one Cod. Its digestive powers are said to be very great, and under the influence of the gastric juice, the shell of the crab or lobster grows red, just as it does when under the action of boiling water, and that even before the flesh is one-quarter digested. The stomach of the Cod often affords a rich harvest to the naturalist.

In the Firth of Forth, Cod are taken all the year through, sometimes in tolerable numbers, from whence the Edinburgh market is supplied; they are in best season in the month of February, and remain in excellent condition till the end of April. They begin to deposit their spawn in the months of May and June, when they frequently ascend the Firth as far as Alloa, and are taken on their return in the salmon-nets in a very poor and lean condition. The spawn that is thus annually shed by one parent fish it is said, can give birth to nine millions three hundred and eighty-four thousand of young. The fry are observed in the month of August swimming about in company with sprats, whitebait, and herrings, from two to three inches in length, beautifully freckled with light brown and yellow. The growth of the Cod fish is said to be remarkably rapid, though the degrees of its progression are not ascertained. From the month of July to the end of October the large Cod are observed to be long and thin, particularly those that are captured on sandy banks or in shallow water, being then of very light colour, with the muscle soft, unwholesome, and insipid to the taste; the fish not having had time sufficient to recruit themselves after the fatigue of spawning. The best Cod are found in deep and rocky situations in the neighbourhood of the Isle of May and all around the mouth of the Firth. The dark variety of Cod generally known by the name of Rock or Red Cod, is considered as the firmest and sweetest fish. It is found in very deep water, and feeds almost entirely on young Lobsters and Star-fish.

Cod are observed to thrive better while under confinement than most of the species of the same family, and, in some instances, they are found improved by the change. Elias Cathcart, Esq. of St Margaret's, near North Queensferry, has kept for some time a number of marine fishes in a salt-water pond of about two hundred feet in length, and five fathoms deep, in which the tide flows and ebbs twice in the day. The principal fishes preserved are cod, haddock, whiting, flounders, and skate, which are retained prisoners by means of an iron grating, placed at that part of the pond which communicates with the Firth. They are fed by the keeper, with sprats, young herrings, and other small fishes, besides, occasionally with the intestines of sheep, which the cod are observed to devour with avidity. All the fish appear to thrive well, especially the cod, which are found to be firmer in the flesh and thicker across the shoulders than those obtained from the Firth of Forth.

The Cod when in season, is white, firm, and of most excellent flavour. Its flesh is capable of being preserved in a state fit for eating much longer than that of most other species of this class. " Almost all parts of the Cod are adapted for the nourishment of man and animals, or for some other purposes of domestic economy. The tongue, for instance, whether fresh or salted is a great delicacy ; the gills are carefully preserved to be employed as baits in fishing ; the liver which is large, and good for eating, also furnishes an enormous quantity of oil, which is an excellent substitute for that of the whale, and applicable to all the same purposes ; the swimming bladder furnishes an isinglass not far inferior to that yielded by the sturgeon, the Iceland fishermen prepare large quantities of it, which in England sells for a high price ; the head in the places where the cod is taken, supplies the fishermen and their families with food. The Norwegians give it with marine plants to their cows, for the purpose of producing a greater proportion of milk. The vertebræ, the ribs, and the bones in general are given to their cattle by the Icelanders. The lens are made into necklaces for children, and the ear-bones are often found in the possession of the curious. Even their intestines and their eggs contribute to the luxury of the table."* Its fishing is consequently of great importance, as affording subsistence and occupation to a numerous population.

The Cod is easily distinguished from other British fishes by having three dorsal fins, the lower half of the lateral line white, and a barbule on the lower jaw. Mr Jenyns, not without good reason, has very justly omitted the *Gadus Callarias* of Linnæus as a British species.

MORRHUA ÆGLEFINUS.—THE HADDOCK.

Specific Characters.—Lateral line black; a large black spot on each side under the first dorsal fin; first anal fin commencing under the second dorsal.

Description.—Head, of a specimen two feet in length, one-fourth the whole length of the fish; depth of the body rather less than the length of the head. Colour of the back dusky brown; belly dirty white; all the fins dusky, the dorsal, caudal, and pectorals rather more so; lateral line black; between the base of the first dorsal and pectoral fins, a large dark spot, varying in size and intensity of colour in different individuals; pupil large of a deep blue. First dorsal fin somewhat of a triangular form, slightly curved at the summit, commencing in a line over the base of the pectorals; second ray the longest, reaching, when folded down, to the base of the third ray of the second dorsal fin, the fifth ray as long as the base of the fin, the remaining rays rapidly decreasing in height, the last very small. Second dorsal fin commencing at a short interval from the termination of the first, the fourth ray the longest, about half the length of the base of the fin, the rest of the rays gradually decreasing; the last ray very short.

* Griffith, *Animal Kingdom.*

Third dorsal fin arising close behind the second, the fifth ray the longest, equalling the length of the eighth ray of the first dorsal, the sixth ray about half the length of the base of the fin, the rest of the rays gradually diminishing to the last but three, from thence more rapidly. Caudal fin slightly forked, the middle ray about one-half the length of the longest ray of the same fin. First anal fin commencing in a line under the fourth ray of the second dorsal, and ending a little behind the last ray of the same fin, the sixth ray the longest, about half as long as the base of the fin, the rest of the rays gradually decreasing, the last very short. Second anal corresponding in size to the third dorsal, and placed rather nearer the tail. Under jaw the shortest; both jaws armed with numerous small sharp teeth, placed in many rows, as well as the front of the vomer. Eyes large; gill-cover ending in a flattened point behind; branchial rays seven; under jaw furnished with a small conical barbule placed on the under and anterior part; lateral line commencing over the operculum, taking a gentle curve half-way down the side, from thence running straight to the base of the middle caudal ray; scales small and very adherent, pectorals pointed, fourth ray the longest; origin of the ventrals placed in advance of the base of the pectorals, the third and fourth rays the longest, being as long as the seventh ray of the first dorsal; cæcal appendages numerous. Number of fin rays—

1st D. 16; 2d D. 21; 3d D. 19; P. 20; V. 6; 1st A. 24; 2d A. 22; C. 25. "Vert. 54."

The Haddock, like the Cod, is a northern fish, yet it has not been observed in the Baltic, or so far south as the Mediterranean. It is taken all round the British coasts, but in much greater numbers on the eastern shores than elsewhere. Pennant states that shoals of Haddocks appear periodically on the Yorkshire coast, and about the 10th of December, on their first arrival, they form a bank or shoal three miles in breadth, and eighty miles in length, and that, on these occasions, they are so numerous that three fishermen within the space of a mile may fill their boats twice in a day. In stormy weather the haddock refuses every kind of bait, and seeks refuge among marine plants in the deepest parts of the ocean, where it remains until the violence of the elements is somewhat subdued.

Some years ago haddocks were remarkably plentiful in the Firth of Forth, and found almost in every part of it, but of late, they have very much decreased both in size and number, and are now confined to the bay near Aberlady and mouth of the Firth. The Edinburgh market is well supplied with these fish all the year through, but in the months of December and January they are more numerous, and in much better condition than at any other period of the year. They shed their spawn in the early part of March, and in the months of October and November the young are taken from four to six inches in length, when they are considered remarkably good. Haddocks are occasionally taken two feet and a half in length, but one of eighteen inches is reckoned more preferable for the table. These fish are preserved for use in a variety of different ways, and form the principal food of many of the lower inhabitants of Edinburgh. When smoked in a peculiar manner, they are known by the name finnan haddies, which are sold in small bundles and much used for the table. When simply dried they are called speldrings, and are consumed in a raw or uncooked state, though inferior to such as are preserved by the former mode.

The quality of the flesh of the haddock varies according to the place in which these fish are found, their size, their age, their sex, and the period of the year. It is in general white, firm, wholesome, and well flavoured, but in every respect inferior to the cod. It feeds principally on crustacea.

The Haddock is easily distinguished from the cod at all times, by having a large black spot on each side of the body under the first dorsal fin. This singular spot tradition assigns to the impression of St Peter's finger and thumb, when he took the tribute-money out of the mouth of a fish, which is supposed to have been the haddock; but, unfortunately for the legend, in the sea where that miracle was performed the haddock does not exist.

Morrhua lusca.*—The Bib.

Specific Characters.—A dusky spot at the base of each pectoral fin; first anal fin commencing under the middle of the first dorsal; scales larger.

Description.—From a specimen sixteen inches in length. Head one-fourth of the whole length, excluding the caudal fin; depth of the body compared to the whole length, caudal included, as one to three and a half. Colour of the back dusky brown, inclining to yellow towards the sides; belly dirty white; all the fins dusky, becoming lighter at the base; caudal fin margined with black; a dusky spot at the upper part of the base of each pectoral; lateral line about the same shade as the body; first and second rays of the ventrals whitish; eyes opaque. First dorsal fin commencing over the base of the pectorals, and reaching when folded down to the base of the fourth ray of the second dorsal, the first and second rays simple, the rest branched, the third the longest, the remainder rapidly decreasing in height, the sixth as long as the base of the fin, the last very small, scarcely perceptible. Second dorsal commencing at a short distance from the termination of the first; the two first rays simple, the fifth the longest, less than half the length of the base of the fin, the succeeding ones gradually decreasing, the last very short and fine. Third dorsal fin commencing immediately behind the second, the fifth ray the longest, the eighth half as long as the base of the fin, the last scarcely perceptible; caudal fin even at the end; ventral fins rather small, placed a little before the base of the pectorals, the first two rays very much produced, the second rather the longest reaching to the fourth ray of the anal; pectorals when expanded somewhat of an oval form, the fourth ray the longest, equalling the length of the first dorsal fin, all the rays branched except the first; the twelfth ray half the length of the third. First anal fin commencing in a line under the middle of the first dorsal, and terminating under the first ray of the third dorsal, the first ray very small, the succeeding ones gradually increasing to about the fifteenth, the remainder gradually decreasing, the last three rather more suddenly, the middle ray about

* *Morrhua lusca*, Yarr. *Gadus luscus*, Jen., Penn., Flem., Linn. *Bib*, *Pout*, *Whiting Pout*, *Blinds*, *Brassy*.

one-fourth the length of the base of the fin. Second anal fin commencing immediately behind the first and terminating at a short distance from the caudal, corresponding in size and form with the third dorsal, but placed rather farther back. Snout rounded and rather obtuse; upper jaw the longest; maxillary extending back to beneath the middle of the orbit. Teeth in the lower jaw placed in one row, rather long and sharp, slightly curved inwards; those in the upper jaw of a similar kind, rather more numerous, with a band of smaller teeth behind; eyes large, covered with a loose thick membrane, giving a prominent appearance; operculum of a triangular form, ending in a flattened point over the base of the pectorals; gill-opening large; branchial rays seven; barbule at the extremity of the lower jaw placed underneath, about an inch in length, equalling the diameter of the orbit; snout and cheeks of a metallic-grey appearance. Scales in the middle of the body large and closely imbricated; those which cover a great portion of the dorsal, caudal, and anal fins are small, of an oval form, and very deciduous. Lateral line commencing at the upper part of the operculum, taking a sudden bend under the anterior portion of the second dorsal, from thence passing straight to the base of the middle caudal ray. Number of fin rays—

1st D. 13; 2d D. 24; 3d D. 17; P. 15; V. 6; 1st A. 31; 2d A. 18; C. 25.

The Bib is readily distinguished from the haddock and the cod, by the great depth of the body compared to the length; in the length of the base of the first anal fin, which commences under the middle of the first dorsal, and frequently rather more in advance; whereas in the haddock and cod this fin commences under the third or fourth ray of the second dorsal. It very much resembles the *Morrhua minuta* or Power Cod, particularly when from five to six inches in length; but the latter fish is rather longer in proportion to its depth; the anal fin is shorter with not more than twenty-six or twenty-seven rays, and commencing in a line behind the first dorsal. The *Morrhua barbata*, *Gadus barbatus*, and *Asellus barbatus* of authors are now considered by Mr Yarrell and Mr Jenyns as mere synonyms for the *Morrhua lusca* or Bib.

This fish, the Brassy of Scotland, I have frequently found to exceed the length of seventeen inches, but the more common size is about a foot. It is taken on the east and west coasts of Scotland, on the coasts of Norway and Sweden, and in almost every part of the English shores, particularly in those places where they are deep and rocky. Several are brought to the Edinburgh market in the months of December, January, and February, when they are considered best for the table. They are out of condition in April, May, and June. In taste they are said to resemble the whiting, but are coarser in the flesh, and considered not so easy of digestion. The brassy is taken in the Firth of Forth principally near the Isle of May, with long lines set for cod and baited with mussels. It is seldom found as high up the Firth as Inchcolm, but when taken beyond that point, it is generally thin and ill flavoured, not meeting with that abundance and variety of food which it finds in deeper and more rocky situations.

GENUS *MERLANGUS*.—Dorsal fins three; lower jaw without a barbule.

MERLANGUS VULGARIS.*—THE WHITING.

Specific Characters.—Under jaw shortest; a black spot at the base of the first ray of the pectorals; caudal fin even at the end.

Description.—From a large specimen twenty-three inches in length. Head about one-fourth of the whole length; depth of the body rather less than the length of the head, or one-fifth the whole length of the fish. Colour of the back and sides reddish-brown, frequently with stripes of yellow; belly white; dorsal fins bluish, slightly dusky; anal fins straw-colour, minutely freckled with pale brown; caudal darkish towards the end; a large dark spot at the base of the first ray of the pectorals; lateral line rather darker than the body; pupils dark

* *Merlangus vulgaris*, Cuv., Yarr., Flem. *Gadus Merlangus*, Penn., Linn., Don.

blue. First dorsal fin somewhat of a triangular form, commencing a little behind the base of the pectorals; third and fourth rays the longest, about equalling the base of the fin; first ray spinous, stouter than the rest; the last very short and slender. Second dorsal commencing at a short interval from the termination of the first; fourth and fifth rays the longest, about one-third the length of the base of the fin; the first stout and spinous; the last very short and slender, and readily overlooked. Third dorsal longer than the first and rather shorter than the second, commencing close behind the termination of the latter, and ending at a short distance from the base of the short caudal rays; fourth and fifth rays the longest, about half the length of the base of the fin; the first stout and spiny; the rest soft and flexible; the last but three half the length of the seventh; pectorals moderate; the fifth ray the longest, about equalling the base of the first dorsal fin; all the rays soft and flexible except the two first which are simple; the fourteenth ray one-half the length of the fifth; first anal fin very long, commencing in a line under the last ray but five of the first dorsal, and terminating in a line under the first ray of the third dorsal; the first ray very short; the seven succeeding ones gradually increasing in length; the eighth one-fifth the length of the base of the fin; the following twelve or fourteen of equal length; the remainder gradually diminishing; the last very short; second anal fin commencing close behind the termination of the first, corresponding in shape and size to the third dorsal, but placed rather nearer the tail; caudal fin even at the end; ventrals small, situated before the pectorals; second ray the longest. Under jaw rather the shortest, armed with a row of sharp teeth, with a few smaller ones at the base; upper jaw with teeth of a similar kind, but the smaller ones more numerous and placed in two or three rows; eyes round and moderate; maxillary extending back to beneath the anterior part of the pupil; gill-opening large; branchial rays seven. Lateral line commencing at the upper part of the operculum, taking a slight bend under the anterior part of the second dorsal, from thence passing straight to the middle ray of the tail. Scales on the back and abdomen very small, those down the middle of the body considerably larger; intervening membranes of the caudal fin covered with minute scales which are scarcely perceptible except when in a dried state; caudal extremity of the body terminating in a point. Number of fin rays—

1st D. 13; 2d D. 22; 3d D. 20; P. 21; 1st A. 36; 2d A. 23; V. 6; C. 30; "Vert. 55."

The Whiting is distinguished from the cod, haddock, and brassy, by having no barbule on the chin. It is known from the coalfish, the pollack, and green cod, by the under jaw being rather the shortest; in having a black spot at the base of the first ray of the pectorals; and in the caudal fin being even at the end.

The Whiting is esteemed one of the most delicate and wholesome fish we have, and is considered by many persons to be superior in flavour to the haddock or cod, either in the recent or salted state. It is universally distributed throughout the British coasts, but is found in greater abundance on the sandy than on the rocky parts, keeping generally in large shoals a few miles from land. January and February are the months in which this fish is found most plentifully. It sheds its spawn in March when not far from shore, and is then easily taken with the net. The hook when baited with mussel it seizes with great avidity, and in this manner numbers are taken and brought to market, where they meet with a ready sale. In April, May, and June, they are out of condition, and ought not then to be made use of as an article of food, particularly by invalids, with whom the flesh is apt to create nausea and sickness; but in December, January, and February, when the Whiting is in the best condition, no fish agrees better with weak stomachs, and is often retained when all other food has been loathed and ejected. A Whiting about a foot in length is considered the best size for the table, and when boiled it proves the most wholesome. In the month of August, young Whitings are seen from three to four inches in length in pools left by the receding of the tide, in company with podleys, young cod, and other small fishes. Their food is principally mollusca and crustacea.

Merlangus carbonarius.*—The Coalfish.

Specific Characters.—Under jaw longest; caudal fin deeply forked; lateral line straight throughout.

Description.—From a specimen a foot in length. Head one-fourth the length of the body, caudal fin excluded; depth rather less than the length of the head. Colour of the back and sides dark grey; belly dirty white; dorsal, caudal, and anal fins dusky and minutely freckled; ventrals white. First dorsal fin of a triangular form, commencing a little behind the base of the pectorals; third and fourth rays the longest, equalling the base of the fin; the first ray spinous, about half the length of the second; the last very short. Second dorsal commencing at a short interval from the termination of the first; third and fourth rays the longest, about half as long as the base of the fin; the rest gradually decreasing in height; the first ray simple, about half the length of the second; the remainder soft and flexible. Third dorsal commencing at a short distance from the last, and leaving a wide space between its termination and the short caudal rays; the fifth ray the longest; the rest gradually decreasing in height; the last about half as long as the fourth; the ninth about one-third the length of the base of the fin; caudal deeply forked, the middle ray not half the length of the longest ray of the same fin. Pectorals pointed, the fourth and fifth rays the longest, more than equalling the length of the first dorsal fin; ventrals small, placed in advance of the base of the pectorals. First anal fin commencing in a line under the interval between the two first dorsals, and terminating rather behind the last ray of the second dorsal; the fifth ray the longest, about one-third the length of the base of the fin; the remainder gradually decreasing in height; second anal corresponding with the third dorsal, but terminating rather nearer to the caudal. Teeth small and fine, one or two rows placed in the lower jaw and three or four rows in the upper jaw, and a few along the vomer; under jaw the longest; maxillary extending back to beneath the anterior margin of the orbit. Lateral line commencing at the upper part of the operculum and taking a straight course to the base of the tail; scales small and adherent, those covering the caudal fin very minute and of an elongated form. Number of fin rays—

1st D. 12; 2d D. 18; 3d D. 20; 1st A. 24: 2d A. 22; P. 19; V. 6; C. 32.

* *Merlangus carbonarius*, Yarr., Jen., Cuv., Flem. *Gadus carbonarius*, Linn., Penn., Don. *Coalfish*, *Seithe*, *Sillock*, *Grey-Lord*, *Black-Pollack*, *Rauning Pollack*, Cornwall.

This fish varies considerably in colour according to its age. When young, about three inches in length, it is of a light grey on the back, with the ventral and anal fins minutely spotted with dark brown; when it increases to four inches, it is of a beautiful deep green on the back, with the sides of a lighter tinge, the fins shaded with orange and closely freckled with brown; when it becomes a foot in length the back is dark grey; and as the fish increases in size, the back and sides become darker, and at length assume a deep black, with the belly of a dirty white.

The Coalfish very much resembles the pollack in appearance, particularly when young. It is distinguished from it, however, at all ages, by having the lateral line straight throughout its course, and the middle portion of it when full grown, broad and whitish; whereas the lateral line in the pollack takes a very perceptible bend under the termination of the first dorsal, and never assumes a white appearance. The Coalfish, when from four to five inches in length, from the great resemblance it bears in colour to the Green Cod, has been occasionally confounded with it. The length of the under jaw, however, compared with the upper, will at all times distinguish them.

In all the northern seas and in the Baltic, the Coalfish is said to abound; nor does it appear to lessen materially in number as we proceed southwards, since, on the coast of Cornwall, four men with two boats and lines have been known to capture twenty-four hundredweight in a very few hours. The young of these fish, known by the name of *podleys*, are very common in the Firth of Forth in the months of August and September, when they are sent to market in great numbers. The larger individuals seem to leave the Firth soon after they have spawned, and do not reappear until the following spring. In the Orkneys they are said to form the great support of the poor. They inhabit deep and rocky situations, and are very voracious; they take a baited hook or an artificial fly freely, and afford excellent diversion to the angler.

The growth of these fish in the early part of their existence, appears to be rapid. In the early part of spring the spawn is deposited, and the fry are seen in June about two inches in length; in August they are four inches; in September five, when they are considered a delicious fish for the table; but as they grow older they get coarser, and are less in demand. They are frequently taken the length of three feet.

Merlangus pollachius.*—The Pollack.

Specific Characters.—Under jaw the longest; lateral line curved; caudal fin slightly concave.

Description.—From a specimen two feet ten inches in length. Head about one-fourth of the whole length, caudal included. Depth of the body less than the length of the head. Colour of the back and sides dusky green; belly dirty white; all the fins dusky brown. First dorsal fin commencing in a line over the middle of the pectorals; first two rays simple, the rest branched; the third and fourth the longest, equalling the length of the base of the fin; the remainder of the rays rapidly decreasing in height, the last very short. Second dorsal commencing at a short distance from the termination of the first; first two rays simple and stout; the rest soft and flexible; the third the longest, equalling in length the fifth ray of the first dorsal; the remainder gradually diminishing; the last very short; the sixth about one third the length of the base of the fin. Third dorsal commencing at a short interval from the last, and ending not far from the short lateral rays of the caudal; the fifth ray longest, about half the length of the base of the fin; the rest of the rays gradually decreasing; the last very short; caudal fin slightly concave at the extremity; pectorals pointed; the fourth ray the longest, equalling the length of the base of the third dorsal; ventrals in advance of the base of the pectorals; the longest ray about the length of the eighth ray of the first dorsal. First anal fin commencing in a line under the posterior por-

* *Merlangus pollachius*, Yarr., Flem., Jen. *Gadus Pollachius* Linn., Penn., Don. *Pollack, Whiting, Pollack, Lythe.*

tion of the first dorsal, and terminating rather behind the last ray of the second dorsal; the seventh ray rather the longest; the remainder gradually decreasing. Second anal corresponding to the third dorsal. Teeth small and sharp, placed in one row in the lower jaw, and in three or four rows in the upper jaw, and a few on the vomer; under jaw considerably the longest; maxillary extending back to beneath the anterior margin of the orbit; operculum ending in a strong blunt point. Lateral line curved from its origin to the third or fourth ray of the second dorsal, from thence running straight to the tail; all the fins completely covered with very small elongated scales which are scarcely perceptible except when the fish is in a dried state; scales of the body small and rather deciduous. Number of fin rays—

1st D. 11; 2d D. 19; 3d D. 17; 1st A. 27; 2d A. 17; P. 19; V. 6; C. 30.

The Pollack is distinguished from the whiting and the green cod, by the under jaw projecting beyond the upper. It is known from coalfish in the lateral line not being straight throughout, and in the caudal fin not being forked.

This species of fish, although frequent in the Orkneys and Shetland Isles, and common along the eastern and southern shores of England, is acknowledged to be a rare visitant in the Firth of Forth, where seldom more than half a dozen are taken during the season, and those generally of large size; the young in this neighbourhood are seldom seen. It is found on the west coasts of England and Scotland, and along the shores of Ireland in tolerable numbers, but becomes less frequent as we approach the Northern Seas. The flesh as food is remarkably good, particularly during the winter months, and is considered but little inferior in quality to that of the whiting, being white, solid, and easy of digestion. It spawns in February, after which it remains out of condition till May. The Pollack does not seem choice as to what it feeds on, and is easily taken with a baited line. It inhabits deep and rocky situations, and seldom wanders far from land.

MERLANGUS VIRENS.*—THE GREEN COD.

Specific Characters.—Jaws of equal length; caudal fin deeply forked.

Description.—From a specimen ten inches in length. Head about one-fourth of the whole length, caudal included; depth of the body rather less than the length of the head. Colour of the back and sides of a light glossy green; the belly silvery-white; dorsal, caudal, and anal fins, dusky green, minutely freckled with dark spots; ventrals pure white; sides irregularly marked with a number of small dark blue spots. First dorsal fin of a triangular form commencing in a line over the middle of the pectorals; the fourth ray the longest, equalling the length of the base of the fin, the remaining rays rapidly decreasing, the last very short; second dorsal commencing a little behind the termination of the first, the fourth ray the longest, the rest gradually decreasing, the last very short, scarce perceptible, the sixth about one-third the length of the base of the fin; third dorsal arising at a short interval behind the last, leaving a space between its termination and the caudal fin, the fourth ray the longest, about half the length of the base of the fin, the rest gradually decreasing, the last very small; caudal deeply forked, the middle ray about half the length of the longest ray of the same fin; ventrals small, about half the length of the pectorals; third ray of the pectorals the longest, equalling the length of the base of the third dorsal fin; anal fin commencing under the last rays of the first dorsal, and terminating rather behind the last ray of the second dorsal; seventh ray the longest, about one-third the length of the base of the fin, the remaining rays gradually decreasing, the last very small; second anal corresponding with the third dorsal. Teeth small and sharp in both jaws, and a few on the vomer; jaws of equal length; maxillary extending back to beneath the anterior margin of the orbit; eyes moderate; branchial rays seven. Scales of the body small, deciduous, and finely striated, having somewhat of a granular appearance; caudal fin covered with minute scales of an elongated form; lateral line straight throughout its course. Number of fin rays—

1st D. 12; 2d D. 20; 3d D. 19; P. 15; V. 6; 1st A. 27; 2d A. 19; C. 38.

The Green Cod very much resembles in appearance the young of the coalfish, and has frequently been confounded with it. It is, however, of a much lighter green on the

* *Merlangus virens*, Yarr., Jen., Flem. *Gadus virens*, Linn., Penn.

back, and the jaws are of equal length; in other respects the two fish are very similar. The pollack, when young, is likely to be mistaken for the Green Cod, but the former has the under jaw considerably the longest, and the lateral line taking a gentle curve over the pectorals. This fish does not appear to be so common a species as is generally supposed. It is said to inhabit the coast of Norway, and is found as far south as on the shores of Cornwall. Dr Fleming says "it is frequently taken in the Firth of Forth during the summer;" but of late, it has certainly become, in that locality, a scarce fish, as I have not been able to obtain above half a dozen examples for these last five years, and those were taken with a hook, in the months of July and August, off the pier-head at Newhaven. It feeds on small marine animals, and its flesh is considered rather insipid.

GENUS *MERLUCIUS*.—Dorsal fins two; no barbule at the chin.

MERLUCIUS VULGARIS.*—THE HAKE.

Specific Characters.—Under jaw longest; pectorals dark.

Description.—From a specimen twenty-one inches in length. Head one-fourth the length of the body, caudal fin not included; depth of the body considerably less than the length of the head. Colour of the back and sides dusky brown; belly and anal fin dirty white; dorsal and ventrals dusky; lower portion of the pectorals and caudal nearly black. First dorsal fin of a triangular form, commencing in a line over the base of the pectorals; the first ray simple, nearly as long as the second, the third equalling the length of the base of the fin; the remaining ray rapidly decreasing, the last very short; second dorsal commencing a little behind the termination of the first, running down the back to within a short interval of the short lateral rays of the caudal fin; the first twenty-two rays of equal length, as long as the sixth ray of the first dorsal, the twenty-third to the twenty-seventh rapidly increasing; the remaining rays gradually diminish-

* *Merlucius vulgaris*, Cuv., Yarr., Jen., Flem. *Gadus merlucius*, Penn., Don.

ing, the last very short. Pectorals about the length of the base of the first ten rays of the second dorsal, the fourth, fifth, and sixth rays nearly of equal length, giving a rounded form to the end of the fin ; ventrals about as long as the pectorals, the fifth and sixth rays the longest, the first much shorter than the last ; the base in advance of the pectorals. Anal fin commencing in a line under the third ray of the second dorsal, and terminating rather behind the last ray of the same fin ; the first, second, and third rays gradually increasing in length, the following eighteen about equal height ; the twenty-seventh considerably the longest, the rest gradually diminishing, the last very short. Caudal fin rather shorter than the pectorals, and slightly concave at the end ; gape wide ; maxillary extending back to beneath the middle of the orbit ; under jaw the longest. Teeth long and slender, one row in each jaw with some short ones at the base, a few on the anterior part of the vomer ; operculum triangular, ending in a blunt point over the base of the pectorals. Lateral line taking a slight curve from its origin to beneath the third or fourth ray of the second dorsal, from thence passing straight to the middle ray of the caudal fin. Scales of the body moderate, fifteen in an oblique row between the middle of the second dorsal fin and lateral line ; head covered with small scales as well as the caudal fin. Number of fin rays—

1st D. 10 ; 2d D. 39 ; P. 14 ; V. 7 ; A. 37 ; C. 20. (Mr Yarrell enumerates only twenty-nine rays in the second dorsal, and twenty-one in the anal.)

The Hake is at once easily distinguished from all the British species of this family, by having two dorsal fins and by having *no barbule* on the chin. In Mr Yarrell's work, from an error of the press, this fish is stated to have a barbule on the chin.

The Hake is frequently taken the length of three and sometimes four feet, and is at all times considered a coarse fish. It is said to abound in the Atlantic Ocean, as well as in the Mediterranean Sea. Numbers are taken on the south and west coasts of England, and in the Bay of Galway on the west of Ireland ; but it is seldom met with on the east coast of Scotland. About two years ago, a single specimen was taken in a stake-net, near Musselburgh, and sent to the Edinburgh market, where it appeared to be unknown.

The Hake is stated to be so plentiful on the Nymph Bank, off the coast of Waterford, that six men with hooks and lines have been known to take one thousand in the course of a night, besides a number of other fish. It is a very voracious feeder, and pursues herring, pilchards, and mackerel, with great avidity. It spawns in the early part of spring. Great numbers are sent to Spain in a dried and salted state, but seldom made use of in England, except by the poorer class of inhabitants, who find it a cheap article of food.

GENUS *LOTA*.—Dorsal fins two; a barbule on the chin.

LOTA MOLVA.*—THE LING.

Specific Characters.—Upper jaw longest; body dusky olive.

Description.—From a small specimen fourteen inches in length. Head one-fifth of the whole length, flattened on the summit; depth of the body considerably less than the length of the head. Colour of the back and sides dusky olive; belly silvery-white; first dorsal fin with a large dark spot on the posterior rays; lower portions of the second dorsal and anal fins edged with white, with a dark band beneath; caudal fin barred with black, and margined with white; First dorsal fin short, about one-fifth the length of the second, commencing over the posterior half of the pectorals; the first three rays gradually increasing, the rest of equal height, except the last three, which decrease rapidly. Second dorsal commencing at a short interval from the termination of the first, and ending close to the short lateral rays of the caudal fin; the rays in the three anterior thirds of the fin all of equal length, the succeeding ones gradually increasing; the last eight or nine rapidly decreasing, giving the end of the fin a rounded form. Pectorals and ventrals of equal length, as long as the base of the first dorsal; anal fin commencing under the tenth or eleventh ray of the second dorsal, and terminating in a line under the last ray but four of the same fin, with which it corresponds in form; caudal fin rounded at the end. Jaws armed with a number of small,

* *Lota molva*, Yarr., Jen., Cuv. *Gadus molva*, Penn., Linn. *Molva vulgaris*, Flem. *Asellus longus*, Will.

sharp, irregular teeth, as well as the anterior part of the vomer; under jaw rather the shortest; gape wide; maxillary extending back to beneath the middle of the orbit; operculum of a triangular form, ending in a point behind. The head, body, dorsal, anal, and caudal fins covered with small, elongated, adherent scales; lateral line taking a slight bend from its origin to beneath the commencement of the second dorsal fin, from thence running straight to the end of the tail; chin furnished with a long slender barbule about the length of the dorsal rays. Number of fin rays—

1st D. 15; 2d D. 70; P. 17; V. 6; A. 60; C. 37.

The Ling is a fish well known both in the recent and salted state, and is said to attain to the length of seven feet; but the more ordinary size is from three to four feet. It is common along the English, Irish, and Scottish coasts, and, like the Cod and Hake, forms a considerable article of commerce. Large quantities are annually salted and dried, the greater part of which is exported to Spain. The liver of the Ling produces abundance of oil, which has been used in certain rheumatic affections, with apparent success. In the Firth of Forth, Ling are taken with lines, principally about the Isle of May, where they are found more plentiful than further up the estuary; occasionally small ones are met with near Inchkeith, but scarcely ever above Queensferry. According to Pennant, when a Ling is in season the liver is white, and abounds with fine flavoured oil; but as soon as it is out of season, the liver assumes a reddish appearance, and affords no oil. The same is the case with the Cod and many other fishes, but in a less degree. In June, the Ling sheds its spawn, after which it remains out of condition till August, when it again becomes wholesome food.

GENUS *MOTELLA*.—Dorsal fins two, the first with slender rays, scarcely perceptible; the second long, continuing nearly to the base of the tail; snout with barbules, one on the chin.

MOTELLA VULGARIS.*—THE THREE-BEARDED ROCKLING.

Specific Character.—Snout with two barbules, and one on the chin.

Description.—From a specimen sixteen inches in length. Head about one-fifth of the whole length; depth of the body much less than the length of the head. Colour of the head, back, and sides, yellowish-brown, marked with a few large, irregular, dusky spots; pectoral, dorsal, and caudal fins, brown; belly, ventral, and anal fins, pale dusky-yellow; irides bright yellow. First dorsal fin, about an inch and a half in length, commencing over the base of the pectorals and terminating in a line over the end of the fourth ray of the same fin; the first ray much the longest and stoutest, the rest very fine, scarcely perceptible. Second dorsal arising at a short interval from the termination of the first, and ending close to the short lateral rays of the caudal fin; all the rays nearly of equal height, about half the length of the middle ray of the pectoral fin. Anal commencing in a line under the twelfth or thirteenth ray of the second dorsal, and terminating in a line with the last ray of the same fin; all the rays nearly of equal height, but rather shorter than those of the second dorsal; caudal fin rounded at the end; ventrals in advance of the base of the pectorals; the second ray greatly produced, being as long as the base of the first fifteen rays of the anal; pectorals rather longer than the caudal, the three or four middle rays of equal length, giving a rounded form to the end of the fin. Gape rather wide; under jaw the shortest; maxillary extending back to beneath the posterior margin of the orbit. Teeth numerous, and of irregular length, in both jaws as well as on the front of the vomer; under jaw the shortest, with a long barbule on the chin, and one on each side of the snout in front of the eyes. Scales of the head and body adherent, small, finely striated, and of an oval form; lateral line scarcely perceptible. Number of fin rays—

1st D. 76; 2d D. 57; P. 23; V. 7; A. 50; C. 20.

It is distinguished from the common ling and burbot in the first dorsal fin being scarcely perceptible, and in having a barbule in front of each eye.

* *Motella vulgaris*, Cuv., Yarr. *Motella tricirrata*, Jen. *Mustela marina*, Ray. *Gadus mustela*, Penn. *Gadus tricirratus*, Bloch. *Sea-Loche Whistle-fish.*

This is not an uncommon fish along the Devonshire and Cornish coasts, where it is found to frequent rocky and weedy localities. It has been taken on the west of Scotland, and in Belfast Bay on the coast of Ireland, but is by no means of common occurrence towards the north. It is rare in the Firth of Forth, as well as along the whole of the eastern shores of Scotland. Its flesh is seldom made use of as food. It sheds its spawn in January and February, and feeds principally on crustaceous animals.

MOTELLA QUINQUECIRRATA.*—THE FIVE-BEARDED ROCKLING.

Specific Character.—Snout with four barbules, and one on the chin.

Description.—From a specimen ten inches in length. Head one-sixth of the whole length, caudal excluded; depth of the body under the pectorals greater than the length of the head. Colour of the head, back, and sides, dark brown; belly and ventrals dirty white; pectorals, dorsal, anal, and caudal, dusky brown; irides yellowish. First dorsal fin very inconspicuous, commencing a little anterior to the base of the pectorals, and terminating in a line over the end of the pectoral ray; the first ray about three times as long as the succeeding ones, and about one-third the length of the base of the fin; the rays when folded down become lodged in a sulcus behind the nape. Second dorsal commencing at a short distance from the last, and running down the back to within a short interval of the small lateral caudal rays; all the rays nearly of equal height, as long as the base of the first seven rays of the anal; caudal rounded at the end; pectorals of a similar shape, but rather smaller. Anal commencing in a line under the eleventh ray of the second dorsal, and terminating on a plane with the last ray of the same fin; all the rays nearly of equal height, rather less than those of the second dorsal; ventrals in advance of the pectorals; the second ray much produced, as long as the middle ray of the caudal. Under jaw the shortest; maxillary extending back to beneath the posterior margin of the orbit. Teeth small and blunt, nearly all of equal height, placed in three or four rows in each jaw, as well as on the anterior part of the vomer; snout furnished with four barbules, and one on the chin;

* *Motella quinquecirrata*, Cuv., Yarr. *Motella mustela*, Jen. *Gadus mustela*, Linn., Penn.

gill-opening large; branchial rays seven; operculum small, of a triangular form, ending over the pectorals in a point. Scales on the head, body, and on some portion of the fins, small and adherent; lateral line indistinct. Number of fin rays—

1st D. 50; 2d D. 50; P. 15; V. 7; A. 40; C. 20.

This fish, in a great measure, resembles the last species, and has been stated by some authors to be identical, varying only in the number of barbules on the snout; but, if we compare the fishes together, we shall find them to differ in many respects, entitling them to rank as distinct species.

In the *Three-Bearded Rockling* the teeth are of unequal length and sharp pointed; some of them are of large size, and projecting considerably beyond the rest, particularly in the lower jaw. In the *Five-Bearded Rockling* the teeth are excessively blunt, all of the same size and of equal length. The pectoral fins in the *three-bearded* species are longer than the caudal fin, and the body is marked with a number of large, scattered, dusky spots; whereas in the *five-bearded* species the pectorals are not so long as the caudal, and the body has no spots. The *Three-Bearded Rockling* has about fifty rays in the anal fin, and the snout is never furnished with more than two barbules, and one on the chin. In the *Five-Bearded Rockling*, the anal fin has never more than forty-three rays, and the snout is always furnished with four barbules; besides, this species is seldom found more than a foot in length, and the head is small, compared to the length of the body.

According to Mr Low, the Five-Bearded Rockling is common in the Orkney Islands, where it is found under stones, among sea-weed, but seldom exceeding nine to ten inches in length. Mr Yarrell has found it a very common fish on the Kentish coast in autumn, left by the retiring of the tide in small pools among rocks. It has been taken on the coast of Ireland, and I have found it of frequent occurrence at Brixham, on the coast of Devon, in rocky situations under stones and sea-weed. In the Firth of Forth, about the month of July, this fish is frequently taken with the hook and brought to market, when it is sold in company with young cod, whiting, and podleys; altogether they are said to make a very palatable fry. The Five-Bearded Rockling inhabits hard sandy coasts, as well as rocky places, and feeds on small shells and crustacea. It spawns in January and February, and the young are seen about two inches in length in July.

Genus *BROSMIUS*.—Dorsal fin one, extending the whole length of the back; one barbule on the chin.

Brosmius vulgaris.*—The Torsk.

Specific Characters.—Ventral fins fleshy; caudal margined with white.

Description.—From a specimen twenty inches and a half in length. "The greatest breadth at the end of the pectorals, four inches and a half; at the vent four inches; something more than half-way from the vent to the tail, two inches; at the tail, one inch and a quarter. The length of the head four inches; from the point of the nose to the commencement of the dorsal fin six inches. Length of the dorsal fin thirteen inches; from the point of the lower jaw to the vent eleven inches. Length of the anal fin eight inches; tail something more than two inches. The head small in proportion to the fish, with a single barbule upon the chin; upper jaw a very little longer than the lower; in the jaws there are great numbers of very small teeth, and in the roof of the mouth a rough or toothed bone, much in the shape of a horse-shoe; a pretty broad furrow runs from the nape to the commencement of the dorsal fin, which runs the whole length of the back to within about an inch of the tail; the tail is rounded; the anal fin begins at the vent and ends at the tail; but is not joined with it; the rays of the dorsal and anal fins are numerous, but the softness of these and the thickness of the investing skin, hinder them from being counted with exactness; the edges of the dorsal, anal, and tail, are white, the rest dusky; the pectoral fins

* *Brosmius vulgaris*, Yarr., Cuv. *Gadus brosme*, Penn., Don.

are rounded, broad, and of a brown colour; the ventrals small, thick, and fleshy, ending in points; the body to the vent is roundish; the belly from the throat growing suddenly very prominent, continuing so to the vent, where it becomes smaller to the tail; behind the vent, the body is pretty much compressed; the colour of the head is dusky; the back and sides yellow, which becoming lighter by degrees is lost in the white of the belly; the lateral line is scarcely discernible, but runs nearer the back than to the belly, till towards the middle of the fish; in its passage backwards it curves a little downwards and runs to the tail." Number of fin rays—

"D. 49; P. 21; V. 5; A. 37; C. 35."—*Yarrell.*

It is readily distinguished from its congeners by having but one dorsal fin.

The Torsk is scarcely known on the southern shores, being confined principally to the northern seas. It is said to be occasionally taken in the Firth of Forth, and brought to the Edinburgh market, where the young of the Ling is frequently mistaken for it. Mr Yarrell states it "to be a northern fish, scarcely occurring below 60° or above 73°; not migrating regularly, and therefore rarely seen by the ichthyologists of the South. Plentiful on the coast of Norway as far as Finmark, off the Faroë Islands, and the west and south coasts of Iceland; rare on the north and east coasts of Iceland. It must be uncommon in Greenland, as Fabricius only knew it from the report of the natives. Just touches the most northern point of Denmark, at Skagen in Jutland, where it is sometimes taken: not at all in the south. Approaches the land early in the year in shoals, that of Iceland in January; remains there in company with the five-bearded, and goes away again late in the summer. Lives in deep water, and is therefore seldom taken, even when it is most abundant. Prefers a rocky bottom, on which sea-weeds grow. Never found any thing in its stomach; and this has probably given rise to the saying, that it lives on the juice of sea-weeds. Spawns in April and

May among the *fuci* along the coast. Is rarely taken with the cod-hooks, more frequently at the smaller lines. Sometimes taken by the Norwegian fishermen among the Halibuts. It must have less power of resisting the violence of the sea than its congeners, as it is thrown up dead in incredible numbers on the coasts of the Faroë Islands and the south coast of Iceland after a storm. Its flesh is hard, but well flavoured. In Iceland seldom dried, but eaten fresh. Jan Olsen says, that the fresh flesh is badly tasted, but when dried it is the best food. In Norway it is treated like the Stock-fish, but forms no branch of merchandise. The hard roe, according to Pontoppidan, has good flavour. Its enemies are the larger species of cod. It is much infested by a worm which form a *nidus* in its skin, and produces rounded swellings." It is said to grow occasionally to the length of three feet and a half, the average size being about eighteen inches.

GENUS *RANICEPS.*—Dorsal fins two; the first scarcely perceptible; the second long; one barbule on the chin, none on the snout.

RANICEPS TRIFURCATUS.*—THE TADPOLE-FISH.

Specific Character.—First two ventral rays much produced. (See Plate XXXVI.)

Description.—From a specimen four inches and a half in length. Head large and wide, about one third the length of the body, with the crown much flattened and depressed; anterior part of the body rounded and tumid; hinder part compressed. Colour of the body dark sooty black; lips, angle of the mouth, and under the gill-covers, pure white; second dorsal, caudal, and anal fins, deep black, with the margins of the two former shaded with white. First dorsal fin commencing over the base of the pectorals, composed of three small rays

* *Raniceps trifurcatus*, Yarr., Jen., Flem. *Raniceps Jago*, Flem. *Barbus minor*, Penn. *Batrachoides trifurcatus*, Penn.

the middle of which is the longest, being about half the length of the pectorals. Second dorsal commencing over the middle of the pectorals, and running down the back to within a short interval of the tail. Anal fin begins in a line under the termination of the pectoral rays, and ends at a point not quite so far as that at which the dorsal terminates. Ventrals arise under the throat; the two first rays the longest, and extend a little beyond the origin of the anal fin, of a bluish-white colour; the remainder of the rays about one third the length of the first, of a dull black appearance; caudal and pectorals nearly of equal size and shape, slightly rounded at the extremity; the latter of a sooty-black colour with a broad light-coloured band running across the middle. Scales small and adherent, scarcely perceptible when fresh; air-bladder large; coats of the stomach strong; cæcal appendages wanting. Jaws furnished with a number of small, sharp teeth, with a few long ones projecting beyond the rest, particularly on the lower jaw, and on front of the upper; anterior part of the roof of the mouth also furnished with teeth set close together, and arranged in a lateral direction; four cartilaginous prominences at the commencement of the œsophagus, covered with a number of very small sharp teeth, rendering each rough to the touch; tongue broad, smooth, without teeth; under jaw shortest, with a conical barbule placed on the chin; eyes situated a little in advance of the angle of the mouth, of a pale yellow colour. Lateral line commencing over the pectorals, and after running a straight course half-way down the side, takes a sudden bend, from thence straight to the base of the caudal fin. Number of fin rays—

1st D. 3; 2d D. 67; C. 20; A. 57; P. 17; V. 6.

At the origin of the lateral line, are from nine to ten small tubercles, which are not perceptible when the fish is recently taken; but when the skin is somewhat shrunk by exposure to the sun or open air, these gland-like bodies become very evident. In appearance this animal little resembles any of our British fishes as to shape or colour, and may well be compared, from its form, to a frog in the tadpole state, from which circumstance it appears to have derived the name of "Tadpole fish." It does not appear to be so rare a fish as was formerly imagined. It has been taken on the coast of Cornwall, on the Northumberland and Berwickshire coasts, on the west coast of Scotland, and in the

Firth of Forth in the neighbourhood of Alloa. It feeds on small insects, and sheds its spawn in April.

FAMILY VI. PLEURONECTIDÆ.—Body flat, compressed vertically; back of a dark colour; under surface of a pure white; dorsal fin single, extending the whole length of the back; both eyes placed on the same side of the head. The species keep close to the bottom, having no swimming bladder.

GENUS *PLATESSA*. Both eyes on the right side; dorsal fin commencing over the left eye, and not reaching to the caudal; caudal fin rounded at the end.

PLATESSA VULGARIS.*—THE PLAISE.

Specific Characters.—A row of five or six osseous tubercles on the eye side of the head; scales entire. (See Plate XXXVII.)

Description.—From a small specimen a foot in length. Head rather less than one-fourth of the entire length, caudal included; breadth of the body half its length, fins not included. Colour of the body above brownish, with large distant orange spots; under surface pure white, occasionally mottled. Dorsal fin commencing over the middle of the orbit, and terminating at a short interval from the base of the caudal; the middle rays the longest, more than twice the length of the first. Anal fin arising under the middle of the pectoral, and ending under the last ray of the dorsal; the sixteenth, seventeenth, and eighteenth rays the longest, more than twice the length of the first, the succeeding ones gradually diminishing; the last very short; caudal even or slightly rounded at the end; the middle ray as long as the base of the fifteen first dorsal rays; ventrals as long as the fifth or sixth ray of the anal, and situated in advance of the base of the pectorals; a strong spine placed in front of the anal; pectorals rather longer than the ventrals; snout pointed; body contracted at the base of the tail; under jaw longest, ascending; mouth small; teeth even, closely set and rather obtuse; eyes on the right side, full and prominent, both equally advanced towards the end of the snout;

* *Platessa vulgaris*, Yarr., Jen., Flem. *Pleuronectes platessa*, Linn., Penn., Bloch. *Fluke.*

the intervening space narrow, with an osseous ridge in the middle, which, behind the eyes, becomes interrupted, giving rise to a flexuous row of tubercles five or six in number, from the termination of which the lateral line commences, taking a very slight curve over the pectorals, from thence passing straight to the base of the tail, where it accompanies the under surface of the middle caudal ray. Scales entire, small and adherent, and from being deeply impressed in the cuticle it gives the surface a pitted appearance. Number of fin rays—

D. 70; P. 11; V. 6; A. 50; C. 20; B. 6.

The Plaise is readily distinguished by having a row of osseous tubercles, about five in number, placed on the eye side of the head, running with a gentle curve from the origin of the lateral line to the central ridge of the orbits; a character which none of the other species of this genus possess.

It is a fish well known throughout the British coasts, in consequence of its being held in high estimation for the table. It is said to have been taken on some parts of the English coast the weight of fifteen pounds. During the summer months it inhabits rocky situations, but in February and March it approaches the sandy banks for the purpose of shedding its spawn, when great numbers are taken both with the net and line.

In the month of August the young are seen from two to three inches in length at the mouths of rivers, but seldom found beyond the flow of the tide, although they have been retained with success in fresh-water ponds. They are common in almost every part of the estuary of the Forth, but seldom met with of large size; the small ones are named Flukes and are in their best condition as food in May, particularly when taken on rocky ground, where they meet with various species of crustacea and small fishes on which they principally feed.

PLATESSA FLESUS.*—THE MUD-FLOUNDER.

Specific Characters.—Middle of the back along the course of the lateral line, and at the base of the dorsal and anal fins, rough; sides smooth. (Plate XXXVII.)

Description.—From a specimen eleven inches in length. Head rather less than one-fourth of the entire length; breadth of the body, fins not included, half its length. Colour of the upper surface olivaceous brown; fins rather lighter; under surface white; liable to great variation; occasionally both surfaces are of the same colour; sometimes the back is yellow or yellowish-brown, marked with dark red spots, and frequently with large white spots; the colour depending greatly on the nature of the soil on which the fish reposes; if it frequents muddy situations the back is dark; if sandy places it is more or less red. Dorsal fin commencing over the anterior margin of the orbit, running down the back to within a short interval of the base of the lateral caudal rays, the first ray short, about the length of the diameter of the orbit, the succeeding rays gradually increasing in height to the thirty-fourth, which is the longest, being as long as the base of the eleven first dorsal rays, the rest more rapidly diminishing, the last very small; caudal fin even or very slightly rounded at the end, the middle ray as long as the base of the first thirteen rays of the anal, all the rays branched except the three lateral ones, which are simple and shorter than the rest. Pectorals rounded, the middle ray the longest, about half the length of the head; ventrals placed a little in advance of the pectorals; anal commencing under the middle of the pectorals, and ending in a line under the last ray of the dorsal, the first ray short, the fifteen succeeding ones gradually increasing, from thence gradually diminishing to the last, which is very short, the longest equalling the length of the thirty-fourth ray of the dorsal, a small spine in front of the first ray; snout rather pointed; under jaw longest; mouth small; teeth obtuse, placed in a single row; eyes on the right side of the head equally in advance; operculum terminating in a point over the base of the pectorals. Lateral line taking a slight curve over the pectorals, from thence running straight to the tail, when it accompanies the lower margin of the middle caudal ray; on each side of the anterior portion of the lateral line are a number of small, rounded, stellated tubercles, giving a roughness to that part when the finger is passed along the lateral line; the head and cheeks have also a few tubercles of a similar kind; as well as the base of the dorsal and anal fins; scales of the body small, entire, and very adherent. Number of fin rays—

D. 62; P. 10; V. 6; A. 45; C. 18.

* *Platessa flesus*, Yarr., Jen. *Pleuronectes flesus*, Linn., Penn. *Fresh-water Fluke, Mud-Flounder.*

This species of Flounder is distinguished by the upper surface being perfectly smooth, except the middle of the back along the course of the lateral line, and the base of the dorsal and anal fins, which are rough with small rounded stellated tubercles ; by passing the hand down the back they are readily felt.

The Mud-Flounder, as it is frequently named in Scotland, is rather more common on our coasts than the last-described species, and is found at the mouths of rivers nearly all the year round, up which it sometimes ascends to a considerable distance, particularly when the waters are discoloured and increased in size by heavy rains. In general, it is a dirty feeder, subsisting on slugs, worms, and dead animal matter, and inhabiting muddy situations in preference to fine sandy banks. In the months of July and August these fish are taken in great numbers in the Firth of Forth in the salmon nets, particularly above Queensferry; as well as in Leith Harbour with the hook. They take the bait most eagerly, and require but little skill in their capture. The average size is from seven to nine inches in length, and one of double that is considered uncommon. The largest specimen I have met with taken from the Firth of Forth, measures the length of sixteen inches. Pennant has heard of them weighing six pounds. Those found in the river are said to be held in higher estimation for the table than those met with in the sea, and are at all times inferior in flavour to the other species of flat fish. They spawn in brackish water in March and April, and the young are seen in June scarcely half an inch long. A variety of this fish is often met with, with the eyes on the left side of the head; some authors formerly considered it as a distinct species, under the name of *Pleuronectes passer*, but since it differs in no other respect from the common kind, naturalists are now agreed to make no distinction between them.

Platessa limanda.*—The Saltwater Flounder.

Specific Characters.—Scales ciliated; lateral line much arched over the pectorals; rays of the dorsal and anal fins rough. (Plate XXXVII.)

Description.—From a specimen a foot in length. Head less than one-fifth of the whole length, caudal included; body rather more than twice the length of its breadth, fins excluded. Colour of the upper surface yellowish-brown, sometimes pale yellow; marked with a few obscure orange spots; fins rather lighter; under surface pure white. Dorsal fin commencing over the middle of the left orbit and terminating at a short distance from the caudal rays, the first ray short, less than the diameter of the orbit; the succeeding ones gradually increasing in length to about the fortieth ray; the remainder rather more rapidly diminishing, the last very short. Caudal rounded at the end, the middle ray as long as the base of the first seventeen rays of the dorsal, all branched except the three lateral ones which are shorter than the rest; pectorals more than half the length of the head, the three or four middle rays of equal length. Ventrals small, placed in advance of the base of the pectorals. Anal fin commencing a little beyond the end of the ventral rays, and terminating in a line under the last ray of the dorsal, the twenty-third or twenty-fourth ray the longest, the rest gradually diminishing. Both eyes placed on the right side of the head, the under of which is rather in advance; mouth small; under jaw longest. Teeth obtuse, placed in one row in each jaw; lateral line taking a high curve over the pectorals, from thence passing straight to the end of the middle caudal ray. Scales of the body more than twice the size of those in the last-described species, ciliated at the free margin, rendering a roughness to the surface when the hand is passed from tail to head; each ray in the dorsal and anal fins is accompanied by a series of ciliated scales running along the anterior margin; these scales are more perceptible on the middle rays, and are frequently wanting in the lateral ones; the caudal rays are furnished with a row of scales on each side, but not ciliated, causing the fin to feel perfectly smooth; no scales on the pectorals or ventrals except a few at the base of the first and second ray; a sharp, stout, reclining spine immediately at the commencement of the anal fin. Number of fin rays—

D. 75; P. 11; V. 6; A. 57; C. 16.

* *Platessa limanda*, Yarr., Jen. *Pleuronectes limanda*, Bloch, Penn. Don., Linn. *Common Dab, Saltwater Fluke.*

The essential characters are: lateral line much arched over the pectorals; dorsal and anal fins rough to the touch; pectoral, ventral, and caudal fins, smooth; back rough when the hand is passed from tail to head. Head, lateral line, and base of the dorsal and anal fins, without tubercles.

This species of flat fish is found to frequent most of the sandy banks throughout the British coasts, but is not of so common occurrence as either the Plaise or Mud-Flounder. There are few fish of the kind which surpass it in flavour, particularly when taken in the months of February and March, and it even rivals the sole in delicacy. In the Firth of Forth numbers are caught with long lines baited with mussels, and they are frequently found with other flounders entangled in the salmon-nets at Musselburgh and Queensferry. They delight in shallow water in preference to the deep, and are seldom seen in rocky situations, or at the mouths of fresh-water rivers. They spawn in the months of April and May, and are then, and for two months afterwards, of little value for the table, the flesh being at that period soft, and ill flavoured. Crustacea and small fishes appear to be their principal food. I obtained a specimen of fifteen inches in length in Edinburgh in the month of March; one of eight or nine inches is considered the average size.

Platessa microcephalus.*—The Smooth Dab.

Specific Characters.—Upper surface smooth; head without tubercles; teeth deficient on the eye side; jaws equal. (Plate XXXVIII.)

Description.—From a large specimen eighteen inches in length. Head small, about one-sixth of the whole length, caudal included; breadth of the body less than half its length. Colour of the upper surface yellowish-brown mottled with brown of a darker shade; margin of the gill-cover orange-yellow; belly pure white. Dorsal fin

* *Platessa microcephalus*, Flem., Yarr. *Pleuronectes lævis*, Penn. *Pleuronectes microcephalus*, Donn. *Lemon Dab*, *Smear Dab*, *Sandfleuk*, *Mary-sole*, *Town Dab*.

commencing over the anterior part of the orbit, and ending near the caudal rays; the first ray short, about the length of the orbit; the succeeding thirty gradually increasing in height, the next thirty-four about equal, the rest gradually decreasing, the last very short and fine, the middle rays rather longer than half the length of the head. Caudal rounded at the end, the middle ray equalling the length of the head; ventrals small, placed in advance of the base of the pectorals the middle ray as long as the base of the five first rays of the dorsal. Anal commencing nearly under the base of the pectorals, and terminating under the last ray of the dorsal; the twelve first rays gradually increasing in height the following thirty of nearly equal length, the rest gradually decreasing, the last very short, the middle rays as long as the base of the first ten. Pectorals about half the length of the head; lateral line slightly curved over the pectorals, from thence running straight to the *end* of the middle caudal ray. Lips thick and fleshy; jaws of equal length; teeth obtuse, set close together in one row; the first two on the lower jaw a little apart from the rest; on the eye side of the jaws the teeth are deficient; mouth small; lower orbit very slightly in advance of the upper. Scales distinct, oval, entire. Number of fin rays—

D. 87; P. 11; V. 5; A. 73; C. 17.

This fish is readily distinguished from the rest of the species in the same genus, in having both jaws of equal length; in the teeth extending but a very little more than half-way round the mouth, and in the teeth being deficient on the eye side.

The Smooth Dab is not by any means a common fish in the Firth of Forth; it makes its appearance mostly in the spring months, and is taken on the sandy banks off Fifeshire, as well as on the opposite coast, with lines baited with soft mollusca. Two or three seasons sometimes pass when not half a dozen of these fish are seen in the Edinburgh market. In the year 1835 they were unusually plentiful, particularly in the month of February; but after March they are scarcely ever met with. They shed their spawn some time during April, after which they retire to rocky ground, where they generally remain until the commencement of the following year. The Smooth Dab, as an article of food, is considered by some persons to be of little or no value, in consequence of its possessing a strong, disagreeable, tarry flavour; by others again, no flat fish is said to surpass it in excellence, the flesh being firm and well-tasted. These opposite opinions may be easily accounted for when we consider that the quality of the fish depends solely on the period of the year in which it is caught. In December, January, and February, the Smooth Dab is in good season for the table; but in April, May, and June, it is found to be of very inferior quality, and on some occasions has been proved unwholesome. It feeds on small shell-fish and crustacea. I have also met with this species occasionally on the Devonshire coast; it is said to be rare in Cornwall.

Platessa limandoides.*—The Long Rough Dab.

Specific Characters.—Rays of the pectoral and caudal fins rough; lateral line nearly straight. (Plate XXXVIII.)

Description.—From a specimen eleven inches in length. Head one-fifth of the whole length, caudal included; breadth of the body nearly one third of its length, fins not included. Colour of the upper surface pale brownish-grey; under surface pure white. Dorsal fin commencing over the anterior part of the left orbit, and terminating at a short distance from the caudal fin; the first ray short; the forty succeeding ones gradually increasing; the following ten about equal height; the remainder gradually diminishing; the last small, rather shorter and finer than the first. Anal commencing a little behind the base of the pectorals and terminating under the last ray of the dorsal, in form similar to the dorsal; the middle rays equalling the length of the pectorals; caudal somewhat angular at the end; the middle ray as long as the base of the first fourteen rays of the anal, all branched except the three lateral ones, which are much the shortest. Ventrals in advance of the base of the pectorals; the middle ray which is the longest reaching to the anal spine. Pectorals less

* *Platessa limandoides*, Yarr., Jen. *Pleuronectes limandoides*, Shaw, Bloch. *Sandsucker*, *Long Fleuk*, *Sand Fleuk*.

than half the length of the head, and as long as the base of the nine first dorsal rays. Mouth large; under jaw longest; teeth long and slender, and very sharp, placed a little apart from each other, and in one row in each jaw. Eyes large, the upper rather in advance; an elevated bony ridge between; lateral line broad and distinct, taking a very slight turn over the pectoral fin, from thence running straight to the end of the middle caudal ray. Scales of the body large, ciliated and very deciduous; those on the rays of the fins, smaller and more adherent. Number of fin rays—

D. 85; P. 10; V. 6; A. 69; C. 17.

The Long Rough Dab in some measure resembles the salt-water Flounder, in having the back rough, and the dorsal and anal rays furnished with a row of ciliated scales; but it differs from it, however, in being a narrower fish, and in having the lateral line nearly straight; the caudal, pectoral, and ventral rays rough; the mouth large, and the teeth long and sharp: whereas in the salt-water flounder, the lateral line is much bent over the pectorals; the caudal, pectoral, and ventral rays smooth; the mouth rather small, and the teeth blunt.

In the Edinburgh market this fish receives the name of Sandsucker, from an erroneous idea entertained by the fishermen in supposing it to feed on nothing but sand; for, on opening the stomach, it appears filled with small, granular, sand-like particles, which seem to be the broken fragments of some species of *Asterias*.

This fish I first recorded as British, in the Edinburgh New Philosophical Journal for July 1835, from specimens taken in the Firth of Forth. I have since met with it on the Berwick and Devonshire coasts. It frequents sandy shores, and is taken by the hook in company with the plaise and other kinds of flat fish, principally in the months of May, June, and July, when several may be found daily in the Edinburgh market. Its flesh is sweet and good, but rather dry. The largest specimen I have met with measures fifteen inches in length. Dr Clarke of Ipswich was the first naturalist to notice the Long Rough Dab as occurring in the Firth of Forth, from whence he obtained several specimens in the summer of 1834. According to Mr Yarrell, a specimen was seen by Dr John Harwood on the Sussex coast in 1833.

PLATESSA POLA.*—THE POLE-DAB.

Specific Characters.—Head without tubercles; scales large, not ciliated; under jaw longest. (See Plate XXXVIII.)

Description.—From a large specimen nineteen inches and a half in length. Head small, one-fifth of the length, as far as half-way down the caudal rays; breadth of the body, fins included, exactly half the length of the whole fish. Colour of the upper surface, yellowish-brown; under surface pure white. Dorsal fin commencing over the middle of the left eye, and ending at a short distance from the base of the caudal rays; the first ray short, about half the length of the orbit, the twenty-five succeeding ones gradually increasing in height, the forty following rays of equal length, as long as the base of the first ten, the remainder gradually decreasing, the last very short and fine. Ventrals rather small, placed in advance of the base of the pectorals; the middle ray the longest, equalling the length of the thirteenth ray of the dorsal. Anal commencing nearly under the base of the pectorals, and terminating in a line with the last ray of the dorsal; the first ray very short, the ten succeeding ones rapidly increasing, the forty following of equal height, as long as the middle rays of the dorsal, the remainder gradually diminishing, the last very small. Caudal rounded or somewhat angular at the end, the middle ray as long as the base of the first sixteen rays of the anal; pectorals pointed, rather more than half the length of the head. Mouth small; under jaw longest; teeth obtuse, small, set close together, in one row in each jaw, all of equal height. Eyes large, the lower one placed very conspicuously in advance of the upper; lateral line nearly straight throughout its course, bent very slightly over the pectorals. Scales on the body large, entire, and very deciduous; those on the fins small and adherent. Number of fin rays—

D. 103; P. 9; V. 6; A. 91; C. 20.

The Pole Dab is distinguished from the plaise in having no tubercles on the head, and the scales of the body being

* *Platessa pola*, Yarr., Jen., Cuv. *Pleuronectes pola*, Lacepede. *Pole, Craig Fluke, French Sole.*

large and deciduous; it is distinguished from the mud-flounder, in the middle of the back and base of the dorsal and anal fins being perfectly smooth and free from tubercles; from the salt-water flounder, in the scales not being ciliated, the dorsal and anal rays being smooth, and the lateral line over the pectorals nearly straight; from the smooth dab, in having the under jaw longest, and the teeth extending the whole way round and not being deficient on the eye side; from the long rough dab, in having all the rays of the fins perfectly smooth, and the mouth small.

This fish was first recorded as new to the British Fauna, in the Edinburgh New Philosophical Journal for 1835. The only locality then known for it was the Firth of Forth. Mr Yarrell, however, had obtained a specimen in Bond Street in 1833, but on what coast it was taken does not appear to be known. In 1836 I met with three examples at Brixham, on the coast of Devon, where they were taken in the trawl-net with other fishes. In the Firth of Forth, since the time I first discovered it, I have obtained fifteen specimens, from the largest of which the above description was taken. According to Baron Cuvier, this fish is not unfrequently taken along the coast of France, where it is held in high estimation as food. The flesh of those taken in the Firth of Forth was considered equal, if not superior, to that of the sole. They shed their spawn in May and June, when they are found in sandy situations, and are then taken with lines. In the winter months they inhabit rocky ground, and feed on different kinds of crustacea. In the stomachs of those examined were found the remains of small crabs and star-fish.

GENUS *HIPPOGLOSSUS*.—Both eyes on the right side; dorsal fin commencing over the left eye; caudal fin concave at the end.

HIPPOGLOSSUS VULGARIS.*—THE HALIBUT.

Specific Characters.—Lateral line arched over the pectorals; teeth in two rows in the upper jaw.

Description.—From a specimen twenty-one inches in length, and ten and a half in breadth, fins included. Head about one-fourth of the whole length. Colour of the upper surface dusky brown, occasionally marked with six or eight large white or bluish spots; under surface pure white. Dorsal fin commencing over the anterior part of the left eye, and ending at a wide interval from the base of the caudal rays; the first twenty-four rays nearly of equal height, about half the length of the orbit; the succeeding fifteen rapidly increasing, the longest rays equalling the length of the base of the first ten rays, the remainder gradually diminishing, the last very short. Caudal concave; the middle ray considerably less than the length of the long lateral rays; pectorals as long as the base of the first twelve rays of the anal; the fourth ray the longest, all branched except the two first; ventrals placed in advance of the pectorals, the middle ray as long as the seventh of the anal. Anal fin commencing in a line under the twenty-fifth ray of the dorsal, and ending under the last ray of the same fin, the first ray short, the seventeen succeeding ones rapidly increasing, the remainder gradually diminishing, the last very short; the longest rays equalling those of the dorsal. Gape wide; under jaw longest; teeth long and sharp, set a little apart, placed in two rows in the upper jaw, and in one in the lower. The left eye, smallest; lateral line much arched over the pectorals, from thence running straight to the end of the middle caudal ray; scales small, of an oblong form, rather adherent. Number of fin rays—

D. 97; P. 15; V. 6; A. 73; C. 18.

This fish is readily distinguished from all the other flat fish by the caudal fin being concave at the end.

The Halibut is a native of the Northern Seas, where specimens of large size, weighing nearly five hundred pounds, are said to have been occasionally taken. It is frequently met with along the east coast of Scotland, but seems to be rare, or entirely unknown, on the south coast of England. A fine specimen was taken off the Isle of Man in April

* *Hippoglossus vulgaris*, Yarr., Jen., Cuv. *Pleuronectes hippoglossis*, Linn., Penn., Don.

1828, and sent to the Edinburgh market. It measured seven feet six inches in length, three feet six inches in breadth, and weighed three hundred and twenty pounds. It seems most voracious, and subsists principally on crustacea and small fish. Pennant states that two instances occurred in one year of its swallowing the lead weight at the end of a line with which the seamen were sounding; one off Flamborough Head, the other going into Tynemouth Haven. In the latter instance the fish was taken, in the former it disengaged itself. The Halibut, in the Firth of Forth, inhabits deep and rocky places, and is frequently taken of large size near Inchkeith, and in the neighbourhood of the Bass. In the months of July and August, specimens are caught about a foot and a half in length, and sold in the Edinburgh market at the rate of fourpence a pound, where they are named Halibut-Turbot, and are frequently disposed of as turbot. The large individuals are considered coarse and dry eating; the part which adheres to the side fin is esteemed the best, and by some is regarded as a very delicious morsel. They spawn in spring.

GENUS *RHOMBUS*.—Both eyes on the left side, dorsal fin commencing in front of the right eye.

RHOMBUS MAXIMUS.*—THE TURBOT.

Specific Character.—Upper surface of the body with prominent osseous tubercles.

Description.—From a specimen fifteen inches in length. Breadth, fins included, eleven inches; head one-third of the length of the body, caudal not included; body of a rhomboidal form approaching to round. Colour of the upper surface yellowish-brown, mottled

* *Rhombus maximus*, Cuv., Yarr. *Pleuronectes maximus*, Penn., Jen., Flem. *Rawn Fluke, Bannock Fluke.*

and spotted with dark brown; under surface pure white; occasionally of a dark appearance, and instances have occurred in which both surfaces were of the same colour. Dorsal fin commencing anterior to the right eye, between it and the upper lip; the first ray short, about the length of the orbit, the thirty-six succeeding ones gradually increasing, the rest gradually diminishing, the last ray about the length of the first, the longest ray equalling the length of the base of the first nine rays of the same fin. Anal fin arising in advance of the base of the pectorals, and ending under the last ray of the dorsal, being separated from the caudal fin by a short interval; origin of the pectorals placed under the nineteenth ray of the dorsal, the fourth and fifth rays rather the longest, equalling the length of the base of the first eight rays of the dorsal. First ray of the anal short, the succeeding seventeen gradually increasing, the remainder gradually diminishing, the last rather shorter than the first, the longest ray, as long as the base of the first eight rays of the same fin. Base of the ventrals long, placed in a line under the cheeks, the rays gradually increasing from the first; the fin in form and size is similar to the anterior portion of the dorsal as far as the ninth ray. Under jaw longest; teeth small and sharp, set a little apart, arranged in several rows, particularly in the front of each jaw; eyes rather small, the under one rather in advance of the upper; lateral line much arched over the pectorals, after which it passes straight to the base of the tail, from thence along the under margin of the middle caudal ray; caudal fin rounded at the end, the middle ray equalling the length of the base of the first eleven rays of the anal. Both sides of the body smooth, excepting being furnished with prominent osseous tubercles having their blunt points directing forwards; on the upper surface, they are more numerous than on the lower; head and cheeks rough, with tubercles of a similar kind, but smaller, more numerous and set close together, particularly between the eyes and along the margin of the preoperculum; body apparently without scales, marked with a number of irregular depressed lines, particularly on the under surface. Number of fin rays—

D. 66; P. 11; V. 6; A. 48; C. 15.

The Turbot is seldom met with in Orkney and still rarer towards the Shetland Isles. Along the east coast of Scotland, in the bays of the Moray and Dornoch Firth, they are occasionally taken but of small size, and do not appear in any numbers until we approach the English coast. At the mouth of the Firth of Forth, they are found more plentiful, and specimens weighing from twenty to thirty pounds are not unfrequently taken, from whence the Edinburgh market is abundantly supplied. On the Yorkshire coast an extensive Turbot fishery is carried on, principally with the hook, when lines of three miles in length are used. Each line which is placed across the current and allowed to remain for six hours and then hauled up, has more than two thousand hooks. The bait generally used is the sand-eel, but portions of other fish will answer as well, provided they be fresh. On the coast of Devon, turbot are taken in trawl-nets; but not in any numbers, until they leave the rocky parts, and approach the sandy ground to deposit their spawn. This they shed in spring. The flesh of the turbot is the most esteemed as food of all the Pleuronectidæ, and meets with a ready market at a high price. When fresh it is wholesome, but if eaten when in the slightest tainted, there are few stomachs with which it is found to agree, being liable to create nausea and sickness, and that sometimes to an alarming extent. It is in best condition for the table when in roe. The most common weight of this fish is from five to ten pounds. It is recorded to have been taken the weight of one hundred and ninety pounds, measuring six feet across.

Rhombus vulgaris.*—The Brill.

Specific Characters.—Body smooth, without tubercles; scales distinct, entire, not ciliated.

Description.—From a specimen fifteen inches in length; breadth, fins included, ten inches. Head about one-fourth of the whole length; form much resembling that of the turbot, but rather more oval. Colour of the upper surface dark brown, with numerous white and dusky spots; under surface pure white. Dorsal fin commencing in front of the right eye, between it and the upper lip, and terminating at a short interval from the base of the caudal rays; the

* *Rhombus vulgaris*, Yarr., Cuv. *Pleuronectes rhombus*, Jen., Don., Penn. *Pearl, Brett, Kite, Bonnet-Fluke.*

first ray short, the succeeding ones as far as about half-way down the back, gradually increasing; the rest gradually diminishing, the longest ray equalling the base of the first nine rays of the same fin. Anal commencing in advance of the base of the pectorals, and ending in a line under the last ray of the dorsal, the first ray short, the succeeding ones gradually increasing to about half-way down the fin; the remainder gradually diminishing, the last about the length of the first, the longest rays equalling the length of the same rays of the dorsal. Caudal rounded at the end, all the rays branched except the two or three lateral ones; ventrals situated in a line under the preoperculum, appearing like a continuation of the anal; a small space intervening, in which is placed the vent; pectorals arising in a line under the twentieth ray of the dorsal, the third and fourth rays the longest, equalling the longest ray of the anal. Under jaw longest, ascending obliquely; teeth small and sharp, placed in many rows in front; gape wide; maxillary extending back to beneath the middle of the eye; eyes small, the lower placed rather in advance of the upper. Lateral line forming a considerable arch over the pectorals, after which it runs straight to the base of the tail, from thence along the under margin of the middle caudal ray; body smooth without tubercles; scales small and distinct. Number of fin rays—

D. 81; P. 11; V. 6; A. 63; C. 16.

This fish, inferior to the turbot in excellence as well as in size, is seldom found weighing more than ten pounds. On the Cornish and Devonshire coasts it is common, where it is known by the name of Kite, but becomes less frequent as we advance towards the northern shores. In the Firth of Forth it is taken with the hook principally about Aberlady Bay, but scarcely ever found as high up the Firth as Queensferry. It is of much less frequent occurrence than the turbot. It feeds on crustacea and small fish, and spawns in spring.

Rhombus hirtus.*—Muller's Topknot.

Specific Characters.—Upper surface of the body, rough; scales ciliated; first ray of the dorsal not longer than the second.

* *Rhombus hirtus*, Yarr. *Pleuronectes hirtus*, Mull., Jen. *Pleuronectes punctatus*, Penn. *Black Fluke.*

Description.—From a specimen eight inches in length; breadth, fins included, five inches. Head more than one-fourth of the whole length. Colour of the upper surface of the body reddish-brown mottled and spotted with very dark brown or black; a broad black band extending vertically across the head; commencing about the base of the twentieth ray of the dorsal, passing down through both eyes, and ending under the lower portion of the preoperculum; under surface white. Dorsal fin arising between the right eye and upper lip, and ending at the base of the caudal, but not connected to it, a few of the rays passing underneath the tail; the first ray short, the succeeding sixty gradually increasing in height, the rest more rapidly decreasing, the longest rays equalling the base of the first twelve rays of the same fin, all the rays branched except a few of the first and last; caudal fin small; rounded at the end, the middle ray about the length of the longest rays of the dorsal. Ventrals commencing in a line under the left eye; appearing like a continuation of the anal, to which it is slightly connected. Anal arising under the preoperculum, answering to the dorsal and terminating in the same manner under the base of the tail. Pectorals about half the length of the head, all the rays branched except the first, the third and fourth longest. Lateral line taking a strong curve over the pectorals, after which it passes straight to the middle caudal ray; under jaw longest ascending obliquely to meet the upper; teeth small and fine, placed in many rows in front, and a few on the vomer forming a dense cluster; gape rather wide, maxillary very oblique; orbits round, the lower one rather in advance of the upper; basal and posterior margins of the preoperculum meeting at a very obtuse angle; operculum terminating in a blunt point over the base of the pectorals; upper surface of the body very rough, presenting a velvet-like appearance; scales ciliated, small, adherent, with their free margins directing outwards, extending along the rays of the fins, as well as on the cheeks, eye-lids, and jaws. Number of fin rays—

D. 93; P. 11; V. 6; A. 74; C. 14.

This species has been for a long time confounded by naturalists with the *Rhombus punctatus* or Bloch's Topknot, which it, at first sight, very much resembles; but, when closely compared, thereis found a wide difference between them. Mr Yarrell was the first to point out the error in which ichthyologists had previously laboured, and has given an excellent figure of both species in the second volume of his British Fishes. Muller's Topknot is distinguished from Bloch's Topknot, in the under surface of the body being perfectly smooth, and in the first ray of the dorsal fin not being longer than the second; whereas, in the latter species, the under surface is rough, with ciliated scales, and the first ray of the dorsal fin is about three times as long as the second ray.

There is no other species with which the present one could well be mistaken, in consequence of its very singular and striking appearance. In the Edinburgh market it receives the name of the *Little Black Hairy Fluke*, and is very rarely seen except during stormy weather. It has been taken several times on the English coast, and, according to Mr Yarrell, once on the coast of the county of Down in Ireland. It inhabits deep and rocky ground, and seldom takes a bait. Those which have fallen under my observation were taken in the Firth of Forth, in crab-cages, generally near Inchkeith, but not beyond Inchcolme. They feed on small shells and star-fish. Their flesh is soft, and insipid to the taste.

GENUS *SOLEA*.—Both eyes on the right side; dorsal fin commencing over the upper lip, and reaching to the caudal.

SOLEA VULGARIS.—THE SOLE.

Specific Characters.—Upper side of the body dark brown; pectoral tipped with black; greatest breadth not half the length.

Description.—From a specimen thirteen inches and a half in length. Breadth, fins included, six inches. Head about one-seventh of the whole length. Colour of the back dark brown; under surface pure white. Dorsal fin commencing over the upper lip, running down the back, to be connected with the caudal rays; the middle rays rather the longest, equalling the length of the base of the four first rays of the same fin. Caudal small, rounded at the end; all the rays branched, except two or three of the short lateral ones; pectorals small, about as long as the middle rays of the dorsal; ventrals placed in advance of the pectorals, appearing as if a continuation of the anal, but separated from it by a deep notch, in which is placed the vent. Anal commencing in a line under the base of the pectorals, answering to the dorsal, and terminating nearly in the same line; snout obtuse and rounded. Mouth rather small, irregular; jaws nearly of equal length; teeth very small and fine, placed in many rows in front; on the eye-side they are entirely wanting; gill-cover rounded; eyes small, the left rather in advance; the right, situated nearly over the angle of the mouth; left side of the head, furnished with numerous white cirri; scales small and adherent, finely ciliated at their free margins, rendering the whole back rough to the touch when the hand is passed from tail to head; lateral line straight throughout its course, excepting at the commencement, where it takes a high curve under the seventh or eighth ray of the dorsal. Number of fin rays—

D. 80; P. 8; V. 5; A. 67; C. 18.

There are few marine fishes better known than the Common Sole, which is universally esteemed as a delicate, wholesome, and well-flavoured article of food, especially when in season. It is found to inhabit the Baltic, the whole of the Scotch and English shores, and as far southwards as the Mediterranean. It frequents sandy ground, where it feeds on small shells and crustacea, and possessing no swimming-bladder it keeps close to the bottom. At the mouth of the Firth of Forth, soles are taken with the net, but in sparing numbers, falling far short of the demand required in the Edinburgh market. A solitary specimen is occasionally found on lines set for haddocks, and then generally of large size; one of twenty-two inches in length was caught a short time since near the Bass, the skin of which is now preserved, being the largest example that had been seen in that neighbourhood for many years; yet on the south coast of England they have been taken considerably larger; one of twenty-six inches long, and eleven inches and a half wide, and weighing nine pounds, is recorded to have been seen at Totness in 1826. Along the Devonshire coast these fish are taken in great abundance, particularly off Brixham and Torbay, where trawl-nets are principally used, and the numbers thus captured are found sufficient to supply the different markets within a distance of fifty miles. Soles have been found to live and thrive well in fresh-water ponds, and to grow thicker in proportion than those at sea. They shed their spawn in March, when they remain unfit for the table till the end of May, after which they increase in quality with the advance of the season. Those about a foot in length are considered better food than the larger ones. The dried skin of the Sole is much used for fining coffee, and is, for that purpose, a good substitute for isinglass.

FAMILY VII. DISCOBOLI.—Eyes placed one on each side of the head; ventral fins united in a disk-like form; skin without scales.

GENUS *CYCLOPTERUS*.—Body deep; rough with osseous tubercles.

CYCLOPTERUS LUMPUS.*—THE LUMP-FISH.

Specific Characters.—Back elevated, with a row of large, conical, osseous tubercles, arranged along the summit, in front of the dorsal fin.

Description.—From a female specimen nineteen inches in length; greatest depth ten inches. Colour of the back dusky blue; belly yellowish-white, approaching to red; dorsal and caudal dusky; irides pale yellow. Body remarkably deep and thick; back elevated, and rather compressed, more so towards the dorsal ridge, along which, in front of the dorsal fin, is placed a row of conical, osseous tubercles, slightly granulated, about seven or eight in number. Dorsal fin commencing very remote from the head; the first and second

* *Cyclopterus lumpus*, Cuv., Yarr., Jen., Penn., Don., Flem. *Lump-sucker*, *Sea-owl*, *Hen Padle* (female), *Cock Padle* (male).

rays simple, the rest branched, the fourth the longest, equalling the length of the base of the fin, the last about half the length of the third. Caudal fin rounded at the end, the middle ray as long as the fourth ray of the dorsal, all branched except the two first on each side; base of the pectorals very broad, passing downwards and forwards beneath the throat, where it partly conceals the disk of the ventrals; the first ray longest, equalling the length of the base of the anal fin, the rest gradually diminishing, the last very short; anal fin commencing under the fourth ray of the dorsal and ending at a distance of half the length of the fin from the caudal; in other respects it answers to the dorsal; ventrals united, forming together a circular disk, with a funnel-shaped cavity in the middle, placed immediately under the base of the pectorals; the rays of the dorsal, caudal, anal, and pectoral fins, furnished with a number of small, rough, osseous tubercles, diminishing in size as they approach the summits. Mouth broad; under jaw rather the longest; teeth small and fine, placed in three or four rows in front of each jaw; eyes situated behind the angle of the mouth, and in a line with the upper corner of the operculum; gill-opening extending half-way down the base of the pectorals; skin covered with a number of granulated, osseous tubercles of various sizes, giving a roughness to the surface when the hand is passed in either direction. Immediately over the eye a row of large tubercles commences, which runs down the sides to the base of the caudal fin; over the base of the pectorals another row commences, which terminates at the same point as the first; on the side of the abdomen a third row is placed, which does not extend beyond the commencement of the anal fin. A little in front of the dorsal fin, across the back, is placed a deep, ragged looking notch; in a vertical line under which is situated the vent. Number of fin rays—
D. 10; P. 20; A. 10; C. 11.

The male fish is much smaller than the female, and when in spawning condition, the whole under surface is of a bright red, particularly the ventral disk to which the fishermen give the name of *the Rose*, in consequence of a supposed resemblance to that flower. In the northern seas the Lump-Fish is said to be a very common species, when, in the months of April and May, considerable numbers are taken and made use of as food. It is sometimes, in this country, eaten in the salted state; but, by the Greenlanders, it is held in higher estimation when perfectly fresh. They also eat its roe after having reduced it, by boiling, to a pulp. It is a fish well known along most of the British shores; but is found less frequent towards the south. On the west coast of Scotland, sometimes as many as two dozen are taken in the salmon-nets at almost every tide, principally in the month of June, when they seek the sandy ground to deposit their spawn. The fishermen boil them down with vegetables for their pigs, and consider them to be fattening food. The flesh when cooked, is soft and very rich, and is considered by some of the inhabitants of Edinburgh as a luxury; but there are few stomachs with which it agrees, in consequence of its oily nature. The males are considered the best for the table.

The Lump Fish or Padle, as it is named in Scotland, is often taken in the Firth of Forth in the salmon-nets at Musselburgh and Queensferry, generally about the month of June, and entirely disappears after the month of August. It seldom takes a bait; its food consists of marine worms and small fish, and as its intestinal canal is longer than that of most other fishes, it is well calculated to sustain hunger for a considerable time. In the winter season it conceals itself under rocks, or attached to their base by means of its ventral disk, with which it adheres with considerable force. Pennant, on throwing one of these fishes into a pail of water, found it adhered so firmly to the bottom, that on taking it by the tail the whole vessel was lifted, though it held some gallons. From its being a heavy inactive fish, and possessing but few or no means of defence, it readily becomes the prey of seals, squali, and other voracious inhabitants of the sea.

GENUS *LIPARIS*. Body rather elongated, smooth, without tubercles.

LIPARIS VULGARIS.*—THE SEA-SNAIL.

Specific Character.—Dorsal and anal fins connected with the caudal.

Description.—From a specimen five inches in length; greatest depth one inch and a quarter; head not quite one-fifth of the whole length. Colour of the body pale yellowish-brown, mottled and spotted with dark brown; belly dirty white. Dorsal fin commencing in a line over the middle of the pectorals, running down the back to be connected with the caudal rays; the first ray very short; the succeeding rays gradually increasing in height to about a little more than half-way down the fin; the rest of the rays very gradually diminishing, the last two or three rather more rapidly; the longest rays equalling the length of the base of the first seven rays of the anal. Pectorals very broad, extending downwards and forward under the throat; the first twelve or thirteen rays nearly of equal length, as long as the middle ray of the caudal; the rest gradually diminishing as far as the last but six, which are very much produced. Anal commencing in a line under the seventh ray of the dorsal, and running down to be united to the caudal, a little farther back than the termination of the last dorsal ray; ventrals united, forming a concave disk, placed under the throat between the termination of the pectorals; caudal rounded at the end. Jaws about equal; teeth small and closely set, arranged in two or three rows in front of each jaw; eyes small, placed rather behind the angle of the mouth; operculum ending in a small point directed backwards over the base of the pectoral; body covered with an unctuous, thin, loose, skin, without scales or tubercles of any description; gill-opening very small, entirely closed in front of the base of the pectorals. Number of fin rays—
D. 36; P. 34; A. 28; C. 12; Cæca 16.

This fish is occasionally taken in the Forth above Alloa, in nets used for the capturing of spirlings; but does not appear by any means common. A few examples have also been found in the cruives at Kincardine along with other small fishes. According to Mr Low, it is found in Orkney, in many places under stones, but more particular-

* *Liparis vulgaris*, Yarr., Cuv. *Cyclopterus liparis*, Linn., Penn., Don., Jen. *Unctuous sucker*.

ly at the point of the Ness at Stromness, where they may be picked up by dozens. It has been observed as far north as Greenland, as well as on the southern shores of England. It sheds its spawn in February, and feeds on small shells and marine insects. It is chiefly used as bait for other fishes.

This species very much resembles the *L. Montagui*, with which it is likely to be confounded, but in the latter species the dorsal and anal fins are unconnected with the caudal.

III.—APODES.

Ventral fins wanting.

FAMILY VIII. ANGUILLIDÆ. Body very much elongated, eel-shaped ; scales scarcely apparent.

GENUS *ANGUILLA*. Dorsal commencing considerably behind the pectorals, and forming with the anal a caudal ; lower jaw longest.

ANGUILLA ACUTIROSTRIS.*—THE SHARP-NOSED EEL.

Specific Characters.—Snout sharp ; gape extending to beneath the middle of the eye ; the distance before the dorsal about one-third of the entire length.

Description.—From a specimen thirty inches in length. From the point of the snout to the base of the pectorals, about one-ninth of the whole length, and one-third as far as the origin of the dorsal. Colour of the back as far as a little below the lateral line, dark olive ; belly yellowish-white ; pectorals dark. Snout sharp, compressed at the sides. Teeth small and closely set, placed in one row on the sides of each jaw, and in many rows in front ; under jaw longest ;

* *Anguilla acutirostris*, Yarr., Jen. *Muræna anguilla*, Linn., Penn. *Anguilla vulgaris*, Flem.

angle of the mouth extending back to beneath the middle of the eye; pectorals rounded; all the rays finely branched. Dorsal fin commencing at about one-third of the whole length from the snout, and running down the back to form, with the assistance of the anal, the caudal fin; the terminating rays rather the longest. Anal fin commencing a little in front of the middle, and answering to the dorsal; a number of mucous pores about the head and sides; gill-opening small, placed in front of the lower half of the base of the pectoral fin; scales small, scarcely perceptible; skin soft and very slimy, marked with a number of capillary lines arranged in threes, giving an appearance as if the skin had been finely plaited; lateral line straight throughout its course; ventral fins wanting.

There is a variety of Eel frequently met with, known by the name of Silver Eel, with the back of a light colour, the sides of a silvery lustre and subtranslucent, and the pectorals nearly black; in other respects it answers to the above description of the common Sharp-nosed species. Eels are said not to exist in the Arctic Regions. They abound, however, in many of the European rivers, and are caught in immense numbers in Holland as well as in the rivers emptying themselves into the Baltic, and form a considerable article of trade. They frequent nearly the whole of the rivers and lakes throughout Britain, and are found more or less numerous in almost every part of the world. In all the large towns in England they are much sought after as an article of food, and by some are held in high estimation, particularly when cooked by potting or stewing them; but, on account of the large proportion of oil which they contain, are extremely unwholesome, and apt to create severe indigestion, and alimentary disturbance from their use. In Scotland, the Eel is seldom or never eaten, under an erroneous impression of its not being a true fish, but a kind of water-serpent, and so a prejudice is excited against it.

This fish inhabits both the river and sea, and, in the month of April, deposits its spawn in the brackish waters.

In June, the young are seen from two to three inches in length, making their way up the fresh-water rivers in innumerable multitudes, keeping a few inches below the surface, and at a short distance from the bank. No obstacle appears to arrest their progress. They have been known to climb up posts, and to ascend into trees, and from thence let themselves drop down into the adjoining stream. They have also been observed crawling over land from one pond to another, and Albernus tells us, that he has known them to collect together under a hay-rick, to keep themselves warm, yet all perished through excess of cold. In November, December, and January, if the season be mild, Eels redescend the rivers in their passage to the sea, and are then taken in great numbers in cages and other snares set for that purpose; but if the weather be cold, and the water low and clear, they are found to bury themselves under the surface of the mud, frequently at a depth of from four to six inches, and there remain during the frost. After a heavy fall of rain, so as to discolour the water and increase the size of the rivers, these fish leave their hiding places and range about in search of food; this they do with greater eagerness during the night than by day. They feed on worms, insects, and carcasses, and it is a common occurrence to find in the abdomen of a dead cat or dog, which has remained under water for a week or more, several pounds of Eels.

A most extravagant idea was entertained amongst the ancients, as regards the generation of eels. Aristotle believed that they sprang from the mud; Pliny that the scrapings of their bodies which they left on rocks, were animated and became young eels; other ancients supposed that they sprang from grass, horse-hair, and carcasses of animals; Helmont believed that they came from May-dew; Rondelet says they couple after the manner of serpents, and that they are viviparous. But it has been now sufficiently proved by Mr Yarrell that the generation of these fishes is effected in the ordinary course of nature, and that they are oviparous.

Eels are said sometimes to attain to the length of six feet three inches. They are very abundant in the Firth of Forth, as well as in every river and streamlet which enter it.

ANGUILLA LATIROSTRIS.*—THE BROAD-NOSED EEL.

Specific Characters.—Snout broad and rounded; gape extending to beneath the posterior part of the orbit; the distance before the dorsal, more than one-third of the entire length.

Description.—From a specimen three feet in length. The distance from the point of the snout to the base of the pectorals, about one-seventh of the entire length. Colour of the back of a dark olive; belly yellowish-white; pectorals dusky green (the whole fish is liable to great variation as to colour). Dorsal fin commencing, at a distance from the point of the snout, of rather more than one-third of the whole length of the fish, and ending by uniting with the caudal; the terminating rays rather the longest. Anal fin commencing close behind the vent, and answering to the dorsal; caudal formed by the continuation of the dorsal and anal; pectorals rounded, the middle ray equalling the length of the gape; gill-opening small, situated in front of the lower portion of the base of the pectorals. Head rather flattened; jaws broad and rounded; the lower one the longest; teeth small, closely set, placed in many rows in each jaw. Lateral line not very apparent; a few mucous pores about the head and throat, and over the pectorals; scales very small and adherent, deeply imbedded in the skin; the whole surface of the body covered with a thick mucous secretion; ventral fins wanting. Number of fin rays—
P. 17; D., A., and C. 480.

In the Firth of Forth, the Broad-nosed Eel is less frequently met with than the Sharp-nosed species, but in other respects their habits appear similar.

* *Anguilla latirostris*, Yarr., Jen.

GENUS *CONGER*.—Dorsal fin commencing over the end of the pectorals; and forming with the anal a pointed caudal; lower jaw not projecting beyond the upper.

CONGER VULGARIS.*—THE CONGER-EEL.

Specific Character.—Dorsal and anal fins margined with black.

Description.—From a specimen twenty-one inches in length. Colour of the back and sides a pale yellowish-grey; dorsal and anal fins margined with deep black, which is very conspicuously seen in young specimens; lateral line spotted with white, frequently very obscure. Dorsal fin commencing immediately over the end of the pectorals, all the rays short, nearly of equal length throughout, except where they terminate to unite with the anal, to form the acute pointed caudal. Anal fin commencing close behind the vent, in a line under the seventieth ray of the dorsal, and answering in other respects to that fin; ventrals wanting; pectorals rounded, the middle ray about the length of the lower jaw, as far as the angle of the mouth. Eyes large; head depressed; snout narrow towards the extremity; lips fleshy; lower jaw rather the shortest; gape wide; angle of the mouth in a line under the posterior margin of the iris; teeth blunt, irregular, small, and numerous, placed in one or two rows on the sides of each jaw, and in many rows in front, especially on the upper jaw, when the teeth are rather longer and larger; those on the vomer extending but a short way back. Lateral line straight throughout its course, from the point of the upper jaw to the base of the pectorals, about one-seventh of the whole length of the fish; skin thick and firm, covered with a mucous secretion; gill-opening small, situated in front of the lower part of the base of the pectorals. Number of fin rays—

P. 17; D., A., and C. 546. "Vert. 152."

The Conger is a common fish on many of the rocky parts of the British coast. It is found in the Shetland and Orkney Isles, and along the east and western shores of Scotland, but in no great plenty. It abounds on the coast of Cornwall, where "it is not uncommon for a boat with three men to bring on shore from five hundredweight to two tons," the fishing being performed during the night. "They are

* *Conger vulgaris*, Yarr., Cuv. *Muræna Conger*, Linn., Penn., Don. *Anguilla Conger*, Jen.

taken principally with long lines, called by the fishermen bulters; each line is about five hundred feet long, with sixty hooks placed eight feet apart from each other, baited with pilchards or sand-eels, and not unfrequently such a number of bulters are fastened together as to reach a mile in length." Congers are extremely voracious, preying on all kinds of small fish, as well as shells and dead animal matter. A fine specimen was taken in the month of November 1834, at a short distance below Alloa, and sent to the Edinburgh market, where, on opening its stomach, sixty-eight spirlings were found in a perfectly fresh state; they were consequently exposed for sale, and soon obtained a purchaser. The Conger is remarkably tenacious of life, and will live several hours out of water. The fishermen in Cornwall are aware of this; and are said to be in the habit of striking the fish on the abdomen, which proves an effectual mode of causing instantaneous death. The Firth of Forth is an excellent nursery for the Conger, in consequence of the rich feeding ground between Alloa and Stirling, where, in the months of July and August, the young are frequently taken with the hook from one to five pounds in weight. Specimens have been taken occasionally in the Firth weighing seventy pounds; they are said to grow to the length of ten feet, and to acquire a weight of one hundred and thirty pounds. These fish spawn in December and January; and are frequently brought to the Edinburgh market, where one of four feet in length will fetch a price of from a shilling to eighteen pence; the flesh is considered good, but in general rather dry. A young conger-eel from one to two feet in length, is distinguished from the common eel in the dorsal fin commencing over the end of the pectorals; in the under jaw not projecting beyond the upper jaw; in the caudal being acutely pointed; in the dorsal and anal fins being margined with black; and in the end of the pectoral rays being half-way between the point of the snout and the commencement of the anal fin; none of which characters are possessed by the common eel.

GENUS *AMMODYTES.*—Dorsal and anal fins separated from the caudal by a short space; caudal fin forked.

AMMODYTES TOBIANUS.*—THE SAND-EEL.

Specific Character.—Dorsal fin commencing in a line over the extremities of the pectorals.

Description.—From a specimen eleven inches in length. Head, measuring from the point of the under jaw to the posterior extremity of the operculum, one-fifth of the whole length, caudal excluded; body elongated, somewhat of a square form, with the angles rounded, nearly of equal thickness throughout. Colour of the back dusky green; sides and belly silvery-white. Dorsal fin commencing in a line over the end of the pectoral rays, and running down the back to within a short interval of the caudal rays; all the rays simple, and nearly of equal length throughout, being about half the length of the pectorals. Anal fin commencing immediately under the twenty-ninth ray of the dorsal, and ending a little before the caudal, all the rays simple, answering to the dorsal. Caudal fin deeply forked, the middle ray about half the length of the longest ray of the same fin; pectorals pointed; ventrals wanting. Snout sharp; gape wide; under jaw projecting considerably beyond the upper, and ending in a strong point; maxillaries long; pedicels of the intermaxillaries very short; upper jaw turns up at its extremity when the jaws are widely expanded, causing the maxillaries to become vertical; vomer with one long tooth directed forwards and downwards, and bifurcated at its extremity; eyes small; orbits round, situated rather nearer the point of the under jaw than to the posterior margin of the gill-cover; suboperculum large, marked with a number of diverging striæ, terminating in a rounded point, directed over the base of the pectorals; gill-opening large; body covered with small scales; lateral line taking its origin behind the head, and running close under the base of the dorsal fin; throughout its whole course down the back, along the middle of each side a second line is visible taking a course parallel to the former. Number of fin rays—

D. 58; P. 12; A. 31; C. 18.

* *Ammodytes tobianus*, Yarr., Jen. *Horner, Wide-mouthed Launce.*

This species is found in many situations along the east and west coasts of Scotland; it has been taken on the Berwickshire coast, on the coasts of Yorkshire and Suffolk, and as far south as on the shores of Devon and Cornwall. It is seldom or never observed to frequent rocky places, or where the ground is hard and stony, but is found almost invariably on fine sandy banks where it conceals itself by burrowing under the surface, at a depth of from four to six inches. It is generally considered a rare fish on most of the British coasts, compared with the *A. lancea*, the next species to be described. It is, however, not unfrequently met with in the Firth of Forth, more particularly in the sands at Musselburgh and Portobello, where numbers are raked out from under the sand, after the ebbing of the tide. In Edinburgh they receive the name of *horners*, and are brought to market in August, and sold by the dozen. The flesh is wholesome and palatable; they shed their spawn in September. Specimens are occasionally met with measuring fourteen inches in length.

AMMODYTES LANCEA.*—THE SAND-LAUNCE.

Specific Character.—Dorsal fin commencing in a line over the middle of the pectorals.

Description.—From a specimen six inches in length. Head one-fifth of the entire length, caudal not included; body elongated, approaching to square, with the angles rounded, nearly of equal thickness throughout. Colour of the back and upper part of the sides dusky green; belly silvery-white; caudal of an olive tinge. Dorsal fin commencing over the middle of the pectorals, or frequently over the lower third, and terminating at a short distance from the caudal; all the rays simple, and nearly of equal height, about half the length of the long caudal rays. Anal fin arising immediately under the twenty-ninth ray of the dorsal, and ending in a line with the las ray of the same fin; all the rays simple, the anterior ones, excep

* *Ammodytes lancea*, Yarr., Jen. *Ammodytes tobianus*, Penn., Flem *Sand-Eel*, *Riggle*, *Small-mouthed Launce*.

the first two, rather the longest; caudal fin forked, the middle ray rather longer than the longest ray of the same fin; the lobes rounded; all the rays finely branched, except the short lateral ones, which are simple; pectorals pointed; ventrals wanting. Head long and narrow; snout conical; gape small; under jaw longest when the jaws are closed; mouth protractile; maxillaries short; pedicels of the intermaxillaries rather long; when the mouth is widely opened, the end of the upper jaw does not turn up as is observed under similar circumstances in the last-described species, but projects forwards and slightly downwards; one tooth on the vomer bifurcated at its extremity; no perceptible teeth on the jaws; eyes round, situated nearer the point of the snout than to the end of the gill-covers; suboperculum large, beautifully marked with diverging striæ, terminating in a rounded point, directed over the base of the pectorals; lateral line commencing behind the head and running parallel with, and immediately beneath, the base of the dorsal fin; below it, about half-way down the side, is observed another line taking a similar course; scales small and adherent, arranged in oblique lines. Number of fin rays—

D. 54; P. 13; A. 26; C. 16.

Two species of Sand-Eels, inhabiting our British coasts, have been for a long time confounded, under the name of *Ammodytes tobianus*, but which appear now to be clearly understood;—M. Lesauvage of Caen being the first naturalist to point out the characters in which the two species differ. The *A. lancea* is distinguished from *A. tobianus* in seldom exceeding the length of six inches, in the dorsal fin commencing over the middle, or last quarter of the pectorals; in the upper jaw not turning up when the mouth is widely opened; in the maxillaries being short and the pedicels rather long. Whereas in *A. tobianus* the length frequently exceeds thirteen inches; the dorsal commences over the extremities of the pectorals; when the mouth is widely opened, the end of the upper jaw turns up very conspicuously; the maxillaries are very long, and the pedicels very short.

The *Ammodytes lancea* has been observed in the Orkney

Isles by Mr Low, who records it as being a common fish, and constantly used as bait for other fishes. It is excessively common on the shores of Scotland, as well as on the east, west, and south coasts of England; it also occurs along the coast of Ireland, and, according to Mr Lukis, on the authority of Mr Yarrell, both species are met with at Guernsey. It, like the *A. tobianus,* inhabits sandy ground, and conceals itself under the surface. These fish are much sought after by fishermen, who put much value on them as bait; and on the south coast of Devon they are taken in such numbers with a net, that "they are usually sold to Dieppe fishermen for twenty pence the bushel." They are very plentiful in the summer months in the Firth of Forth, especially on the sands above Queensferry, where the *A. tobianus* is never found. At Musselburgh and Portobello the two species inhabit the same locality. They are caught after the recess of the tide in the wet sand, by scraping away the surface with a rake or a stout stick, when they are observed twisting about with the greatest activity, and will, if not soon taken up, conceal themselves again beneath the sand. I have seen these fish swimming about in large shoals, but they refused to take a bait of any description. Their food is said to be marine worms and very small fishes. They frequently appear in the Edinburgh market during the summer months, and are sold by the measure. On the south coast of England they are salted and dried for winter use. The period of their spawning has been differently stated by different authors; I have not myself been able to detect ova in them sufficiently advanced to form an opinion as to the period of their deposition.

ORDER III.—OSTEODERMI.

Operculum large; branchial opening very small; body mailed with transverse angular plates; snout much produced; one dorsal with simple, slender rays.

GENUS *SYNGNATHUS*.—Body slender; snout prolonged into a tube, with the mouth placed at the extremity; gill-opening towards the nape.

SYNGNATHUS ACUS.*—THE GREAT PIPE-FISH.

Specific Characters.—Pectoral fins present; crown of the head carinated.

Description.—From a specimen fourteen inches and a half in length; head measuring from the point of the snout, to the posterior extremity of the operculum, about one-eighth of the entire length; body anteriorly heptangular; at the caudal extremity quadrangular. Colour of the back yellowish-brown, with sixteen dark broad patches, half an inch in breadth, placed a quarter of an inch from each other; belly pale yellow. Upper surface of the back flat, with a ridge on each side, commencing at the gill-opening, over the base of the pectorals, and running down as far as the last ray but four of the dorsal fin where it terminates; immediately behind the pectoral fin a second ridge takes its origin and runs parallel with the one on the back, as far as in a line under the fifth or sixth ray of the dorsal, where it becomes abruptly lost; under the pectoral a third ridge commences, which passes down the whole length of the body, and ends at the base of the caudal fin; on the under surface of the belly a fourth ridge is observed, which begins under the throat and terminates at the vent; a little above the end of the second ridge, and in a line under the third ray of the dorsal fin, another ridge commences, and terminates at the base of the tail. Crown of the head very conspicuously carinated, by a ridge commencing at the nape, passing over the head and becoming lost between the eyes; eyes rather large, orbits rising above into a sharp granulated ridge, forming a depression

* *Syngnathus acus*, Linn., Yarr., Jen., Penn. *Tangle-Fish*, Scotland, a name so given by the fishermen, in consequence of its being found under seaweed, which they call tangle.

between; on the anterior part of each eye is placed a small spine directed laterally. Snout produced about half the width of the head; mouth very small placed quite at the extremity; lower jaw shortest, ascending to meet the upper; teeth wanting; a small granulated ridge on the upper part of the snout, extending from the middle of the upper lip, to between the eyes, where it is joined by another small granulated ridge passing down from the summit of the cranium; on each side of this latter ridge, in another which terminates at the upper and posterior margin of the orbit; operculum large; very much resembling a mussel-shell in form, marked with granulated and diverging striæ; gill-opening small, situated in a line over the posterior margin of the operculum. Body mailed with about sixty-three osseous plates, beautifully striated. Dorsal fin situated immediately before the middle of the back, all the rays soft and simple; the middle ones rather the longest; the base of the fin equalling the length of the head, snout included; the last ray placed half-way between the tip of the nose and the end of the caudal rays; vent in a line under the sixth dorsal ray, and immediately before the anal fin, which is very small and scarcely visible, consisting of only three short, simple rays. In the *male* there is a long longitudinal slit extending from behind the vent, to nearly half-way down towards the tail; caudal and pectoral fins rather small, and rounded at the end; ventrals wanting. Number of fin rays—

D. 43; P. 12; A. 3; C. 12.

This species of Pipe-fish is not unfrequently met with in the Firth of Forth, where it is found lurking under sea-weed in shallow water. It is occasionally taken on the Portobello sands, in shrimping nets, but in warm weather it keeps farther from land. We are informed by Mr Yarrell, that the male differs from the female, in the belly from the vent to the tail fin being much broader, and in having, for about two-thirds of its length, two soft flaps, which fold together and form a false belly. They breed in summer; the females casting their roe into the false belly of the males. Early in the summer, roe is found in those without a false belly, but never any in those with it; but later in the summer no ova are found in the females, but in the false belly of the males only. They begin to breed when only four or five inches in length. Mr Yarrell has ascertained that the males of *Syngnathus acus* carry their living young in the anal pouch, even after they have been hatched there. He has been frequently told by fishermen that on opening them, they had found the living young within the pouch, which they called the belly, and that when these young were shaken out into the water over the side of the boat, they did not swim away, but when the parent fish was held in the water in a favourable position, the young would again re-enter the pouch.

The Great Pipe-fish I have also found on the coast of Berwick, on the Devonshire coast, and on the shores of the Solway; it feeds on small mollusca, minute crustacea, and the ova of other fishes. It is of little or no value either as bait or food.

SYNGNATHUS TYPHLE.*—THE DEEP-NOSED PIPE-FISH.

Specific Characters.—Pectoral fins present; head not carinated, or raised above the level of the back.

Description.—From a specimen ten inches in length; head measuring from the point of the snout to the posterior extremity of the operculum about one-sixth of the entire length; body anteriorly heptangular; quadrangular at the caudal extremity. Colour of the back and sides, greenish-yellow; belly pale yellow. Back flat, with a ridge on both sides, commencing at the gill-opening, and terminating at the last ray but six of the dorsal fin; behind the pectoral fin commences a second ridge which runs down the side as far as in a line under the fourth dorsal ray; at the lower extremity of the base of the pectoral arises a third ridge which runs down the whole length of the body, to the base of the caudal fin; under the throat a fourth ridge takes its origin, and, after running down the mesial line of the abdomen, terminates at the vent; immediately under the third ray of the dorsal, and above the termination of the second ridge, commences another ridge, which, after taking an oblique course for a short distance, towards the last ray of the dorsal, passes straight to

* *Syngnathus typhle*, Linn., Yarr., Jen., Don. *Short Pipe-fish, Lesser Pipe-fish.*

the caudal fin; summit of the head not carinated or raised above the level of the back; eyes rather small, the space between flat; a small obtuse tubercle in front of each eye, from which extends a narrow line to the point of the upper jaw; extremity of the snout as deep as the head; under jaw shortest, ascending obliquely to meet the upper; the lower margin rounded. Gill-opening small, situated above the upper and posterior border of the operculum; gill-covers large, finely granulated and striated, approximating under the throat; teeth not perceptible; snout compressed, especially towards the extremity, where it takes a slight turn up. Body protected by fifty-three osseous plates, beautifully marked with fine striated lines. Dorsal fin situated rather nearer the tip of the tail than to the point of the snout; the middle rays rather the longest; the base of the fin as long as from the tip of the lower jaw to the posterior margin of the orbit; caudal fin twice the length of the pectorals; the middle ray about twice the length of the two first lateral rays; when expanded it presents at the end an angular form. Vent placed in a line under the third ray of the dorsal, and immediately in front of the anal fin, which is excessively minute, composed of only three rays; ventrals wanting. In the male there is a long longitudinal slit or pouch, extending a considerable way down the body, and commencing close behind the vent. Number of fin rays—

D. 36; P. 13; A. 3; C. 9.

Some naturalists have very erroneously considered *S. typhle* and *S. acus* as mere varieties of the same fish. In *S. typhle* the twelfth ray of the dorsal fin is situated exactly in the middle of the fish; the head is not raised above the level of the back; between the eyes, perfectly flat; the upper margins of the orbits not in the slightest degree raised; the pectorals not half the length of the caudal; base of the dorsal fin considerably less than the length of the head; the caudal fin angular at the end; the body with but fifty-three osseous shields. Whereas in *S. acus* the last ray of the dorsal fin is in the middle of the fish; the head very much raised over the gill-covers; between the eyes a deep depression, formed by the upper margins of the orbits being much raised; pectorals about the length of the caudal; base of the dorsal fin equalling the length of the head;

the caudal rounded at the end; and the body with sixty-three osseous shields.

The Deep-nosed Pipe-Fish is rather rare in the Firth of Forth, although a place apparently favourable for its habits. It frequents water from three to four feet deep, where the bottom is of a sandy nature and covered with the smaller kinds of *fuci*, among which it prowls about in search of minute aquatic insects. I have taken them in pools, at North Berwick, left by the receding of the tide, but further up the Firth they seem but little known. It is a common fish on the east coast of England, as well as along the shores of Devonshire and Cornwall. At Brixham in the month of September, I saw as many as four dozen taken at one haul of a net, and I was informed at the same time by the fishermen, that in the earlier part of the season they would sometimes enclose five times that number; which being of no service, are invariably returned again to the sea.

Syngnathus æquoreus.*—The Æquoreal Pipe-Fish.

Specific Characters.—Pectoral fins wanting; caudal obsolete; dorsal and vent nearly in the middle of the entire length.

Description.—" Length from twenty to twenty-four inches, readily distinguished from both the foregoing species by the want of the pectoral and anal fins. Form slender and very much elongated; body compressed, with an acute dorsal and abdominal ridge, also with three slight ridges on each side, hence the trunk from the gills to the vent is octangular; the tail is obsoletely quadrangular, becoming almost round towards the tip, which is extremely tapering; transverse shields or plates, between the gills and the vent, twenty-eight in number; from the vent to the extremity of the tail, sixty or more, but, from the extreme minuteness of the last few not admitting of being counted with exactness; head not more than one-twelfth of the entire length, without any elevated ridge on the occiput; snout narrower than the head, similar in shape to that of *S. acus*, but much shorter in relation to the entire length of the fish; dorsal occupying

* *Syngnathus æquoreus*, Auctorum.

nearly a middle position in the entire length, the distance from the last ray to the end of the tail, at the same time, a little exceeding that from the end of the snout to the commencement of the fin; vent a very little before the middle, being nearly in a vertical line with the commencement of the last quarter of the dorsal fin; tail compressed at the extremity, shewing a very small rudimentary caudal fin; the rays, however, so obsolete, and so much enveloped in the common skin, as to be scarcely distinguishable. (*Colours*) Yellowish, with transverse pale lines, with dark margins, one in each joint, and another down the middle of each plate, giving it the appearance of possessing double the number of joints it really has; these markings, however, cease, just beyond the vent." Number of fin rays—

"D about 40; A. 0; C. 0? P. 0." Jenyns.

This fish was first recorded as British by Sir Robert Sibbald, who obtained a specimen in the Firth of Forth prior to the year 1685. No other instance of its occurrence in that locality has since been noticed. It has been procured in Berwick Bay by Dr Johnstone, on the Devonshire coast by Colonel Montagu, and on that of Cornwall by Mr Couch. It is one of the rarest of our British Fishes.

SYNGNATHUS OPHIDION.*—THE SNAKE PIPE-FISH.

Specific Characters—Pectoral fins wanting; caudal obsolete; dorsal and vent before the middle of the entire length.

Description.—From a specimen fifteen inches in length; head one-eleventh of the entire length; body elongated and slender; back nearly flat; abdominal ridge acute, also with three slight ridges on each side; hence the trunk from the gill to the vent is heptangular, and of a uniform thickness, behind the vent the body tapers, and is somewhat quadrangular, becoming quite round near the extremity of the tail, the tip of which is compressed into a very minute rudimentary caudal fin. Colour of the back and side yellowish-brown, with transverse pale lines with dark margins, one in each joint, and another down the middle of each plate, giving it the appearance of possessing double the number of joints it really has, precisely similar to the markings of the *Æquoreal Pipe-Fish* as described by Montagu; these markings cease behind the termination of the dorsal fin, nor do not pass completely round the trunk, but become lost on

* *Syngnathus ophidion*, Auctorum.

each side of the abdominal ridge; they are indistinctly seen on the back, those on the sides being very conspicuous; belly pale yellow. First ridge commencing immediately over the gill-opening, and running down the side of the back, where it becomes gradually lost as it approaches the extremity of the tail; second ridge commencing at the posterior margin of the operculum; and takes a course down the side as far as the vent, where it suddenly bends, after which it passes down towards the end of the tail where it, like the first, becomes lost; third ridge takes its origin at a little below the commencement of the second ridge, and, after running parallel with it as far as under the middle of the dorsal fin, disappears at the side of the anal aperture; the fourth or abdominal ridge is more prominent than the rest, it commences under the throat, and is lost at the anterior part of the vent. The transverse plates of the trunk, between the gills and the vent, twenty-eight in number; from the vent to the extremity of the tail, sixty-one (about the same number as is observed in the *Æquoreal Pipe-Fish*). Dorsal fin commencing considerably before the middle of the entire length; all the rays simple, the middle ones rather the longest, giving the fin somewhat of a rounded form; the base much longer than the length of the head, being as long as from the point of the snout to the middle of the third shield of the trunk; the last ray situated exactly in the middle of the whole fish; vent placed immediately in a line under the twenty-eighth ray of the dorsal. Occiput on the same level as the back, gradually sloping in front as far as to the anterior part of the orbits, from thence to the tip the snout becomes slightly sinuous; under jaw shortest, ascending obliquely to meet the upper; chin rounded; tip of the snout about the depth of the diameter of the orbit; mouth very small, placed at the extremity; jaws without teeth; gill-cover in form very much resembling a small mussel-shell, closed on all sides by a continuous membrane, except on each side of the nape, where there is a small gill-opening; eyes placed half-way between the tip of the jaws and the origin of the second plate of the trunk. Number of fin rays—

D. 43; C. 7; P. and V. wanting.

The only examples of this fish I have seen, were taken in the Firth of Forth at North Berwick, in the month of July, when two specimens were found under sea-weed in a small pool of water which had been left on the recess of the tide. Their stomachs were filled with a minute species of shrimp, and apparently eggs of crustacea. Mr Yarrell has found this species of Pipe-Fish not uncommon at the mouth of Pool Harbour, in company with *S. acus* and *S. typhle.* It has also been found on the coast of Devon, and, although a rare fish, it seems better known than the last-described species, with which it has occasionally been confounded. The best distinguishable character is in the position of the dorsal fin. Mr Yarrell states, that "in this species, as well as the two others belonging to this second division," *S. æquoreus* and *S. lumbriciformis*, "neither male nor female possesses an anal pouch, but the ova, after exclusion from the abdomen of the female, are carried for a time by the male in separate hemispheric depressions on the external surface of the abdomen, anterior to the anus. The females have no such depressions." The *S. lumbriciformis* has been taken by Dr Johnston in Berwick Bay, but has not been noticed as occurring in the Firth of Forth; from its small size it is very liable to be overlooked.

ORDER IV.—GYMNODONTES.

Opercule and rays concealed beneath the skin; branchial opening small; snout not produced; true teeth wanting.

Genus *ORTHAGORISCUS.*—Jaws undivided; body very much compressed, short, truncated behind; rough, but without spines; not capable of inflation; dorsal and anal fins uniting with the caudal.

Orthagoriscus mola.*—The Short Sun-Fish.

Specific Characters.—Depth about two-thirds of the length; skin rough.

* *Orthagoriscus mola*, Yarr., Cuv., Jen. *Tetradon mola*, Penn.

Description.—" From three to four feet in length. Form oblong, approaching orbicular, truncated behind ; sides very much compressed, the dorsal and ventral lines presenting a sharp edge ; depth behind the pectorals about two-thirds of the entire length ; thickness rather more than one-third of the depth. Head not distinguishable from the trunk ; mouth small ; jaws exposed ; the lamellated substance undivided ; eyes moderate, about equidistant from the corner of the mouth and the branchial aperture, which last is of an oval form, and situated immediately before the pectoral fin. Skin destitute of scales, but everywhere very rough with minute granulations ; no lateral line ; dorsal placed at the further extremity of the body, short, but very much elevated, its height equalling two-thirds or more of the depth of the body, terminating upwards in a point ; rays very much branched ; anal opposite, and exactly similar, to the dorsal ; caudal, with the posterior margin slightly rounded, very short, but its depth (or breadth, measured vertically), nearly equalling that of the body, extending from the dorsal to the anal, with both of which fins it is connected ; pectorals small, rounded, attached horizontally ; ventrals wanting. Number of fin rays" (*Jenyns*)—
" D. 17 ; A. 16 ; C. 14 ; P. 13."—*Bloch.*

The Short Sun-Fish is not of unfrequent occurrence on the British coast ; it has been observed several times on the coast of Scotland, and on the English coast as far south as on the shores of Cornwall. Colonel Montagu mentions one that was caught at Salcombe, in July 1799, that weighed three hundred pounds. They have been known to weigh as much as four hundred or five hundred pounds.

Mr Couch says " the Short Sun-Fish is migratory, keeping probably at the bottom, and feeding on sea-weeds in its ordinary habits ; but in calm weather it mounts to the surface, and lies, perhaps asleep, with its head, and even its eyes, above the water, floating with the tide." Seven or eight examples have occurred in the Firth of Forth. Dr Neill says " a specimen was brought to him by the fishermen, who informed him that when they observed it, it was swimming along sideways, with its back fin frequently above water. It seemed to be a stupid, dull fish ; it made little or no attempt to escape, but allowed one of the sailors to put his hands under it, and lift it fairly into the boat." The flesh is not made use of as food, but yields a large quantity of oil.

SUB-CLASS II.—PISCES CARTILAGINEI.

Bones cartilaginous; cranium divided by indistinct sutures; branchiæ generally fixed; membrane without rays; maxillary and intermaxillary bones either wanting or rudimentary; the palatines, or vomer alone, supplying their place.

ORDER I.—ELEUTHEROPOMI.

Branchiæ free, with one large external aperture on each side, furnished with a strong opercule; upper jaw formed by the palatine bone, firmly united to the maxillary; intermaxillary rudimentary.

GENUS *ACIPENSER*.—Body elongated, mailed, as well as the head, with osseous tubercles, arranged in longitudinal rows; mouth placed beneath, very protractile, small, without teeth; nostrils and eyes lateral; four pendent barbules on the under surface of the snout.

ACIPENSER STURIO.*—THE SHARP-NOSED STURGEON.

Specific Characters.—Osseous tubercles in five longitudinal rows; snout pointed.

Description.—From a specimen five feet in length. Body elongated, tapering from the head to the base of the tail, approaching in

* *Acipenser sturio*, Auctorum.

form to pentagonal, covered with a number of large osseous plates arranged in five longitudinal rows; the first row commences at the nape, and runs down the back; the central plates the largest and more elevated than the rest; the second row arises over the posterior margin of the operculum, and runs down the side as far as the end of the tail; the third row runs from the pectoral down the side of the abdomen; rows similar to the two last are also observed on the opposite side of the trunk; each dorsal plate has a broad base, with a sharp elevated keel, terminating in a point directed backwards; the sixth, seventh, and eighth plate, more raised than those preceding; the base of each is rough with granulations; the keel smooth, and plain. Colour of the back dusky grey; belly dirty white; fins dusky; keels of the scales white. Skin rough, with minute plates and points of various shapes, scattered irregularly over the surface; head sloping in front, covered with rough broad osseous plates; snout pointed, somewhat of a conical form; four barbules on the under surface, arranged in a cross direction, placed about half-way between the point of the snout and the anterior margin of the mouth; mouth situated beneath, about in a line with the eye, of an oval form, without teeth, bordered by cartilage, capable of being greatly protruded. Eyes small; operculum large, flat, and osseous, marked with a number of granulated striæ, radiating from a centre. Dorsal fin placed very remote from the head; caudal bilobed, the upper lobe much the largest; anal placed under the posterior half of the dorsal; ventrals a little in advance of the dorsal; pectorals situated low down, in a line with the posterior margins of the gill-covers. Number of fin rays—

D. 33; A. 23; C. 127; V. 23; P. 28.

The Sturgeon inhabits both fresh and salt water, and is a common fish in most of the northern parts of Europe. In some of the American rivers they are found in such vast abundance during the months of May, June, and July, that as many as six hundred are said to have been taken in two days. On the British shores they are by no means common; seldom more than one individual is taken in the same locality during the season, and then almost invariably in estuaries, or at the mouths of large rivers. They are mostly taken in salmon-nets, but no instance has been recorded of their being found on lines, or of their taking a bait of any description, although small fish and vermes seem to be their principal food. They are found during the winter to inhabit the ocean, and to ascend rivers in the spring and summer months for the purpose of depositing their spawn; the fry, as soon as they are extruded from the eggs, are said to seek the sea, and it appears on that account that very young ones are seldom or never found. In the Firth of Forth the Sharp-nosed Sturgeon is taken, on an average, once in every three years, and then generally in the salmon-nets at Musselburgh or Queensferry. It is sometimes found on the coast of Cornwall, but more commonly on our northern shores. A muddy bottom seems to suit their habits the best, which they are said to explore with their snout like swine in search of food. The flesh of the Sturgeon is much esteemed; it seems, however, to have been more highly prized in former times than at present. The roe of this fish is salted, and exported under the name of caviare. The best isinglass is made from the sound or swimming bladder, and sold at a high price.

Acipenser latirostris. *Parn.*—Broad-nosed Sturgeon.

Specific Characters.—Osseous tubercles in five longitudinal rows; snout blunt.

Description.—From a specimen seven feet nine inches in length; weight eight stones. Colour of the back and sides, olive, with a shade of grey; belly dirty white. Body armed with five rows of osseous shields, the first row commencing behind the head, and runs down the central ridge of the back; the two next rows arise one on each side of the former, but nearer to the central ridge than to the pectoral fins; immediately on the lower margins of the pectorals the other two rows commence; skin rough, with a number of small angular osseous plates intermixed with very minute spicula; the first free shield on the central ridge is nearly orbicular, and very slightly carinated; the remainder in that row are of an oval form, with their margins entire; the keels of the fifth and sixth shields one-eighth of an inch high, all the rest are lower; the lateral shields are broad, slightly carinated, and, like those on the central ridge, not hooked in the centre, as is observed in the sharp-nosed sturgeon. From the tip of the snout to the commencement of the first free shield on the dorsal ridge, one foot eight inches; from the tip of the nose to the orbit measures six inches; the snout at the extremity, three inches wide and one deep; from the tip of the nose to the mouth, six inches and a half; the space between the eyes measures five inches; the cirri, which are four in number, are placed two inches and a quarter from the tip of the snout. Mouth two inches and a half wide; the upper lip with three fleshy lobes; the under lip with two lobes; summit of the head rough, with the central plates beautifully radiated and of a fibrous appearance; position of the fins the same as in other sturgeons.

This fish differs from the common Sturgeon (*Acipenser sturio*) in having the tip of the snout much broader than the mouth; in the keels of the dorsal plates being but slightly elevated; and in having the cirri placed nearer the tip of the snout than to the mouth. It was taken with a net in the month of July near Alloa, and sent to the Edinburgh market, where it received a sale of a shilling a pound. A few weeks after another of nearly equal size was captured in the Tay, which was also sent to the Edinburgh market, and on close examination I was unable to discover any characteristic differences between it and the one taken in the Forth.

This sturgeon I believe to have been hitherto an undescribed British species, nor have I as yet been able to identify the fish in any of the works of continental authors, therefore I have proposed, in the mean time, the name *latirostris*, as characteristic of the species.

In the stomach of the one from the Tay was found an entire specimen of the sea mouse (*Aphrodita aculeata.*)

ORDER II.—PLAGIOSTOMI.

Branchiæ fixed, with five small external openings on each side; no opercule; jaws represented by the palatine and postmandibular bones, which alone are armed with teeth; pectorals and ventrals always present; the latter (in the *male*) furnished on their internal margins with long appendages.

FAMILY SQUALIDÆ.—Body more or less elongated; tail thick and muscular; branchial openings on each side of the neck, never underneath.

GENUS *SCYLLIUM*.—First dorsal fin never in advance of the ventrals; temporal orifices as well as the anal fin always present; teeth sharp and pointed, with small denticulations on each side.

SCYLLIUM CANICULA.*—THE SMALL-SPOTTED DOG-FISH.

Specific Character.—Valves of the nostrils approximate, covering the anterior part of the mouth.

Description.—From a female specimen one foot eleven inches in length. Anterior part of the body of a rounded form, tapering towards the tail where it becomes compressed; greatest thickness between the pectoral and ventral fins; from the point of the snout to the last gill-opening but one on the neck, exactly one-seventh of the entire length, and one-fourth as far as the posterior extremity of the base of the first dorsal fin; second gill-opening is placed mid-way between the point of the snout and the end of the pectoral fin. Colour of the head, back, and sides, reddish-grey, thickly spotted with dark brown; belly and under the throat dirty white without spots; the spots on the dorsal, caudal, and behind the pectoral and ventral fins, large and few; outer surface of the pectoral, ventral, and anal fins,

* *Scyllium canicula*, Yarr. *Squalus canicula*, Jen. *Morgay, Robin Huss.*

plain. Snout blunt, rounded, and depressed, projecting beyond the upper jaw; nostrils rather large, placed underneath, about half-way between the point of the snout and the anterior part of the orbit, and immediately in front of the upper lip, mostly concealed by a prolongation of skin, so as to form a sort of valve over each aperture; each valve is somewhat of a triangular form, extending over and partly concealing the anterior part of the mouth; under the outer margin of each valve and partly concealed, is a small truncated lobe of a square form, not extending beyond the lip. Mouth large, the angle of which extends as far as in a line with the middle of the orbit; under jaw shortest; teeth small and sharp pointed, placed in three or more rows in each jaw; each tooth is furnished with a small denticulation on each side of its base. Eyes rather large, of an oblong oval, placed as far from the point of the snout, as the distance is between each; branchial openings five, arranged in a longitudinal series on each side of the neck, the four first nearly of equal size, about half the size of the orbit; the fourth situated immediately over the anterior extremity of the base of the pectoral; the fifth, which is the smallest, placed rather beyond that point. Behind each eye, a little below the posterior angle, is a small temporal orifice, communicating with the mouth. Skin rough, with small denticulated scales, allowing the hand to be passed from head to tail, but not in the opposite direction; the extremity of the snout perfectly smooth, appearing as if the points of the scales had worn down. First dorsal fin, situated over the middle of the space between the ventral and anal fins, and mid-way between the fourth branchial opening and the end of the tail; the anterior margin oblique; the posterior margin vertical; the height rather more than equals the base. Second dorsal, about the same form as the first dorsal, but rather smaller, situated nearer it than to the end of the tail, and a little behind the termination of the anal fin. Caudal, truncated or very slightly rounded at the end; the upper lobe commencing at first low, a little behind the second dorsal, gradually expanding and terminating abruptly; the anterior lower lobe somewhat of the same form as the anal fin, but rather larger; the posterior lower lobe much smaller, of a triangular form. Anal fin, placed a little in advance of the second dorsal, and half-way between the commencement of the ventrals, and the termination of the anterior lower lobe of the tail; the form somewhat triangular, the base more than twice the length of the height; the lower end free. Ventrals in advance of first dorsal, situated about mid-way between the end of the pectorals and the anal fin; the lower portions acute and free; the posterior margins more oblique than the anterior margins. Pectoral broad, truncated behind, its length equalling the space between the point of the snout and the first branchial aperture. "The *male* is characterized by having the ventrals larger than in the other sex, and united throughout their length by an intermediate membrane: they are also furnished on their inner margins with fusiform appendages, not extending beyond the fin, in young subjects, but lengthening in adults; in the *female*, the ventrals have the last third portions of their inner margins separate." (Jenyns.)

The *Spotted Dog-Fish* and the *Lesser-Spotted Dog-Fish* of Pennant, appear to be both the same species, differing only in sexual variety; but whether they are the same as the one here described, or the one next to be noticed, is a question not easily determined, in consequence of Pennant having omitted the essential characters by which the two species are distinguished. We are indebted, however, to Mr Jenyns, in his excellent work on the British Vertebrate Animals, for first clearly pointing out the true specific distinctions in the two species of Spotted Dog-Fish (*S. canicula* and *S. catulus*), which principally rest on the formation of the nasal valves, as will be shewn when speaking of *S. catulus*.

The Small-Spotted Dog-Fish is generally considered a common species throughout the British coast, but is found in greater numbers on the southern shores of England than on those shores farther north. In the Firth of Forth it is comparatively rare, making its appearance generally in the month of June, when a few are captured in the salmon-nets at Musselburgh and Queensferry. On the coast of Devon it is taken mostly in the trawl-net and occasionally with the hook.

It is a voracious feeder, and subsists principally on small fishes. The skin of this and of the other species of Shark, is much used in the arts for various purposes; the finer parts being used by cabinetmakers as a substitute for glass-paper, and turners employ it for polishing wood. The flesh is coarse, and seldom used as food.

SCYLLIUM CATULUS.*—THE LARGE-SPOTTED DOG-FISH.

Specific Characters.—Valves of the nostrils separate; not reaching to the mouth.

Description.—From a female specimen one foot eight inches in length. Anterior part of the body rounded; belly somewhat flattened; caudal extremity compressed, greatest thickness behind the pectorals, tapering from the ventrals; from the point of the snout to the third gill-opening on the neck, exactly one-sixth of the entire length, and one-fourth as far as the middle of the space between the two dorsals; first gill-opening is placed mid-way between the point of the snout and the end of the pectoral fin. Colour of the head, back, and sides, reddish-grey, spotted with dark brown; belly, under surface of the pectoral and ventral fins, dirty white; behind the fins spotted. Snout blunt, rounded, and slightly depressed, projecting beyond the upper jaw; nostrils rather large, elongated, placed beneath, much nearer the point of the snout than to the anterior part of the orbit, and immediately in front of the upper lip; the inner half concealed by a prolongation of skin so as to form a sort of valve; each valve is somewhat of a triangular form, rather short, not reaching to the upper jaw, having a lobe underneath of a similar form, but somewhat smaller. Mouth large, the angle of which extending back as far as in a line with the middle of the orbit; under jaw shortest; teeth small and sharp pointed, placed in three or more rows in each jaw; each tooth is furnished with a small denticulation on each side of its base. Eyes moderate, of an oblong-oval; branchial openings five, arranged in a longitudinal series on each side of the neck, the first the largest, rather more than equalling the length of the orbit, the last the smallest, about half the size of the first, the fourth placed immediately over the anterior extremity of the base of the pectoral fin. Behind and a little under the posterior angle of the orbit, is situated a small temporal orifice communicating with the mouth; skin rough, allowing the hand to be passed from head to tail, but not in the opposite direction, owing to the scales being strongly denticulated, with the points directed towards the caudal extremity; the tip of the snout perfectly smooth. First dorsal fin somewhat of a triangular form, rather less than equalling its height, situated over the middle of the space between the ventral and anal fins, and mid-way between the third branchial opening and the end of the tail; its anterior margin oblique, the posterior vertical. Second dorsal about the

* *Scyllium catulus*, Yarr., Cuv. *Squalus stellaris*, Jen. *Rock Dog-Fish*, Bounce.

same form as the first, but rather smaller, situated in a line over the posterior portion of the anal fin, and half-way between the origin of the ventrals and the end of the tail. Caudal truncated rather obliquely, commencing low at a short distance from the second dorsal, and expanding gradually towards the extremity; the anterior lower lobe about twice the size of the anal fin and somewhat of the same form; the posterior lower lobe considerably smaller, of a triangular form, with the apex pointing downwards. Anal fin with its posterior extremity situated mid-way between the commencement of the ventrals and the end of the tail; ventrals in advance of the first dorsal, the lower portions not so acutely formed as in *S. canicula*. Pectorals broad, truncated behind; its length considerably less than the space between the point of the snout and the first branchial opening. The male is characterized in the same manner as in the last species.

Mr Jenyns remarks, "(*form*) closely resembling the *S. canicula*, but differing essentially in the structure of the lobes of the nostrils and in the form of the ventrals. The former are not united as in that species (*S. canicula*), and of a smaller size, leaving the whole of the mouth and the upper lip visible; the ventrals, instead of being cut obliquely, are cut nearly square, their posterior margins meeting at a very obtuse angle; they are united or separate according to the sex in a similar manner. The snout is rather more elongated, and, according to some authors, the tail rather shorter, giving the dorsal a more backward position; but this last character I have not noticed myself."

The two species now before me (*S. canicula* and *S. catulus*), differ in other characters besides those above pointed out by Mr Jenyns. In *S. canicula*, the whole of the second dorsal fin is behind the anal; in *S. catulus* it is in a line over the lower portion of the anal. In *S. canicula*, the small lobe which is situated immediately under the outer margin of the nasal valve, is of a square form; in *S. catulus* that lobe is somewhat of a triangular form and about three times broader than its length, extending from the inner corner of the nasal aperture along half its base, or nearly as far as the posterior margin of the nasal valve; the teeth in *S. catulus* are about double the size of those in *S. canicula.*

The Large-spotted Dog-Fish, so named by Mr Yarrell to distinguish it from the small-spotted species, is occasionally taken on the coast of Devon in the trawl-net, but it does not appear to be of so common occurrence as *S. canicula.* In the Firth of Forth examples are occasionally found in the salmon-nets at Queensferry. It is stated by the fishermen, that it is more frequently met with on some of the shores further north, and at Wick, specimens of large size have been taken in the herring-nets; but as the two species are so closely allied, it is not improbable that they have been greatly confounded. I have seen examples of both species of three feet and a half in length. They feed on almost any animal substance, and extrude their purses or eggs during the winter months. On dissecting a specimen in the month of September, I found two purses of large size, but the fœtus was not in the slightest developed. At one of the extremities of the horny capsule were attached two strong, slender tendrils, very much resembling that which is used by fishermen under the name of Indian weed. This and the last described species are said to produce many young at a time. I have occasionally observed a variety of this species, or probably the young, about a foot in length, with the head, back, and sides, of a deep reddish-brown, marked with a few large dark scattered spots.

GENUS *LAMNA.*—First dorsal fin in advance of the ventrals; anal fin present; temporal orifices wanting; the branchial openings all before the pectorals.

LAMNA CORNUBICA.*—THE PORBEAGLE.

Description.—"Body fusiform, very narrow at the tail, and strongly keeled there on each side; skin smooth when stroked backwards, of a uniform greyish-black colour, the belly white; snout obtusely pointed, with a band of punctures on each side of the forehead terminating above the eyes, a few similar punctures behind the eyes, and a triangular patch of them before the nostrils, they are the apertures of canals filled with a transparent jelly; eyes round, dark blue; branchial slits five, cut across the neck, the posterior oblique and close to the pectoral fin; back rounded; dorsal fin triangular, with a free, pointed, pale-coloured process behind; posterior dorsal fin also pointed posteriorly; pectorals somewhat triangular, obliquely sinuate on the posterior edge, black; ventral fins rhomboidal, meeting on the mesial line, on which are the anal and generative apertures; anal fin small, pointed behind; tail lunate, with unequal lobes, the superior and largest with a projecting outline near the tip; above the tail there is a flat space bounded by a short transverse ridge, and a similar one opposite on the ventral side; lateral line straight; the keel on the body runs forward on the tail, and there is a small keel beneath this confined to the tail itself. The length along the lateral line five feet eight inches and a half; circumference in front of the dorsal fin, two feet eight inches and a half; from the snout to the eye, four inches and three quarters; diameter of the eye, one inch and one-tenth; breadth between the eyes, five inches and one quarter; from the snout to the margin of the upper lip four inches and a half, thence to the angle of the mouth also four inches and a half; breadth of the mouth from angle to angle eight inches and one quarter; from the snout to the first gill-aperture one foot three inches; snout to pectoral fin one foot six inches and a half; length of pectoral fin one foot one inch; breadth of pectoral fin six inches and a half; snout to dorsal fin two feet one inch and three quarters; height of dorsal fin nine inches and three quarters; length of dorsal fin ten inches and one quarter; length of the free portion of it three inches; space between the first and second dorsal fins one foot eight inches; length from the snout to the anal aperture three feet eight inches; extreme breadth of the tail one foot eight inches; length of the tail in the mesial line six inches and one quarter."—(Dr Johnston.)

This species of Shark is met with occasionally on the Devonshire and Cornish coasts, but is said to occur more frequently

* *Lamna cornubica*, Cuv., Yarr., Flem. *Squalus cornubicus*, Jen., Don., Penn.

during autumn on the northern coast. Several specimens have been taken in the Firth of Forth, principally in the herring-nets, among which they are very destructive. They feed on fishes and pursue their prey in companies. Dr Johnston has met with examples in Berwick Bay. They are ovoviviparous, and their flesh is seldom made use of, except as bait for other fishes. The essential characters of this species are: the first dorsal fin before the ventrals; all the branchial openings before the pectoral except the *last*, which is situated *obliquely* over the anterior extremity of the base of that fin; teeth serrated on both edges; anal fin *present*; temporal orifices *wanting*; snout pyramidal.

GENUS *GALEUS*.—First dorsal fin in advance of the ventrals; anal fin present; temporal orifices present; the last branchial opening above the pectoral; teeth sharp.

GALEUS VULGARIS.*—THE COMMON TOPE.

Description.—From a small male specimen fourteen inches in length. Body fusiform, greatest thickness in the region of the pectorals; snout depressed; end of the tail compressed; from the point of the snout to the second gill-opening on the neck exactly one-fifth of the entire length; first gill-opening is placed mid-way between the end of the snout and the commencement of the first dorsal fin. Colour of the back and sides dusky grey; belly dirty white. Snout pointed, slightly rounded at the tip, projecting, about the length of the base of the first dorsal fin, beyond the anterior margin of the upper jaw; nostrils small, placed beneath, considerably nearer the mouth than to the point of the snout, and a very little in advance of the anterior extremity of the orbit. Mouth large, the angle extending back as far as in a line with the posterior extremity of the orbit; under jaw shortest; teeth sharp pointed, of a triangular form, placed in three or four rows in each jaw, the inner edge of each strongly denticulated, the outer edge, which is placed obliquely, smooth and cutting. Eyes large of an oblong-oval, situated over the mouth;

* *Galeus vulgaris*, Cuv., Yarr. *Squalus galeus*, Jen. *Penny Dog, Miller's Dog.*

branchial openings five, arranged in a longitudinal series on each side of the neck; the first four nearly of equal size; the last, which is placed immediately over the anterior extremity of the base of the pectoral, somewhat smaller than the rest; a little behind the posterior angle of the orbit is situated a small temporal orifice about the size of a pin's head; skin rough when the hand is passed from tail to head, but smooth in the opposite direction. First dorsal fin placed half-way between the tip of the nose and the end of the second dorsal; somewhat of a quadrangular form, its base about equalling the height of the anterior part; the posterior extremity ending in an acute point. Second dorsal fin placed about half-way between the first dorsal and the end of the tail, and corresponding to the former in shape, but of half the size. The extremity of the caudal lobe obliquely truncated, the anterior lower portion somewhat of a triangular form, concave at the posterior margin, and much larger than the rest of the lobe. Anal rather small, situated under the lower part of the second dorsal. Ventrals placed in the middle of the space between the two dorsals, cut obliquely at their lower edges. Pectoral rather larger than the first dorsal, approaching to triangular, rounded at the upper border and concave at the posterior margin.

The Tope Shark is frequently taken in the Firth of Forth, and specimens of three feet or more in length are now in the College Museum of Edinburgh, obtained from that quarter. Dr Johnston has observed it on the coast of Berwick. "On the Cornish coast," says Mr Yarrell, "this is a common and rapacious species, but is not so destructive as the Blue Shark. The larger specimens, which are about six feet long, abound chiefly in summer; and the young, to the number of thirty or more, are excluded all at once from the female in May and June. They do not reach the full size until the second year, and continue with us through the first winter, while those of larger size retire into deep water. No use is made of this fish beyond melting the liver for oil. When caught on the fishermen's lines, this fish sometimes has recourse to the same attempt at deliverance as the Blue Shark, by twisting the line throughout the whole length round its body."

The fishermen in the Firth of Forth have frequently mistaken the present species of Shark for a full-grown example of the common dog-fish, they supposing that the absence of the dorsal spines is entirely owing to the age of the fish, but the absence of the anal fin in the Dog-Fish, and its presence in the Tope, will at all times distinguish the two species from one another. The essential characters of the Tope are, first dorsal fin before the ventrals; last branchial opening placed immediately over the anterior extremity of the base of the pectorals; teeth denticulated only on the edge placed nearest the angle on the mouth; anal fin as well as the temporal orifices, *present;* snout depressed.

GENUS *MUSTELUS.*—First dorsal fin in advance of the ventrals; anal fin present; temporal orifices present; teeth blunt, forming a closely-compacted pavement in each jaw.

MUSTELUS LÆVIS.*—THE SMOOTH HOUND.

Description.—From a small specimen fourteen inches in length. Body fusiform, rounded, greatest thickness in the region of the pectorals, tapering gradually towards the caudal extremity, where it becomes compressed; snout and head depressed; from the tip of the snout to the third gill-opening on the neck, exactly one-sixth of the entire length, and one-third as far as the middle of the space between the two dorsals. Colour of the head, back, and sides, of a light bluish-grey, marked with numerous small white spots, which disappear as the fish increases in age; belly dull pearly-white. First dorsal fin rather large, of a triangular form, the height more than equalling the base; placed over the posterior portion of the pectorals, and half-way between the point of the snout and the middle of the second dorsal fin; the lower portion of the posterior margin terminating in a point directed backwards. Second dorsal rather smaller than the first dorsal, and corresponding to it in form; placed a little in advance

* *Mustelus lævis*, Cuv., Yarr. *Squalis mustelus*, Jen., Penn. *Skate-toothed Shark*, *Ray-mouthed Dog*, *Smooth Shark*.

of the anal fin, and about mid-way between the first dorsal and the tip of the caudal lobe; pectorals of a triangular form with the posterior margins cut obliquely, the length equal to the distance from the point of the snout to the temporal orifice, immediately behind the posterior angle of the orbit; ventrals placed under the middle of the space between the two dorsals, of a triangular form, cut obliquely, and about half the size of the pectorals. Anal rather small, placed under the posterior half of the second dorsal, and answering to it in shape: caudal with the lower lobe cut obliquely; the anterior under lobe slightly concave at the posterior margin, and rather larger at the commencement. Snout rounded; nostrils underneath, partly covered with a small cutaneous flap, placed half-way between the tip of the snout and the posterior angle of the mouth; gape rather small; under jaw the shortest; teeth small and blunt, forming a close compacted pavement in each jaw, very similar to those observed in young individuals of *Raia clavata*. Eyes rather large, of an oblong oval form, placed over the mouth, and about half-way between the point of the snout and the commencement of the second gill-opening; skin smooth and soft, when the hand is passed from head to tail, but rough in the opposite direction; gill-openings on each side of the neck, five in number, the last the smallest, and placed immediately over the anterior part of the base of the pectoral; lateral line rather indistinct, and straight throughout its course.

The most common size of this species of Shark that I have met with in the Firth of Forth is from twenty to five and twenty inches in length. It is generally found in the salmon-nets, along with the common dog-fish, with which it is frequently confounded by many of the fishermen, although, when closely examined, the differences between them are very obvious. On the southern shores of England it is occasionally taken the length of three feet or more, and is found in greater numbers on the Cornish and Devonshire coasts than on the eastern shores of Scotland. Dr Johnston has known it taken in Berwick Bay; Mr Couch says "it is common on the coast of Cornwall, but not abundant, and keeps close to the bottom on clean ground, where it feeds on crustaceous animals which it crushes previous to swallowing, and for which its flat pavement teeth are well adapted; it also takes a bait, but is less rapacious than most of the tribe. The young are produced alive in November, the whole coming to perfection at once; but they are few in number, not perhaps exceeding a dozen, and soon after birth they all go into deep water, from which they do not emerge until the following May." Mr Yarrell says it has been taken on the coasts of the counties of Antrim and Londonderry, and he has seen it at various places on the coasts of Kent and Sussex. Dr Fleming records it as being used in the Hebrides as food, and the flesh is esteemed a delicate dish.

The principal character which distinguishes this fish from the rest of the Sharks is in the form of the teeth, which are, as before observed, arranged in a compacted pavement, with their summits perfectly smooth, the teeth of Sharks generally being very sharp pointed, more or less of a triangular form.

GENUS *SELACHUS*.—First dorsal fin in advance of the ventrals; anal fin and temporal orifices both present; teeth not denticulated at the sides; branchial openings all before the pectorals, nearly surrounding the neck.

SELACHUS MAXIMUS.*—THE BASKING SHARK.

Description.—" The body is the thickest about the middle, and diminishes towards both extremities; when afloat the form is nearly cylindrical; the skin thick and rough, of a brownish black colour, with tints of blue. The head conical, the muzzle short, rather blunt, smooth, and pierced with numerous circular pores; eyes near the snout, small, oval, the elongation horizontal, the irides brown; half-way between the eye and the first branchial opening is the temporal orifice, oblique and small; branchial openings five on each side, of great vertical length, each set including the whole side of the neck, and leaving only a small space above and below; nostrils oval, small, placed rather laterally, and opening on the edge of the upper lip;

* *Selachus maximus*, Yarr. *Squalus maximus*, Jen., Penn., Flem.

pectoral fin of moderate size for so large a fish, the form somewhat triangular, placed close to the last branchial orifice, convex anteriorly and thick, slightly concave and much thinner behind; the ventral fins also of moderate size, rather elongated at the base, placed behind the middle of the whole length of the fish, convex in front, concave behind, the inner and posterior half free, exhibiting in the male the cylindrical appendage. The first dorsal fin, placed before the middle of the whole length of the fish, is much the larger of the two, forming an elevated triangle; anterior edge but slightly convex, posterior edge concave, with an elongated point at the base directed backwards; the second dorsal fin much smaller than the first, rounded above, attached throughout half its base only, and placed at two-thirds of the distance from the first dorsal to the caudal fin; anal fin is still smaller than the second dorsal, but of the same shape. From the line of the anal fin to the base of the tail, there is a strong and prominent keel-like edge on each side; and just in advance of the base of the caudal fin; both above and below, is a groove, that underneath rather smaller than that above. The caudal fin divided into two lobes, the upper one larger than the lower; the posterior edge of the caudal fin appears to become notched and abraded by age and use, and is frequently found unequal at its margin, and variable in shape."—(*Yarrell.*)

The Basking Shark, one of the largest of this tribe of fishes, has been observed several times on the British coast. Mr Low considers it as common in the Orkneys. Dr Neill states in the Wernerian Transactions, vol. i., that it is common in the Scottish seas, occasionally, though seldom, entering the Firth of Forth. It has been taken, according to Mr Yarrell, on the coasts of Waterford, Wales, Cornwall, Devonshire, and several times at different places on the coast of Sussex. It has been known to measure thirty-six feet in length. Pennant supposes that it subsists entirely on marine plants, for on examination of the contents of the stomach, no remains of fish have been found. Mr Low says, that a specimen he examined contained a red pulpy mass, like bruised crabs or the roe of Echini. Its food is considered by Linnæus to be Medusæ. It is stated by Blainville, that no less than four distinct species of shark have been confounded by naturalists under the name of *Squalus maximus*.

GENUS *SPINAX*.—First dorsal fin in advance of the ventrals; anal fin wanting; temporal orifices present; branchial openings all before the pectorals; a sharp, strong spine in front of each of the dorsals.

SPINAX ACANTHIAS.*—THE PICKED DOG-FISH.

Description.—From a specimen eighteen inches in length. Body fusiform; nose long; head depressed. Colour of the back and sides, slate-grey; under part dull white, in young specimens the back is spotted with white, and the caudal lobe is often margined with pale yellow. First dorsal fin somewhat of a quadrangular form, terminating behind in a projecting point, directed towards the caudal extremity; the height in front more than equalling the length of the base; situated about one-third of the whole length from the point of the nose. Second dorsal fin smaller than the first, and answering to it in shape; placed about mid-way between it and the end of the caudal lobe; in front of both dorsals is a strong, sharp spine, the one behind being much the longer of the two. Caudal lobe rounded at the end; the lower lobe triangular and rather larger than the second dorsal; ventrals approaching to a quadrangular, situated under the middle of the space between the two dorsals. Pectorals of a triangular form, rather larger than the first dorsal, concave behind, slightly rounded on the upper margin. Nostrils small, placed beneath, about half-way between the tip of the snout and the upper jaw, partly covered by a minute membranous flap; branchial openings five on each side of the neck, all before the pectorals. Under jaw shortest; teeth small, not denticulated, placed in two or three rows in each jaw, their points directed towards the angle of the snout, very sharp and cutting; a large temporal orifice situated a little behind the posterior angle of each orbit; lateral line tolerably defined; skin rough when the hand is passed from tail to head, but of a granulated feel in the opposite direction.

The Dog-Fish is a well-known species of Shark, and is common on almost every part of the British coast, more especially on that of Cornwall, where as many as twenty

* *Spinax acanthias*, Cuv., Yarr. *Squalus acanthias*, Jen., Linn. *Bone-dog*, *Hoe*, Orkney, *Dog-fish*.

thousand are said to have been taken in a net at one time. In the Firth of Forth they are captured principally in the salmon nets, in the months of July and August, when they are seen, after the recess of the tide, hanging in dozens, with their heads in the meshes of the net. In the neighbourhood of Edinburgh they are never made use of except occasionally as bait for other fishes, although in some parts of Scotland the flesh is salted, and dried and eaten by the poorer classes of the people. The Dog-fish is ovoviviparous, producing many young at a time. It is very voracious, feeds on small fishes, and pursues its prey in companies, when it proves of great annoyance to the fishermen. This fish is readily distinguished from the rest of the British sharks, in having a sharp conspicuous spine in front of each dorsal fin, a character which none of the others possess, and which, in this species, is always found constant.

GENUS *SQUATINA*.—Body broad, flattened horizontally, pectorals large, separated from the neck by a cleft, in which are the branchial openings; mouth at the extremity of the snout; eyes above not lateral; temporal orifices present; no anal fin; both dorsals behind the ventrals.

SQUATINA ANGELUS.*—THE ANGEL-FISH.

Description.—From a specimen twenty-one inches in length; it is said sometimes to grow to the length of eight feet. Form, more resembling the ray than that of the shark; body broad and depressed anteriorly, somewhat of a triangular form from the snout to the end of the pectorals, elongated and tapering behind the ventrals; the upper part of the body rather convex; the under part flat; the greatest breadth across the pectorals; head in front of a rounded form, wider than the body, not including the pectorals; mouth rather large, situated at the extremity, somewhat protractile; under jaw a little the shortest; teeth very sharp, broad at the base, placed

* *Squatina angelus*, Cuv., Yarr. *Squatina vulgaris*, Flem. *Squalis squatina*, Linn., Bloch, Penn. *Monk-Fish*, *Fiddle-Fish*, *Shark-ray*, *Kingston.*

wide apart from each other, arranged in three or four rows in each jaw, with the points directed inwards ; vomer smooth, without teeth ; eyes above, small, placed wide apart from each other ; nostrils small, situated at the extremity of the snout in front of the eyes ; furnished with two elongated valves or loose membranes attached to the inner margins ; temporal orifices large, nearly twice the size of the orbit, placed transversely a little behind, and on the outer side of each eye ; snout blunt, slightly notched in the middle ; branchial openings rather small, placed on each side of the neck in front of the pectorals ; pectorals large, somewhat of a triangular form at the outer edge, terminating in front by an acute detached point or angle, rounded at the lower margin ; ventrals, not half the size of the pectorals, situated behind, of a triangular form, with the inferior extremities terminating in a loose point directed backwards ; dorsal fins two, placed behind the ventrals ; the first is situated about half-way between the tip of the caudal lobe and the termination of the pectoral fins, somewhat of a triangular form ; the anterior margin oblique ; the posterior margin nearly vertical ; the second dorsal is rather smaller than the first and nearly of the same form, placed about half-way between the base of the caudal lobe and the termination of the first dorsal ; ventrals wanting. Skin on the under surface of a dirty white ; on the upper surface grey, inclining to chocolate, very rough, covered with numerous, small prickly tubercles with broad bases and bent points, causing the skin to feel granulated when the hand is passed from head to tail, and very rough in the contrary direction ; caudal fin obliquely bifurcated, the upper lobe rather the longest, of a triangular form, a little more than equalling the size of the first dorsal.

On some parts of the English coast, more especially in the counties of Devon and Cornwall, we find this singular looking fish of frequent occurrence, and from its supposed resemblance in form to that of a fiddle it has occasionally received the name of Fiddle-Fish. It is frequently taken on the coasts of Kent and Sussex, where it is called a Kingston, but on the eastern shores of Scotland it is seldom seen. It has been, however, noticed by Dr Neill as occurring occasionally in the Firth of Forth, and I myself have met with two examples taken with the hook in the month of June from the same quarter, but they were rather small, not exceeding two feet in length,—the fishermen having no name for them farther than that of *Mongrel Skate.*

This fish frequents deep water, keeping close to the bottom, and is said to conceal itself under the soft soil; it is very voracious, and preys on small fishes, principally on the smaller kind of flounders. The flesh is said to be occasionally eaten, and is recorded to have been formerly held in high estimation; some parts of the skin, however, are of value for polishing wood, but every way inferior to the skin of some of the Sharks.

Mr Yarrell says, a second species of this genus has been supposed to occur on our coasts, but the Angel-Fish is liable to some variation in colour, depending on the nature of the ground in the locality in which it is found. The sexes also exhibit some differences. The females produce their young alive in June. This fish appears as closely allied to the skates as it does to the sharks, but differs from both in many respects. It is readily distinguished from the skates, in the mouth being at the extremity, and the gill-openings being on each side of the neck and not underneath. It differs from the true sharks in having the eyes placed on the upper surface and not laterally.

Family RAIIDÆ.—Body very much flattened, resembling a disk; tail more or less long and slender; branchial openings beneath; pectorals extremely large, uniting in front with the snout, extending backwards to near the base of the ventrals; mouth and nostrils beneath; eyes and temporal orifices above; dorsals when present almost always upon the tail.

Genus *RAIA*.—Tail slender, furnished with one or more rows of spines, and two small dorsal fins towards its extremity.

(I. *Snout sharp, more or less elongated.*)

Raia batis.*—The Skate.

Specific Characters.—Body on the upper surface rough, of a grey colour beneath; no spines in front of the eyes. (See Plate XL.)

Description.—From a female specimen two feet in length, the tail included. Body rhomboidal; the distance from the tip of one pectoral to that of the other, equalling the space between the point of the snout and the last spine but six on the tail; from the point of the snout to the temporal orifice, one-third the length, as far as the end of the anal fin, and one-fourth the length to the commencement of the first dorsal. Body thin; snout pointed, conical; pectorals large, somewhat of a triangular form, uniting in front at the snout, and terminating at the base of the ventrals; the anterior margins nearly straight, the posterior margins rounded; ventrals about twice as long as they are broad, each composed of five rays; the first ray stout and flat, the third the longest, giving a rounded form to the extremity of the fin; anals commencing close behind the ventrals, the outer margin of each rounded, terminating below in a free point, composed of twenty rays; the middle rays rather the longest, the first ray taking its origin with the last ray of the ventral. Tail short, considerably less than the length of the body, when reflected not reaching beyond the anterior part of the orbit; along the mesial line is a row of spines or tubercles, about sixteen in number, commencing at the base of the anal, and terminating at the commencement of the first dorsal; there is also frequently a solitary spine between the two dorsals; each tubercle has a broad oval base, and a sharp point directed backward. In adult specimens there are three rows of spines on the tail, the two lateral ones having the points of the spine pointing outwards, but *not upwards,* as Mr Yarrell has represented in his figure of the skate. (Vol. ii. p. 421.) The lateral spines are frequently very few, sometimes not exceeding six in number. First dorsal fin small, rounded at the free extremity; the length about equalling the base; placed at a short distance from the end of the tail; second dorsal rather smaller than the first and about the same form, commencing at a short distance from its termination; caudal fin rudimentary. Colour of the upper surface of a dusky grey, occasionally with a pale yellowish tinge; under surface of a dusky bluish- rey, marked with a number of dark specks, particularly about the under surface of the

* *Raia batis,* Linn., Yarr., Penn., Don., Flem. *Blue Skate, Grey Skate.*

snout and around the mouth; eyes rather small, flattened above, placed immediately in front of the temporal orifices, which are of an oval form and rather smaller than the orbits. Skin above rough, presenting a granulated feel to the touch; no spines in front of the eyes or along the mesial line of the back; that part round the base of the ventrals is generally smooth. Mouth large, placed beneath, capable of being widely expanded; teeth numerous, sharp pointed, with broad bases, arranged in several rows in each jaw.

"The *males* in this, and in all the other species of this family, besides possessing the ventral appendages, are characterized by several parallel rows of sharp hooked spines on the anterior lobe, and at the angle of each of the pectorals. These spines are always very much reclined and partly concealed, with the points directed inwards. They are quite independent of the other, generally larger and more erect spines, which are more or less characteristic of the particular species. The number of rows, and the number in each row, depend upon age, being greatest in the oldest individuals; sometimes in *very young males* these sexual spines, as they may be termed, hardly shew themselves at all. It may be added that the teeth also often differ in the two sexes, the *males* generally having them sharper and more pointed than the other sex."—*Jenyns.* In some parts of the coast the fishermen name those individuals with the ventral appendages much developed, the *Three-tailed Skate*, they being, at the same time, perfectly aware that it is the characteristic mark of the males only. The females are said to cast their eggs from May to September, and the young appear some time during the spring following. Their eggs are brown, coriaceous, and squared, with the angles prolonged into points. These are often met with on the sea-shores, and commonly known by the name of Sailors' Pockets.

This species of Skate as noticed by Pennant is sometimes taken the weight of two hundred pounds. It is common on all parts of the British coast, and has received various names according to the locality in which it occurs. In Scotland it is named Skate or Blue Skate, in England Grey Skate ; and according to Yarrell, at Lyne Regis, on account of its dusky grey colour, it is called Tinker. In the Firth of Forth these fish are met with in great numbers, particularly in the neighbourhood of the Bass and the May, where they are taken in nets, and are often found on lines set in deep water for cod. In the spring months, the Edinburgh market has a daily supply, and so great is the demand required, that no less than a dozen cart loads are sold during the week. Some persons cook them when newly caught, others dress them in the salted condition, while others again allow them to hang in the open air for weeks, until they have acquired a green putrescent appearance, and in this state they are considered a luxury. The pectoral fins are the parts generally made use of as food, and when cut in a peculiar form are sold under the name of *crimped skate*, which is esteemed a delicate morsel. The French are said to be remarkably fond of this species of skate, especially when large ; the smaller specimens about the size of a common plate when fried are particularly sweet and delicate, and are brought to the Edinburgh market in the month of July with other skate of small size.

According to Colonel Montagu, the immense quantities of this tribe of fishes which are taken in the county of Devon, are chiefly used for baiting crab-pots. It has been computed that four boats employed in crabbing, consume in one season twenty tons of fish, principally ray; but it is probable, not less than forty tons of ray are brought on shore by fishermen of the small hamlets of Torcross on the south coast of Devon, in one season, besides what are consigned to the deep immediately as useless. The reason of this vast consumption of coarse fish in catching crabs, is, that they are extremely nice in the choice of their food, and will not enter the pots when the bait is the least tainted. In this particular the crab differs from the lobster, which cannot be taken but by bait in a state of putridity. The skate is very various, and keeps to the bottom on rocky ground; it takes a baited hook with eagerness, and feeds on almost any animal substance it meets with, but flat fish and crustacea seem its principal food. "Mr Couch has known five different species of fish, besides crustacea taken from the stomach of a single individual." The principal characters which distinguish this species of skate, are, the snout sharp, conic, the lateral margins not parallel; the skin on the upper surface of the body rough, having a granulated feel when the hand is passed over the pectorals; no spines round any part of the orbits, or along the dorsal ridge of the body; the lateral spines at the base of the tail, when present, are perfectly straight, their points directed outwards, and not downwards as those on the central ridge; the under surface of the body is *never white*, but of a dusky greyish-blue marked with a number of dark specks. In young individuals the upper surface is smooth to the touch; and the lateral caudal spines are wanting.

RAIA OXYRHYNCHUS.*—THE SHARP-NOSED RAY.

Specific Characters.—Body, on the upper surface, smooth, on the under surface of a pure white; no spines in front of the eyes.

Description.—" In the length of the body, this species sometimes exceeds six feet, and weighs nearly five hundred pounds. The back is quite smooth of a plain brown colour; the under surface white.

* *Raia oxyrhynchus*, Mont., Yarr., Jen., Penn. *White Skate, Burton Skate.*

free from spots or specks; the body is remarkably depressed, more so than that of the grey skate, and is not so dark a colour. Tail short, with three rows of spines all pointing downwards."

The *Raia batis or Grey Skate* has been frequently confounded with the *Sharp-nosed Ray*. The differences between them, however, have been very clearly pointed out by Colonel Montagu. "The *Sharp-nosed Ray* has a slender snout, the margins of which, in a moderate sized fish, run nearly parallel to each other, from three or four inches at the extremity; the snout of the *Grey Skate*, on the contrary, is truly conical. *The Sharp-nosed Ray* has its skin quite smooth; the *Grey Skate* is entirely rough above, or granulated like a dog-fish, and partly so beneath. The under part of the *Sharp-nosed Ray* is white without spots; the *Grey Skate* on that part is dusky grey, covered with minute dusky spots, having a pale speck in the middle. Both species have three rows of spines on the tail when arrived at maturity, but those of the *Grey Skate* differ from most other rays, by the points of the lateral rows turning forward.* The teeth of both species are sharp, with a broad base; but those of the *Grey Skate* are not near so long, and more closely connected. The sexes of both species are discriminated by the formidable reclined hooked spines on the pectorals, as well as by the posterior appendages which are peculiar to the males." It is recorded by Dr Neill in the 1st vol. of the Wernerian Memoirs, that this species of ray is occasionally met with in the Firth of Forth; and I am informed by the fishermen that specimens of large size are frequently taken off the coast of Aberdeen; but as no example has hitherto fallen under my own immediate notice,

* In those specimens I have examined, these points were always directed outwards, *not forwards*.

I cannot vouch for the accuracy of the statement, as it is probable that the fishermen might have confounded it with a large example of the *Grey Skate*. It seems not an uncommon fish on the coast of Cornwall; "where the smaller sized specimens are taken throughout the year; but those which are larger, keep in deep water and are only taken in summer and autumn." It is said to be a fish much sought after by the French, who consume large quantities of it during Lent.

RAIA INTERMEDIA.—THE FLAPPER SKATE.—*Parnell.*

Specific Characters.—Body on the upper surface smooth; on the under surface of a dark, dusky grey; one or more spines in front of each eye. (Plate XL.)

Description.—From a female specimen two feet in length, tail included. Body rhomboidal, the transverse diameter equalling the distance between the point of the snout and the last tubercle but three on the central ridge of the tail; from the point of the snout to the temporal orifice, rather more than one-third the length, as far as the end of the anal fin, and one-fourth the length as far as the termination of the first dorsal. Body very thin; snout pointed, conical; pectorals large, somewhat of a triangular form, uniting in front at the snout, and terminating at the base of the ventrals; the anterior margin rather concave, the posterior margin rounded; ventrals about three times the length of their breadth; anals commencing close behind the ventrals and terminating in a free point, rounded at the outer margins. Tail short and firm, being no longer than the space from the base of the anal fin to the anterior margin of the orbit; along the mesial line is a row of tubercles with sharp points directed downwards, about eighteen in number, commencing at the base of the anal and terminating at the commencement of the first dorsal fin; no lateral spines visible. First dorsal fin small, rounded at the free extremity, situated about one-third the length of the tail from the tip; the base about equalling the length; second dorsal rather smaller than the first, and about the same form, placed about half-way between the termination of the first and the tip of the tail; caudal fin rudimentary. Colour of the upper surface of the body of a dark olive-green with numerous large white spots; on the under surface dark grey with minute specks of a deeper colour. Eyes rather small, flattened above, placed in front of the temporal orifices; skin both above and below perfectly smooth; a strong, sharp, bent spine in front of each orbit; no spines or tubercles of any description on the back. Mouth large, placed beneath; teeth small, not so large or so sharp as those in *Raia batis.*

This fish, which was obtained in the Firth of Forth in the month of May, seems to be a new species of Skate, since I am not aware of its having been previously described. It appears to be the connecting link between *Raia batis* and *Raia oxyrhynchus*, to both of which it is closely allied, and it is from this circumstance that I suggest the specific name of *intermedia.*

It is distinguished from *Raia batis*, in the upper surface of the body being perfectly smooth, without granulations, and of a dark olive colour spotted with white; in the anterior part of each orbit being furnished with a strong spine pointing towards the tail; in the dorsal fins being more remote from each other, and in the anterior margins of the pectorals rather more concave, giving the snout a sharper appearance; whereas, in *Raia batis*, the upper surface of the body is rough to the touch, of a uniform dusky grey without spots; the orbits without spines; the dorsals nearly approximate, and the anterior margins of the pectorals nearly straight.

It is likewise removed from *Raia oxyrhynchus*, in the snout being conic; the under surface of the body dark grey; a spine in front of each orbit, and the back of a dark olive-green spotted with white; whereas, in the *Raia oxyrhynchus*, the snout is sharp and long, with the lateral margins parallel near the tip; the under surface of the body pure white, and the back of a plain brown without spots.

I have met with two examples of a variety of this fish which were taken in the salmon-nets at Queensferry. They were both of small size, about eighteen inches in length.

The back was of a uniform dark olive-green without spots of any description, covered with a thick mucus; under surface of a dark grey; body very thin; snout sharp, conical; pectorals at their anterior margins rather sinuous, passing off somewhat suddenly at that part, in a line with the temporal orifices, giving the outline of the anterior part quite a different appearance to that observed in *Raia intermedia;* the anterior part of each orbit is furnished with a spine; back perfectly smooth; tail with one row of spines on the dorsal ridge; fins, and in all other respects, similar to *Raia intermedia.* (Plate XLI.)

RAIA CHAGRINEA.*—THE SHAGREEN RAY.

Specific Characters.—Body on the upper surface very rough; on the under surface of a pure white; a row of spines round the inner edge of each orbit; two rows of large bent spines on the tail. (Plate XLI.)

Description.—From a female specimen three feet two inches in length, tail included. Body of a rhomboidal form; the transverse diameter rather greater than the distance between the tip of the snout and the end of the anal rays; from the point of the snout to the tip of the pectoral, from thence to the base of the ventral fin on the opposite side, equal; the length of the tail equal to the distance from its base to the posterior margin of the orbit; from the tip of the snout to the middle of the eye, one-seventh of the whole length, caudal included; the transverse cartilage is situated mid-way between the extremity of the nose and the termination of the base of the anal fin. Snout sharp, conate; the anterior margins of the pectorals slightly sinuous; the posterior margins rounded; ventrals narrow, being three or four times longer than their breadth, placed between the termination of the large broad pectorals and the commencement of the anals, composed of five rays, of which the second is the longest. Anals rounded at their outer margins, and terminating free below, about five times the breadth of the ventrals, each furnished with about twenty-one rays. Dorsals approximate, small and thin, situated nearly at the extremity of the tail, both of equal size, rounded at their posterior free margins; each fin furnished with eight rays, which ap-

* *Raia chagrinea*, Mont., Penn., Jen.

pear to branch off from one large ray situated horizontally. Caudal fin rudimentary, about half the length of the base of the second dorsal. Colour of the upper surface of the body of an uniform yellowish-brown; under surface pure white. Eyes large; a temporal orifice situated at the posterior part and a little on the outer side of each orbit; mouth large, placed beneath; teeth strong and sharp pointed, arranged in each jaw in many rows. Skin on the upper surface very rough, having a granulated feel when the hand is passed over the pectorals; at the base of the ventral and anal fins, the skin is perfectly smooth. About six large bent spines, with broad bases, situated on the upper part of the snout; round the inner margin of each orbit are from ten to twelve of these spines, arranged in the form of a crescent; on the dorsal ridge, from the nape to the transverse cartilage, is a row of six spines; about a little more than half-way down the back, commence two rows of spines, which run down the tail as far as the first dorsal fin; the first ten or twelve spines are very small, the rest gradually increase in size as they proceed; no spines on the central ridge of the tail; each spine has its broad base more or less grooved, and its point directed backwards; on each side of the base of the tail are a number of small hooked spines, placed in two or three irregular rows.

It appears nearly certain, that the fish figured and described in Mr Yarrell's work on the British Fishes, vol. II. p. 414, under the name of the *Long-nosed Skate* or *Raia chagrinea*, is not the same as the *Shagreen Ray* of Montagu, or of Pennant, nor does it agree with the fish above described, which seems to me identical with the *Shagreen Ray* of Montagu. In Mr Yarrell's example, the nose is very long, much longer than that observed in the *Grey Skate*; the upper surface of the body *slightly* roughened and of a light lead colour; the second fin on the tail about its own length from the end. The under surface of a dirty greyish-white marked with dusky spots like the true skate (*Raia batis*); the lateral caudal spines are represented in the figure as being perfectly straight, their points directed outwards. In the specimen now before me, although it belongs to the sharp-nosed division of skates, the snout is not so long as that observed in the *Grey Skate* of equal size. If we compare two specimens, one of *Raia batis* and the other of *Raia chagrinea* of Montagu, each of three feet in length, we shall find, that, *Raia batis* measures, from the tip of the snout to the eye, seven inches; whereas, in the *Raia chagrinea* of Montagu, the distance between these points measures but five inches, presenting a very striking difference when the two fish are placed together.

The principal characters which distinguish the *Raia chagrinea* from the rest of the skates, are in the dorsal surface of the tail having only two rows of spines, and none on the central ridge; these rows commence at the first dorsal fin, and extend nearly as far as half-way up the back of the fish, where the spines become very small, and not half the size of those on the lower portion of the tail.

This is a rare species of Skate, few naturalists appearing to have met with it. Colonel Montagu has noticed it on the Devonshire coast, and Pennant obtained a specimen from Scarborough; but whether it is found to inhabit the Cornish coast does not appear to have been altogether accurately determined, since the fish figured and described by Mr Yarrell under the name of *Raia chagrinea*, may probably prove a new species.

In the Firth of Forth the *Shagreen Ray* is occasionally taken in skate-nets set in deep water, more especially in the months of May and June, when a few may be seen in the Edinburgh market along with grey skate and thornbacks. It is known to fishermen under the name of *Rough Flapper*, and its flesh is considered inferior as food to that of the other species of skate, it being soft and dry. It feeds on small star-fish and crustaceous animals in general.

(II. *Snout short, and rather obtuse.*)

Raia maculata.*—The Spotted Ray.

Specific Characters.—Upper surface smooth, marked with distinct, roundish, dusky spots. (Plate XLII.)

Description.—From a female specimen eighteen inches in length, tail included. Form of the body more strictly rhomboidal than that of the last-described species; from the tip of one pectoral to that of the other, about equalling the space between the point of the snout, and half-way down the tail; from the point of the snout to the tip of the pectoral, from thence to the end of the base of the anal, about equal; from the base of the anal to the tip of the tail, nearly equalling the length of the body; from the tip of the snout to the temporal orifices, one-sixth part the length of the whole, tail included. Colour of the upper surface reddish-brown, marked with a number of large, dusky, brown spots, particularly on the pectorals. ("A *variety* is not uncommon in which the usual spots are nearly obsolete, but there is more or less trace of one oscillated spot in the middle of each pectoral. Montagu has noticed two kinds of this last variety, one with a large dark spot surrounded with a white circle, the other with a black spot within a white circle, the whole surrounded by five equidistant dark spots. *Another variety* is in the museum of the Cambridge Philosophical Society, in which the upper parts are pale orange-yellow, with light, rufous, brown spots."—*Jenyns.*) Under surface white; snout obtuse, scarcely projecting beyond the margins of the pectorals; the outline of the anterior part of each pectoral, sinuous; the posterior part rounded; ventrals small and narrow, about three times longer than their breadth, situated between the termination of the pectorals and the commencement of the anals, composed of five rays, of which the second is rather the longest. Anals about three times broader than the ventrals, each rounded at the outer margin, and terminating in a free point below, composed of seventeen rays; dorsals small, two in number, situated at the lower part of the tail, and at a little distance from each other; both nearly of equal size and rough to the touch, rounded at the posterior margins, furnished with a reclined ray from which arise seven smaller ones; caudal rudimentary, about half the length of the second dorsal. Eyes rather small; temporal orifices larger, one placed at the outer and posterior part of each orbit; mouth placed on the under

* *Raia maculata*, Yarr., Jen., Mont. *Raia rubus*, Don. *Homelyn Ray, Hommelin, Sand ray, The Home.*

surface of the body, nearly in a vertical line with the eyes; teeth small and blunt, arranged in several rows in each jaw. In adult individuals the teeth are sharp pointed in both sexes. Body on the upper surface smooth; in some specimens it is slightly granulated on the anterior part of the pectorals and between the eyes; round the inner margin of each orbit are four or five strong hooked spines with their points directed towards the tail; on the dorsal ridge is a row of spines which commences immediately behind the nape, and runs down the back, along the central ridge of the tail as far as the first dorsal fin; the spines on the tail are stronger than those above; a solitary spine is often placed at each extremity of the transverse dorsal cartilage; in adult specimens there are three rows of spines on the tail, but when young the lateral rows are wanting. The series of spines down the line of the back is frequently interrupted, and sometimes rudimentary. The *males*, besides possessing the usual anal appendages, have their pectorals armed with two or three rows of strong bent spines with the points directed towards the dorsal line, which, however, do not shew themselves till a certain age.

There are four species of skate met with on the English shores, belonging to the short-nosed division of rays, three of which are found to occur on the coast of Scotland; and although the spotted ray is one of the rarest of the species met with in the Firth of Forth, it is said to be one of the most common along the line of the southern coast. Seldom more than six or eight examples of this fish are observed in the Edinburgh market during the season, and the largest scarcely ever exceeding the length of twenty inches, while, on some parts of the English coast, they are occasionally found from two and a half to three feet in length.

The Spotted-Ray is distinguished from the rays already described, in the snout being short and obtuse, extending but a little beyond the anterior margins of the pectorals, and in the upper surface of the body being marked with a number of distinct, dusky spots, about the size of the temporal orifices. It is at once distinguished from the two next species to be noticed by the smoothness of the upper surface of the pectorals.

Raia clavata.*—The Thornback.

Specific Characters.—Upper surface very rough; one row of spines down the line of the back. (Plate XLII.)

Description.—From a female specimen twenty inches in length, tail included. Form of the body rhomboidal, similar to that of the spotted-ray; its transverse diameter equalling the space between the tip of the snout and half-way down the tail; from the point of the snout to the tip of the pectoral, from thence to the lower point of the anal fin, equal; from the base of the anal to the tip of the tail about the length of the anterior margin of the pectoral; from the tip of the snout to the temporal orifices one-third of the length, as far as the termination of the base of the anal fin. Colour of the back of a bluish-grey, with a number of ill-defined, large, whitish spots scattered over the pectorals, liable to great variations. In some examples there is a large ocellated spot on each side of the dorsal line. Under surface pure white; snout obtuse, slightly projecting beyond the anterior margins of the pectorals; the outline of the anterior border of each pectoral sinuous; the posterior border slightly rounded; ventrals small, placed between the commencement of the anals and the termination of the pectorals, their length about three times longer than their breadth; anal rounded at the outer margin, and ending below in a free point, furnished with about twenty rays, of which the last is rather the longest. Dorsal fins two, rather remote, nearly of equal form and size; placed on the lower portion of the tail; their posterior margins rounded and somewhat free. Caudal fin rudimentary, nearly half the length of the base of the second dorsal. Eyes about the size of the temporal orifices; mouth situated beneath, teeth blunt, arranged in several oblique rows in each jaw. (In the *females* both young and old, the teeth are always blunt, allowing the finger to be passed freely over them in any direction; in young *males* the teeth are also blunt; but in adult specimens they generally become long and very sharp.) Body on the upper surface very rough, covered with minute spicula, besides a number of large spines with broad bases; these spines however are very variable, in different individuals, both in number and position; in some examples they are nearly altogether wanting; but the series along the middle line of the back and tail is almost always present.

In the specimen now before me, there is one spine on the upper surface of the snout; one on each side a little farther

* *Raia clavata*, Cuv., Yarr., Jen., Mont., Penn., Flem. *Maiden Skate.* Scotland.

down and set wide apart from each other; four on the inner margin of each orbit; none on any part of the pectorals; a row commencing behind the nape, and running down the central ridge as far as the first dorsal fin; also a few on each side of the tail. In another specimen of three feet in length, there are more than three hundred large spines on the upper surface of the body, mixed with innumerable small spicula, and one hundred and eighty on the under surface, besides a hundred and fifty on the tail, arranged in seven rows. I have occasionally met with a variety, having two rows of spines running up the back as far as the nape, the dorsal ridge being without spines. A specimen presenting this anomaly is in the College Museum of Edinburgh.

The Thornback is a common species in the Firth of Forth, and seems generally dispersed throughout the British coast. It is so well known and so strongly characterized by the roughness of its skin on the upper surface, that it is seldom mistaken for any of its congeners. Large quantities are taken in nets in the months of May and June in nearly every part of the Firth of Forth; but more especially on the sands of Aberlady, Musselburgh, Burntisland, and Queensferry. The young specimens from a foot to a foot and a half in length, are named *maidens* or *maiden skates*, and are considered the best size for the table, the flesh being sweeter and more delicate than that of the larger individuals. It forms a cheap and wholesome article of food to numbers of the lower classes of inhabitants.

This fish is very voracious, and feeds on every kind of small flounder. It is particularly fond of herrings and sand-eels, as well as crustaceous animals, such as small crabs and lobsters, which the teeth of the female are well adapted to crush. Its flesh during the spring and summer months is not so firm or so wholesome as in autumn and winter. The eggs are shed in the early part of the season, and are occasionally found on the shores with the embryo skate enclosed. When about to be excluded from the horny capsule its tail is disproportionately long, ending in a sharp point without an apparent rudiment of a fin. It is capable of being preserved alive in a glass vessel for a considerable period, the sea-water being daily renewed.

That the adult male Thornback has sharp-pointed teeth does not appear a character so constant, as is supposed by some authors, since I have met with three full grown examples, in which the teeth were as blunt as those observed in the female Thornback. One of the specimens now before me, obtained in the Firth of Forth in the month of September, presents the following characters. Length of the whole fish two feet two inches; transverse diameter of the body twenty-one inches; anal appendages six inches, extending half-way down the tail; at near the tip of the broadest part of each pectoral is a row of long reclined spines, about twelve in number, with their point directed towards the dorsal line; also on or near the margins of the pectorals, in a line with the eyes, are several large spines placed in a cluster with their points directed downwards; *teeth blunt*, allowing the finger to be passed in either direction over their summits, without the vestige of a point to be felt; the teeth being as blunt as those observed in the female specimens of the Thornback.

A variety of the Thornback is said sometimes to occur, having a dorsal fin on the back, and is named by some authors *Raia Cuvieri*. A specimen is recorded by Dr Neill to have been taken in the Firth of Forth in 1808.

Raia radiata.*—The Starry Ray.

Specific Characters.—Upper surface rough, with large, sharp tubercles radiated at their bases; three rows of spines on the tail running up the back as far as the transverse cartilage. (Plate XLIII.)

Description. — From a female specimen, seventeen inches in length. Form of the body rhomboidal; but not so broad in proportion to its length as that observed in the thornback; its transverse diameter equalling the space between the tip of the snout and the last tubercle but six on the central ridge of the tail; from the point of the snout to the tip of the pectoral fin, from thence to the base of the last anal ray on the opposite side, equal; from the tip of the tail to the base of the last anal ray, from thence to the posterior part of the eye about equal; from the tip of the snout to the temporal orifices about one-sixth of the whole length, caudal included. Colour of the back of a pale yellowish-brown; under surface of a pure white. Snout obtuse extending but a very little beyond the anterior margins of the pectorals; the outline of the front of the pectorals, somewhat sinuous; the posterior outline, especially at the lower extremity, rounded. Ventrals small, about three times the length of their breadth; composed of three rays of which the second is rather the longest. Anals rounded at their outer margins, and terminating below, free; furnished with fifteen or sixteen rays, the lower ones the longest. Dorsal fins two, placed on the lower part of the tail, at a little distance from each other; both nearly of equal size and shape, rounded at the posterior border. Caudal rudimentary. Eyes rather large, flattened on their summits, about twice the size of the temporal orifices, which are placed one at the posterior part of each orbit. Teeth small and sharp pointed, arranged in five or six rows in each jaw. On the upper surface of the body are a number of large conical spines with grooved bases, intermixed with smaller ones with stellated bases, irregularly scattered over the pectorals, snout, back, and tail; at the base of the ventrals the skin is perfectly smooth and free from spines; on the tail are three rows of spines which extend up the back as far as the nape; the spines forming the middle row being about twelve in number, and three times as large as those on the sides. On each orbit are four large spines, two placed anteriorly and two posteriorly; between the eyes the skin is rough with minute spines with stellated bases; one large spine on the nape, and two at each extremity of the transverse cartilage of the back, from whence commences a row of minute spines, which runs down the back to the base of the tail, where it is lost. All the spines have their points directed backwards; those forming

* *Raia radiata*, Don., Yarr. Jen.

the lateral rows on the tail are very much crooked; those on the central ridge being nearly straight. The under surface of the body is perfectly smooth, without spines of any description.

This beautiful little Skate, which appears the smallest and best marked species of the genus, was first figured and described by Mr Donovan, from a small specimen taken somewhere off the north coast. It has since been found by Dr Johnston in Berwick Bay; and by myself, several times in the Firth of Forth; but in no other localities has it yet been discovered. It inhabits deep water, and is taken with the hook in rocky places in the months of March, April, and May; but after June until the following spring, it is seldom met with. It is considered as good food, not inferior to that of the maiden skate. From two to three specimens can be obtained nearly every week in the Edinburgh market, during the months of April and May.

The only skate likely to be confounded with the Starry Ray, is a young specimen of thornback; but it is at all times distinguished, by having three rows of spines running from the tail up the centre of the back; whereas, in the thornback, there is seldom more than one row of spines along the centre of the back, the lateral rows on the tail scarcely ever extending higher up than the anal fins.

GENUS *TRYGON*.—Tail slender, armed with a sharp, serrated spine; but without fins.

TRYGON PASTINACA.*—THE STING RAY.

Specific Character.—Back smooth. (Plate XLIII.)

Description.—From a female specimen nineteen inches in length, tail included, and eleven inches in breadth. The outline more approaching to orbicular than in the genus Raia; the central portion of

* *Trygon pastinaca*, Yarr., Cuv. *Raia pastinaca*, Penn., Don., Jen. *Common Trygon, Fire Flaire.*

the body very much raised and convex, becoming thin towards the edges; (*dimensions*) from the tip of the snout to the outer extremity of the pectoral, from thence to the middle of the anal fin, equal; from the tip of the snout to the temporal orifices, one-third the length to the base of the anals; from the point of the caudal spine to the base of the last anal ray, from thence to the anterior part of the eye, equal. Colour of the upper surface of the body dark olive with a slight tinge of yellow; under surface white; flesh with a faint blush of red. Snout small and pointed, extending but a very little beyond the anterior margins of the pectorals; ventrals wanting; anals small; the lower and inner margins rounded, the outer margins straight; no fins on the tail or back. Body both above and below perfectly smooth, excepting along the central line of the back, where there is a series of rudimentary tubercles situated beneath the skin. Eyes small; temporal orifices large; teeth small and blunt, arranged in several rows in each jaw; tail long, round, and slender, equalling in length the transverse diameter of the body, tapering at the extremity to a fine point. About the middle of the tail is placed a sharp-pointed osseous spine of two inches and a half in length, convex on the upper surface, and grooved from the commencement to half-way down; on its under surface is an elevated central ridge with a deep groove on each side extending the whole length; the sides of the spine are sharply serrated wit the points of the teeth directed towards the body of the fish.

We know nothing regarding the habits of the Sting Ray on the coast of Scotland, as its appearance so far north is very rare. The only example I have met with, is that from which the above description is taken. It was captured in the Firth of Forth in the salmon-nets above Queensferry in the month of August, and sent me as being the only fish of the sort the fishermen had ever seen. Mr Yarrell says, "It is more frequently taken on the southern coast than elsewhere, from Sussex even as far west as the county of Cork in Ireland. It appears, however, otherwise to occupy an extensive range, being found in the Mediterranean, from thence to a high degree of north latitude on the coast of Norway."

According to Mr Couch, "This species keeps on sandy ground at no great distance from land, and, in summer, wanders into shallow water, where it is often entangled in the fishermen's nets,—the only way in which it is usually caught, for it rarely swallows a bait. The manner in which this fish defends itself, shews its consciousness of the formidable weapon it carries on its tail. When seized or terrified, its habit is to twist its long, slender, and flexible tail round the object of attack, and, with the serrated spine, tear the surface, lacerating it in a manner calculated to produce violent inflammation." It is said, that the ancients were in the habit of using the spine of this species to tip their arrows and spears. The flesh of the Sting Ray is seldom eaten, as being rank and disagreeable to the taste; when cut, it emits a stronger ammoniacal odour than any of the other species of the family.

ORDER III.—CYCLOSTOMI.

Branchia purse-shaped, fixed, opening outwards by several apertures; jaws represented by an immoveable cartilaginous ring, formed by the union of the palatine and mandibular bones; body elongated; no pectorals or ventrals; the skeleton very imperfectly developed; the intestinal canal straight and narrow, without a spiral valve.

Genus *PETROMYZON*.—Seven branchial openings on each side of the neck; maxillary ring armed with strong teeth.

Petromyzon marinus.*—The Sea Lamprey.

Specific Characters.—Body greenish, marbled with dark brown; second dorsal and caudal fins separate.

Description.—From a specimen two and a half feet in length. Body cylindric and nearly of equal size as far as the first dorsal fin, from thence gradually tapering to the end of the tail; head indistinct; from the point of the snout to the posterior part of the eye,

* *Petromyzon marinus*, Cuv., Yarr., Jen., Penn., Flem.

one-tenth of the whole length of the body; eyes small and round placed mid-way between the tip of the snout and the fifth branchial opening. Mouth large, of an oval form; when widely expanded, circular; border by a fleshy lip, fringed on the inner surface; armed on the inside with numerous hard conical tooth-like projections, disposed in concentric rows, increasing in size as they advance inwards; the outer row very small, scarcely perceptible, all the points directed inwards; immediately beneath the tongue is a semicircular bone with eight sharp, conical teeth pointing outwards; on the roof of the mouth is a strong, conical tooth divided in the middle with the points directed outwards and downwards; tongue bilobed, having each lobe rounded and armed with six fine sharp-pointed teeth; also a number of minute teeth at the root of the tongue. Branchial openings seven on each side of the neck, arranged in a longitudinal series, in a line with the eye; between and a little in front of the eyes is a small aperture scarcely larger than a pin's head. Two dorsal fins, the first commencing exactly mid-way between the eye and the end of the tail, somewhat of a triangular form, the base about four times longer than its height; second dorsal commencing at a short distance from the termination of the first, and ending at a very short interval from the caudal, commencing at first low and attaining its greatest height somewhat suddenly, from thence sloping gradually off to near the commencement of the caudal, its height about one-sixth part the length of its base. Caudal truncated, commencing at first low and then gradually expanding; pectoral and anal fins wanting. Colour of the back and sides greenish marbled with dark brown; beneath of a yellowish tinge. Skin perfectly smooth, without scales.

The Lamprey is a migratory fish; it leaves the sea early in the spring, and enters the large rivers to spawn, and after this process is accomplished, it returns again to its natural residence some time in autumn. According to Yarrell, " it has a very extensive geographical range. It is found in the Mediterranean, and from thence northwards in most of the rivers in Europe as far as Scandinavia, during spring; it appears to be common in the rivers of North America, attaining a larger size in those of the more southern states, but not exceeding seventeen or twenty inches in length in a high northern latitude. Dr Mitchell also includes this species among his fishes of New York. It is rather common during spring and summer in some of the rivers on the southern coast of England, particularly the Severn, and is found in smaller numbers in several of the rivers in Scotland and Ireland about the same period of the year." In the month of May, Lampreys are considered in perfection as food, when numbers are prepared in various ways for the table, but after June they lose the firmness of their flesh, and become soft and unwholesome. The death of Henry the First was occasioned by eating lampreys, probably when out of season. Pennant informs us that it has been an old custom for the city of Gloucester, annually to present his Majesty with a lamprey pie covered with a large raised crust.

Above Alloa in the Forth, where these fish are not uncommon, the fishermen, when they accidentally take them in the nets, invariably return them again to the water, having a prejudice against them. They are consequently never, under any circumstances, seen in the Edinburgh markets. The lamprey and the other species belonging to this genus have the habit of fixing themselves by suction to stones and other solid bodies; by the same means they attack the largest fishes, pierce and devour them.

Petromyzon fluviatilis.*—The River Lamprey.

Specific Characters.—Second dorsal and caudal fins uniting; body dusky blue.

Description.—From a specimen nine inches in length. Body nearly of equal size for two-thirds of its length, gradually tapering to the end of the tail; head indistinct; mouth oval, when expanded it becomes circular; lip fleshy, minutely fringed at the inner margin, armed on the inside with a number of yellowish, conical, tooth-like, projections; on the under surface is a semicircular bone with seven long, slender, sharp-pointed teeth directed downwards and forwards; on the roof of the mouth are two triangular bony projections set a little apart from each other, pointing downwards and inwards; tongue rough; eyes moderate; branchial openings seven on each side of the neck, arranged in an oblique line from the lower part of the eye back-

* *Petromyzon fluviatilis*, Auctorum.

wards; between and a little in front of the eyes, is a small aperture through which the water escapes. Dorsal fins two, distinctly separate, somewhat of a triangular form, the first considerably smaller than the second, and situated about mid-way between the tip of the tail and the third branchial opening; the height about one-sixth the length of the base. Second dorsal commencing at a short distance from the termination of the first, beginning at first low and attaining its greatest height rather suddenly, from thence gradually sloping off and uniting with the caudal: pectorals and ventrals wanting; caudal cut obliquely above and below, terminating in a point; skin perfectly smooth. Colour above of a dusky blue, beneath silvery white.

This species of Lamprey is met with in much greater numbers in some of the rivers in England, such as the Thames, the Severn, and Dee, than in any of the rivers either in Ireland or Scotland. It was formerly a fish of considerable importance. "It was taken in great quantities in the Thames from Battersea Reach to Taplow Mills, and was sold to the Dutch as bait for the turbot, cod, and other fisheries. Four hundred thousand have been sold in one season for this purpose, at the rate of forty shillings per thousand. From five pounds to eight pounds the thousand have been given; but a comparative scarcity of late years, and consequent increase in price, has obliged the line fishermen to adopt other substances for bait. Formerly the Thames alone supplied from one million to twelve thousand Lamperns annually."* These fish are frequently observed in some of the larger rivers entering the Firth of Forth, and specimens are occasionally seen in the Firth itself; but as the fishermen place no value on them either as bait or for food, they remain totally disregarded. Some authors suppose, that the River Lamprey is a migratory species, ascending the rivers in spring and returning again to the sea after spawning; but Mr Yarrell is induced to believe that

* Yarrell's *British Fishes*.

it generally remains all the year in the fresh water, as specimens can be obtained in the Thames all the year through. It has been conjectured by some, that this species, as well as the last described, had both sexes united in the same individual, but this is now satisfactorily proved not to be the case. They spawn in the month of May, and are in the best condition for the table from October to March.

Petromyzon Planeri.*—Planer's Lamprey.

Specific Characters.—Dorsal fins contiguous, second dorsal uniting with the caudal.

Description.—From a specimen five inches in length. In form it very much resembles the Lampern, but rather thicker in proportion to its length; head bending slightly, falling obliquely from the summit; mouth of an oval form, circular when expanded; placed at the extremity; lip thickly fringed, furnished on the inner surface with a number of small, yellowish tooth-like projections with pointed summits; a large semicircular tooth below with seven small sharp points directed forwards; on the roof of the mouth one tooth with two remote points directed downwards. Eyes rather large of a rounded form, situated about half-way between the tip of the snout and the fourth branchial opening; head indistinct, a small nasal orifice placed on the summit a little in advance of the eyes. Branchial openings seven on each side of the neck, arranged in a line commencing at a short distance behind the lower portion of the eye, taking an oblique direction backwards and slightly downwards. Colour of the back and sides dusky blue; belly of a dirty silvery-white; fins light dusky grey. First dorsal fin commencing mid-way between the tip of the snout and the end of the tail, somewhat of a semicircular form, terminating by uniting with the second dorsal; its height about one-third the length of its base. Second dorsal about twice the size of the first and similar in shape, but reaching its greatest height rather more suddenly. Caudal contiguous with the termination of the second dorsal; cut obliquely both above and below, and ending in an obtuse point; body marked throughout the whole length with a number of fine lines passing from above downwards. Vent situated immediately under the middle of the anterior half of the second dorsal, and furnished with a prominent fleshy tubercle in front; skin everywhere smooth.

* *Petromyzon planeri*, Yarr., Jen., Cuv. *Planer's Lamprey. Fringed-lipped Lamprey.*

This species of Lamprey closely resembles the Lampern both in its appearance and habits, and from having a number of external openings placed along the sides of the neck, has been improperly named the *nine-eyed eel*. It, however, is readily distinguished from the lampern in the two dorsal fins being contiguous, whereas in the lamperns these fins are widely apart. Planer's Lamprey is occasionally met with in the Forth, the Teith, and the Allan, besides in several other rivers in Scotland. Mr Yarrell has obtained it from a brook in Surrey, and he also received specimens from Lancashire which measured nearly eight inches in length. It appears to be a common fish in the rivers of Sweden, where it spawns in April and May.

GENUS *AMMOCŒTES*.—Seven branchial openings on each side of the neck; mouth without teeth; upper lip semicircular, covering only the upper part and sides of the mouth.

AMMOCŒTES BRANCHIALIS.*—THE PRIDE.

Description.—From a specimen rather more than two and a half inches in length, and somewhat thicker than a common earth-worm of equal length. The anterior part of the body, as far as the first dorsal fin nearly of equal diameter, from thence gradually tapering to the end of the tail where it terminates in a sharp point. Eyes small, scarcely apparent; branchial openings seven on each side of the neck, arranged in a row running backwards and slightly downwards; orifice of the mouth somewhat of a square form; upper lip thin and membranous, terminating on each side in a free truncated lobe; under lip transverse; "mouth without teeth, but furnished with numerous short membranous cirri." Dorsal fins two, not very apparent, the first taking its origin, half-way between the tip of the tail and the end of the snout, and terminating a little in front of the second dorsal; the length of its base six or seven times greater than

* *Ammocœtes branchialis*, Cuv., Yarr., Jen., Flem. *Petromyzon branchialis*, Linn., Penn. *Pride*, *Sand-Pride*, *Sand-prey*, *Mud-Lamprey*.

its height; second dorsal rather longer and more elevated anteriorly, sloping gradually to be continuous with the caudal; vent placed a little behind the commencement of the second dorsal; skin smooth, marked with a number of fine lines placed at equal distances, which encircle the body throughout its whole length.

The Pride was first discovered by Dr Plot in the Isis, and was formerly considered to be peculiar to the rivers near Oxford, where it is said to be of frequent occurrence. It is also found in many parts of England, and is a common species in some of the rivers of Scotland, particularly in the Forth and Tweed; but its habit of concealing itself in soft mud from which it seldom emerges, seems the principal cause of its not being more frequently met with. It spawns about the beginning of May, and is said to feed upon worms, insects, and dead animal matter.

As these sheets were passing through the press, the author, at the request of the Society, has included his most recent discoveries, so as to make the list of fishes found in the Firth of Forth complete, up to the present period. The number of species enumerated amounts to one hundred and twenty-five, about forty of which have been added by himself from personal observation, and six of these had not previously been recorded as British.* One hundred and sixty preserved specimens were exhibited as illustrative of the essay, and some of the rarer species have since been presented to the Society's Museum.

* The author has lately discovered four other fishes new to Britain, which are not included in Mr Yarrell's work on the British Fishes, viz. *Gobius albus*, Trans. Roy. Soc. Edin. 1837. *Trigla lucerna*, and *Monochirus minutus*, Zool. Bot. Mag. vol. i. *Coregonus microcephalus*, Ann. Nat. Hist. No. iii.

The following new British fish was obtained after the preceding sheets had passed through the press; it holds a rank in the genus *Motella*. See page 353.

MOTELLA CIMBRIA.*—THE FOUR-BEARDED ROCKLING.

Specific Characters.—Snout with three barbules, and one on the chin. (Plate XLIV.)

Description.—From a specimen fourteen inches in length. Form closely resembling that of the Five-bearded Rockling, but the length of the head somewhat greater compared to that of the body. Body elongated, rounded in front, compressed behind, tapering from the vent to the caudal extremity; greatest depth less than the length of the head. Head one-sixth of the entire length, caudal fin included, slightly depressed; snout blunt, projecting considerably beyond the under jaw; eye large, of an oval form, placed high up, and about its own length from the point of the snout; operculum rounded, oblique; gill-opening large; gape wide; maxillary extending in a line with the posterior margin of the orbit; *teeth* sharp and fine, situated in two rows in the under jaw, and in five rows in the upper; a few are also placed in a cluster on the anterior part of the vomer; *barbules* four, one a little in front of each nostril, one at the extremity of the upper lip, and one on the chin; tongue fleshy, smooth, and without teeth. Fins.—First dorsal obsolete, scarcely discernible, commencing over the operculum, and terminating a little in front of the second dorsal, composed of a number of short, fine, capillary rays, of which the first is the largest, presenting an appearance, according to Linnæus, of the letter T, but this latter character I was unable to recognise in the present example, owing to that ray having been somewhat destroyed previously to the fish coming into my possession; second dorsal taking its origin in a line over the ends of the pectorals, and terminating a little in advance of the caudal, the anterior portion nearly of equal height, the rays in the posterior half, more sensibly increasing in length to the last but four, from thence rapidly diminishing, the first ray simple, the rest branched; anal, commencing in a line under the twelfth ray of the second dorsal, and ending under the last ray but three of the same fin, in form similar to the second dorsal, but the rays scarcely more than one-half the length, the first ray simple, the rest branched; caudal rounded at the extremity, the length of the middle rays equalling the space between the first and twelfth rays of the anal, the lateral rays simple; ventrals jugular, the second rays the longest, about two-thirds the length of the pectorals; pectorals rounded at the extremities, equalling the

* *Gadus cimbrius*, Linnæus.

length of the caudal, the first rays stout and simple, the rest branched. The fin rays in number are—

1st D. 50; 2d D. 50; P. 16; V. 5; A. 43; C. 20; Vert. 52.

Scales small, smooth and adherent, covering the head, body, and membranes of the dorsal, caudal and anal fins; lateral line distinct, formed by a number of oval depressions placed at intervals from each other, commencing over the operculum, taking a bend under the ninth, tenth, and eleventh rays of the second dorsal fin, from thence running straight to the middle ray of the caudal. Colours.—Back and sides of a greyish-brown, belly dirty white; second dorsal fin edged with white, which is more apparent towards the caudal end; upper half of the caudal tipped with white; pectorals, caudal, and lower part of the dorsal dark brown, approaching to black; anal and ventrals dusky.

Two well known species of *Motella* are frequently met with on our coasts, the *Motella quinquecirrata*, and the *Motella vulgaris*, but I am not aware of the *Motella cimbria* (*Gadus cimbrius* of Linnæus), having previously been noticed as a British fish. It was found in June last, a little to the east of Inchkeith, on a haddock line baited with muscles, and sent me by the fishermen of Newhaven, as being the only fish of the kind they had ever met with. From its general appearance, they at once recognised it to be closely allied to the Five-bearded Rockling (*Motella quinquecirrata*), a common species throughout the coast; but, on comparison, the differences between them were obvious, and although the two fishes do disagree in some particulars, yet it is difficult to point out accurately and satisfactorily to those who are not in the habit of handling them, what these particulars are. Some authors, placing no dependence, as a character, on the number of barbules on the snout, and consider the Five-bearded Rockling and the Three-bearded Rockling as mere varieties; but this is not admitted either by Mr Yarrell or by Mr Jenyns, who very justly consider them as deserving of a place as distinct species in their valuable works on British Ichthyology. The Four-bearded Rockling, according to Linnæus, occurs in the

Atlantic and Norway seas, and is distinguished by the first ray of the anterior dorsal fin presenting the form of the letter T. On dissecting the specimen, I found the stomach filled with shrimps and small crabs. The cæcal appendages were few in number; the roe was large, the ova small and numerous, and apparently in a fit state to be deposited. It is probable that the habits of this fish are similar to those of the other species, but from its rarity it is difficult to determine.

The *Motella cimbria* differs from the *Motella quinquecirrata* in the following respects;—In the snout having but three barbules; the head one-sixth of the whole length; the teeth sharp and slender, placed in two rows in the under jaw; the eye large, of an oval form; the snout much produced; the gape wide; from the point of the snout to the posterior extremity of the maxillary, from thence to the origin of the pectoral, equal; the lateral line very distinct; the tips of the upper half of the caudal rays white; the second ray of the ventral fin but slightly produced; the rays in the anterior half of the second dorsal, nearly double the length of those of the anal:—whereas in the *M. quinquecirrata* the snout is furnished with four barbules; the head one-sixth the length as far as the base of the caudal fin; the teeth blunt and stout, placed in three rows in the under jaw; the eye small, nearly circular; the snout but slightly produced; the gape rather small; from the point of the snout to the posterior extremity of the maxillary, from thence to the origin of the ventral, equal; the lateral line very indistinct; the caudal fin of a uniform brown; the second ray of the ventral fin much produced; the rays in the anterior half of the second dorsal about equal the lengths of those of the anal.

The form and arrangement of the teeth in this species are very striking.

In the Magazine of Natural History, for January 1838, No. xiii, is the following notice of the Argentine (*Scopelus Humboldtii*) in the Firth of Forth, by Dr W. B. Clarke, of Ipswich.

"I discovered this highly elegant little fish, whilst looking amongst the various bodies cast up by the water at Portobello, and observed it lying entangled in some sea-weed which had been accumulated in masses, and left by the retiring tide. The fish was dead, but from its freshness could not long have been so.

"In the Animal Kingdom of Cuvier, translated by Griffith, we have the following description of the genus.

'SCOPELUS, *Cuv*—SERPES of *Risso.*

'Mouth and gills extremely cleft; the two jaws furnished with very small teeth; the edge of the upper entirely formed by the intermaxillaries; the tongue and palate smooth. Their muzzle is very short and obtuse; there are nine or ten rays to the gills; and besides the usual dorsal, which corresponds to the interval of the ventrals and the anal, there is another very small one behind in which the vestiges of rays are perceptible.'

"These fishes are caught in the Mediterranean intermingled with the anchovies, and they are there called Melettes, as are other small fishes. One of them, the *Serpes Humboldtii*, Risso pl. x. fig. 38, is remarkable for the brilliancy of the silvery points which are distributed along the body and tail.

"Mr Yarrell in his valuable work upon the British Fishes states, 'Pennant and the Rev. Mr Low of Orkney, appear to be the only British observers who have met with, on our shores, examples of this brilliant little fish, which Cuvier considers as belonging to the genus *Scopelus.*' Pennant's specimen was taken in the sea, near Downing in Flintshire; Mr Low's fish was brought to him by a boy, who said he found it by the edge of the water amongst sea-weed. The receipt of an additional portion of MS. recently confided to me by William Wolcott, Esq., furnishes a notice written by his father, of a third instance of the occurrence of the Argentine, which was found stranded on the shore near Exmouth. Pennant's description agrees in many respects with my fish; the *figure* contained in Mr Yarrell's work, which was taken from Pennant's, differs very materially about the head and the tail, although it resembles it in the form of the body. If Pennant's *figure* be an exact representation, the fish it was taken from was certainly a different species from the one under description. Pennant describes his as follows, viz. 'Length two inches and a quarter; the eyes large; irides silvery; the lower jaw sloped much; the teeth small; body compressed and of an equal depth, almost to the anal fin; tail forked; back was of a dusky green; the sides and covers of the gills as if plaited with silver; the lateral line was in the middle and quite straight; on each side of the belly was a row of circular punctures, above them another which ceased near the vent.'

"My specimen would correspond with the above, except the following; viz. Length one inch and fifteen-sixteenths; the back of a dense blue-black, presenting in certain lights a brownish tinge; lateral line central and straight, but inclining upwards, at about its anterior sixth towards the upper angle of the operculum.

"The number and arrangement of the *guttæ*, in the specimen under consideration, are as follows; viz. On each side, upper series between *os hyoïdes* and origin of pectoral fin, five; upper abdominal series between base of pectoral and a spot perpendicularly over the ventral, nine; lower abdominal series, from a spot perpendicularly beneath the posterior margin of orbit to base of ventral, twelve; between base of ventral and commencement of anal, six; the two anterior directed downwards and backwards; the *four posterior* forming an arch from a little above the second gutta to the commencement of the anal fin ; one large gutta in a line with the upper abdominal series is placed slightly anterior, but above the commencement of anal fin ; between the anterior commencement of anal and base of caudal twenty-four, but between the eighth and ninth from the caudal fin there is a space where a spot appears to have been obliterated. About midway between the anterior commencement of the dorsal and base of caudal, but rather nearer the latter, there is a slight elevation where apparently the fleshy fin has its origin ; but in the specimen under description it is scarcely perceptible, being, even with the aid of a lens, only like a slight membranous ridge.

" The formula of the fin rays appears to be, D. 9; P. 17 ; V. 8 ; A. 20 ; C. 18.

" Mr Yarrell's formula is, D. 9 ; P. 17 ; V. 8 ; A. 15 ; C. 19.

" Mr Yarrell remarks, ' the figure of this fish referred to in Risso's work, represents the anal fin as containing many more rays than are represented in the figure of Pennant.' The fish obtained by me possesses more rays than Pennant's would appear to have had, judging from the figure which he has published.

" Length of head compared with whole length of fish as one to four ; diameter of eye to length of head as one to three ; first dorsal fin commences midway between end of nose and tail ; depth of body to whole length of fish, as one to five and a half ; nostrils double, situated in a depression midway between the eye and centre of intermaxillary bone. The *operculum* is extremely large, and appears to be developed at the expense of the free operculum, which is very small, and joins the former by a straight moveable suture running in a line perpendicularly downwards from posterior margin of the orbit ; it forms an obtuse angle triangle with the obtuse angle pointing downwards and backwards; the sub-orbital bone occupies the anterior inferior half of the orbit, and is of a beautiful argenteous lustre, like the *operculum*. There are five oval spots forming a fan-shaped figure, occupying the space between the anterior ridge of the superior maxillary bone, and the anterior inferior angle of the preoperculum beneath the suborbital bone, and distinctly seen through the transparent intermaxillary bone which is very large. There is one *gutta* upon the *preoperculum* at its anterior inferior angle of the suboperculum; there is no appearance of branchiostegous rays whilst the opercula are closed.

"The sides of this elegant little fish are of the most resplendent argenteous lustre; the guttæ are of a dense opaque white, and round their margin, especially along the sub-caudal series, there is a steel-blue tinge, giving that part of the body a very beautiful appearance. The upper abdominal series have an arched appearance, from this tinge not being continued round the inferior margin of the *guttæ*. The back of the specimen under description, which has been in spirit ever since its capture, is of a dense blue-black, presenting, in certain lights, a brownish tinge. From specimens of this fish having been found in the above localities, viz. in the sea near Flintshire, on the shore in Orkney, in Devonshire, and, lastly, in Edinburghshire, we may infer that it is generally, although sparingly, diffused through the British seas. Probably ere long we may hear of other examples of its occurrence upon our shores, or in our seas; for I am convinced that, from the admirable character of Mr Yarrel's work, it will have the effect of exciting such an interest in the inhabitants of the boundless deep, that many interesting facts respecting the ichthyology of our seas will soon be brought to light, which, but for such a publication, would have remained unrecorded, perhaps unnoticed."

DR PARNELL'S ARRANGEMENT OF THE FISHES OF THE FIRTH OF FORTH, which, by a simple analysis of character, facilitates the Naming of the different Species:—for example, the *Lamprey* (Petromyzon) having seven branchial openings on each side, is referred from Division 1. to Division 64, under which number the reader finds it distinguished from Ammocœtes by the presence of teeth.

Division.			Page.
1.	One branchial opening on each side*............ 2		
	Five branchial openings on each side†.......... 56		
	Seven branchial openings on each side‡......... 64		
2.	Ventral fins wanting................................ 3		
	Ventral fins present................................. 9		
3.	Dorsal and caudal fins contiguous................ 4		
	Dorsal and caudal fins separate:.................. 6		
4.	Body very much elongated, eel shaped.......... 5		
	Body oval, truncated behind........................	*Orthagoriscus.*	401
5.	Under jaw longest....................................	*Anguilla.*	384
	Under jaw shortest...................................	*Conger.*	388

* The branchial or gill-opening is in general a large aperture situated on each side of the neck, and covered by a thin osseous plate or gill-cover, as in the *Herring* (Clupea), *Trout* (Salmo), &c.; sometimes we find it reduced to a small orifice on each side of the nape, as in the *Pipe-Fish* (Syngnathus), *Dragonet* (Callionymus), &c.; occasionally it is an opening above the base of the pectorals, as in the *Sun-Fish* (Orthagoriscus); sometimes, as in the *Eel* (Anguilla), it is an opening of an oval form in front of the lower part of the base of pectorals; at other times again it is in the form of a large opening concealed behind the pectorals, as in the *Angler* (Lophius).

† These openings are either placed along each side of the neck, as in the *Shark* (Squalus), or on the under surface of the body as in the *Skate* (Raia).

‡ These are always in a longitudinal series on each side of the neck, as in the *Lamprey* (Petromyzon).

Division.			Page.
6.	Caudal fin forked	7	
	Caudal fin not forked	8	
7.	Under jaw longest	*Ammodytes.*	399
	Under jaw shortest	*Xiphias.*	215
8.	Teeth very strong and prominent	*Anarrhichas.*	230
	Teeth wanting	*Syngnathus.*	394
9.	One dorsal fin	10	
	More than one dorsal fin*	34	
10.	Both eyes on the same side of the head	11	
	One eye on each side of the head	14	
11.	Caudal fin rounded at the extremity	12	
	Caudal fin crescent-shaped at the extremity	*Hippoglossus.*	372
12.	Eyes on the right side of the head	13	
	Eyes on the left side of the head	*Rhombus.*	373
13.	Dorsal and caudal fins separate	*Platessa.*	361
	Dorsal fin reaching quite to the caudal	*Solea.*	378
14.	Dorsal fin commencing before or over pectorals.	15	
	Dorsal fin commencing remote from pectorals.	25	
15.	Caudal fin forked	16	
	Caudal fin not forked	18	
16.	Teeth present	17	
	Teeth wanting	*Lampris.*	223
17.	Anterior part of the dorsal fin without scales	*Pagellus.*	203
	Anterior part of the dorsal covered with scales	*Brama.*	209
18.	Chin with a long barbule	*Brosmius.*	357
	Chin without a barbule	19	
19.	Anal and caudal fins not contiguous	20	
	Anal and caudal fins contiguous	24	

* The first dorsal fin is sometimes very small and composed of fine rays which make it liable to be overlooked, as in the *Tadpole Fish* (Raniceps), *Rockling* (Motella), &c.; the first dorsal fin in the *Angler* (Lophius), is rather inconspicuous; the *Dory* (Zeus) has but one dorsal fin which is deeply abbreviated in the middle, appearing at first sight as if two fins; the *Stickle back* (Gasterosteus), I have here considered as having but one dorsal fin; in the *Salmonidæ* the second dorsal, or adipose fin, is without rays and ituated over the posterior part of the anal fin.

Division.			Page.
20.	Membranes of the anterior part of the dorsal fin terminating in loose filaments	21	
	Membranes of the dorsal fin entire	23	
21.	Preoperculum entire	22	
	Preoperculum denticulated	*Crenilabrus.*	259
22.	Base of the dorsal fin without spines	*Labrus.*	256
	Base of the dorsal with a series of forked spines.	*Zeus.*	220
23.	Teeth in one row only in each jaw	*Blennius.*	233
	Teeth in two rows in front of each jaw	*Murænoides.*	235
24.	Ventrals united in the form of a concave disk...	*Liparis.*	383
	Ventrals separate	*Zoarces.*	237
25.	Dorsal fin situated over the anal fin	26	
	Dorsal situated over the ventrals or nearly so..	31	
26.	Mouth placed underneath, without teeth	*Acipenser.*	403
	Mouth placed at the extremity, with teeth	27	
27.	Three or more spines in front of the dorsal fin.	*Gasterosteus.*	190
	No spines in front of the dorsal fin	28	
28.	Caudal fin forked	29	
	Caudal fin not forked	*Cyclopterus.*	380
29.	Dorsal fin with finlets	*Scomberesox.*	276
	Dorsal fin without finlets	30	
30.	Length of dorsal fin exceeding twice its height.	*Belone.*	274
	Length of the dorsal about equalling its height.	*Esox.*	272
31.	Snout with barbules	*Cobitis.*	270
	Snout without barbules	32	
32.	Tongue rough with minute teeth	*Clupea.*	315
	Tongue smooth without teeth	33	
33.	Central line of the belly very rough, strongly serrated	*Alosa.*	329
	Central line of the belly smooth	*Leuciscus.*	268
34.	Two dorsal fins	35	
	Three dorsal fins	55	

Division.			Page.
35.	Second dorsal fin adipose, without rays.........	36	
	Second dorsal fin not adipose, with rays.........	37	
36.	Anal fin with fewer rays than the first dorsal....	*Salmo.*	278
	Anal fin with more rays than the first dorsal....	*Osmerus.*	312
37.	Caudal fin forked..	38	
	Caudal fin not forked.....................................	45	
38.	Dorsal fins wide apart	39	
	Dorsal fins approximate	41	
39.	Second dorsal fin without finlets	40	
	Second dorsal fin with five finlets	*Scomber.*	210
40.	First dorsal fin with eight rays......................	*Atherina.*	230
	First dorsal fin with four rays.......................	*Mugil.*	225
41.	Second dorsal fin with eight finlets...............	*Thynnus.*	213
	Second dorsal fin without finlets...................	42	
42.	Tongue smooth, without teeth........................	43	
	Tongue rough, with teeth..............................	*Labrax.*	170
43.	Three detached rays at base of each pectoral.	*Trigla.*	174
	No detached rays at the base of the pectorals.	44	
44.	Anal fin with twenty-seven rays..................	*Caranx.*	217
	Anal fin with ten rays..................................	*Perca.*	168
45.	Ventral fins united together.........................	*Gobius.*	240
	Ventral fins separate....................................	46	
46.	Ventral fins situated before the pectorals.......	49	
	Ventral fins situated behind the pectorals......	47	
47.	Vomer without teeth......................................	48	
	Vomer with teeth in front..............................	*Cottus.*	183
48.	Body with large scales, snout without spines...	*Sciæna.*	200
	Body with osseous plates, snout with spines...	*Aspidophorus.*	188
49.	A large opening behind each pectoral fin.......	*Lophius.*	253
	No opening behind the pectorals..................	50	
50.	Chin with a barbule.......................................	51	
	Chin without a barbule..................................	53	

Division.			Page.
51.	From two to four barbules on the nose	*Motella.*	354
	Nose without barbules..............................	52	
52.	First dorsal fin with three rays....................	*Raniceps.*	359
	First dorsal fin with fifteen rays..................	*Lota.*	352
53.	Ventrals smaller than the pectorals..............	54	
	Ventrals larger than the pectorals................	*Callionymus.*	248
54.	First dorsal fin with five rays......................	*Trachinus.*	172
	First dorsal fin with nine rays......................	*Merlucius.*	350
55.	Chin with a barbule....................................	*Morrhua.*	333
	Chin without a barbule	*Merlangus.*	342
56.	Branchial openings on the under surface	63	
	Branchial openings on the sides of the neck...	57	
57.	Anal fin wanting..	58	
	Anal fin present..	59	
58.	A sharp spine in front of each dorsal fin........	*Spinax.*	420
	Dorsal fins without spines..........................	*Squatina.*	421
59.	Temporal orifices wanting...........................	*Lamna.*	413
	Temporal orifices present...........................	60	
60.	First dorsal fin situated behind the ventrals....	*Scyllium.*	407
	First dorsal fin situated before the ventrals....	61	
61.	Teeth very blunt...	*Mustelus.*	416
	Teeth very sharp..	62	
62.	Teeth denticulated on the outer side only......	*Galeus.*	414
	Teeth entire, not denticulated.....................	*Selachus.*	418
63.	Tail with fins..	*Raia.*	424
	Tail without fins...	*Trygon.*	440
64.	Teeth present...	*Petromyzon.*	442
	Teeth wanting..	*Ammocœtes.*	447

APPENDIX.

HISTORY OF THE SOCIETY.

(Continued from Vol. VI. p. 581.*)*

TWENTY-FIFTH SESSION.

ROBERT STEVENSON, Esq. Vice-President, in the chair.—The Secretary read a letter, communicated by Dr Gillies, from the lady of an officer at Malta, containing a sketch of the new volcanic island, and mentioning some remarkable particulars regarding a recent earthquake at Samos.—Professor Jameson then communicated some interesting facts regarding the new volcanic island, contained in a letter from one of his correspondents. He next made observations on the following subjects :—1. The occurrence of what was called a "Shower of Manna" in Persia; and exhibited specimens of the substance that fell, and which he stated to be a kind of lichen, which being loosely attached to rocks, trees, or the soil, had been carried up into the air by whirlwinds. 2. The discovery by one of his pupils, of a very extensive bed of ligneous debris, near the city of Rome, and which, in primeval times, had constituted a forest there. 3. The ascertainment of the fact, that, in the mines of Freyberg, the temperature uniformly increases with the depth of the mine, 1831. Dec. 10.

proving that there is an internal source of heat. 4. The notice of a species of Cæsalpinia, the pods of which are fully equal to oak bark, for the purposes of tanning. Lastly, The Professor gave an account, which he illustrated by sketches, of observations made by Dr Alexander Turnbull Christie, on the caves of Sicily.—The Rev. Dr Scot of Corstorphine then read an essay on the Oreb, or Raven of the English translation of the Bible.—Dr Gillies read an extract from a Buenos Ayres newspaper, dated 2d April 1831, giving an account of the liberation and welfare of M. Bonpland, the botanical companion of Alexander von Humboldt in South America.

1831. Dec. 24. Professor Graham, Vice-President, in the chair.—Mr Neill read a notice regarding a specimen of Siren lacertina, which had been kept alive for more than six years past at Canonmills, near Edinburgh.—Mr James Wilson made some remarks on the allied batrachian reptiles; and Professor Necker of Geneva being present, mentioned his having kept a specimen of the Proteus anguinus, from the caves of Carniola, in a well at his garden at Geneva, for about six years, where it increased in size, but became dark coloured, instead of flesh-coloured as in its native recesses.

1832. Jan. 28. Robert Stevenson, Esq. Vice-President, in the chair.—The Secretary read a notice regarding some of the rarer plants found native in the counties of Dumfries and Galloway; communicated by Mr Lloyd.—The Rev. Dr Scot of Corstorphine, read an essay on the species of dog mentioned in the Bible.—Professor Jameson then laid before the meeting a series of meteorological observations made at Inverness, and the description of a simple rain-gauge, calculated to measure the fall to the ten-thousandth part of an inch; communicated by Mr Mathew Adam, Rector of the Academy of Inverness.—Mr Blackley, who had spent a considerable time in Greenland, exhibited some curious drawings of Greenland scenery, taken by him on the spot.—A specimen of the Lammergeyer of the Himalaya Mountains, was placed on the table.

David Falconar, Esq. formerly Vice-President, in the chair. 1832. Feb. 25.
—Professor Jameson read a letter from Captain Alexander, dated Washington, containing interesting notices of his late extensive journeys through North and South America. He also read a letter by Arthur Connell, Esq. on the action of the iodic acid and iodine on vegetable colours.—The Secretary read a communication from W. C. Trevelyan, Esq. regarding a Roman monument found in the county of Durham, the inscription on which commemorates the capture of a remarkable wild boar.—A fine specimen of the chamois was placed in the room, for the inspection of members; and Mr Hay exhibited some curious obsidian heads, and Terra Cotta ornaments, the work of the ancient Mexicans, brought home by him from the neighbourhood of the Pyramids, twelve leagues from the city of Mexico.

David Falconar, Esq. formerly Vice-President, in the chair. March 10.
—Professor Jameson read an account of a very interesting collection of fossil bones received by him from the caves of Wellington Valley, in New Holland; and communicated the results of an examination of these bones by Baron Cuvier and Mr Pentland, for whose inspection they had been sent from Edinburgh to Paris. The Professor also communicated an analysis of a peculiar product of a recent eruption of Vesuvius, made by Dr William Gregory, lecturer on chemistry. —The Secretary read a notice by Mr Macadam of Plymouth, regarding the very indestructible quality of the timber of the Zygophyllum arboreum of Carthagena.—A specimen of the gazelle of Africa was exhibited; and it was mentioned that the animal had died at the seat of Lord Rothes, in Fifeshire,

where two or three gazelles still survived, having been sent to his Lordship from Tripoli.—A parrot and a humming-bird from Terra del Fuego were also shewn, proving that Bougainville was correct when he reported, in his Voyage, that birds of these tribes were to be found in that inhospitable climate, though his accuracy in this respect had been impugned.—Some facts relative to the disappearance of the new volcanic island near Sicily, were laid before the Society.

1832. March 31. Robert Bald, Esq. formerly Vice-President, in the chair.—The Rev. Dr Scot read an essay on the topaz of the ancients.—Dr Greville (for the Secretary) read remarks on the climate of Bengal, contained in a letter from George Macritchie, Esq. to Professor Jameson, accompanied by meteorological tables kept by Mr Macritchie during his residence in India.

April 21. Dr Charles Anderson, formerly Vice-President, in the chair.—The Secretary read a communication from the Rev. James Farquharson of Alford, on the signal destruction of bees by the Motacilla alba.—There was exhibited specimens of lava and scoriæ from Graham's Island, sent home by Dr Davy.

TWENTY-SIXTH SESSION.

1833. Feb. 9. Professor Graham, Vice-President, in the chair.—Professor Jameson read a communication from Lord Greenock, on the silicification of organic bodies; with a notice of the discovery of fossil teeth in the red sandstone at Paxton, in Berwickshire; illustrative specimens were laid on the table.—The Secretary then read a paper communicated by Mr Macgillivray, on the characters and habits of the rock-dove of the Outer Hebrides.—Specimens of the hawfinch, Corythus enucleator, recently shot at Drumlanrig, were exhibited to the meeting.

1833. March 23. Mr Wilson read a paper by himself on the natural history of the glow-worm; a colony of which, found in the neighbourhood of Edinburgh, he had made the subject of particular observation. He pointed out the change of habits, in regard to food, which takes place among these insects, at a certain period of their transformation, the larvæ being predaceous, or attacking living prey, particularly minute testacea, and other mollusca, while the perfect insects are herbivorous.—A communication by Mr Macgillivray was then read, regarding the occurrence of a flock of foreign water-fowl, the Anas Ægyptiaca, on the eastern coast of Scotland; but the author suggested the possibility of these birds having strayed from Lord Wemyss's pleasure-grounds at Gosford; and that the present instance could not therefore, with certainty, be regarded as illustrating the natural migration of the species. A drawing was exhibited of the leader of the flock, which had been shot by Captain Sharpe.—An extensive and valuable series of highly finished representations of the indigenous animals of Great Britain, chiefly quadrupeds and birds, by Mr Macgillivray, was also exhibited to the meeting. Professor Jameson pointed out that their peculiar excellence consisted in their combining, with great beauty of pictorial effect, a more accurate representation of the forms of the crania, as always identical in the young and old of the same species,—an important particular, greatly neglected by ornithological draughtsmen; and also in there being less mannerism in the general treatment of the plumage, the characteristic form and texture of the feathers of each species being particularly attended to by Mr Macgillivray.

R. Jameson, Esq. President, in the chair.—A communication from Dr Scouler of Glasgow was read, giving an account of the discovery during last autumn (1832) of two specimens of the Sorex remifer of Geoffroy, in the vicinity of that city. They differ from the water-shrew in being of a larger size; of a deep velvet-black on the back and sides, and a ferruginous brown beneath, with the tail rounded at its origin, but compress- April 20.

ed towards the extremity ; the toes ciliated. The most obvious character seems to be the very flat nose or snout, which resembles that of the Chrysochloris capensis. The Sorex remifer was detected many years ago in Norfolkshire by Dr Hooker, and was figured by the late Mr Sowerby in his Miscellany, under the name of *Sorex ciliatus ;* but this is quoted in Dr Fleming's work on British Animals, as a synonime of *S. fodiens*.

TWENTY-SEVENTH SESSION.

1833. Dec. 14. Dr Charles Anderson, Vice-President, in the chair.—Mr Nicol's observations on the structure of recent and fossil coniferous trees were read, and illustrated by an extensive suite of specimens.—Dr Hibbert then exhibited a splendid fossil tooth, which he and Mr Witham had procured at a newly opened bed in the limestone quarries at Burdiehouse, three miles south of Edinburgh. The Doctor described the interesting relic as the tooth of a saurian animal. Professor Jameson remarked that the tooth differed from those of the Gavial, Ichthyosaurus, Plesiosaurus, and such other saurians as he had examined, and said (for reasons which he adduced) he entertained little doubt that the sp endid tooth now exhibited would turn out to belong to an extinct kind of fish. He added, he had a faint recollection of a published figure of a similar fossil tooth, found in the coal-formation in the west of Scotland.—Professor Jameson then exhibited a fossil tooth found in red sandstone, in Berwickshire, by the Right Honourable Lord Greenock ; and assigned reasons for regarding it as the tooth of a fish.

1834. Jan. 18. Professor Graham, formerly Vice-President, in the chair.—Dr Traill read a description of a specimen of the Squalus cornubicus, captured near Kirkwall in Orkney last autumn, and also an account of the different species of shark which occur in the Orkney seas ; and he exhibited a specimen of the angel-fish (Squalus squatina), which he had procured during his late visit to the Orkneys.—The Secretary read a notice regarding a peculiar growth of the Senecio Jacobæa, by J. W. Reddoch, Esq. Falkirk.—Professor Jameson then communicated an analysis, by Mr Walker, of the substance of the fossil tree lately found in the strata of Craigleith Quarry; shewing that, besides lime and alumina, and a comparatively small amount of silica, it contains a considerable proportion of carbonate of magnesia, the last being an ingredient not detected in the fossil trunks previously discovered in the quarry.—Dr Traill exhibited one of his portfolios, containing the figures of some new birds, fishes, &c., and gave some account of them.

Professor Jameson, President, in the chair.—Dr Traill read a memoir of the Rev. George Low, the naturalist of Orkney, and laid before the meeting some of his unpublished sketches and original notes.—Dr Stark, in the absence of his father, read a notice regarding the Mytilus polymorphus of Pallas, a colony of which was lately detected in the Union Canal not far from Edinburgh.—Dr Allen Thomson then communicated remarks on fœtal development in its early stages, and exhibited several specimens of the fœtus of the domestic cat between the thirteenth and fifteenth day; also of the fœtus of the common fowl and swan, and of a double monstrous fœtus of the goose. 1834. Feb. 1.

Professor Jameson, President, in the chair—Dr Thomas J. Aitkin read a memoir on the nerves of smell and hearing in the cod, and illustrated his observations by a demonstration of the nerves, especially the olfactory, in the head of a large specimen of the fish.—Dr John Coldstream then read a paper on the structure and habits of the *Limnoria terebrans*, a small crustaceous animal which destroys wooden erections on our shores; and exhibited sketches of the animal, and specimens of the timber which had suffered from its depredations. Feb. 15.

Dr Robert Kaye Greville, Vice-President, in the chair.—Pro- March 1.

fessor Jameson read a long and interesting letter, addressed to him by Dr Meredith Gairdner, and dated Fort Vancouver, 31st August 1833, containing the details of the observations made by him during a voyage from this country to Columbia River on the north-west coast of America.

1834. March 15. Dr Charles Anderson, Vice-President, in the chair.—The Secretary read Mr William Nicol's additional observations on the structure of recent and of fossil coniferous plants; and Mr Nicol being present, exhibited both drawings and specimens of the sections made by him.—Dr Traill then read a notice of an improved barometer, invented by Mr Henry Leske of Kirkwall, Orkney.—Professor Jameson laid before the meeting, drawings, both magnified and of the natural size, of a small stickleback, having four dorsal spines, apparently undescribed, although found in the ditches of Hope Park, where it was first detected by Mr Stark.

March 29. David Falconar, Esq. formerly Vice-President, in the chair. —The Secretary read Mr Mark Watt's observations on the attractive and repulsive powers of light as exhibited upon metals when in a state of galvanic action; and Mr Watt exhibited his apparatus, and described its mode of action.—The Secretary next read an account of the strata found in excavating Hartlepool Docks, communicated by Mr James Milne, architect, resident engineer there.—Mr George Stevens laid before the meeting a suite of polished specimens of the porphyry and syenite of the great quarries at Elfdalen in Dalecarlia, with outline sketches of vases and other ornaments there constructed of these materials.

April 12. Professor Jameson, President, in the chair.—The Secretary read a letter from Mr J. F. Swan of Douglas, Isle of Man, addressed to Principal Baird, giving a geological account of the spot where the fossil elk now in the University Museum was found.—Dr Greville then laid before the meeting a very characteristic drawing by Mr Price, and a short notice, of a remarkable appearance in the Claydach coal and iron mines, Breconshire, which the Doctor conjectured to be the lower extremity of a gigantic monocotyledonous vegetable. The remains are about ten feet in height, and five feet in diameter.—The Secretary read a letter from Mr James King, Sydney, New South Wales, respecting his discovery of a very pure sand near Sydney, free from metallic or other impurity, and wishing the Society to express its opinion of the importance of this sand as an article of commerce.

Dr Charles Anderson, Vice-President, in the chair.—Mr Neill 1834.
read a notice regarding the discovery, by Mr Walter Calverley April 26.
Trevelyan, of Trichonema Bulbocodium, growing plentifully in sandy turf, on "the Warren," near the mouth of the Exe, Devonshire, evidently a native habitat, and the plant therefore falling to be added to the British Flora.—Professor Jameson read Dr Meredith Gairdner's Physico-Geognostical sketch of Owhyee, the island where Captain Cook was killed, and exhibited various specimens of quadrupeds, birds, and minerals, from that island; and likewise two remarkably compressed skulls of North-west American Indians.—The Secretary read some notices regarding the poisonous toad-fish of Van Diemen's Land; communicated by Dr A. Henderson, R.N.—Dr Greville exhibited the radical leaf of the remarkable monocotyledonous aquatic discovered in Madagascar by the late M. De Petit Thouars, and called Hydrogeton fenestralis, the whole having the appearance of a skeleton-leaf.—Professor Jameson then gave an account of the Rev. Mr O'Heirn's (curate of Ardguine, Portaferry) magnetical experiments, with a description of a new instrument invented by that gentleman, called the magneto-electric ring. The Professor also communicated a table, constructed by Mr Brown of Langfyne, shewing the quantities of rain which fell in 1833 at

fifteen different stations in the west of Scotland, and at Mount Edgecombe in Devonshire. Lastly, Professor Jameson gave an account of the various whales which have been found in the Firth of Forth. He then exhibited two paintings by Mr Townsend, of the Delphinus Tursio, lately stranded on the beach of Portobello.—Dr Traill then read remarks on some of the Cetacea, particularly those which come in herds in the Orkney Seas; and mentioned, that the fact of the young sucking their dams had been repeatedly witnessed by intelligent inhabitants of the islands.

The Society directed that the following circular be printed and circulated:—

"PREMIUMS OFFERED BY THE WERNERIAN NATURAL HISTORY SOCIETY.

"EDINBURGH, 10*th May* 1834.

"The Wernerian Natural History Society offers the following honorary premiums; open unconditionally to all scientific naturalists.

"1. Twenty sovereigns, or a suitable piece of plate of that value, for the best Geological Account, with a Geognostical Map, Sections, and Specimens, of the Three Lothians, with as much of the neighbourhood as may be required for the elucidation of the districts.—To be given in against December 1835.

"2. Ten sovereigns, or a piece of plate of that value, for the best Natural and Economical History of the Fishes, marine, fluviatile, and lacustrine, of the River District of the Forth. A collection of specimens of the fishes will be desirable.—To be given in against December 1835.

"3. Ten sovereigns, or a piece of plate of that value, for the best Account of the Entomology of the Three Lothians, and River District of the Forth; with a collection of specimens, and map of the distribution of the Insects.—To be produced against December 1836.

"4. Ten sovereigns, or a piece of plate of that value, for the best Essay on the Botany of the Mountains of Scotland, in connection with their Geological Structure and Composition; with specimens, and a map of the distribution of the Plants. In this Essay the range of elevation, and the northern and southern limits of the different species, should be attended to, and any facts tending to illustrate the geographical distribution of plants carefully recorded. It would also add greatly to the interest of the communication if it were accompanied with a coloured Geognostical Map of the mountainous districts examined.—To be produced against December 1837.

"5. Ten sovereigns, or a piece of plate of that value, for the best Account of all Avertebrate Animals (with the exception of their larvæ), inhabiting the River and Frith of Forth, their tributary streams, and the lakes included in the basin of the Forth; with a collection of specimens.—To be given in against December 1837.

"Communications may be addressed either to Professor Jameson, the President, or to Mr Neill, Secretary of the Society, Edinburgh."

TWENTY-EIGHTH SESSION.

David Falconar, Esq. Vice-President, in the chair.—Professor Jameson read a short notice, by Mr William Nicol, on the structure of some specimens of fossil wood; and also an account of the analysis of a coprolite found at Wardie, by Dr Gregory and Mr Walker. The Professor likewise exhibited and described a specimen of Squalus glaucus, captured last autumn near Helmsdale in Sutherland. 1834. Nov. 29.

Professor Jameson in the chair.—The Secretary read the Rev. John Hodgson's account of the remains of a skeleton of a species of deer found, in 1833, in diluvial sand, below the foundation of the Roman wall, near Walton, in Cumberland.—The Assist- Dec. 13.

ant-Secretary Mr Torrie, then read Dr Martin Barry's account of his ascent to the summit of Mont Blanc in September last.—Dr Greville, Vice-President, having taken the chair, Professor Jameson communicated the analyses, by Dr Gregory and Mr Walker, of coprolites from Wardie and from Fife, in which these chemists detected fluoric acid; on which occasion Professor Jameson made remarks connected with his early discovery of fossil fishes in the secondary strata of the middle district of Scotland.

1835. Jan. 24. Professor Jameson in the chair.—The Assistant-Secretary read Mr Robert J. Hay Cunningham's account of the geology of the islands of Mull and Iona, at the same time exhibiting specimens of the rocks, and numerous sections of the strata and veins.—The Secretary read a notice by Bewick Blackburn, Esq. Civil Engineer, in regard to the remains of deer mentioned in Mr Hodgson's paper read 13th December last.—Mr P. Small Keir, formerly a Vice-President, having taken the chair, Professor Jameson exhibited a new bird, which appeared to belong to the genus Eurylaimus of Horsfield, and which he named E. Dalhousiæ, in honour of the Countess of Dalhousie, by whom it was brought from India. The E. Dalhousiæ was described in the following terms:—*Bill* greenish-black; on its edges, along the culmen, and at the tip, yellowish-white; length 3-4ths of an inch; breadth at base 3-4ths of an inch. *Nostrils* ovoid, inserted at the base of the bill, and partially covered with feathers. *Body* grass-green above; below, apple-green. Throat of a golden-yellow, which extends round the neck, and terminates at the occiput with a few sky-blue feathers. Occiput and top of the head, greyish-black, with a crest of sky-blue. Ear-coverts and face golden-yellow, mixed with sky-blue. *Wings* short; 1st and 4th quills equal, 2d and 3d the longest; external webs of quill-feathers grass-green; internal bluish-black, with a broad band above in their centre of sky-blue; below, there is one of greyish-white, which extends across the internal web of the seven first primary quills. *Tail* Berlin-blue, very long, and strongly forked; the two middle tectrices much the longest. *Tectrices* twelve in number. Total length of body from the tip of bill to point of tail, eleven inches; tail, five inches. *Tarsus* weak, and rather longer than middle toe; length an inch and a quarter. *Toes*, external united to middle by two joints; internal by one. The specimen of this very rare and beautiful bird, which is a native of Northern India, was brought from thence by Lady Dalhousie. It was remarked, that it is distinguished from the typical specimen by the following characters:—The first that strikes us is the position of the nostrils, which, as already noticed, are inserted at the base of the bill, and partially covered with feathers. In the typical species they are quite naked, and inserted at a distance from the base. Secondly, the strong cuneiform tail, and shortness of the wings; and lastly, the weakness of the tarsi. Although the bird presents a peculiar group of characters, it was not considered advisable to form a genus of it, until its habits and manners should be made known. Its locality is also interesting, from its pointing out that this genus probably extends over all India proper.—At the same meeting, a specimen of a new Meleagris, from New Holland, was exhibited and described. The trivial name of Lindesayii was given in honour of Colonel Lindesay, a distinguished officer, and very active naturalist, formerly commander of the 39th regiment in New South Wales, but now removed to India. This bird gave rise to the erroneous opinion that *vultures* exist in the Australian continent.

Dr Greville, Vice-President, in the chair.—Professor Jameson, in a series of geological observations which he read to the Society, among other interesting topics, noticed the following:— 1835. Feb. 7.

1st, *Beds of recent Shells on the banks of the Firths of Forth and Clyde, situated considerably above the present level of these estuaries.* These beds, Professor Jameson remarked, had been pointed out by him to his pupils, during his geological walks, from the year 1806 up to the present time. One of his pupils, the late Assistant-Surgeon Macgregor, in 1811, read before the Society a paper on the recent sea-shells he noticed about 4½ miles from Glasgow. Captain Laskey, in 1814, read a memoir on a bed of sea-shells, estimated 40 feet above the level of the Clyde, which he examined in the line of the Ardrossan Canal, a few miles from Glasgow, of which memoir an abstract was published in the 4th volume of the Society's Memoirs. He enumerated the following shells:—1. *Turbo* littoreus, 2. rudis, and 3. terebra; 4. *Nucla* minuta, and 5. nuclea; 6. *Patella* vulgaris, and 7. pellucida: 8. *Buccinum* lapillus, and 9. undatum; 10. *Mytilus* edulis; 11. *Venus* islandica, 12. striata, 13. literata; 14. *Pecten* opercularis, the subrufus of Donovan; 15 *Balanus* communis; 16. *Anomia* ephippium; 17. *Tellina* plana; 18. *Nerita* littoralis, 19. glaucina; 20. *Mya* truncata; 21. *Trochus* crassus; 22. *Cardium* echinatum. All these shells, Captain Laskey remarked, still inhabit the Frith of Clyde and its shores, but occur below Dumbarton, or where the water is constantly salt. Captain Laskey also described to the Society a bed of dead sea-shells near to Dumbarton, and above the present level of the Clyde, among which he particularized *Venus* sulcata, *Pecten* islandica, and *Ostrea* islandica of Turton. Dr Fleming afterwards read to the Society "A short account of a bed of fossil shells found on the banks of the Forth to the west of Borrowstonness." This bed he described as entirely of sea-shells, mixed with a small portion of sand. The *common oyster* is in greatest abundance; and along with that shell all those species which are found in plenty on the shores of the Frith of Forth; such as *Mytilus* edulis, *Venus* rhomboidea, *Mactra* truncata, *Buccinum* undatum, *Turbo* littoreus, *Patella* vulgaris. The bed is about 3 feet thick, and below it is a bed of gravel resting upon the sandstone of the district; it extends in a straight line along the bank of the Forth, in a direction from east to west, nearly three miles, and is about thirty-three feet above the rise of ordinary spring-tides. Mr Bald, in the Memoirs of the Society, mentions sea-shells as occurring at Alloa, twenty feet above the present level of the Frith of Forth; also sea-shells several miles to the westward of Stirling Castle, particularly valves of the oyster of uncommon size, although no recent specimens are now found so large, nor any live oysters above Queensferry; also a bed of sand and oysters at the foot of Clackmannan Hill. Mr Adamson, another member of the Society, in a memoir published in vol. iv. of the Society's Memoirs, describes a bed of sea-shells in the isle of Lonach in Loch Lomond, twenty-two feet above the present level of the sea at Dumbarton, in which were some species apparently new to conchologists, and several echini. In 1821, in an account read to the Society of remains of the elephant found in an alluvial bed near to Kilmarnock, it was noticed that these remains were accompanied by sea-shells of the same species as those living in the present sea. In 1824, Mr Blackadder, land-surveyor, laid before the Society a paper, an abstract of which appeared in the 5th volume of the Society's Memoirs, on what he calls the Superficial Strata of the Forth district. He there mentions common sea-shells of the Forth as occurring at Polmaise, below Stirling, at Grangemouth, and other places near the shores of the Forth; and also some instances of their occurrence far from the present natural habitat of these shells, but everywhere above the present sea-level. Mr Blackadder of Edinburgh, a few years ago, described in a memoir laid before the Society a bed of sea-shells considerably above the present level of the Frith at Wardie and Newhaven. And within these few months, Mr Maclaren, in a well known periodical, "The Scotsman," describes a portion of the shell-bed between Leith and Portobello, and Dr R. Thomson, in his interesting new journal, "The Records of General Science," gives several additional particulars regarding the shell-bed on the banks of the Clyde. From these details, it probably follows, either that at some former period the waters of the Clyde and Forth were considerably higher than they are at present, or that the land has risen.

2. *Coal-Formation.* Professor Jameson explained, that the chief geological characters of the *Old* and the *New* Coal-formations in Scotland had been made out by the Wernerian Society many years ago. He also noticed, that in 1811, in a memoir read before the Society, it was maintained that nearly the whole, if not the whole, of the sandstone, both red and white, of the island of Arran, belonged to the *old coal-formation*, and that, upon this sandstone, on the opposite coast of the mainland, as near to Saltcoats, the more common or newer beds of the coal-formation were seen resting He also remarked, that, in 1805, in the "Mineralogical Account of Dumfriesshire," the occurrence of beds of red sandstone connected with the coal-formation of that county is noticed; also, that in the same publication, descriptions are given of the Roslin red sandstone, and of other deposits of red sandstone, as members of the coal-field of the Lothians; and lastly, that this red sandstone occurred generally in the lowest part of the coal-formation. The red sandstone connected with quartz-rock, granite, &c. and older than the red sandstone of the carboniferous system, Professor Jameson remarked, was well displayed on the banks of Loch Ness, in the county of Sutherland, and in many other places in Scotland. The *coal*-formation at Brora in Sutherland was ascertained to be newer than the great coal-formation, from its position, the characters of the sandstones and slates, their organic remains, and the *peculiar nature of the coal;* and the same was said to be the case with the coal of Skye, Canna, Mull, &c. The place of the coal of Brora, in the Oolite system, was first fixed by Messrs Murchison and Sedgwick.

3. *Syenite or Granitel of Skye, Craig of Ailsa, St Kilda, Arran, &c.*—Professor Jameson requested the attention of geologists who may visit Arran, to the syenite and granite rocks,

apparently in connexion with sandstone and conglomerate, in the line extending from the upper part of Glencloy to the great body of granite of the northern division of the island. He also recommended geologists to examine particularly the two chief granites of the island, viz. the small granular, and occasionally syenitic varieties on the west side, and the coarse granular on the eastern side of the island, and to bear in remembrance that these western and eastern granites might prove to belong to different formations. The Professor also mentioned a variety of particulars illustrative of the geological positions and mode of formation of the granular crystalline rocks of the Craig of Ailsa, St Kilda, and the Island of Skye, from which it appeared to result, that these rocks, viewing them as of igneous origin, were of newer formation than the great coal-formation.

4. *Organic Remains in the Coal-Formation.*—The labours of Messrs Nicol and Witham, it was remarked, had added considerably to our knowledge of the plants of this formation; and the specimens and details furnished by the President of the Society, also by Dr Fleming, Dr Hibbert, Lord Greenock, and others, were daily extending our acquaintance with the fossil corals, shells, and fishes of this interesting formation. In regard to the fossil fishes and coprolites in the limestone, slate, and ironstone, of the middle region of Scotland, it was remarked, that, in several districts on both sides of the Forth, they were met with in considerable abundance, where they were first pointed out by the President of the Society, and afterwards, in some new localities, by Walter Calverley Trevelyan, Esq., Lord Greenock, Dr Hibbert, and Thomas Jameson Torrie, Esq. Professor Jameson mentioned some beds in the coal-formation so thickly studded with coprolites, that they might be named *coprolite beds;* while others abounded so much with fish scales, that they might not unaptly be termed *scale beds;* and further, that the coprolites were not confined to the *Fern limestones*, but were met with also, although hitherto not so abun-

dantly, in the *coral* and *shell limestones* of the coal-formation; and that hitherto no remains of undoubted fossil saurian animals had been met with in Scotland; the large crocodile-like teeth discovered in the coal-formation, in the year 1793, by the late Rev. D. Ure, and figured by him in his History of Rutherglen and Kilbride, and since, in 1834, by Dr Hibbert, at Burdiehouse, near Edinburgh, belonging probably to an extinct tribe of fishes. The sauroidal character of some of these fossils has elicited the following remarks from Professor Agassiz:—

"It is in the series of deposits inferior to the Lias that we begin to find the largest of those monstrous *Sauroid fishes*, whose osteology reminds us in many respects of the skeletons of saurian animals, viz. by the closer sutures of the bones of the head, by the large longitudinally striped conical teeth, and by the manner in which the spinous epiphyses are articulated with the bodies of the vertebræ, and the sides at the extremity of the transverse epiphyses. The analogy which exists between these fishes and saurian animals, is not confined to the skeleton alone; for in one of the two recent genera I have found a very peculiar internal organization of the soft parts, which renders the similarity greater than it at first appeared. There is, in fact, in the *Lepidosteus osseus*, a glottis like that of the sirens and the salamandrian reptiles, a cellular swimming-bladder, with a trachea, like the lung of an ophidian. Finally, their integuments have often an appearance so similar to that of the crocodiles, that it is not always easy to distinguish them.

"The smallness of the number of fishes found in transition-rocks, prevents us as yet from assigning to them a particular character.* Nevertheless, the species in the collection of Mr Murchison already indicate types which do not extend even to the coal-formation.

* The transition rocks mentioned by M. Agassiz, belong, we believe, to the Silurian class of Murchison, the oldest Secondary of Professor Jameson.

"What is most remarkable in all the fishes inferior to the oolitic series, besides their analogy with reptiles, is, on the one hand, the very great uniformity of the types, and, on the other, the very great uniformity of the parts of the same animal among themselves; so that it is often difficult to distinguish the scales, the bones, and the teeth, from one another. If we may be permitted to hazard some conjectures on this state of things, such as it is presented to us now, we are naturally led to think, that the principle of animal life, which developes itself at a later period under the form of ordinary fishes, reptiles, birds, and mammiferous animals, is at first entirely confined to those singular sauroid fishes which partake at the same time of the structure of fishes and reptiles, and that this mixed character is never lost in this class till the appearance of a larger number of reptiles, in the same manner as we see ichthyosauri and plesiosauri partaking in their osteology of the characters of the cetacea, and the large land saurian animals partaking of the characters of the pachyderma, which were not created till a much later period.

"We are thus led by observation to those ideas of the philosophy of nature which have presented us with an organic and regular development in all created beings, constantly in conformity with the different conditions of existence which are realized at the surface of the globe, in consequence of the changes which it itself has undergone.

"As a result of all the facts I have brought forward, I distinguish, in the whole series of geological formations, two grand divisions, which have their limit at the green-sand deposit. The first, the more ancient, includes only the *Ganoïdes* and *Placoïdes.* The second, more intimately connected with beings at present in existence, includes forms and organizations much more diversified; these are more particularly the *Ctenoïdes* and the *Cycloïdes*, and a very small number of species of the two preceding orders, which disappear insensibly, and of which the analogous living species are considerably modified. As we do not find in the fishes of the first great period, differences corresponding to those which we observe at the present day between fresh-water and salt-water fishes, it appears to me that it is going beyond the facts we possess to admit in the oolitic series and lower down, the existence of distinct fresh-water and marine formations. I think rather that the waters of these remote periods, circumscribed in basins less completely shut in, did not then present the marked distinctions which we remark at the present time."

At the same meeting of the Society an extract was read of a report by the lighthouse keeper at Lismore, of a small flock of brent geese having been attracted by the light in a dark and stormy night, and killed by the violence with which they struck the building. One of the birds happening to strike a pane of the light-room, formed of plate-glass a quarter of an inch thick, passed through it like a shot, with such amazing force, that pimples were raised on the polished metallic reflectors by the particles of the shivered glass.

A model of the head of the Dodo, which is preserved in the Tradescant collection at Oxford, presented to the College Museum by Mr Duncan of Oxford, was exhibited at this meeting, and an account was given by Professor Jameson of what is known respecting that bird, described by Clusius in 1598 as inhabiting the Mauritius, but which appears to be now extinct.

1835. Feb. 21. Mr Macgillivray read some observations on the Dipper (*Cinclus aquaticus*). The peculiarities of form and plumage, adapting it to its amphibious mode of life, were pointed out, and its habits minutely described. The alleged injuries to the salmon-fisheries by this species were rendered doubtful by the results of the author's observations, he having never found any ova or fry of fish in its stomach, which was usually found to contain fragments of coleopterous insects and mollusca, especially *Lymnæa peregra* and *Ancylus fluviatilis*.—The Assistant-Secretary then read Mr Hay Cunningham's paper on the geology of the islands of Eigg, Rume, and Canna; exhibiting, at the same time, illustrative sections and specimens.—The Secretary read a memoir by Mr James Macnab on the local distribution of trees in the native forests of North America.—Professor Jameson placed before the meeting a series of birds from the Himmalaya Mountains, most of which seem identical with the European species, including the Gypaëtas barbatus; Falco tinnunculus, subbuteo; Nisus communis; Circus cyaneus, cineraceus, æruginosus; Lanius excubitor; Oriolus galbula; Turdus merula; Gracula rosea, cyanea; Sylvia rubecola, tithys; Saxicola stapazina; Curruca atricapilla; Sturnus vulgaris; Upupa epops; Picus major, viridis; Yunx torquilla; Pyrgita domestica; Anthus arboreus; Hæmatopus ostralegus.

Bindon Blood, Esq., Vice-President, in the chair.—Sir Patrick Walker exhibited a specimen of a small species of the Mus family, possessing some of the characters of the Marmot, which had been found on his property at Drumsheugh, in the neighbourhood of Edinburgh, its haunts having been disturbed by the progress of building.—Mr Macgillivray read remarks on varieties of the Fox observed in Scotland. The author distinguished four races or varieties: 1. The *Hound Fox*, tall, slender in the limbs, with a very attenuated muzzle, a bright reddish-yellow fur, the lower parts of the body greyish-white, the tail yellowish-grey, with long black hairs scattered towards its extremity, and about three inches of the tip white. 2. The *Cur Fox*, similar to the hound fox, but smaller, with the body deeper, the legs shorter, the tip of the tail white. These two races seem to pass into each other, and can scarcely be distinguished except in the extremes. 3. The *Dog Fox*, compact in form, with comparatively short limbs, the head rather broad, the muzzle pointed, the fur deep red, the lower parts brownish-red, the tail yellowish-grey, darkened with black hairs, and having the tip of the same 1835. March 7.

colour. 4. The *Mastiff Fox*, larger and stronger, its limbs more robust; the head much broader, a dull greyish-yellow fur, profusely interspersed with whitish hairs, the tail dusky, with long black hairs scattered over it, and a small white tip.—Dr Traill then exhibited a series of beautiful and correct drawings of British quadrupeds, cetacea, birds, reptiles, and fishes, executed by Mr Macgillivray, and which are intended for his projected work on the vertebrate animals of Great Britain. The Assistant-Secretary read Mr Nicol's account of his examination of the specimens of fossil wood from the island of Mull, collected by Mr Cunningham; also of various specimens from the North African Desert, collected by Mr Munro and others from the Karoo Ground in Southern Africa.

1835. March 21. Dr Charles Anderson, formerly Vice-President, in the chair. —The Assistant-Secretary read Mr Hay Cunningham's paper on the geology of the Island of Skye, which was accompanied by numerous sketches and specimens.—Sir Patrick Walker laid before the meeting a series of fine marbles which he had brought from the quarries of Bagnères de Bigorre.—Professor Jameson exhibited and described a series of birds from the Himalayan Mountains, considered as identical, or nearly so, with the European: Strix passerina; Alcedo ispida; Parus major; Motacilla alba, boarula; Garrulus glandarius; Caryocatactes vulgaris; Ardea nycticorax; Numenius arquata, phœopus; Tringa squatarola, hypoleucos, pusilla, ochropus; Charadrius pluvialis; Cursorius hæmantopus; Podiceps minor; Œdicnemus crepitans; Pterocles arenarius; Anas clypeata, penelope, querquedula, crecca. After exhibiting and comparing the trivial characters of the above species with the European, it was stated, that even if all the external characters were the same, but if the shape of the head differed, we were entitled, from that character alone, to make a new species; and as illustrative of this opinion, it was stated, on the authority of Brehm and others, that, generally speaking, no two species with plumage, &c. the same, but with different shapes of head, agreed in their habits and manners, nor were they ever found to breed with each other. Professor Jameson also exhibited a specimen of the female of the Cypselus longipennis, which he had received from Northern India, and stated that it only differed from the male figured by Temminck and Swainson, in wanting the brownish-red patches on the side of the neck ; in other characters it is identical.

Dr Charles Anderson, formerly Vice-President, in the chair. 1835. April 4.
—There was read a communication from Mr R. H. Parnell regarding some new and rare fishes which he had procured from the Frith of Forth. In addition to the ample list of fishes found in the Forth, given by Dr Neill, and published in the Transactions of the Society, the author has detected nine others, two of which are new to science ; one he referred to the genus Solea, the other to that of Platessa.—Professor Jameson exhibited and described a series of quadrupeds and birds. Among the more interesting of the quadrupeds were the Hylobates lar, leuciscus, albimanus, and hoolock ; the latter of which, however, he stated, was probably not a true species, but the female of the Ounko of Frederick Cuvier. Among the birds, two were described as new to science, viz. Aquila nigra, and male of Lophophorus Nigelli.

Aquila nigra.—Bill yellowish-brown, length 2 inches ; length of gap $2\frac{1}{4}$ inches ; cutting edge of upper mandible furnished with a protuberance. Nostrils ovoid. Face between the eyes covered with stiff hairs, which radiate as it were from a centre. Body, tail, and legs of a reddish-brown colour, with the exception of the middle of the back and rump, which are greyish-white ; length of body from tip of bill to tip of tail, 3 feet ; from the tip of one wing to the tip of the other, 5 feet 7 inches ; wings about 3 inches shorter than the tail. Tail square, but rather rounded, consisting of twelve feathers, the four centre ones being slightly banded below with greyish-white; length 14 inches. Legs feathered to the toes. Toes furnished with three scutellæ, which are largest on the back one; feet yellow; claws bluish-grey. *Hab.* South America. The Professor applied the specific term Nigra to this bird, from black being the predominant colour of its plumage, and remarked with regard to the generic name Aquila, that it belongs to that genus, of which the type is Aquila fulva, from the cutting edge of the upper mandible being furnished with a protuberance; the wings considerably shorter than the tail; tarsi feathered to the toes; and lastly, the first phalanx of all the metatarsal bones being provided with three scutellæ.

Lophophorus Nigelli, male.—This bird was remarked by the Professor to differ from the female already described, in being larger, in having two reddish-brown bands, the one extending from the external angle of the eye, the other from the lower part of the auricular coverts, down to the under part of the neck, where they unite and form a broad diffused ring round it; in the breast being yellowish-white, and some of the feathers with a band of black in their centre; and lastly, in having the feathers of the hypochondriac region more strongly marked, and tipped with a much deeper brown. Like the female, it wants the spur. From the form of the bill, and the absence of the spur in the male, which is so prominent in the other species which have been included in the genus Lophophorus, this has now formed a new genus. The distribution of this species, the Professor remarked, was very wide, from its occurring from Persia, where the female was first discovered, onwards to the Himmalayan Mountains.

A paper was read on the Manners and Customs of the Boshmen of the Sternberg Orange River, communicated by Mr Leslie, and a notice on the Deluges of Deucalion, Ogyges, and Noah.

1835. April 25. Dr Robert K. Greville, Vice-President, in the chair.—Mr James Wilson read an account of the new or rare insects, particularly Coleoptera, found by him during his late tour in Sutherlandshire. After some general observations on the distributions of insects in Scotland and England, and especially on the occurrence of some Scandinavian species in the north of Scotland, and of some of the species belonging to the warm climates of Europe, and in the south of England, the author enumerated and exhibited the principal species he had collected, and made remarks on such as were new, rare, or otherwise interesting.—Dr Neill read an essay on the composition and qualities of a new building-concrete, communicated by Mr Stevenson. The paper was prefaced by a variety of historical details on the subject, which was illustrated by specimens.—The Secretary read an account of a series of new and rare plants collected during an excursion, in the summer of 1834, to the United States and Canada, communicated by Mr James Macnab.—Professor Jameson exhibited a series of new and rare birds; among the latter were the Semi-palmated Goose, Charadrius nigrifrons; Hæmatopus ostralegus, from New Holland; Otis ruficollis, South Africa; Tantalus plumbeus, South America, &c. He also described an Ibis, Tanagra, and Rubecola, new to science.

Ibis spinicollis.—Bill curved, and of a brownish-black colour; upper mandible furnished at its base with 13 greyish bands, each about $1\frac{1}{2}$ line in length; length 7 inches, with the upper mandible projecting over the other at the point. Nostrils linear, and inserted into a groove which extends along the bill to the tip, about $\frac{3}{4}$ of an inch from its base. Head destitute of feathers, also the centre and forepart of the neck, to a distance of $\frac{1}{2}$ inch. Neck, forepart covered with straw-coloured spines, on the back and upper part and sides with short greyish-white downy feathers, under with short bluish-black metallic feathers. Body, above of a brownish-black, each feather being alternately banded with dull and metallic reflections; below greyish-white. First and fourth feathers of wing longest, second and third equal; wings nearly as long as the tail. Length from tip of bill to tip of tail 3 feet 3 inches, from one extremity of the wing to the other $4\frac{1}{2}$ feet. Tail square, and of a greyish-white colour, consisting of 12 feathers, length $7\frac{1}{2}$ inches. Legs of a blood-red colour, feathered to about the middle of the tibia. Tarsus, length 4 inches. *Hab.* Banks of the Murray River, interior of New Holland. From the slender bill, the head, and small part of the neck being destitute of feathers, this bird, the Professor remarked, formed a connecting link between the two divisions of the genus Ibis, Cuv., the specific term *spinicollis* was applied to it from the forepart of the neck being covered with spines.

Tanagra nigricephala.—Bill bluish-black, conical, and much shorter than the head; length 5 lines, gap 7; upper mandible notched at the point, and slightly hooked. Nostrils circular and naked, inserted into the base of the hill. Head of a bluish-black colour; from the outer angle on both sides of the nostril a band of bluish-black extends across the temples to the root of the neck; from the inner, one of greyish-white extends across the ophthalmic region down to the nape. Throat white, with a bluish-black band on both sides, extending narrow from the base of lower mandible, and becomes very broad as it reaches the neck. Body, above of a saffron-yellow, approaching to siskin-green; below of a bright golden-yellow, mixed with orange. Wings of a bluish-black colour, with all the primary and secondary quills tipped with greyish-white, the first primary quill excepted; third quill-feather longest, second and fourth nearly equal, and longer than the first; upper wing-coverts bluish-black, mixed with greenish-yellow; under, yellowish-white. Tail greyish-black, and nearly square; length $3\frac{1}{2}$ inches, and consisting of 9 feathers; upper wing-coverts greenish-yellow, under greyish-white; feathered to the tarsi. Tarsus, length 8 lines, and covered by 5 very broad scutellæ; middle toe 9 lines. *Hab.* West India Islands. In the shortness and form of the bill, in the length of wings in proportion to the tail, in the arrangement of the quill-feathers of wing, the external toe united to middle by first joint, and the form and size of the scutellæ, this bird, the Professor remarked, seemed to hold a prominent place between the genus Pyrgita and Tanagra.

Rubecola Tytleri.—The Professor applied the specific term *Tytleri*, to a *Rubecola* which he described, in honour of the late Lieutenant Tytler, a very active ornithologist, whose labours in India have added much to the interest of the Royal Museum of the University of Edinburgh, and remarked, that although it agreed in the grouping of its colours with the common robin, yet, in the form of the bill, it presented as it were a link between the genus Rubecola and Phœnecura. The specimen was sent to the Royal Museum by Lieutenant Tytler from the Himalayan Mountains.

A series of specimens of the Muscipeta paradisi, Cuv., were exhibited by the Professor, for the purpose of pointing out that the Muscipeta indica is but a sexual variety; and he stated this from the examination of a large series of specimens lately received from the Himmaleh Mountains, some of which shewed the passage of the one into the other. In its distribution this species is very wide, occurring spread over all India and China; and identically the same species is found in Africa.

A fine live specimen of the Noctua nivea, hitherto confounded with the Noctua nyctea, it was announced had been found in Orkney.

TWENTY-NINTH SESSION.

Sir Patrick Walker, Vice-President, in the chair.—Mr James 1835. Nov. 21.
Wilson read Mr P. J. Selby's account of the animals inhabiting the county of Sutherland, and particularly of the birds observed during the excursion thither of a party of naturalists in the summer of 1834.—Professor Jameson communicated a brief notice of some observations, by M. Arago, on the Light of Halley's Comet, finally determining that cometic light is derived from the sun, and not dependent on any kind of phosphorescence inherent in the comet itself. He also made some remarks on the

experiments which have been lately performed in France, on the Solidification of Carbonic Acid, and recommended the repetition of these experiments.—Dr Charles Anderson exhibited a specimen of Cypræa guttata, a rare species, from Java; and he also communicated a description and specimens of a new species of Cypræa, not described by Lamark, and which he denominated C. castanea. The following is the character: "Testa ovato-ventricosa, castaneo-fusca; fasciis binis, latis, obscuris, saturatioribus; marginibus incrassatis, albis, fusco-punctatis; aperturæ extremitatibus intus roseo-rubeis." Shell of a bright chestnut-brown colour on the back, the face and sides white; the latter marked with numerous spots of vivid brown of various intensity; the fauces brown, with a shade of red; length $1\frac{1}{8}$, breadth $\frac{6}{8}$, of an inch. Received from New South Wales, by Dr Coldstream of Leith, without any notification as to its particular locality.—There was also exhibited a male specimen of the Rocky Mountain Sheep (Ovis montana), which Professor Jameson had lately received from the Colombia River from Dr M. Gairdner. He remarked, that although its fur was of no value, it ought to be introduced into this country, not only from the delicacy of its flesh as food, and the fine leather to be prepared from its skin, but also from its noble figure. The Professor stated that he had many years ago brought this animal under the attention of the Society, and it was to be regretted that no steps had as yet been taken towards its introduction, it being, from its hardy nature, likely to do well in our Highland mountainous districts.—Sir Patrick Walker exhibited a specimen of the moth Phalæna (Geometra) papilionaria, taken last summer in Aberdeenshire, and new to Scotland. He then made some remarks on its geographical distribution in England and on the continent of Europe, and mentioned several places, where it is found in great abundance.

1835. Dec. 5. Dr R. K. Greville, formerly Vice-President, in the chair.—1. *Notice of Fossil Fishes found in the neighbourhood of Edin-*

burgh, &c., by Professor Jameson.—The Professor remarked that he had been induced to exhibit a part of his collection of fossil fishes to the Society, for the purpose of correcting an oversight of M. Agassiz, who states, in his work on Fossil Ichthyology, that he had received from Professor Jameson a series of fossil fishes *from Burdiehouse,* whereas none of the specimens he sent him were collected at Burdiehouse, or even in Mid-Lothian, the whole being from Fifeshire. The Professor also stated that the discovery of fossil *ichthyolites* in this neighbourhood was not of a recent date, as he had found bones and scales of fishes more than eighteen years ago in our secondary deposits, and had been in the practice for many years back of stating the occurrence of these remains to his pupils in the lecture-room, and pointing it out in the field. Some general observations were then made on the age of fossil fishes, their distribution in red sandstone and limestone, slate-clay, bituminous shale, and coal in the Lothians, Angusshire, Lanarkshire, &c.; and he concluded by remarking that Agassiz, after an examination of several hundred species of fishes from secondary rocks, had found *no character* whatever to distinguish fresh from salt water fishes. The species exhibited were the following: *Palaeoniscus ariolatus, ornatissimus, Robisoni; Eurynotus crenatus,* and *Pygopterus Jamesoni.*—Dr Traill then made some remarks on the identity of the limestone of Fifeshire with that of Burdiehouse, which he stated was proved not only from its geological position, but also from the fossil fishes which were exhibited by Professor Jameson, they belonging not only to the same genera, but all, with one exception, being of the same species as those found at Burdiehouse.

2. *On the similarity of some Birds from Northern India with European Species, by Professor Jameson.*—In continuation of his list of Birds of Northern India, nearly allied to the European, the Professor remarked, that it was his intention (already stated last year) to bring before the Society every species which should come under his observation, for the purpose of pointing out the

similarity, in many respects, of the ornithology of that region with that of Europe. With this intention, therefore, he had now to lay before the Society three species, bearing a striking resemblance to the European, viz. *Saxicola rubicola*, *Sturnus vulgaris* after second moult, the bird in full plumage having been already exhibited, and *Sitta Europæa*; the last differing, however, in being of a deeper colour below. A fourth species was produced very nearly allied to the *Sitta Europæa*, which, however, presented characters sufficiently marked to form a new species; and from the banded tail being the most prominent, the Professor gave to it the specific name of *vitticauda*. A specimen of the *Sitta frontalis* from Northern India was also exhibited, and its wide geographic distribution pointed out, it being first found in Java, and described by Dr Horsfield.

3. It was mentioned, that the very remarkable fact of the expansion of liquefied carbonic acid, lately observed by the French academicians, has been fully verified by Mr Kemp, lecturer on chemistry, who finds that the expansion is not peculiar to this liquefied gas, but belongs to all other gases in the liquid state. At this meeting of the Society, Mr Kemp exhibited a specimen of the liquefied sulphurous acid gas, hermetically sealed in a glass tube, and separated from the materials from which it had been generated. This specimen of the liquefied gas occupied 8 inches of a tube, 5–8ths of an inch in internal diameter, and when cooled from the temperature of 60° down to 14° of Fahr., or the point at which it becomes liquid under the ordinary pressure of the atmosphere, it contracted one inch, but when heated an equal number of degrees above 60°, viz. 46°, it expanded through a greater distance than it had before contracted by the abstraction of an equal amount of caloric, shewing that the expansion went on at higher temperatures in a slightly increasing ratio, so that the expansion between its liquefying point, viz. 14° and 212°, the boiling point of water, is nearly one-third of its whole volume, the pressure against the expansion being at 212°, about 25

atmospheres. That this property does not belong to the liquefied gases exclusively, but resides equally in all other fluids, when raised above their boiling points, is shewn by the following experiment; thus, ether, when raised from the temperature of 60° to 95° of Fahr., or its boiling point, undergoes an inconsiderable expansion compared with the expansion produced by an equal increase of temperature above its boiling point, when it may be said to be in the same condition with the liquefied gases in regard to pressure, and carbonic acid suffers nearly an equal expansion by an equal increasing temperature with the liquefied gases.—The members afterwards adjourned to Dr Hope's laboratory, when Mr Kemp, Dr Hope's Experimental Assistant, exhibited an apparatus he had constructed for the repetition of the experiment on the solidification of carbonic acid, which he had, at the request of the Society, prepared for that purpose.

Professor Traill, Vice-President, in the chair.—Dr Martin Barry exhibited the ganglion oticum in the human subject, as dissected by himself under the eye of Professor Tiedemann of Hiedelberg, and pointed out, by means of very large and carefully executed diagrams, taken from the drawings of Arnold, its connection with the organ of hearing.—Professor Jameson communicated a notice by M. Dufrenoy on the period and mode of formation of the Monte Somma, and of Vesuvius. He also communicated a notice to prove that we have no historical evidence of the existence of the fossil Elk of Ireland and the Isle of Man as a living species, the rude figure in the cosmographia of Munster not representing the elk but the fallow-deer.—Sir Patrick Walker exhibited some insects which prove very destructive to the pine forests in the Highlands of Scotland, and made a few observations on their mode of boring into the wood. 1835. Dec. 19.

Dr Traill, Vice-President, in the chair.—Mr James Wilson read a paper on the Birds included under the genus Eurylaimus 1836. Jan. 9.

of Horsfield, illustrating his remarks by specimens and figures.—Dr Deuchar gave an account of some new tests for easily distinguishing carbonates from bi-carbonates, and exhibited the mode of making the experiments.—Sir Patrick Walker then read notices regarding the occurrence, near Edinburgh, of several native birds, generally regarded as extremely rare, particularly the Motacilla neglecta, first remarked by him on the banks of the Water of Leith in 1804 (but referred by him to the Motacilla flava, until he became acquainted with Gould's observations), and often observed since that time; likewise the Redstart (Sylvia Phœnicurus) in various places around the city; the Dusky Grebe, shot at Lochend; and the Ardea minuta, killed at the mouth of the Tyne in East Lothian.—Mr K. T. Kemp exhibited the experiment of the solidification of sulphurous acid.

1836. Jan. 23. Bindon Blood, Esq., Vice-President, in the chair.—A paper was read, entitled, "Remarks on the circumstances to be chiefly attended to in the execution of a Geological Survey of Scotland."—Mr Kemp shewed a method of liquefying chlorine at a cold of —26° Fahr., and of keeping it in a liquid state at the temperature of the atmosphere, by a pressure equal to five atmospheres and a half.

Feb. 6. Robert Stevenson, Esq., Vice-President, in the chair.—Mr Kemp described and exhibited experiments, proving that chlorine, iodine, bromine, &c., bleach without the decomposition of water or the presence of oxygen gas. He likewise shewed a modification of the differential thermometer.—Suggestions were communicated, by the Rev. Mr Robertson of Inverkeithing, of easy methods of analysis, for practical purposes, of the mineral waters usually met with.—Dr Martin Barry laid upon the table specimens of red sandstone, from the county of Tyrone, abounding in fossil fishes belonging to the species Palæoniscus catopterus, Agass.—Dr Traill exhibited specimens of sandstone-flag from Pomona, Orkney, containing large scales of fishes.—The Society, on the suggestion of the President and Council, resolved to recommend to the Lighthouse Board the cutting of marks on rocks at half-tide level on various parts of the shores of this country, with the view of ascertaining whether the land is rising, sinking, or stationary; and directed the Secretary to communicate on the subject with the Royal Society of Edinburgh, and the Highland and Agricultural Society of Scotland. A committee was appointed to attend to this matter, and to co-operate with committees which it was hoped might be appointed by the above-mentioned bodies.—Professor Jameson read a notice, by Mr Christie of Banff, regarding the lias found near Banff, and which was discovered there by the author.—Mr Wilson read Lieutenant Champion's (91st regiment) account of the curious phenomenon occurring in the island of Cephalonia, described by Dr Davy.—Sir Patrick Walker exhibited a specimen of the Dusky Grebe shot at Lochend, near Edinburgh, and Professor Jameson exhibited a specimen of the Wryneck taken in Fife.—Professor Jameson made remarks on a collection of birds made by Captain Clunie in New South Wales, among which were specimens of the Sula alba from Moreton Bay. He also shewed a new species of Pernis, he named, after the gentleman who brought it home from India, the P. Elliotii. Two Buzzards lately killed in Britain were placed on the table; one of these nearly allied to the Falco Jackall of Le Vaillant, was killed near Birmingham; and of the other, killed near Newcastle, a minute description was communicated by Mr William Jameson.

Professor Jameson in the chair.—Professor Forbes read remarks on the Physical Geography of the Pyrenees, chiefly in connection with the celebrated hot-springs of that district; and exhibited an extensive series of rocks and minerals.—Mr Kemp read remarks on the ignition and volatilization of carbon 1836. Feb. 20.

in the Torricellian vacuum by galvanic electricity; illustrating them by experiment.

1836. March 12. Professor Jameson, President, in the chair.—The Secretary read Dr Parnell's account of the occurrence of the Whitebait, Clupea alba, in the Firth of Forth in considerable abundance; and also his description of the Sprat or Garvey-herring, Clupea sprattus; both papers being illustrated by beautifully preserved specimens and drawings.

March 26. David Falconar, Esq., formerly Vice-President, in the chair. —The Secretary read Dr Parnell's account of the Tadpole fish, Raniceps trifurcatus, and of the Sea-snail, Cyclopteris liparis, observed by him in the Firth of Forth, and specimens of both were exhibited.—Mr Wilson, for the Secretary, then read remarks on the Vitality of the Toad, communicated by the Rev. Edward Stanley of Alderley Rectory.—Dr Thomas Aitken gave an account of the anatomy of a specimen of the Ursine Sloth, Ursus labiatus, which died a short time ago in a travelling menagerie while at Edinburgh, demonstrating the peculiarities of the organs of respiration and digestion. The stuffed specimen of the animal was also exhibited.—Professor Jameson exhibited a series of birds from Northern India, collected by Mr Hamilton Stirling, which, he remarked, was remarkably interesting, as presenting many species which were not known to exist in that quarter. Mr William Jameson pointed out several of these; of the rapacious order he noticed the Milvus govinda and Accipiter dukhunensis, the former of which was considered to be probably the young of the Falco Cheela. With regard to the geographic distribution of the genus Milvus, it was stated, that it occurs in all the different continents of the Old World and New Holland, but that it has not as yet been detected in the New World, its place being there supplied by the genus Nauclerus. Specimens of the Gypaetos barbatus were again laid before the Society, Professor Jameson having many years ago exhibited this bird sent from Northern India by Lieutenant Tytler (which, since that time, has been discovered by other travellers), for the purpose of pointing it out under the form of the Vultur Niger, it in the young state being considered as a distinct species, and described under this name; and also for the purpose of shewing that it, from the nest upwards, undergoes the same changes as the European species, a character, before all others, marking them to be one and the same species. In regard to British birds in general, in connection with Indian ornithology, Mr Jameson stated, that more than one-third of them occur in India, either identical with, or undergoing certain slight modifications in the colour of the plumage, size, &c., characters which, if their habits and manners are the same, would lead him to consider them rather as marked varieties than as new species. To the diurnal rapacious birds Mr Jameson particularly directed the attention of the Society, and stated, that of the 18 diurnal birds of prey found in this island, the following striking distribution was presented, viz. In common with Europe 3; Europe and Asia 2; Europe, Asia, and New Holland, 1; Europe, Asia, Africa, and New Holland, 3; Europe, Asia, and North America, 5; if, however, the Circus cineraceus exists in North America, which is not at all improbable, we shall have 6; Europe, Asia, and South America, 1; Europe and North America 3. To these conclusions, Mr Jameson remarked, he had come, principally from an examination of the magnificent collection in the Museum of the University of Edinburgh. After some other general observations on the identity of particular species of rapacious birds, in which it was stated, that the Falco cherrug of Gray is the female of the Falco islandicus; the Circus pallidus, Sykes, the young male of the Circus cyaneus; the Circus variegatus, the Circus rufus, &c.; Mr Jameson exhibited specimens of the Gallus bankiva in its various stages, and remarked, that it is probably one of the originals of the domestic fowl, which seems to have originated not from one but from many species; Bucco grandis; Phasianus albo-cristatus in its various stages; Parus (Leiothrix) furcatus, Temminck; Cinclus Pallasii, Temminck. With regard to the characters assigned to the genus Leiothrix by Swainson, of which the Parus furcatus is the type, and which has been justly separated from the true Pariadæ, some observations were made, shewing that several of these are quite inapplicable to the type of the genus. In exhibiting the Cinclus Pallasii, Mr Jameson remarked, that the genus was confined for many years to but one species, the existence of the Pallas dipper being called in question, and that not found out of Europe. Now, however, we have three, and probably a fourth (a bird existing in the collection of the University of Edinburgh, which may be placed in this genus, or rather forms a connecting link between the genus Cinclus and that of Pitta), some of which are found in all the great continents of the world, with the exception of New Holland. That the Cinclus Pallasii is the same as the Cinclus Americanus, an opinion advocated by L. Bonaparte, can only be maintained by those who have not had an opportunity of comparing the two species, being very apt to be misled by the meagre description of the former by Temminck; one character alone distinguishes the two species, viz. the Pallas dipper is more than a third larger than the American; moreover, the latter never assumes the colour of the former, at least Mr Jameson was unable to detect, in a series of specimens of the Cinclus Americanus, in the Museum of the University of Edinburgh, the slightest approach to the tinge of colour assumed by the Pallas Dipper. A specimen of Wryneck (Yunx Torquilla) was exhibited, which was killed in February last in Fifeshire.

1836. April 16. Dr R. K. Greville, formerly Vice-President, in the chair.—A notice was read on the dolomization of the marble limestones of Skye, with analysis of the same shewing their magnesian character. The author stated his views in regard to the geognostical relations of the Plutonian rocks of Skye, which he referred to the porphyry and trap formations. He noticed, besides, the rock of St Kilda and the granite of Arran, both of which exhibit several of the characters of the porphyry series, and may probably, in a geognostical sense, be considered as porphyries rather than granites. The wholesale appropriation to himself of the geology of Scotland (in despite of all the published and unpublished accounts of Scottish, English, and Foreign geologists) by Dr MacCulloch, was noticed; and it was remarked by several members, that a better spirit was now generally abroad, and that few were disposed to follow in the path of the author of the Geology of the Hebrides.—The Assistant-Secretary read a communication by Edward Hamilton Stirling, Esq. on the Calaite or Mineral Turquois Mines of Nishapur in Persia.

Professor Jameson in the chair.—The Assistant-Secretary read a letter from M. le Comte de Moligny, dated Besançon, 8th September 1835, giving an account of a tremendous fall of a part of a mountain called the Dent du Midi. It was therein stated that a space of about two square leagues, extending from the base of the mountain to the Rhone, had thus been covered by debris, in some cases to the depth of ten or twelve feet. 1836. April 30.

Professor Jameson, President, in the chair.—A Report from the Joint Prize Committees, dated 26th November 1836, was read, approved of, and sanctioned. It was of the following tenor: "The Committees were appointed on 9th January last, to examine the communications presented to the Society in consequence of their offer of honorary Premiums for the best Geological Report of the Lothians, and best Account of the Fishes of the district of the Forth; and having considered the recommendation of the Council, that the Premiums should be awarded if the communications were found meritorious, even al- Dec. 6.

though there should be no proper competition,—unanimously agree to report to the Society, 1. That the honorary Premium of Twenty Sovereigns, or a piece of Plate of that value, should be awarded to Robert James Hay Cunningham, Esq., for his Account of the Lothians, with Maps, Sections, and Specimens; it being understood that the author will, at his conveniency, furnish the Society with a particular account of the Faults, Organic Remains, and Mines of the district; and, 2. That the honorary Premium of Ten Sovereigns, or a piece of Plate of that value, should be awarded to Dr Richard Parnell,—upon a selection from the dried specimens submitted to the Society on 30th April last, and containing such species as are mentioned by the author as new to the district, or which may be considered in any way doubtful, being presented for the Museum of the Society."—At this meeting, Dr Paterson gave an account of the fossil fishes found in the strata belonging to the coal-formation at the beach between Newhaven and Granton; illustrating his communication by specimens. And Dr Traill read a notice regarding the poisonous bug of Persia; and exhibited specimens sent home by Dr Bell from Miana.

1836. Dec. 17. Professor Jameson, President, in the chair.—The Assistant-Secretary read Dr Paterson's account of the fossil plants found in the coal-formation at Wardie; while Dr Paterson exhibited to the members the illustrative specimens.—Dr Barry then read a paper on the unity of structure in the animal kingdom, illustrating the same by large diagrams.

1837. Jan. 21. David Falconar, Esq. Vice-President, in the chair.—The Secretary read a note from Professor Jameson relative to a splendid specimen of sun-fish, weighing 217 lb., and apparently a new species, lately captured in Leith Roads, which was exhibited to the meeting.—Mr William Jameson read a notice regarding the occurrence of the Sacred Ibis, Ibis religiosa, in New

South Wales, and exhibited specimens from that region.—Dr Robert Hamilton then read an account of the fur-seal of commerce, found at the New Shetland Islands by the late Captain Waddel, shewing that it is identical with the Otaria Falklandica, first described by Pennant.

Robert Stevenson, Esq., Vice-President, in the chair.—The Assistant-Secretary read a letter from Captain Alexander, the traveller, dated Doorne River, 30°.40′ south latitude, Africa, affording some interesting information. Likewise a letter from David Macadam, Esq., dated H. M. Ship Portland, Athens, May 1. 1836, giving an account of the progress, at that date, of the restoration of that ancient city, accompanied with a copy of a book printed at Athens, containing many inscriptions not hitherto published, and likely to be soon obliterated; also with a meteorological table of the weather on the coast of Helas.—Dr Neill read an account of a curious kind of monstrosity observed in the common garden wall-flower; communicated by Dr Paterson, with specimens of the anomaly.—The Assistant-Secretary then read the Rev. Mr Robertson's account of the Geology of Inverkeithing. He likewise read the Rev. Edward Stanley's account of the analysis of the mineral waters at Rippoldsau.—It was then proposed to the meeting to address a Memorial to the Commissioners for Northern Lights, praying them to establish daily tide-level observations at the different lighthouse stations where suitable situations might present themselves for that purpose. This was unanimously agreed to; and Professor Jameson, Mr Smith of Jordanhill, and the Secretaries, were appointed a committee, with powers to prepare and present such a memorial.* 1837. Feb. 4.

* In consequence of the above resolution, the following memorial was addressed by the committee to Charles Cuningham, Esq., Secretary to the Commissioners of the Northern Lights :—

Sir—

1837. Feb. 18. Dr Thomas Stewart Traill, Vice-President, in the chair.—The Assistant Secretary read Mr William Jameson's critical examination of Mr Swainson's account of the distribution of British birds, his observations being founded on the examination of numerous specimens in the University Museum.—Professor Jameson then read a notice regarding the occurrence of Arragonite near Ely and Craill, and its being found more lately by Lord Greenough at Lochgelly, in secondary trap-rocks. Professor Jameson likewise gave an account of a series of rocks collected in the Caucasian range by Major-General George Wright.—There were exhibited to the meeting a very fine specimen of the red orang-outang of Borneo, the great sloth from South America, a new species of eagle from Northern India, and the great Californian vulture.

Sir—We have been appointed a committee by the Wernerian Natural History Society of Edinburgh, to represent to the Commissioners of the Northern Lights the importance of an accurate determination of the relative levels of sea and land on the British coast, and to request respectfully, but earnestly, that the Commissioners would order daily observations of the levels of high and low water to be made and registered at the lighthouses best adapted to such experiments. Trusting that you will lay this expression of our desire for the promotion of so important an object before the Commissioners, we remain, &c.

To this memorial the following answer was received:—

Northern Lights' Office, Edinburgh,
27th April 1837.

Gentlemen—I beg to acknowledge the receipt of your letter of the 19th, containing a request, on the part of the Wernerian Natural History Society, that the Commissioners of the Northern Lighthouses would order daily observations of the high and low water to be made and registered at the lighthouses best adapted to such experiments. I am directed by the Commissioners to acquaint you, that they will have great pleasure in complying with your request, and that they have made a remit to Mr Stevenson, their engineer, to make the requisite arrangements, and to correspond with you on the subject. I am, &c.

(Signed) C. Cuningham, *Sec.*

Professor Jameson and Committee
of Wernerian Natural History Society, College.

David Falconar, Esq., Vice-President, in the chair.—The Assistant-Secretary read Mr Hamilton Stirling's observations on the Punnah diamond-mines.—A notice regarding the granite at Kingston Harbour, Dublin, and the trap-rocks of the islet of Pladda, off Cantyre, with specimens transmitted by Mr Stevenson, civil-engineer, was read.—The Assistant-Secretary then read a notice regarding recent marine shells found in a bed of clay thirty feet above the present level of the Firth of Forth, by Mr James Nicol, Polmont. Mr Smith of Jordanhill communicated a letter from the Rev. David Landsborough of Stevenston, describing a deposit of similar recent shells mixed with sea-weed at a similar elevation above the present level of the Firth of Clyde.—After a lengthened conversation on the subject of the removal of the Government Trigonometrical Survey from Scotland to Ireland, the meeting agreed to remit to the Council of the Society to prepare a Memorial to Government, requesting that the triangulation of Scotland should speedily be resumed, completed and published. And for this special business, the meeting directed that Mr Smith of Jordanhill and Mr James Stuart Menteath jun. of Closeburn, be summoned to the meeting of Council.—There was then laid on the table Lord Gray's Kinfauns Meteorological Table for 1836, and also that of the Rev. Mr Macritchie of Cluny ; and a skeleton of a common cock, shewing a curious abnormal formation in that bird, was exhibited and explained. 1837. March 4.

David Falconar, Esq., Vice-President, in the chair.—The Assistant-Secretary read a communication from the Rev. Samuel Traill, on the mode of ascertaining the rate of the increase of the internal temperature of the earth ; likewise an account of experiments made by Mr Peter Grant on the new substance named Donium, found in the Davidsonite of the Aberdeen quarries, communicated by Professor Fleming of King's College, Aberdeen.—Dr Martin Barry then read further observations on March 25.

the unity of structure in the animal kingdom, and on congenital anomalies, including hermaphrodites; with remarks on embryology, as facilitating animal nomenclature, classification, and the study of comparative anatomy; illustrating the whole by diagrams.

1837. April 8. Dr T. S. Traill, Vice-President, in the chair.—It was intimated that the Council had passed a resolution, directing the Secretary to write to the Secretaries of the Royal Society of Edinburgh, and the Highland and Agricultural Society, suggesting the importance of co-operation on the part of the principal scientific associations, and especially of these societies, in an application to Government for the resumption of the trigonometrical survey of Scotland.—The Assistant-Secretary read the first part of Captain Mackenzie's account of his overland journey from India.—Mr Smith of Jordanhill read an account of some extraordinary optical phenomena depending on atmospheric refraction, observed in the counties of Ayr and Stirling.—Mr Macgillivray then read a paper on the geological relations, and animal and vegetable productions, of the Cromarty Frith, with observations relative to the estuaries and sea-lochs of Scotland.

April 21. The following Memorial, prepared by the Council and Messrs Smith of Jordanhill and J. Stuart Menteath jun. of Closeburn, was read and approved of.

"Unto the Right Honourable the Lords Commissioners of His Majesty's Treasury, the Humble Memorial of the President and Members of the Wernerian Natural History Society of Edinburgh;

"Sheweth,

"That while your Memorialists view, with the utmost satisfaction, the progress which has been made in the noble Ordnance Surveys of England and Ireland, and are fully alive to the immense advantages which those parts of the Empire are already deriving from the admirable trigonometrical operations by which their physical geography has been defined, your Memorialists beg leave humbly, and most respectfully, to urge upon your Lordships' attention the very defective state of the best existing Maps and Charts of Scotland, and to suggest to your Lordships the propriety of directing the resumption of the Triangulation, and completion of the Trigonometrical Survey, of Scotland, which has been so long and unaccountably suspended, after it had been auspiciously commenced.

"The errors in Arrowsmith's Map of Scotland, which has the reputation of being the best we possess, are so numerous and important as to render the construction of a Geological Map of the country, on which dependence can be placed, an impracticable undertaking; while its erroneous positions of our Coasts and Islands present the most formidable obstacles to navigation. The form and position of headlands, and even of considerable islands, in this map, and in our best charts, are erroneously given; and sometimes dangerous rocks and whole islands are totally omitted. For example, your Memorialists beg leave to call your Lordships' attention to the following facts. The distant rocks of the *Stack* and the *Skerry*, off the northern coast of Sutherlandshire, as well as the Island of *St Kilda*, are totally omitted in Arrowsmith's Map, while the important Islands of Barra and Rona are misplaced, both in latitude and longitude. In some charts the large Island of Arran is laid down as *six miles* from Bute; in others as *nine miles*, and in a third as *twelve miles* distant from that island. Pladda Island Light, in charts, is placed as 16′ N. of Ailsa Craig; whereas its true distance is only 10′ 20″. These last are serious errors at the entrance of so important a river as the Clyde.

"Some years ago Dr MacCulloch was employed, at the public expense, to make a Geological Survey of Scotland, a circumstance utterly unknown to any public body in Scotland, until the Parliamentary papers shewed that he had drawn from the Treasury upwards of L.7000 for that service. But the only fruit of this expenditure is the publication of his posthumous Geological Map, on which unfortunately little reliance can be placed for local details, as a trigonometrical survey should have preceded any attempt to represent the position of the rocks and mineral productions by a coloured map. Of this truth Dr MacCulloch appears to have become sensible, when he had advanced the imperfection of our best maps as an excuse for his delay in preparing the materials he had collected.

"Your Memorialists do not consider it necessary to enter into any detailed observations on this occasion on the numerous and important advantages which must result to navigation, commerce, and agriculture, or the scientific interest which would arise from the completion of the Trigonometrical Survey of Scotland; as your Memorialists have no doubt that these are obvious to your Lordships; and they have the fullest confidence in the desire of his Majesty's Government to extend the benefits of accurate geographical knowledge to all parts of his Majesty's dominions.

"Signed in name of the Society,

"R. JAMESON, *President.*

"UNIVERSITY, EDINBURGH, 26*th* *April* 1837."

The following Minute of Council was also read:—"The meeting directed that 100 copies of the Memorial be printed; that a fair copy be written out for the Treasury, to be signed by the President in name of the Society, and transmitted through a Member of Parliament; and that afterwards a printed copy be transmitted to each of the Lords Commissioners, to the Speaker of the House of Commons, and to each of the Scotch Members of Parliament," &c.—The Assistant-Secretary read a continuation of Captain Mackenzie's account of his overland journey from India, particularly describing the present statistics of Mocha; also an account, by Mr Percy, of a visit, last summer, to the Jardin, near Chamouni, with a list of alpine plants.—Mr

Kemp then exhibited some interesting experiments with potassium, producing readily the metallic bases of various earths, and shewing how the sudden inflammation of the potassium, on coming in contact with water, might be rendered useful in affording an instantaneous though transient light in a dark night at sea.—The Society adjourned till November next.

THIRTY-FIRST SESSION.

Professor Jameson in the chair.—Dr Martin Barry exhibited a living specimen of the Proteus anguinus; and having, with a lancet, drawn a small portion of its blood, shewed the globules by means of a microscope by Schiek of Berlin, these globules being about fifteen times larger than those of the human blood. 1837. Nov. 25.

Professor Jameson in the chair.—The Assistant-Secretary read the Rev. Dr Anderson's account of remarkable fossil remains, especially fishes, found in the sandstone of Fifeshire; and exhibited a series of interesting and beautiful specimens.—He then read the 1st Part of Dr A. Boué's remarks on the scenery, antiquities, population, agriculture, and commerce, of Central Turkey.—Professor Jameson exhibited an enormous tibial bone of a mammoth, from the Himmalaya range in Upper India (from the collection of Colonel Colvin); likewise two skulls of the great or red orang-outang; and a fine specimen of the stork, killed on the mainland of Shetland last autumn, and transmitted by William Mouat Cameron Mouat, Esq. Dec. 9.

Professor Jameson in the chair.—The Assistant-Secretary read Mr G. Maclaine of Batavia's remarks on the geology and mineralogy of Java, and exhibited specimens; likewise remarks on a cheiropterous animal, taken in the tombs of the kings of Thebes, by Dr William Hibbert of the Queen's Royals; communicated by Sir James M'Grigor, Bart.—Mr William Jameson 1838. Jan. 13.

exhibited and described various specimens of new or rare birds from Northern India.

1888. Jan. 27. David Falconar, Esq., Vice-President, in the chair.—The Assistant-Secretary read a communication by Dr Charles Bell, Physician to the British Embassy at the Court of Persia, on the geology of part of the district of Mazunderan.—Professor Jameson exhibited and described a fine specimen of the head of a large mastodon from India; from the magnificent collection of Sewalic fossils presented to the University by Colonel Colvin.—Mr Kemp exhibited the experiment of the solidification of carbonic acid gas.

Feb. 10. David Falconar, Esq., Vice-President, in the chair.—The Assistant-Secretary read, 1*st*, The second part of Dr Boué's remarks on the scenery, antiquities, population, agriculture, and commerce, of Central Turkey. 2*d*, A letter from Dr Smith of Lima, on the use of ice in the cure of cholera morbus in Peru. 3*d*, A letter from J. B. Pentland, Esq. containing notices on elevated beaches in South America. Mr W. Jameson communicated some remarks on gulls, and described a new species from India.—Mr Kemp shewed the action of potassium on various gases.

Feb. 24 David Falconar, Esq., Vice-President, in the chair.—Dr Martin Barry gave microscopic demonstrations of the ciliary motions, as well as of individual ciliæ in the Ostrea edulis, and exhibited diagrams of ciliæ, or rather of vibrating lamellæ, in the four orders of vertebrated animals. He likewise gave a microscopic demonstration of an unimpregnated ovulum of Lepus cunniculus, in which were seen the so-called "chorion," the yolk, containing many globules of oil, the germinal vesicle, and the germinal spot; and exhibited diagrams shewing essentially the same parts in all classes of animals, from infusoria on the one hand, to man on the other, in other words, "fundamental unity of structure."

Professor Jameson, President, in the chair.—Dr Robert Hamilton exhibited beautiful coloured drawings of the known species of seals, and made remarks on the characters and habits of each.—Mr R. J. Hay Cunningham read a paper on elevated beaches, in references especially to a deposit near Cockburnspath.—Dr Martin Barry then read a paper on the blood, in regard particularly to the application of histological characters in zoological classification, first proposed by Professor Wagner of Erlangen, in Bavaria. He pointed out some remarkable coincidences between the size of the red particles, and the degree of concentration of the germinative spots in fishes and amphibia, and gave a microscopic demonstration of the blood granules of the ostrea edulis, and of the unimpregnated ovulum of birds and osseous fishes. 1838. March 10.

Dr Charles Anderson, Vice-President, in the chair.—Dr William Macdonald read a paper on the analogy between the locomotive organs in fishes and insects, illustrating the theory of unity of organization throughout the animal kingdom, with demonstrations from specimens, accompanied by drawings and diagrams.—Dr R. Hamilton concluded his exhibition and description of drawings (by Mr Stewart) of the various species of the seal tribe.—An extensive collection of fossil fishes from Burdiehouse, belonging to R. J. Hay Cunningham, Esq., was exhibited and explained. March 24.

Professor Jameson, President, in the chair.—Mr Hay Cunningham read a geognostical account of the southern part of the mainland of Shetland, exhibiting specimens of the different rocks, and illustrating his descriptions by large coloured sketches of some of the more interesting junctions, veins, &c. April 7.

1838. April 21. Professor Jameson, President, in the chair.—Mr Smith of Jordanhill read a paper on the latest changes of the level of the sea, particularly in the basin of the Clyde, and exhibited a series of shells from elevated beaches.—The Assistant-Secretary read Dr Lawrence Edmonston's observations on the distinctions, history, and hunting, of seals in the Shetland Islands.—He then gave a brief notice of Dr Boué's account of the geology of some parts of European Turkey; and communicated an abstract of Mr John Lawson junior's observations on the geology of the lower district of Moray, with a description of various mineral deposits in the vicinity of Elgin.—There were laid on the table, 1. A series of daily observations on the thermometer, barometer, and rain-gauge, made at the manse of Abbey St Bathan's, by the Rev. John Wallace; and, 2. A comparative register of the sympiesometer and marine barometer, kept in the H. E. I. Company's ship Charles Grant, during a voyage from England to Bombay, in 1836, by Henry Graham, Esq.

LIST OF MEMBERS.

(Continued from Vol. VI. p. 584.)

RESIDENT.

1831.

Dec. 24. Bindon Blood, Esq. F. R. S. E.

1834.

Feb. 1. William Copland, F. R. S. E. F. G. S., Esq. of Collieston.

1835.

Dec. 5. Robert James Hay Cunningham, Esq.
Dr Martin Barry, F. R. S. E.

1836.

Dec. 3. Dr Robert Paterson, Leith.

1837.

Jan. 21. James Smith, Esq. of Jordanhill, F. R. S. E. G. S.

NON-RESIDENT.

1831.

Dec. 24. William Hutton Forrest, Esq. Surgeon, Stirling.

1833.

Mar. 23. James Smith, Esq. of Deanston, by Doune.

1834.

April 26. William Christie, Esq. of the Stangate Glassworks, Lambeth, London.

1836.

Dec. 3. Captain Henry Drummond, H. E. I. C.'s Service.
William Stanger, Esq. M. D. Wisbeach.

1838.

Aug. 11. Dr John Hawkins, Caermarthen.

FOREIGN.

1834.

Feb. 1. M. E. Puillon de Boblaye, Paris.

1836.

Jan. 23. Charles Lucien Bonaparte, Prince of Musignano.
M. Le Comte Dejean, Paris.
M. Lefebre, Secretary of the Entomological Society of Paris.
Professor B. M. Keilhau, Christiania.

CORRESPONDING.

1832.

Dec. 14. James Duncan, Esq.

1835.

Dr Juan Llacayo of Madrid.

1836.

Mar. 26. Edward Hamilton Stirling, Esq. H. E. I. C. S.
April 16. James Robertson, Esq. Mining Engineer, Persia.

1838.

Aug. 11. Rev. John Anderson, D. D. Newburgh.
Rev. David Landsborough, Stevenston.

OFFICE-BEARERS, 1838.

PRESIDENT.

Robert Jameson, Esq. Prof. Nat. Hist. University of Edin.

VICE PRESIDENTS.

Dr John Coldstream,
David Falconar, Esq.
Dr Charles Anderson,
William Copland, Esq.

Secretary, Pat. Neill, LL.D.
Assist. Sec. T. J. Torrie, Esq.
Treasurer, A. G. Ellis, Esq.
Librarian, James Wilson, Esq.
Painter, P. Syme, Esq.
Assist. W. H. Townsend, Esq.

COUNCIL.

R. K. Greville, LL. D.
John Sligo, Esq.
Dr Walter Adam,
Dr William Macdonald,
Dr Martin Barry,
R. J. H. Cunningham, Esq.
William A. Cadell, Esq.
Dr Robert Hamilton.

INDICES.

GENERAL INDEX.

INDEX TO DR PARNELL'S PAPER ON THE FISHES OF THE FORTH DISTRICT.

Note.—Those terms which are printed in italics, express the Scientific and approved names, Latin and English; whilst those in the Roman characters include the more obsolete scientific, and the vulgar or trivial names, in both languages.

ERRATA.

Page 163,	line 12,	from the top,	*for*	*Susa*	*read*	*Sula*
172,	8,	——		*TRACHURUS.*	—	*TRACHINUS.*
192,	30,	——		*biurus,*	—	*leiurus,*
203,	1,	——		*PAGRUS.*	—	*PAGELLUS.*
208,	26,	——		boiled,	—	broiled,
208,	27,	——		crack,	—	cracks,
236,	13,	——		estuary	—	shallows
246,	2,	——		situated	—	striated
272,	1–6,	——		*Betia*	—	*Botia*
276,	8–9–14–34,	——		*sauris*	—	*saurus*
333,	6,	——		*GADUS.*	—	*MORRHUA.*
301,	bottom,	——		doubts	—	doubt

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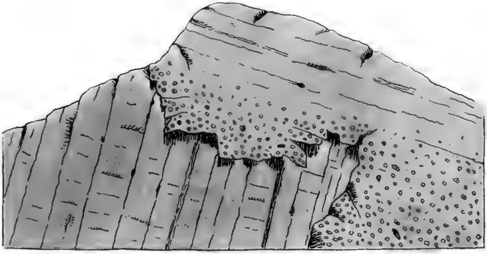
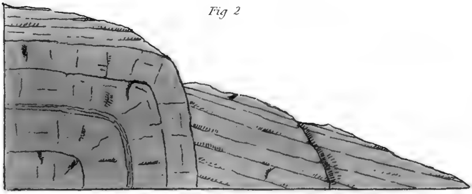
PLATE I.

Fig 1



Junction of Greywacké and Red Sandstone Heriot Water.

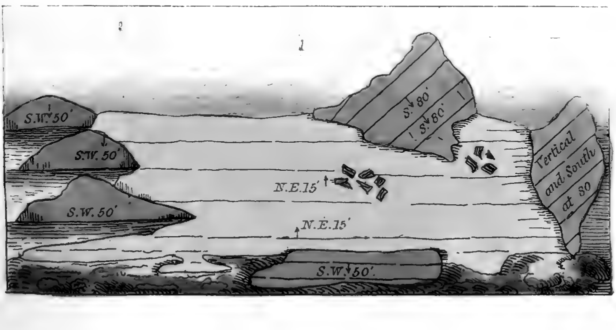
Fig 2



Junction of Greywacké and Red Sandstone near Red Heugh.

Drawn & etched by R. J. H. Cunningham.

Junction of Greywacke and Red Sandstone — Near Red Heugh.

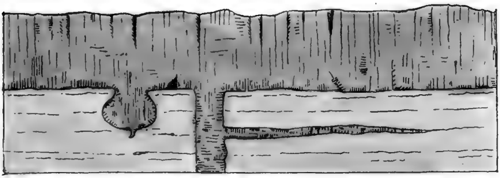


Ground Plan of a Junction of Greywacke and Red Sandstone — near Red Heugh.

Drawn & Etched by R. J. H. Cunningham.

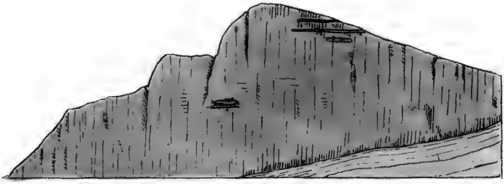
PLATE III

Fig 1



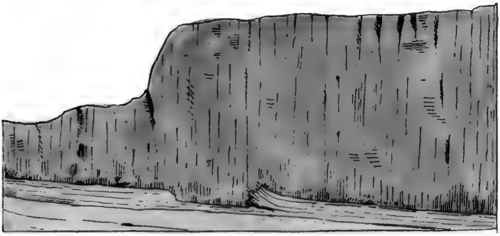
Junction of Greenstone and Sandstone St Leonards Hill.

Fig 2



Junction of Greenstone and Arenaceous Limestone Salisbury Craigs.

Fig 3



Junction of Greenstone and Arenaceous Limestone Salisbury Craigs.

Drawn & etched by R. J. H. Cunningham

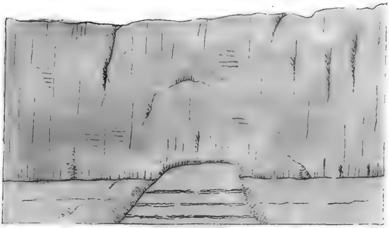
PLATE IV.

Junction of Greenstone and Sandstone Salisbury Craigs.

Drawn & etched by R. J. H. Cunningham

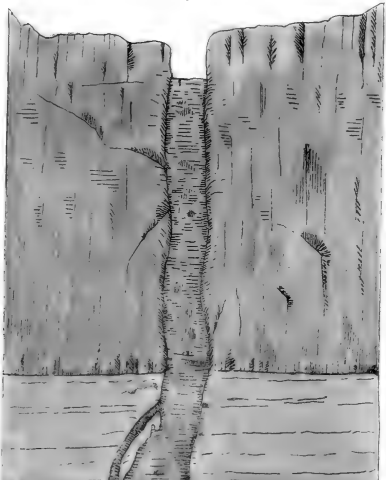
PLATE V.

Fig 1.



Shift in Sandstone. Salisbury Crags.

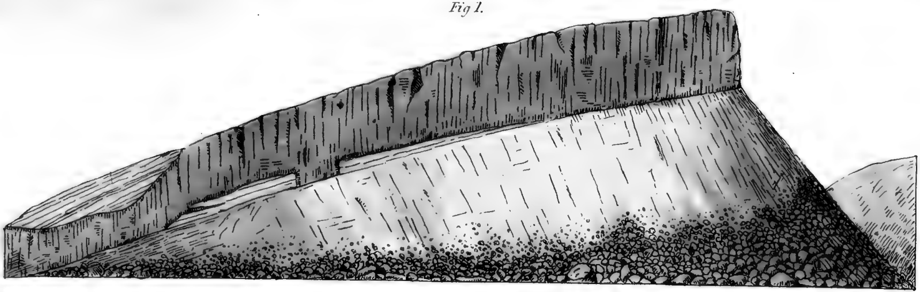
Fig 2.



Vein of Greenstone traversing Greenstone. Salisbury Crags.

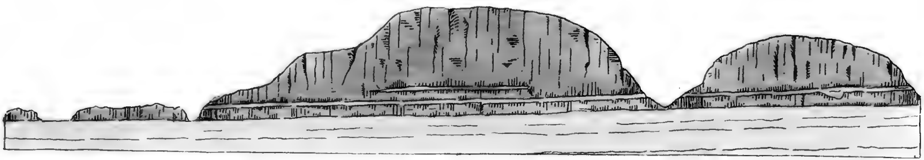
Drawn & etched by R. J. H. Cunningham.

Fig 1.



Sectional View of the Northern Part of Salisbury Crags.

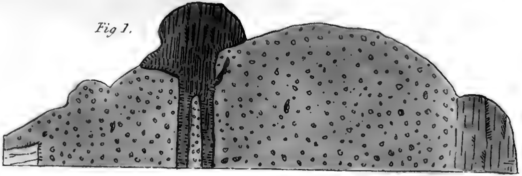
Fig 2.



Junction of Sandstone & Greenstone Porphyry. Arthur Seat.

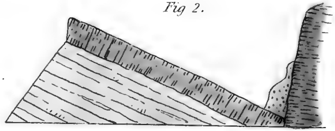
Drawn & etched by R. J. H. Cunningham.

Fig 1.



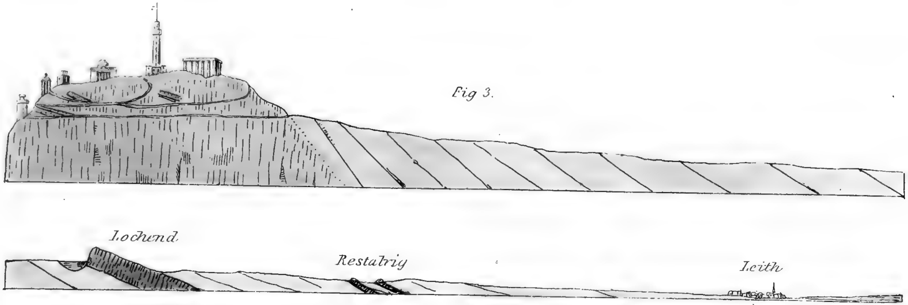
Section of Arthur Seat partly ideal.

Fig 2.



Section Shewing the probable relations of the Basalt of Arthur Seat, to the Greenstone of Salisbury Crags.

Fig 3.

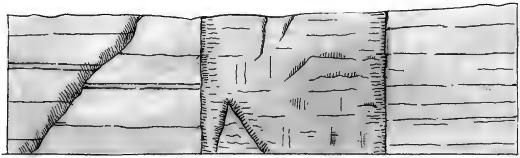


Section from the Calton Hill to Leith

Drawn & Etched by R.J.H. Cunningham.

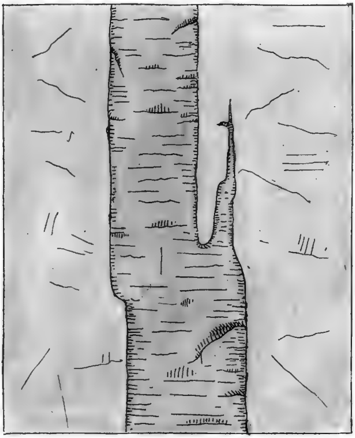
PLATE VIII.

Fig 1.



Greenstone traversing Shale. Water of Leith.

Fig 2.



Ground plan of Greenstone vein traversing Shale. Water of Leith.

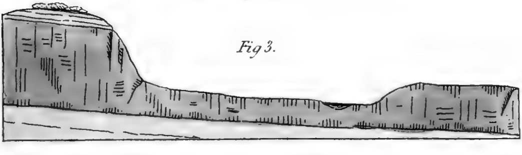
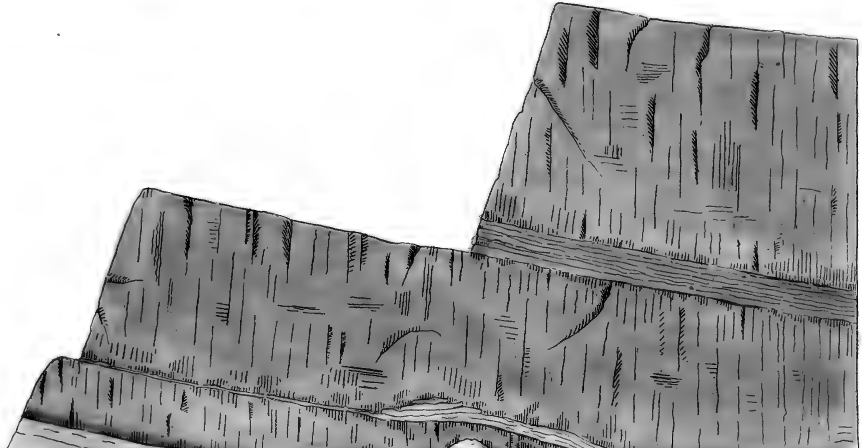


Fig 3.

Greenstone vein. Bells Mills.

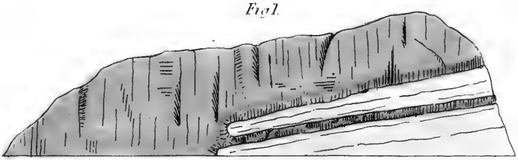
Drawn & etched by R.J.H. Cunningham.



Greenstone enveloping Masses of Slate and Sandstone. Hound Point.

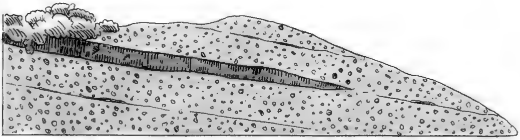
Drawn & etched by R. J. H. Cunningham.

Fig 1.



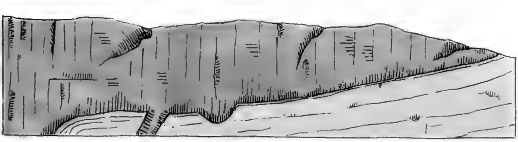
Felspar vein traversing Sandstone and passing into Greenstone. Inch Colm.

Fig 2.



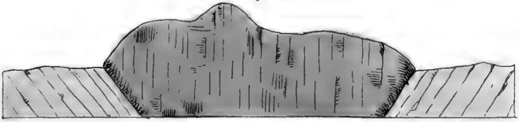
Vein of Greenstone traversing Sandstone Conglomerate. Cairn Muir.

Fig 3.



Junction of Greenstone and Red Sandstone. Sunnyside Quarry.

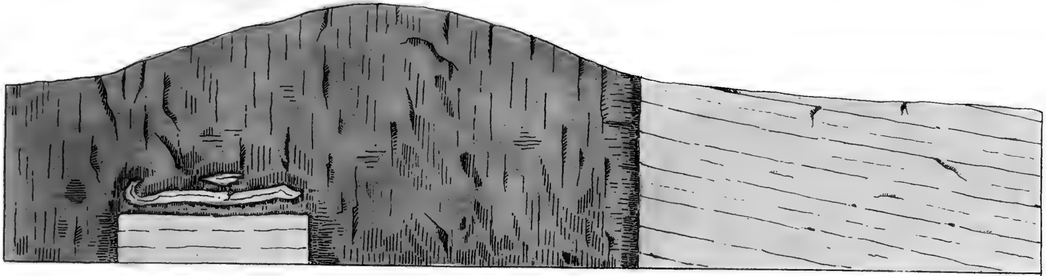
Fig 4.



Junction of Greenstone and Red Sandstone. Whitberry Point.

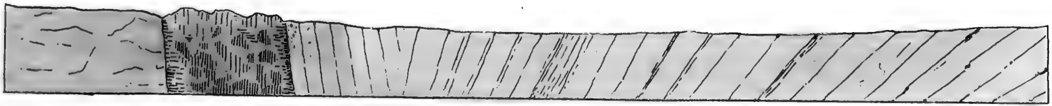
Drawn & etched by R. J. H. Cunningham.

Fig 1.



Greenstone traversing Red Sandstone_Dunbar Castle.

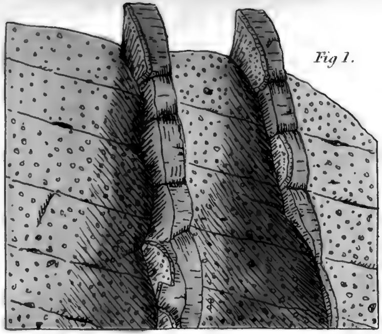
Fig 2.



Greenstone traversing Sandstone_near Broxmouth.

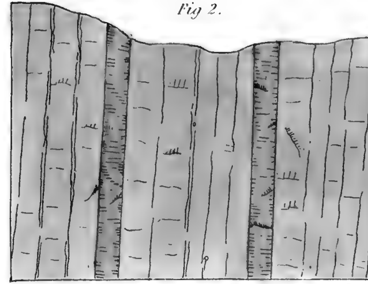
Drawn & etched by R.J.H. Cunningham.

Fig 1.



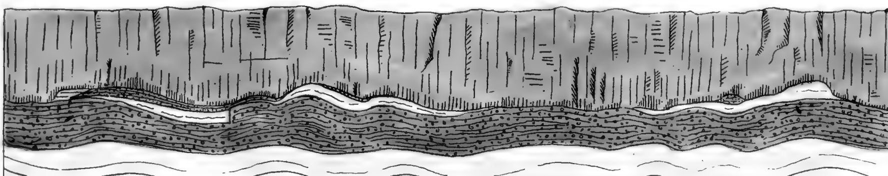
Trap veins traversing Sandstone Conglomerate._Stotan Cleugh.

Fig 2.



Felspar veins traversing Greywackè._Fassney Water.

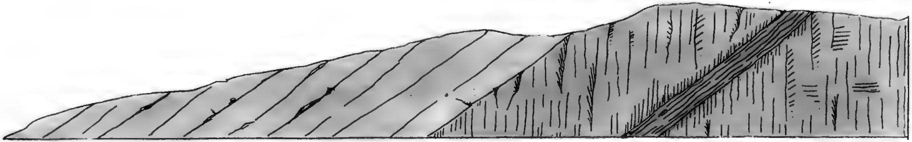
Fig 3.



Junction of Trap Tuffa and M. Limestone._Kirkton. Bathgate.

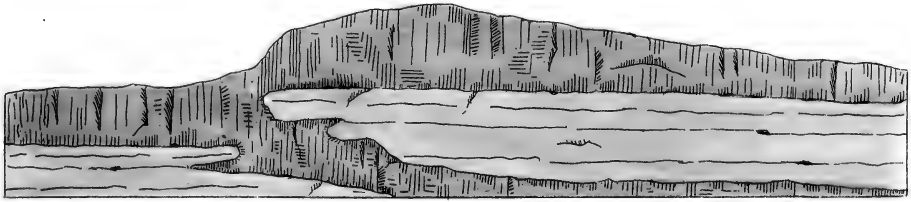
Drawn & etched by R.J.H. Cunningham.

Fig 1.



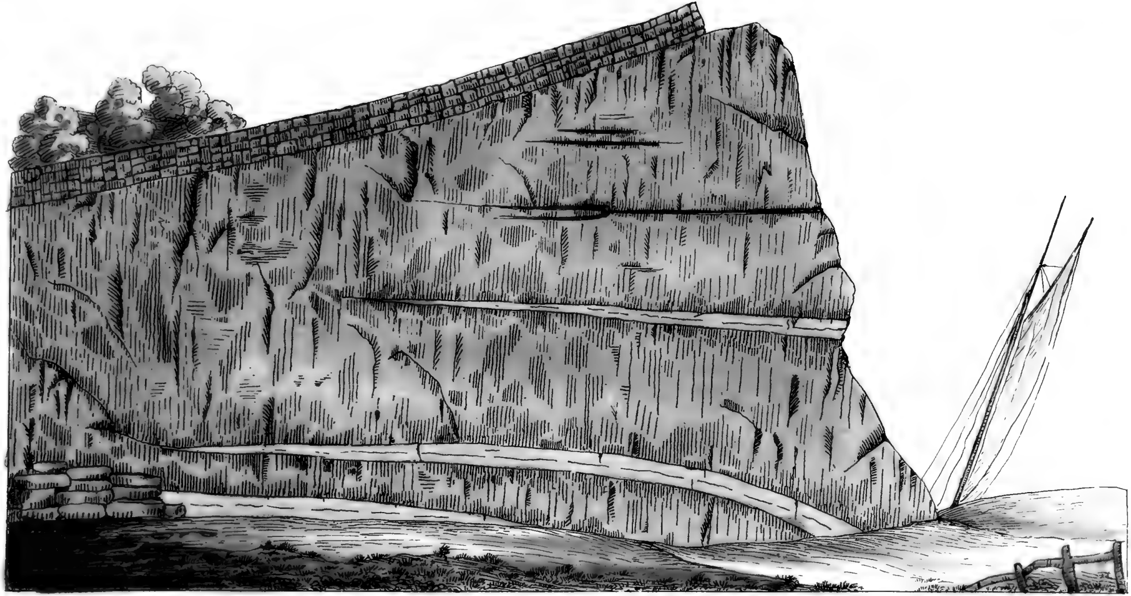
Junction of Greenstone with Sandstone and Slate Clay. Winchburgh.

Fig 2.



Junction of Greenstone and Sandstone.— Winchburgh.

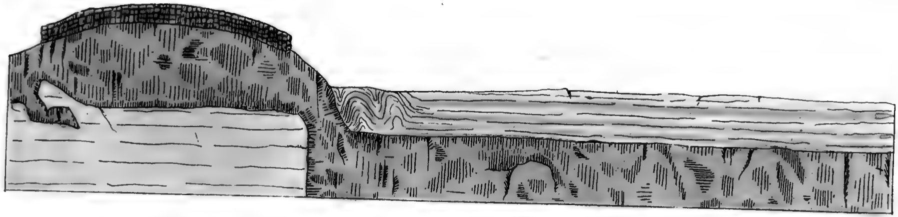
Drawn & etched by R. J. H. Cunningham.



Sandstone and Slate enveloped in Greenstone. Aberdour Harbour.

Drawn & etched by R.J.H. Cunningham

Fig 1.



Junction of Sandstone and Shale with Greenstone near Alexanders Crag.

Fig 2.

Felspar vein traversing the Coal Series _ Whinny Hill.

Drawn & etched by R.I.H. Cunningham.

Junction of Greenstone and Sandstone. Shore near Kirkaldy.

Drawn & etched by R.J.H. Cunningham

Explanation
OF THE COLOURS

STRATIFIED ROCKS.

Greywacke

Red Sandstone

White Sandstone

Mountain Limestone

Slate Clay and Bit. Shale

Arenaceous Limestone

Coal

UNSTRATIFIED ROCKS.

Greenstone

Basalt

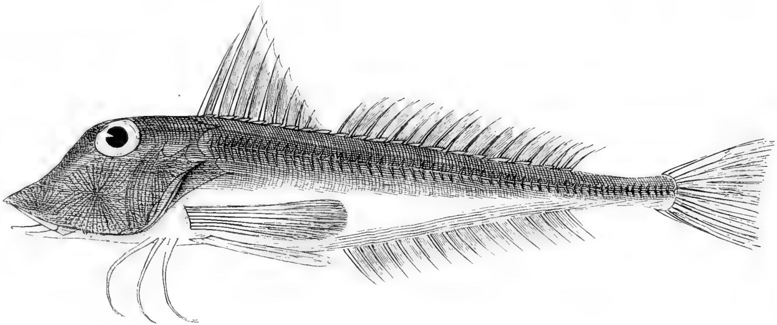
Porphyry Series

Trap Tufa

Pl.XVIII.

Scales from dorsal ridge.

Scale from lateral line.



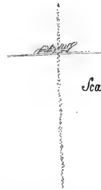
Trigla cuculus . . p.174.

Red Gurnard .... length.14.inches.

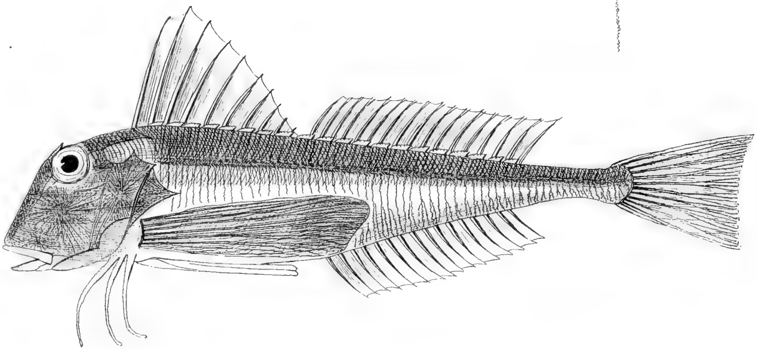
R. Parnell

Pl.XIX.

Scales from dorsal ridge.



Scale from lateral line.



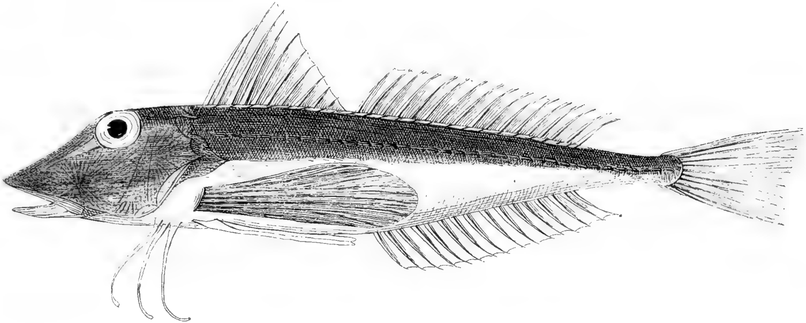
Trigla lineata. p175.

Streaked Gurnard length 13 inches.

R. Powell

Scales from dorsal ridge.

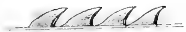
Scales from lateral line



Trigla hirundo .... p176.

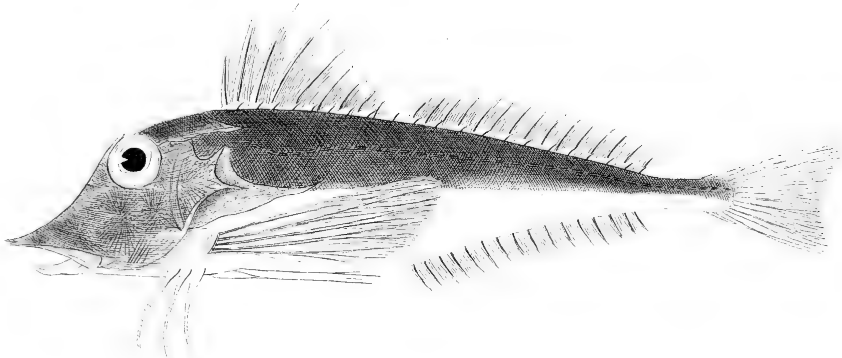
Sapphirine Gurnard .... length. 15. inches.

R. Parnell.



Scales from dorsal ridge.

Scales from lateral line.

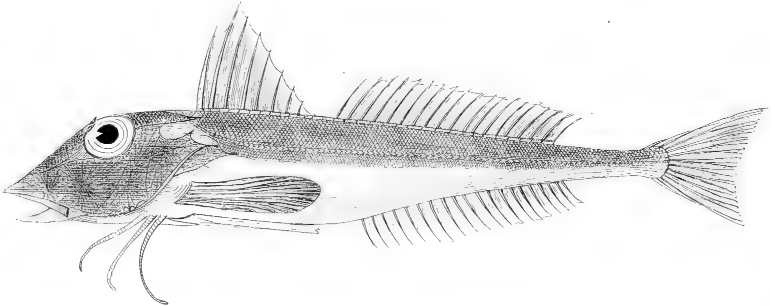


Trigla lyra. .. P.177.
Piper Gurnard length 16. in.

R. Parnell

Scales from dorsal ridge.

Scales from lateral line.



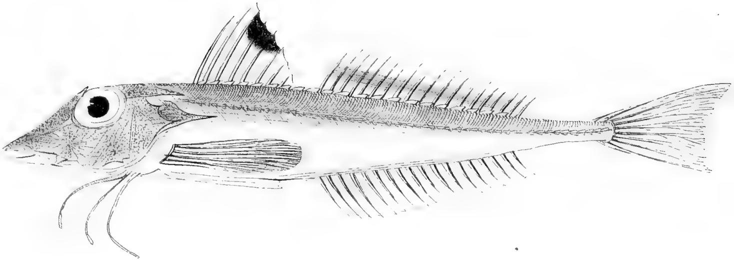
Trigla gurnardus. . . . p. 178.
Grey Gurnard . length. 1. foot.

R. Parnell.

Pl. XXIII.

Scales from dorsal ridge.

Scales from lateral line.

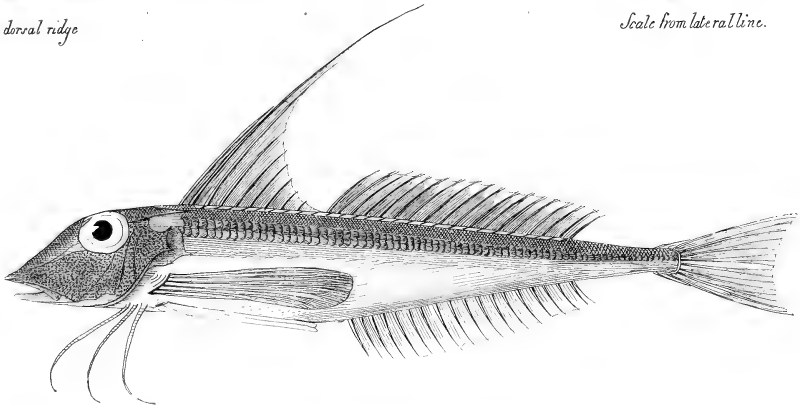


Trigla Blochii. . . . . p. 181.
Bloch's Gurnard. . . . . length. 5. inches.

Pl. XXIV.

Scales from dorsal ridge

Scale from lateral line.

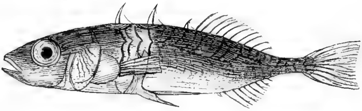


Trigla lucerna. p. 183.

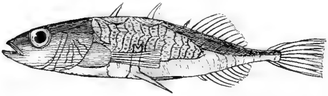
Long-finned Captain .... length 13 inches.

R. Parnell.

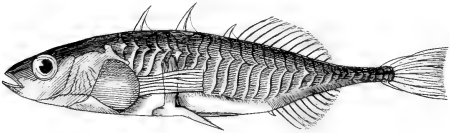
Pl XXV



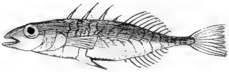
Gasterosteus leiurus .. p. 190.
Quarter-armed Stickleback Natural size.



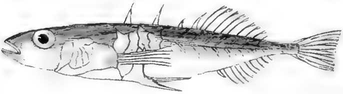
G. semiarmatus p. 192.
Half-armed Stickleback. n. s.



G. trachurus p. 193.
Full-armed Stickleback . . . . n. s.

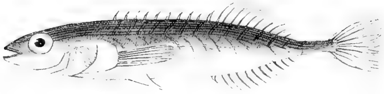


G. spinulosus p. 196.
Four-spined Stickleback. n. s.



G. spinulosus (var) p. 197.

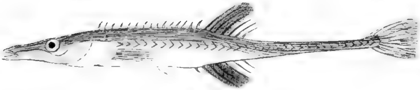
Pl.XXVI.



Gasterosteus pungitius. ..... p.197.
Ten-spined Stickleback. Natural size.

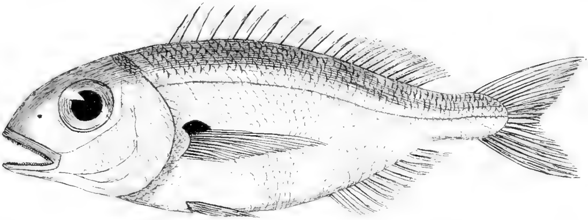
G. pungitius (var) 11 spines. p.198. n.s.

G. pungitius (var) 9 spines ....p.198. n.s.

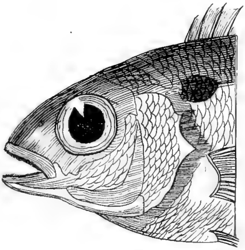


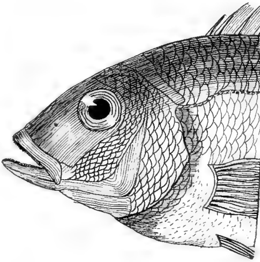
G. spinachia ..p.198.
Fifteen-spined Stickleback. n.s.

Pl XXVII.



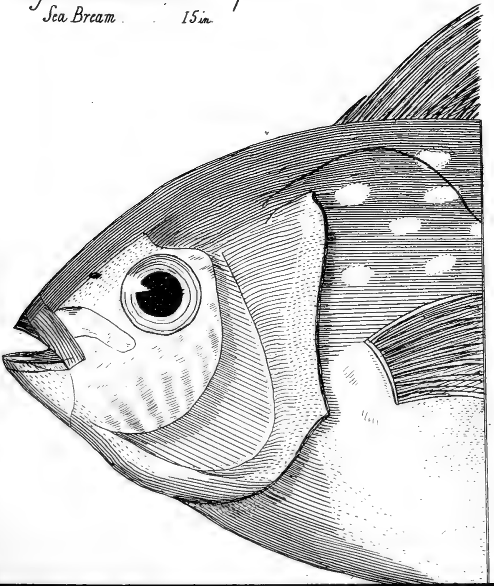
Pagellus acarne. ......p. 204.
Axillary Bream 13 in.



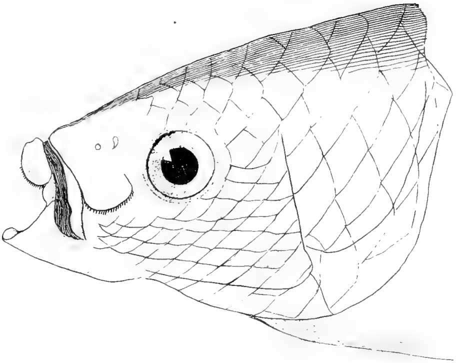


Pagellus erythrinus .... p. 203
Spanish Bream ...... 19 in.

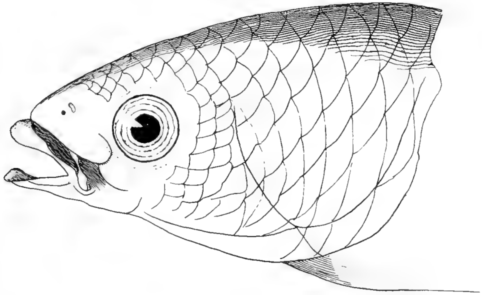
Pagellus centrodontus p. 206.
Sea Bream . 15 in.



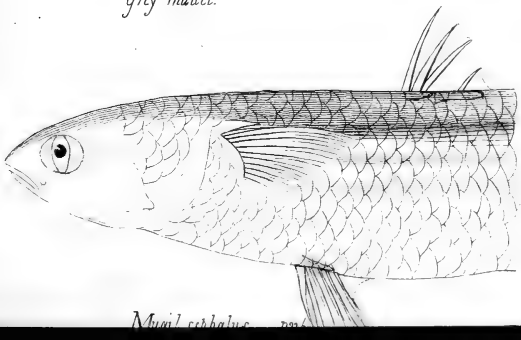
Lampris guttatus. p. 223.
Opah . 3 feet.



Mugil chelo p. 228.
Thick-lipped Grey Mullet.

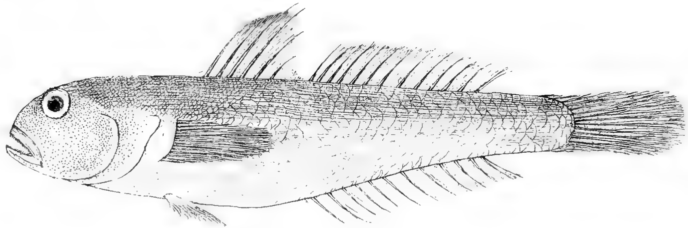


Mugil capito p. 225.
Grey Mullet.

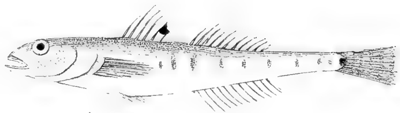


Mugil cephalus

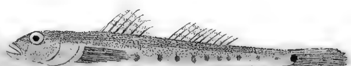
PLATE XXIX.



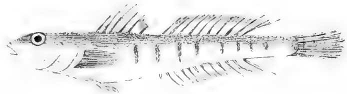
Gobius niger p 240.
Black Goby natural size.



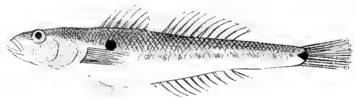
Gobius unipunctatus. p 243
One-spotted Goby. natural size



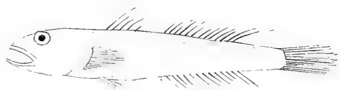
Gobius minutus . . p 242
Freckled Goby Natural size



Gobius gracilis p 245
Slender Goby Natural size



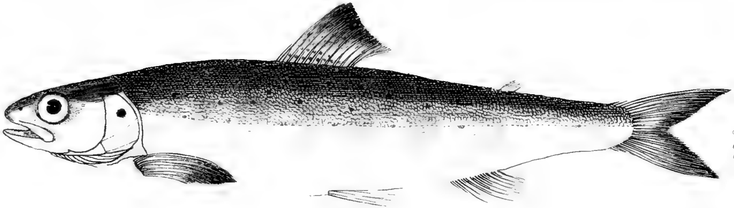
Gobius bipunctatus p 246
Doubly-spotted Goby. Natural size.



Gobius albus p. 248
White Goby . . natural size.

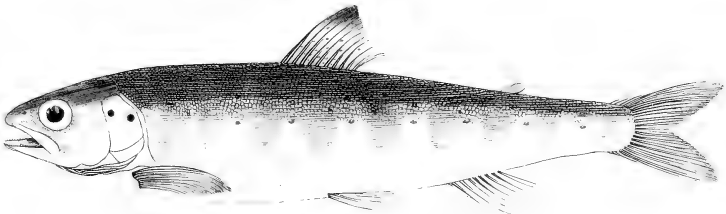
R Parnell

1 Vomerine teeth

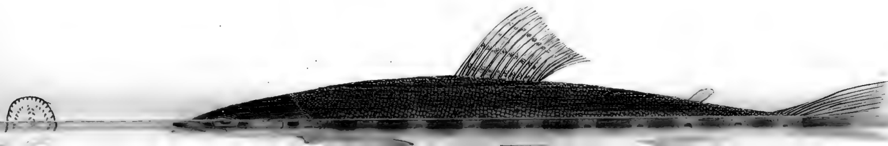


Salmo Salar P. 283.
Young Salmon or Smolt
Drawn from a specimen 8 inches in length

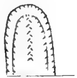
1 Vomerine teeth



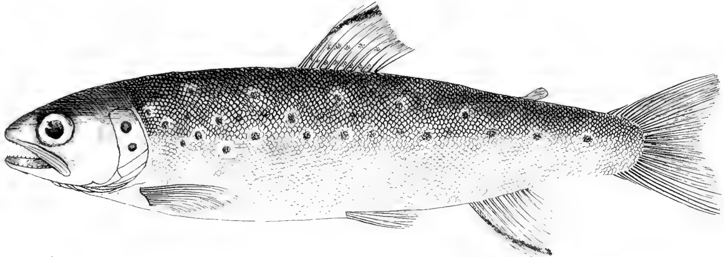
Salmo Trutta P. 295.
Young Sea Trout
Drawn from a specimen 8 inches in length



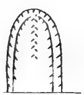
1 Vomerine teeth



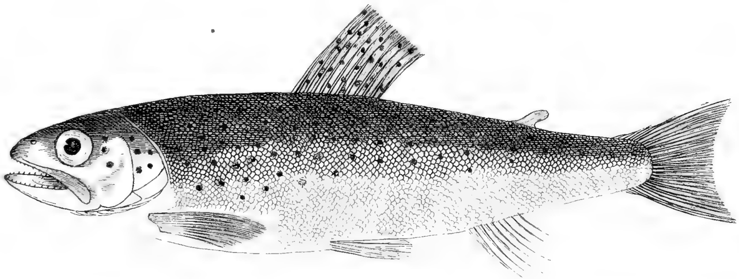
1 Vomerine teeth



Salmo Fario P. 304
Common Trout
Drawn from a specimen 8 inches in length

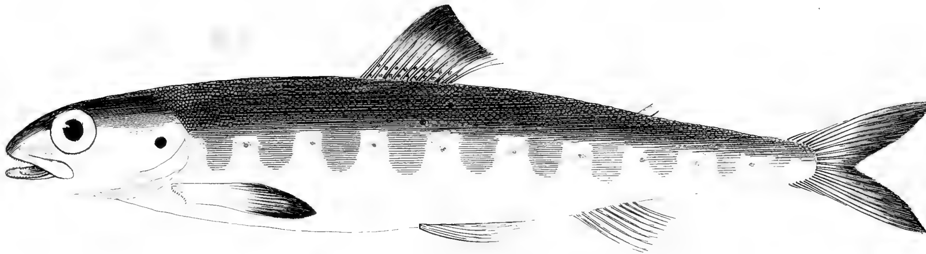


1 Vomerine teeth



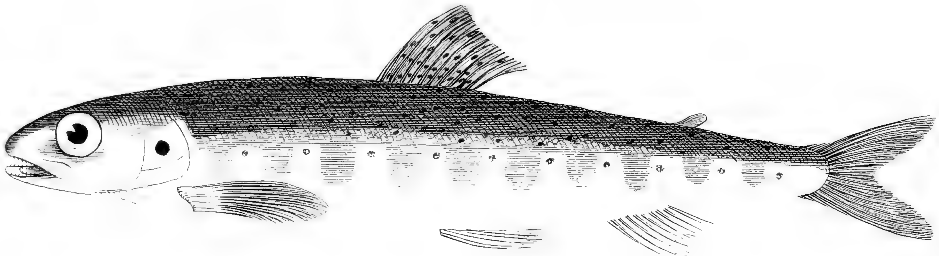
Salmo cæcifer P. 306.
Loch-Leven Trout
Drawn from a specimen 1 foot in length

R. Parnell del^t. & sculp^t.



Salmo Salar
Young Salmon or Smolt. Natural size. Captured May 13th.

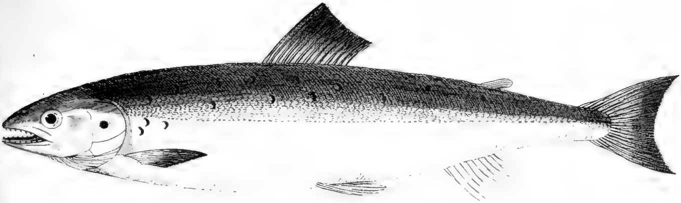
Salmo Eriox
Salmon Trout. Young. Natural size. Captured May 13th.



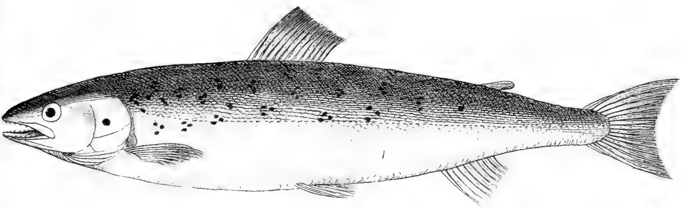
Salmo Salmulus
Parr or Skipper. Natural size. Captured May 14th

R Parnell delt & sculpt.

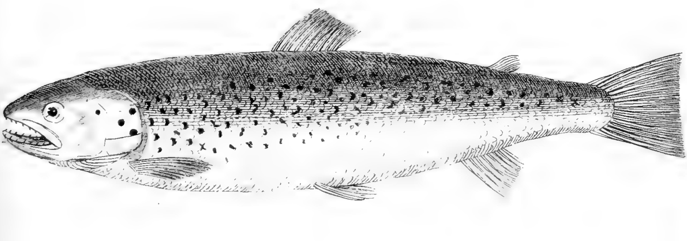
Pl. XXXII.



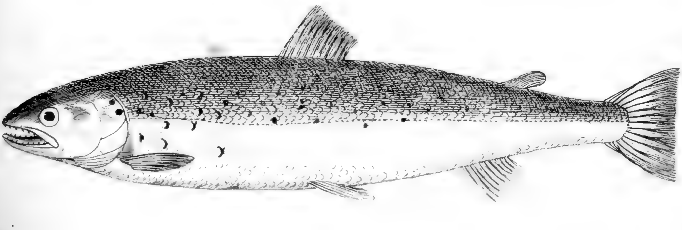
Salmon. p. 278. fig. 1



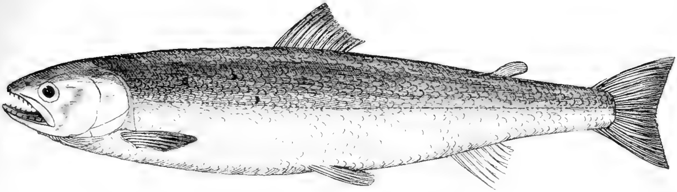
Norway Salmon. p 238. fig 2.



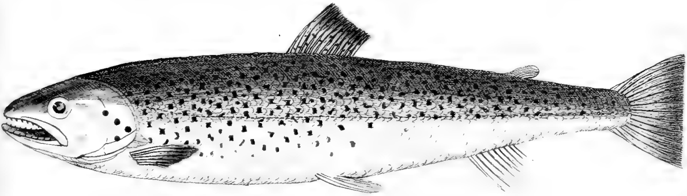
Bull-Trout. p [illegible] fig 3



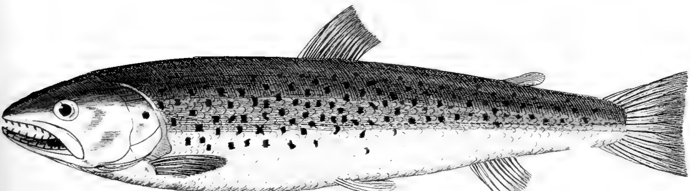
Pl. XXXIII.



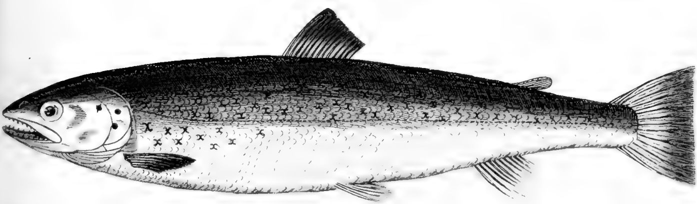
Few-spotted Bull-Trout p 291 fig. 5.



Thickly spotted Bull Trout ....p. 291.... fig. 6.



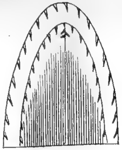
Large-headed Bull-Trout . p. 292 fig. 7.



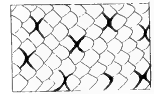
Curved-spotted Bull-Trout p 292 fig. 8.

Pl. XXXIII.*

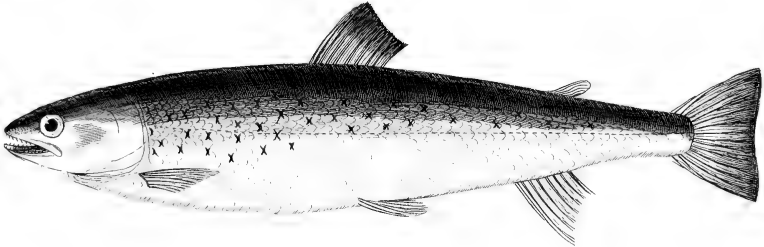
1



1 Vomerine teeth.



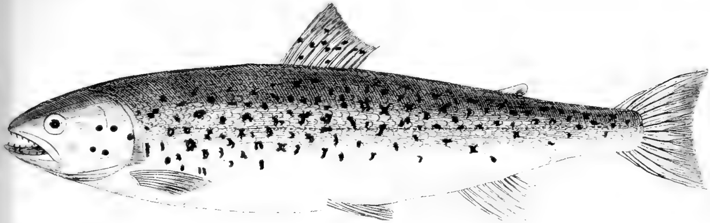
Scales and spots, natural size.



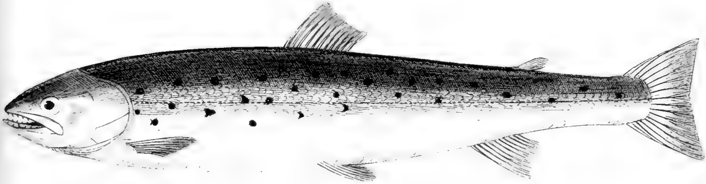
Salmon-Bull-Trout. p. 293

R. Parnell

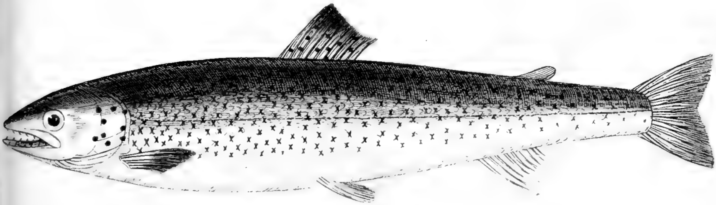
Pl. XXXIV.



Crescent-tailed Bull Trout. p 293. fig. 9.



Norway Bull-Trout p 293 fig. 10.

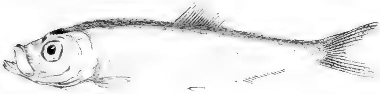


Salmon-Trout p 293. fig 11

Pectoral fin, natural size,
of a Parr eight inches in length . . . p. 139.

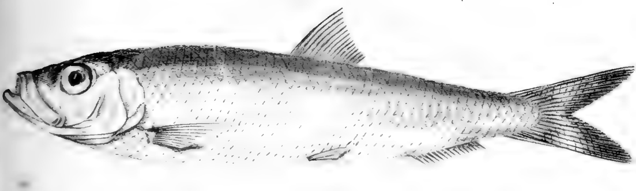
Pectoral fin, natural size,
of a young Salmon eight inches in length p 13

PLATE XXXV.



Whitebait. . . . . . p 325

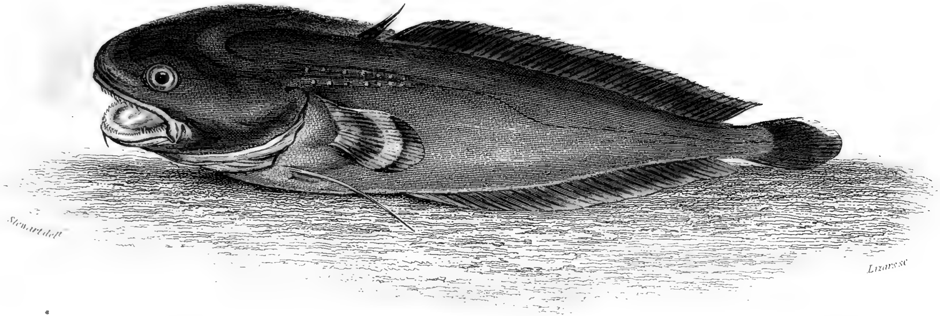
Sprat. .... p 322



Herring. p 315

Stewart del[t] Lizars sc

PLATE XXXVI.



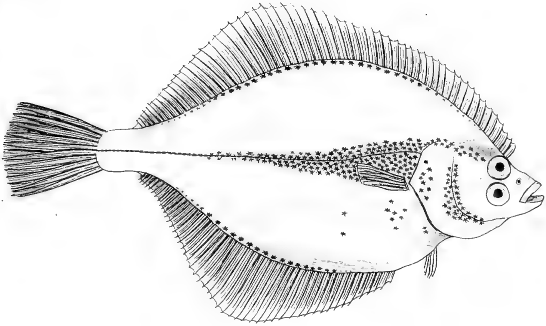
Stewart del.

Lizars sc.

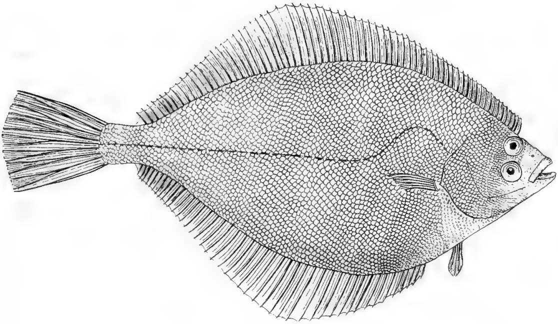
Raniceps trifurcatus.
Tadpole fish.

p 359

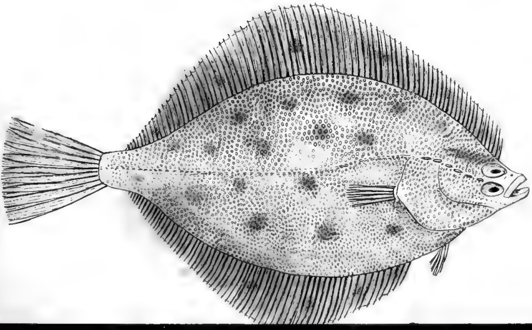
Pl XXXVII



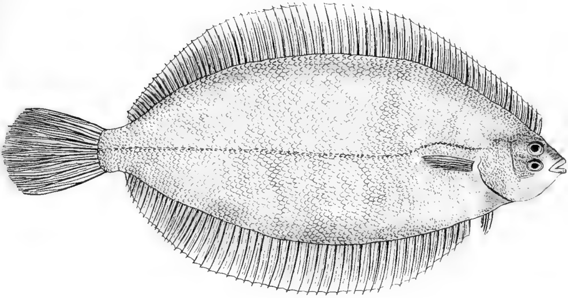
Platessa flesus. p. 363.
Mud Flounder length I. foot.



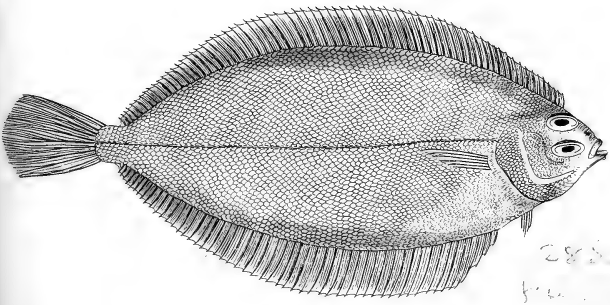
Platessa limanda p. 365.
Saltwater Flounder length I. foot.



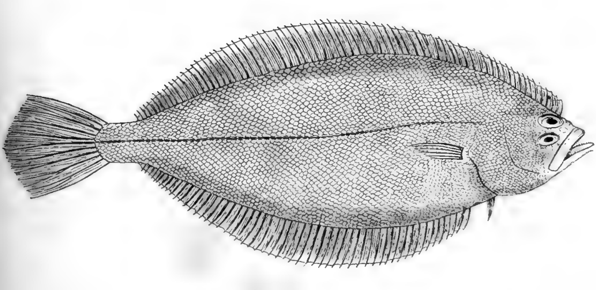
Pl. XXXVIII.



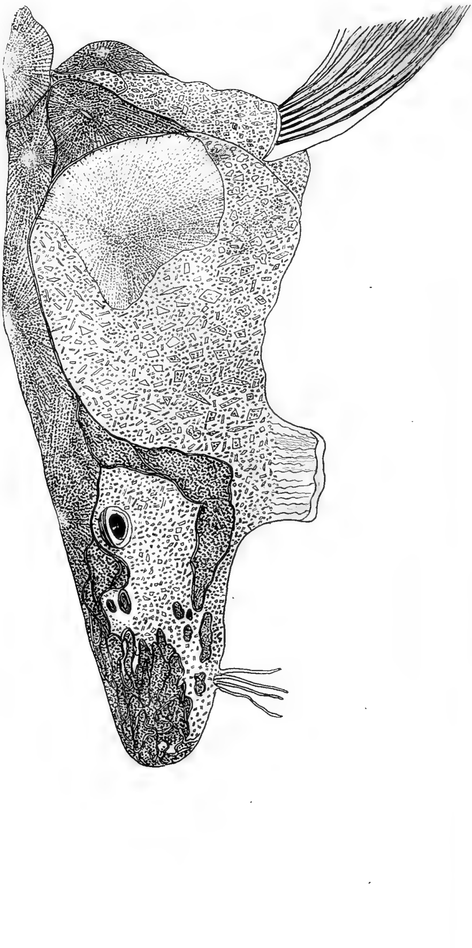
Platessa microcephalus. p. 366.
Smooth Dab. length 17 inches.



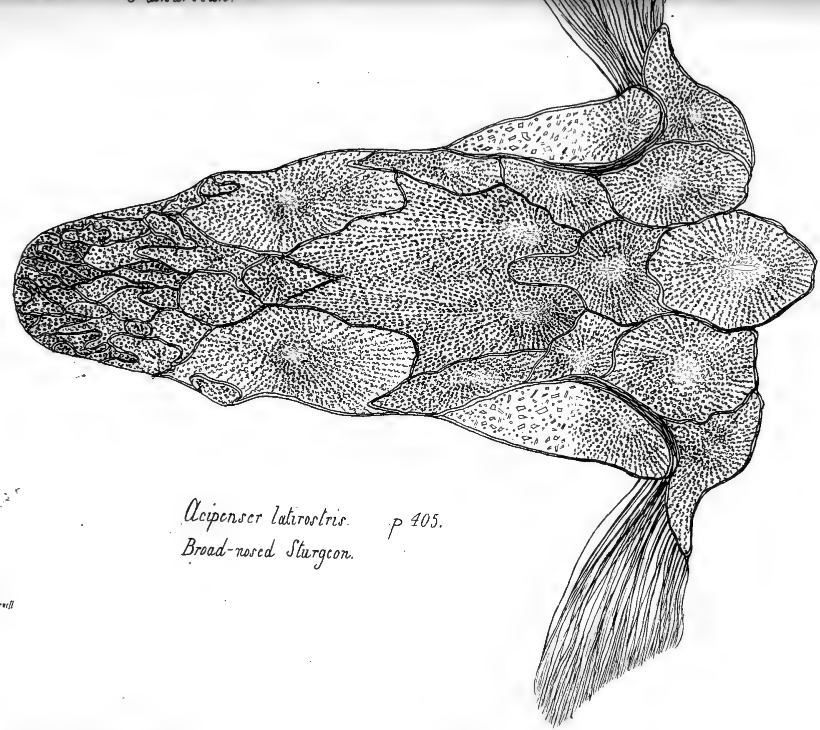
Platessa pola. p. 370.
Pole Dab. length 19. inches



Platessa limandoides. p. 368.

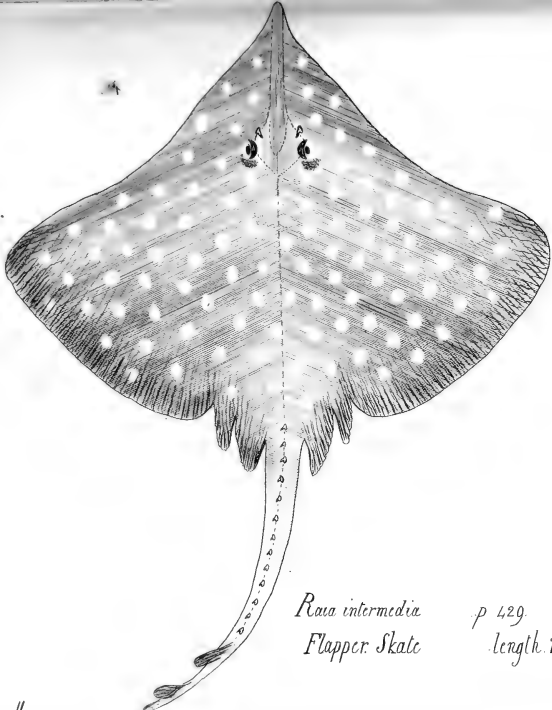


5th dorsal scale.

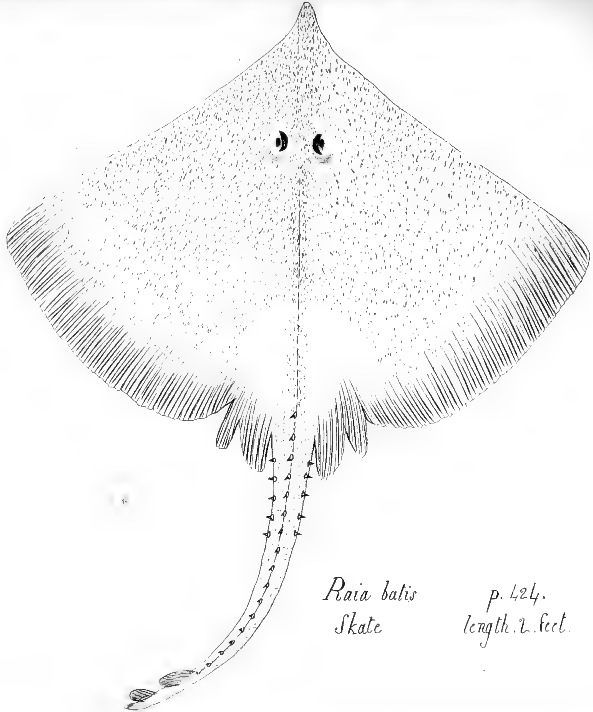


Acipenser latirostris. p 405.
Broad-nosed Sturgeon.

R Parnell



Raia intermedia p 429.
Flapper Skate length. 2. feet.



Raia batis p. 424.
Skate length. 2. feet.

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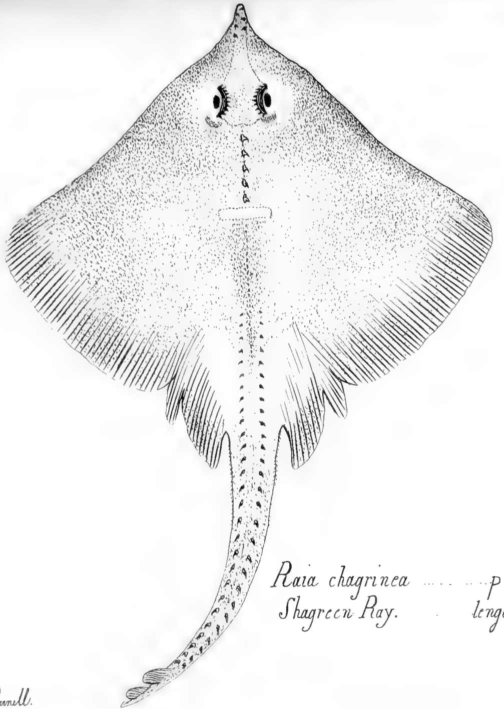
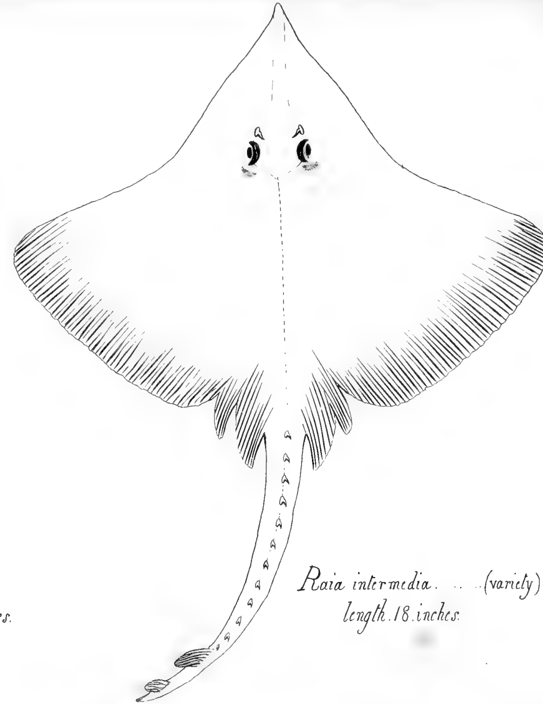
Pl. XLI.



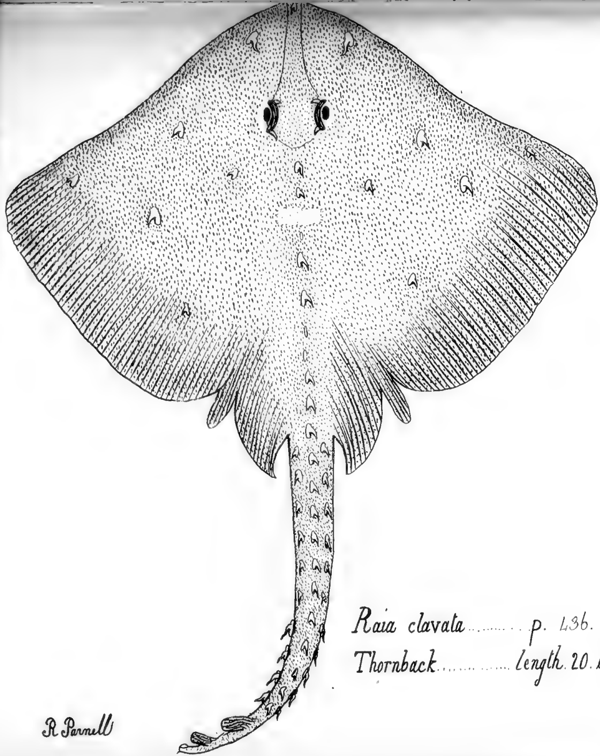
Raia chagrinea ...... p 431.
Shagreen Ray. length. 38. inches.



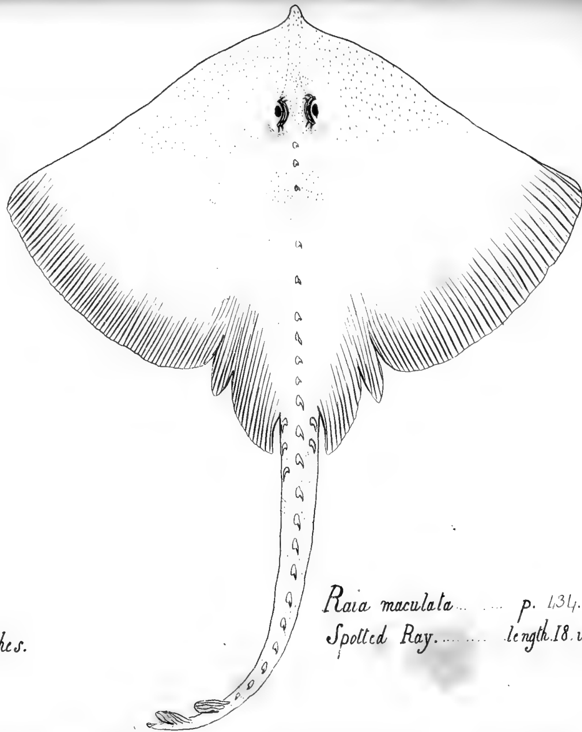
Raia intermedia. .. (variety) p. 431.
length. 18. inches.

R. Parnell.

Pl. XLII.



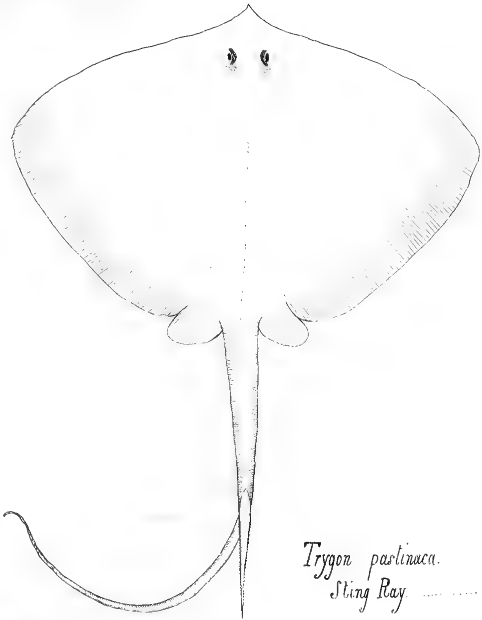
Raia clavata .... p. 436.
Thornback .... length. 20. inches.

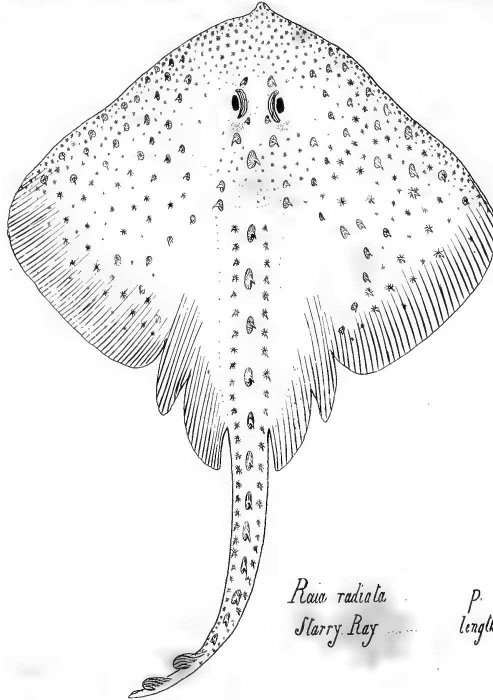


Raia maculata ...... p. 434.
Spotted Ray .... length. 18. inches.

R Parnell

Pl XLIII.



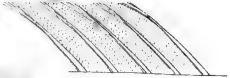


Trygon pastinaca. p 440
Sting Ray .... length. 19. inches.

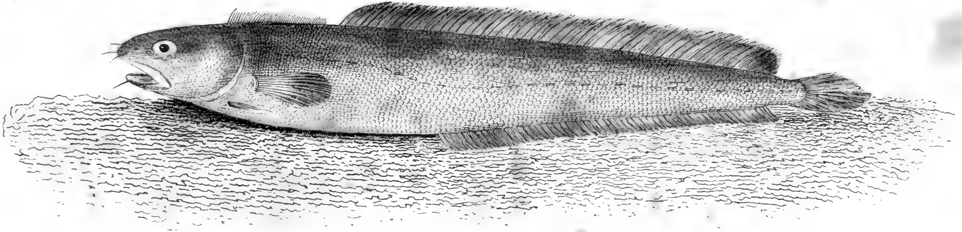
Raia radiata. p. 439.
Starry Ray ...... length. 17. inches.

R. Parnell.

Pl. XLIV.



Middle portion of dorsal fin.

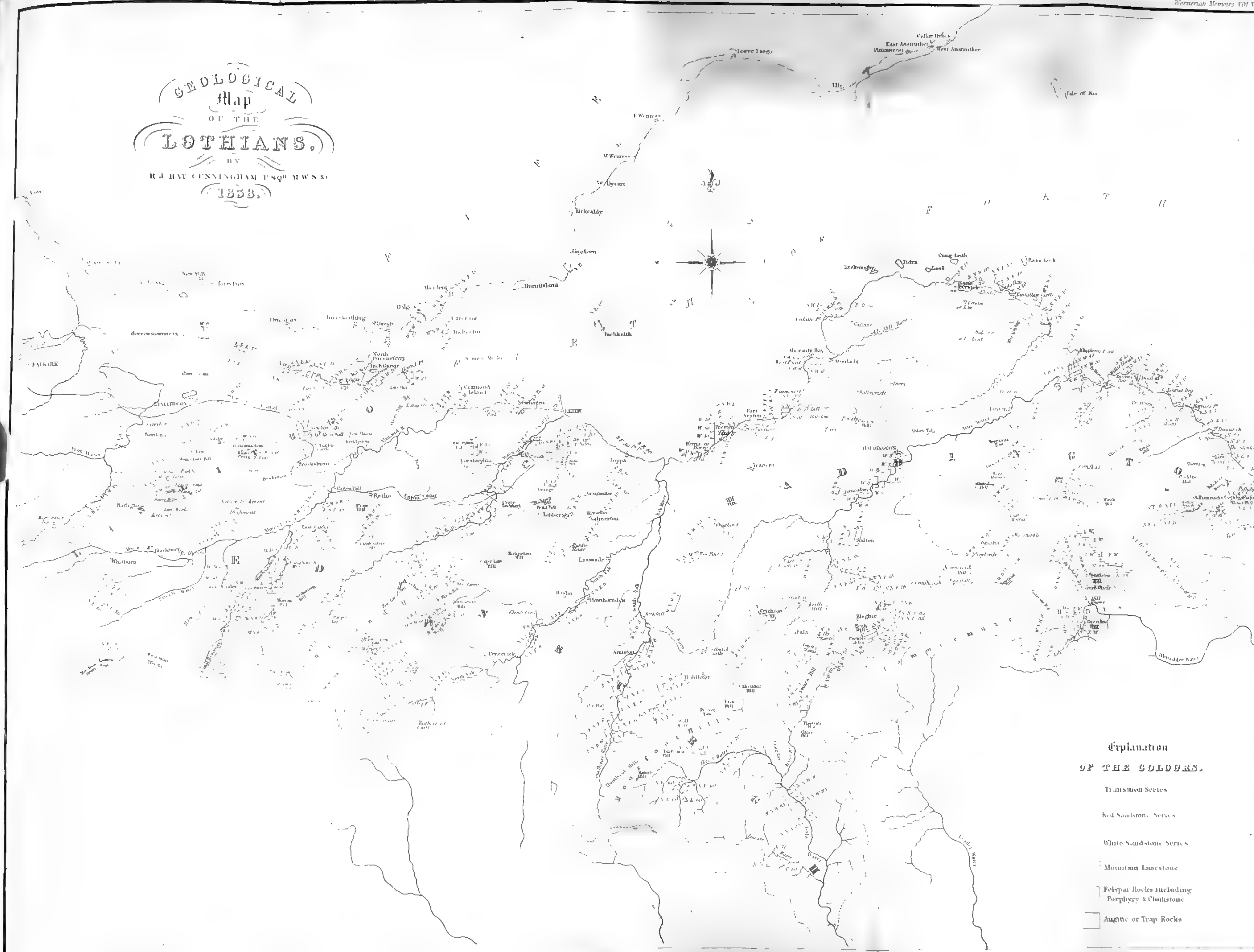


Motella cimbria

length 14 inches

Four-bearded Rockling.

R. Parnell.


GEOLOGICAL
Map
OF THE
LOTHIANS,
BY
R. J. HAY CUNNINGHAM ESQ^R M.W.S. &c
1838.
Lower Largo
Cellar Dykes
East Anstruther
Pittenweem
West Anstruther
Elie
Isle of May
E. Wemyss
W. Wemyss
Dysart
Kirkcaldy
Kinghorn
Burntisland
Inchkeith
Borrowstounness
FALKIRK
LINLITHGOW
Cramond Island
Newhaven
LEITH
Joppa
Ratho
Lasswade
Hawthornden
Penicuick
Fidra
Craig Leith
Bass Rock
HADDINGTON
Saltoun
Crichton
Explanation
OF THE COLOURS.
Transition Series
Red Sandstone Series
White Sandstone Series
Mountain Limestone
Felspar Rocks including Porphyry & Clinkstone
Augitic or Trap Rocks

OBSERVATIONS

ON THE

DISTINCTIONS, HISTORY, AND HUNTING OF SEALS IN THE SHETLAND ISLANDS.

By LAWRENCE EDMONDSTON, M. D.

BALTA SOUND, *30th October* 1837.

CONSIDERABLE obscurity seems yet to attach to the history and distinctions of British Seals. The coasts of Shetland are rather numerously frequented by two species of this family, and afford every desirable facility for accurate acquaintance with them. Being a native of Shetland, and having been for more than twenty years actively engaged in hunting these animals, both as a sportsman and zoologist, it has occurred to me that perhaps I might be able to furnish some facts and views to elucidate our knowledge of them, which are not within the reach of many naturalists. These shall be the subject of this paper.

The remote situation of this country deprives me of the advantage of consulting authors who have made the Phocidæ their especial study, and hence, much of what I shall here state, may have been anticipated. What I shall communicate is derived entirely from my own observations and personal experience, fortified by those of intelligent individuals in Shetland, who have had ample opportunities of acquiring accurate knowledge on the subject.

There are only two species of Seal permanently resident on the coasts of Shetland, and the distinctive characters of these are very prominently marked. They are the Common or Small Seal, *Phoca vitulina* of Linnæus; and the Great Seal, *Phoca barbata* of most authors, or *P. gryphus* of others.

Phoca vitulina, or Common Seal—in the dialect of Shetland, *Tang-fish* or Bay Seal—seems the most generally diffused of all the Phocidæ, and is the best known; for this reason, I shall be very general in its description.

Male.—The length from the nose to the end of the tail is nearly six feet; the ground colour of the skin brownish-grey, irregularly patched and dotted with black; the head, muzzle, and paws darkest; the colour all over the body becomes deeper as the animal advances in age, but still distinctly retains its speckled appearance; the blubber is whitish. The hair is partially or wholly cast every autumn; the face is short and bluff, and the nose rather recurved than convex; the upper lip projects a little beyond the lower; the eyes are large, round and prominent; the iris dark brown; the pupil after death is sometimes oval, more frequently circular, or one eye is in one of these conditions. This appearance, which occurs also in the Great Seal, is therefore not constant or distinctive, but is obviously owing to the peculiar states of contraction or dilatation in which the pupil happens to be at the moment of death. The *female* is not quite so long in the body as the male, but thicker; the colour is lighter, not so distinctly spotted, but more frequently patched, and grows paler with age. The size of the head of the female is somewhat less than that of the male.

The *female* admits the male in September, and brings forth in June. She never produces more than one at a birth, which she seems to suckle for about two months. It is singular that, for a long period, the error should have existed of supposing this animal to bring forth more than one young in a season. No fact regarding this species and the Great Seal is better known to those practically conversant with their habits than this, that neither produces more than one at a birth; and the mistake now alluded to should lead us not to trust too hastily to mere authority on other points less accessible to observation, in the history of these animals. The young of both sexes are nearly of the same colour as the adult male; they are brought forth on low flat rocks near the sea, hardly ever in caves, and follow the mother immediately to the water, swimming and diving with as great apparent ease as herself. The fœtal covering of hair is of a silvery-white and of a silken fineness; this is cast in the uterus some time before birth, and thrown off with the secundines—a singular fact, directly contrasted with what occurs in the young of the Great Seal. The mother is much attached to her offspring, but will not attempt to defend it when surprised and attacked, but leaves it to its fate. About the period of bringing forth, the females collect in herds on the flat shores and rocks, while the males and young of both sexes, with little exception, frequent similar situations, but apart from the others. After parturition, the females separate, and each female, attended by its young one, becomes more solitary; as the season advances, the herds again promiscuously associate. They appear to be polygamous, and during the breeding season fierce contests for the females occur between the males; they may be then often seen springing over the surface of the water in pursuit of each other. They prefer the rocks or pebbly beaches to sand, on which to repose, and where I have often seen a hundred at one time. When the sea and weather are favourable, they appear to spend the greater part of every ebb-tide on land. The favourite rocks on which they rest are almost always observed to have deep water round them, are comparatively clear from sea-weed, and under water at full tide; but, although other situations have these requisites, they are still observed to resort only to the same dormitories for time immemorial. Accident probably originally led to these selections, but now they are retained with all the jealousy of property,—the useful law that determines the young of wild animals to attach themselves to the locality where they have been born and reared, and which habit strengthens, doubtless decides the preference. Their time of ascending the rocks is when the tide begins to fall,—the water must be smooth, and the wind off shore; the favourite seasons are late in spring and early in autumn. The general resorts are among the uninhabited islands, surrounded by rapid currents, but not much exposed to the swell of the ocean. Their chief food consists of small cod and young coal-fish, which there occur in greatest numbers. When any thing is found in the stomach it is remains of fish, though possibly they may now and then be like the hog, omnivorous and feeding on crustacea, and perhaps *fuci*; to this the great length of their intestines may have some relation. They are occasionally subject to fatal Epizooty; some years ago, 1822 I think, many were found dead about the same time on different parts of the coast; the disease was swelling and inflammation of the throat;—they were in good condition. This disease was not observed to affect the Great Seal.

Phoca barbata, Great Seal; in Shetland, *Haff-fish*, or Ocean Seal.

Male.—The largest individual which I have examined was somewhat more than eight feet from the muzzle to the end of the tail; girth round the shoulder six feet. The hide weighed fifty-five pounds; the blubber one hundred and forty-five pounds; weight of the whole body six hundredweight. They are occasionally, however, larger; one shot by myself on a rock, but not got owing to its having rolled over into the sea in deep water, was certainly a foot longer. In this species greater irregularity as to size occurs than in the small seal, and this may partly arise from the more numerous difficulties with which they have to struggle in their earlier years, and the greater uncertainty of obtaining sufficient supplies of their ordinary food. A mode of measuring them to the end of the hind-paws, instead of to the point of the tail, makes also a great difference, and accounts for the reports of very large individuals said to have been met with. The general colour of the body is dark leaden, with irregular and largish patches of black; the belly paler; the head and paws darkest; toes dark brown. As age advances the colour becomes darker, till at length it is throughout bluish-black. In most adult individuals, perhaps I should say in all, there are round the neck, four or five rings of hair, a little longer than that on the rest of the body, which gives the animal the appearance, when rearing his head somewhat out of the water, as if several small ropes encircled the throat. The body is more depressed on the back, and less tapering towards the tail than that of the *vitulina*, the pelvis appearing proportionably broader; the snout is very elongated; the nose aquiline, very similar in profile to that of a ram; the muzzle very broad and fleshy, and the upper lip and nose extending about three inches beyond the lower jaw, so that, in seizing its prey, the animal seems obliged, as I have often seen, to make a slight turn in the manner of a shark. The iris is dark brown. The eyes are placed a little more obliquely towards the nose than in the common seal, and this gives the countenance, when irritated, a more sinister and wild expression. The blubber is of a yellowish colour. His motions in the water are less lively and inquisitive than those of the female, but he is more cautious, and, unless at the breeding season, he is more rarely seen; he swims with his nose on a level with the water and the back of his head elevated; the female with the whole head elevated like the *vitulina.*

Female.—Of this a very elegant and tolerably accurate figure is given in Professor Bell's late work on British Quadrupeds. She differs from the male in being shorter, but proportionally thicker; the head smaller, the muzzle thinner, and the nose less arched; the skin is of a paler colour, more or less patched with darkish blue, and becomes *lighter* with age. In two aged individuals of different sexes, the one appears a pale grey and the other black; the muzzle of the female is thinner than that of the male. The young of both sexes, the first year, are similar in colour to the *female*, the snout of the male being from the first darker. This species brings forth towards the end of September or first of October, sometimes on distant skerries, as the Soolaskerry to the west of Orkney, or the Vee skerries on the west of Shetland; but the general habit is in caves, called here *Hellyers*, where the rocks open to the sea, at the end of which are small beaches where the young remain and are suckled for about six weeks before they are taken to the water. The female, as I have before observed, never produces more than one at a birth, which at that period is covered with a fine yellowish-white hair, which is completely cast off a few days before forsaking the land, and if before this moulting period it is thrown into the water, its motions are awkward as those of a land animal would be, and the power of diving seems scarcely to exist.

The period of gestation is probably about ten months; at least I have observed the sexual congress between a pair who had a young one nearly two months old. This takes place for the most part below water, and continues for a considerable time. The period for giving suck is, I think, longer than in the *vitulina*, and frequently the female breeds long before she has reached the full size. They may, to a certain degree, be considered monogamous—at least there is always a male accompanying a female in a cave where there is only one young one, and there appears to be as many males as females where there are several. But in this latter case I am still inclined to think that "might makes right," and I believe that if there were two females and two males in a cave, and one of the males were killed, the remaining one would console the widow, and if we may judge by the jealous vigilance of the males and the fierceness of their combats, they are not quite assured of the fidelity of their fair ones. In associating with the females, and affectionately attending them while they have young, they differ completely from the *vitulinas*. When the female is killed, however, the male abandons the young. They seem more quarrelsome than the common seal, and the males are seldom taken without exhibiting the marks of deep bites in the skin, and they are not unfrequently seen in combat with each other. They appear to be long lived—at least some individuals assert that they have seen the same pair, known to them by slight varieties of colour and appearance, in the same cave for many years, and my observation does not oppose this. The ovaria also contain many ova, and the animal is several years old before it attains full growth. A strong odour, precisely similar to that of coal-tar, is emitted, especially from the skin, but it pervades the whole body of this species: it is most powerful in the male. This does not exist in the *vitulina*. They are much less frequently and regularly seen on land than the small seal, and are more indifferent as to the time of tide or the wind being off shore. The chief season is summer, and rocks the wildest and most exposed are their favourite haunts. They equally with the other species attach to particular lairs. A common place of repose is on the bottom. An individual may often be seen in some remote creek, raising his head for a few seconds above water, and repeating this every eight or ten minutes on the same spot. He can be seen from above sinking to the bottom, where he is alternately resting and rolling on his back—hence, perhaps, arises the appearance so frequently noticed of the hair being rubbed off this part of the body. They delight in swimming near the rocks during a heavy surf, remaining fixed on a spot, treading the water or *standing*, as the fishermen term it, where the surge impelled on the rock, and the reflux wave meeting, produce a sort of equilibrium. The *vitulina* in general shuns boisterous seas. Now and then a *barbata* is met with in a sheltered inhabited bay, but this circumstance is always the harbinger of a storm. On such occasions they are observed to hold their snouts elevated as if snuffing the air, and appear listless and stupid:—this *meteorological* habit they have in common with the other species. A solitary female is not unfrequently seen associating with a herd of small seals, and taking her siesta along with them,—but the male is rarely present on these occasions, and I have never seen an instance of the small seal intruding on the Haff-fish haunts. Their favourite food is halibot, conger, ling, lump-fish, and toad-fish—perhaps, because these are more easily caught; and the Great

Seal is generally found along those parts of the coast where these fish most abound. This species has always been much less frequent than the other—the young are brought forth at a stormy period of the year, and are exposed for weeks to the sea—few seasons pass over which are not fatal to several; they are also, from the habit of remaining so long on land after birth, more accessible to man, and they seem more dependent on particular kinds of food, and are more exposed to accidents from storms in after-life. The colour of the teeth is yellowish, and they have always the appearance of being much worn, even before the animal is full grown.

On a general view of the two species, in reference to their more external distinctions, the most important and prominent difference is in the form of the head, and this is most palpable, of course, when the animals are swimming, as this part alone is then in sight. This character at once distinguishes, not only the *barbata* from the *vitulina*, but the male *barbata* from the female (the Bull from the She-fish as they are termed here)—it is one with which every fisherman living near their haunts is familiar. The difference, on the other hand, of external appearance between the sexes in the Small Seal is so trifling, that the most experienced hunter can seldom promptly distinguish them.

Phoca barbata dubia.—Another large species of seal is believed by some naturalists to frequent the British coasts, and as the common and now well-known one, the *Haff-fish*, does not realize the idea they have formed of that species, "the great unknown" is still termed by them *barbata*—to me it appears that the evidence of the existence of such a species is very unsatisfactory. Professor Bell, in his meritorious work already referred to, has stated of course all that his active industry and intelligence could accumulate on the subject, and as his work is the latest with which I at least am acquainted, I may assume that it contains all that was known of this presumed species at the period of its publication. But he does not give any description of it but what perfectly applies to the male of the Great Seal of our coasts, which I have already described. He has, it is true, figured a cranium of a different species from the Haff-fish, as that of the animal in question, but he says nothing of the history of the individual to which it belonged. This cranium may prove that there is another species of large seal, but not that it is an inhabitant of our coast. The figure of it looks very like that of the male *barbata*, with the exception of the teeth. I have not seen a specimen or a description of the cranium of the *Phoca cristata*, but I suspect this may be found to be an example of one.

Fabricius is, by many, considered to be an authority of great weight in Arctic zoology. As I have not his work before me, I cannot examine what he has written on this subject, but I remember when I perused it I was struck with the number and inaccurate distinctions of his *phocæ*, and I know well that in some points of his ornithology he is not to be relied on, as I have elsewhere shewn. So sceptical am I of these phocal species of Fabricius, that I am inclined to believe there are only two species peculiar to Greenland, the *cristata* and *Grœnlandica*, their great and small seals, just as the *barbata* and *vitulina* are more especially ours. The specimen of Great Seal, mentioned in Ross's Voyage, is clearly an adult but not aged male Haff-fish.

The negative proof in opposition to the opinion of there being another British Great Seal seems sufficiently conclusive. The male Haff-fish, as we have already seen, differs most remarkably from the female. If there were really another Great Seal, we should have another distinct animal to be met with, and probably two, if we anticipated, as we might from analogy, that the different sexes of such a species would also differ considerably from each other.

Now, we are given by authors to understand that such a species frequents the coast of Shetland as elsewhere; but how, then, does it happen that no one in Shetland has ever seen or heard of any other species of seal frequenting these islands, except the two I have described, which are perhaps more familiarly and better known here than in any other country? All the three species are also said to inhabit the shores of Iceland and the Faroe Isles. The Faroese know only the Common Seal and our Haff-fish as permanent residents, and the *cristata* and *Grœnlandica* as very rare visitants; and in two excursions I have made to these islands, I saw often the two former of these, but no other.

One of the most accurate naturalists that ever visited Iceland was Mohr, and he mentions only two species which he fell in with, and these are the same as we have here. He also states that the *cristata* and *Grœnlandica* occur there, and are well known by the natives. He speaks, it is true, of the *P. fœtida* of Fabricius, but he expressly says of it—"Denne Art fik jeg hverken selv at see, ikke heller nogen tydelig Efterretning om."

How, then, are we to account for the notion of another species of Great Seal? Perhaps in this way—Fabricius particularly, and other zoologists, having given currency to the belief of its existence, and assigned it even "a local habitation and a name," it was to be expected that observers would be on the watch to verify the opinion, and getting glimpses of the male Haff-fish, which is so very marked in its difference from the female, it was natural to conclude that here was the animal of which they were in search.

But a name is not a proof, and until his *ipsum corpus* be produced, I think we are fairly entitled to maintain that no such animal is to be found. I therefore retain the name *barbata* for our Haff-fish, or well-known Great Seal, and resign the poetical title of *Gryphus* to the yet undiscovered species which has so obscured the distinctions, and increased the labours, of some modern zoologists.

Phoca Grœnlandica.—A specimen of this was shot in the bay of Burrafirth in this island, in October 1830, which I witnessed—it was evidently from its size a young one of the same year—was very tame, and much emaciated—on one of its sides was a large ulcer, which presented the appearance of a sore produced by burning. It occurred to me that probably this animal had been kept as a pet in one of the returning Greenland ships, and had fallen overboard near this coast; from what I have heard, however, I dare say that occasionally an individual of this species wanders thus far south. This species seems to be the most incautious of the family—whether this effect may be considered to proceed from boldness or stupidity. Mohr mentions in his Nat. Hist. of Iceland, that they are often met with on that coast during winter, that they are always found in flocks, and from their frequent habit of swimming on their backs, are easily taken in nets which are stretched across their course.

Phoca cristata.—I know no instance of an individual of this having been seen in Shetland.

Of the species *P. Annellata* and *Leporina* I can say little—no such strangers have ever visited Shetland, and I am really much inclined to suspect that further observations will prove them to be merely varieties of the *vitulina.*

Trichechus Rosmarus.—One, an adult, was killed near the island Fetlar, about ten miles from this, during the summer of 1815, and another was observed a few days afterwards, not far from the same place. In the summer of, I think, 1828, one frequented the bay of Balta Sound for a few days, was fired at, but escaped.

I shall now proceed with the observations I have farther to communicate regarding our two resident species of Seal—the common one and the Haff-fish. In general habits there is much similarity between them. Nothing can be more awkward than their motions on land, nothing more elegant and active in their native element. In swimming, the action of the Great Seal is more graceful, easy, and less abrupt than that of the small one. The natural unconstrained mode of diving of both is by raising the head and shoulders a little, and then sinking gently down. When alarmed, or eluding a shot, they uniformly spring to a side. When on the surface they use their fore-paws somewhat as a dog does his, at the same time sculling with the hind paws: under water, the former are laid along the side, the latter are kept together, and the propulsive and other motions performed exactly as a fish, darting with equal velocity through the water. Their sight seems powerful and quick, whether in water or in air, or in viewing objects in the one element from the other. Their touch and hearing are sensitive. Their sense of smelling, I am disposed to think, is not particularly acute, though it does sometimes appear as if they had taken alarm, when we attempt to get within shot of them, from the windward. It seems to be well ascertained that whales are powerfully affected by the presence of certain substances, such as musk, castor, cow-dung, juniper—perhaps, because they emit an odour somewhat similar to ambergris or other of their own excretions. On throwing any of these into the water, when a whale is too near a boat, and danger is apprehended from him, he is observed suddenly to disappear. On these occasions he is likely in quest of his mate, and believing, by the scent of the articles thrown overboard, that she is near him, he sinks immediately into the depths, where, rather than on the surface, he has been accustomed to find her.

Seals also are observed to abandon the place where the blood of any of their species has been shed—probably for the same reason that a bullock shuns the shambles. It has been said that when several seals are resting on a rock, some one of their number acts as sentinel; but this result of discipline or self-denial I cannot say I have seen—"Sauve qui peut" is, I think, rather the watch-word. The herring-gull is their most vigilant vidette at all seasons, as he is of every other kind of our game. The seal he loves especially to take under his wing, and he is the most vexatious interruption to the sportsman.

The voice is plaintive, capable of considerable modulation, and in both species of seal is nearly the same, not unlike the howl of a dog lamenting his master's absence, and expressed by the syllable *oo*, much prolonged. We seldom have the pleasure of listening to the music of the old ones—on the rocks they sometimes growl like bears in chorus against each other, but the young of the Great Seal in the caves often make the rocks re-echo to their symphonies, and thus by imprudent babbling betray their presence to the hunter. When irritated, or when alarmed, they utter a sharp hiss like the sound of a sheep in similar circumstances, which, when swimming, becomes to their companions a signal of danger, and is responded to instantaneously by a general plunge-dive.

They bite severely, giving effect to their hold by swinging their bodies loose from the ground. They often play with their prey after catching and disabling it, as a cat does with a mouse. Before eating a fish, if it be a large one, they skin it by holding it firmly between the fore-paws and tearing off the skin in shreds with their teeth. They have as much use of their fore-paws as an ape has of his hands —lying on the rocks, they may be often seen scratching themselves with them. I have never observed pediculi or other vermin on their skins. They eat under water as well as above, smacking like a hog—indeed, they are rather sea-hogs, than sea-dogs:—they hardly appear to masticate, but tear off mouthfuls and swallow them, well seasoned with essence of brine. They are never observed to feed on land in the wild state. They are thought by some to prey on sea-fowl, pulling them under water and drowning them (as is the usual practice of the otter, who seems to prefer fowl to fish, and is perhaps amphibious more by necessity than choice);—but I doubt this. They will, however, eat flesh in captivity, as occurred in the case of a young Haff-fish, who thereby disfigured the only specimen of Greenland seal known to have occurred on this coast, and whose *corpse* unluckily happened to be lying in the same apartment. The Greenland Seal, however, is often seen to seize birds in the water, and, when kept on board the whalers, is fed chiefly, I believe, on fulmars.

Seals here, as well as every where else, are known to be fond of salmon and trout, and in quest of them will enter rivers and lakes near the sea. In Shetland I have known a few instances of the *vitulina* (none of the *barbata*) entering a lake through a rivulet falling into the sea; but from choice they seldom remain long in fresh water. Such fresh-water sailors as the seals that inhabit Lake Baikal and the Bothnian Gulf, if they are not distinct species, must, I should think, be permanent varieties. I have noticed a female *barbata* near Bornholm in the Baltic, and a *vitulina* caught on the Pomeranian shore.

They are very voracious, and the stomach is large, yet they are capable of enduring long abstinence. The fat or blubber that envelopes them, besides aiding in resisting cold and pressure, and lessening specific gravity, seems obviously intended as a supplemental source of nourishment to an animal that must often be subject to considerable intervals of want of food and exhausting exertion. Here, also, we may perceive one use of the great length of the intestines, which, by long detaining the food, facilitates the absorption of all the nourishment from it. The great secretion of fat may also act in the purification of the blood by abstracting carbon from it. As in the whales, there is no very distinct division between the blubber and the skin, but the one passes insensibly into the other, so that there is considerable difficulty in accurately flaying them. The females are always in better plight than the males, unless shortly after parturition, when, in a few days only, they become very lean. The males also at the same season become lean, but they very quickly fatten again.

The milk is very thick ; tastes saltish and a little fishy ; and is much better adapted for cheese than for butter, from containing more curd than cream.

No account exists in Shetland, I believe, of the *Grampus* or *Cachalot* preying on seals, although both kinds of whales, especially the former, are sometimes seen ; but opinions to this effect are held by some in Orkney. The flesh of both species of seal was formerly eaten by the peasantry, of which I even remember an instance ; the practice is now, however, discontinued. The flesh of the *barbata*, which was chiefly used, is coarser grained, and rather darker in the colour than that of the other, but, with respect to this latter point, the circumstance of their being killed after having been long on land or the contrary makes a great difference; in the former case it is much whiter, because the blood had become more completely arterialized. Much also depends on age. I never could bring myself to taste it, from its nauseous carbonaceous smell, although I have once eaten, without any repugnance, a piece of the flesh of the Ka-an (that is, capable of being driven) whale, and could not distinguish it from tender beef. Neither species appears to migrate. Very rarely an individual has been met with a few miles from land, but this is quite a phenomenon, and viewed as little less than an apparition of evil augury. They are local, remaining during the year in the vicinity more or less of their breeding places,—the tribes attached to certain districts of coast not appearing to mix with the others, and hence breeding within very near degrees of consanguinity. From this circumstance, and also from the individuals of each separate clan being subjected to differences of external agents which do not apply to others, it may arise that slight dissimilarities in their appearance are observed between them, and this may, in some countries, have given occasion to naturalists not intimately acquainted with their habits and general aspect to multiply species.

Of the two species, the *barbata* seems to have the power of remaining the longer under water at a time. The extreme period which I have observed is fifteen minutes; this, however, was in the case of females taken in a net, and here the strength of the animals might have been reduced by nursing and excessive exertion to get loose; in a quiescent and ordinary state, I should conclude they might remain twenty minutes without breathing. This superior power of suspending respiration possessed by cetacea, seals, and aquatic birds is a subject of great interest, and has given rise to much discussion. It has been stated, especially by Bichat, that the venous blood becomes a poison to land animals when it reaches the brain through the arteries. If, in the case of seals, it does not circulate through the cerebral arteries, some peculiarity of structure must exist sufficient to explain so great an anomaly in the course of the blood from what we observe in the other mammalia, and we have also a right to expect to find some arterial blood in the vessels after long submersion. The principal structural appearance that anatomists have hitherto detected, which they suppose has reference to this point, is an enlarged capacity of the abdominal veins; but this, it is obvious, is totally inadequate to account for the phenomenon. The use of this provision is to be rather sought in its adaptation to varying degrees of pressure to which the animal is exposed in descending to different depths, and to its facilitating especially the different states of contraction to which the lungs may be subjected during submersion. To a similar purpose, may not unlikely be referred that peculiarity of circulation in some of the arteries of the chest, spine, and cranium which John Hunter and other anatomists have described in the cetaceæ, for, on the supposition that these plexuses of arteries exist in all aquatic animals, and that they form a reservoir of aërated blood to supply the exigencies of the circulation during the time that respiration is suspended, we must be prepared to shew, 1*st*, That there is a machinery and a power presiding over it, by which the blood is retained in these arteries, or poured from them into the cerebral circulation as its necessities may require. 2*d*, That the venous blood is prevented from entering the left ventricle, and thence flowing through these vessels, as well as through every other ramification of the arterial system. 3*d*, That there is a sufficient quantity of oxygenated blood contained in these canals to support the action of the systemic heart, and supply the arterial circulation, during the long period in which breathing is suspended. *4th*, That venoid blood is equally an immediate cause of asphyxia to aquatic as to land animals, and more generally that what we observe to act as a poison on the one class within a certain time, must necessarily do the same to the other; and farther, that the venous blood is the same in quality in the aquatic as in the terrene mammalia. We may not have ascertained the use of this distribution of arteries in these diving animals, but this is no reason why we should conclude that it must be connected with the respiratory function. Peculiarities of structure may be found to accommodate trivial changes of distribution of the blood, but the question still returns, Whence is derived the arterialized blood which is presumed to be necessary for carrying on the active functions of the animal during so long a period of suspended respiration? Are we to suppose that the cycle of the circulation is during this period nullified, and that the blood in the arteries and veins remains oscillating, without either fluid encroaching on the boundaries of the other? But even this fancy is negatived by the fact that, in the case of seals being instantaneously killed immediately after long submersion, I cannot say that I could detect any arterial blood in the body; throughout, the vital fluid was dark, almost like tar, in the arteries and left ventricle equally as in the veins. But why should we persist in looking to structure as the only source of modification of function? Might it not be as easy to assume that the venous blood of diving animals, when it enters the left auricle, is somewhat different in quality from that of land ones; and that other organs than the lungs have previously deprived it of its more immediately deleterious principles?

Such a change might be effected, for instance, by the liver, which in seals, as in fish, is of great size, or by the kidneys and intestines, but perhaps equally by the skin, for, remaining so long under water, and even when above it performing so few respirations, it seems clear that much carbon, which in land animals is discharged by the lungs, must, in aquatics, be emitted through other channels. Of this view, the strong carburetted odour of the skin of the *P. barbata* may be considered as a not very obscure indication. The dark colour of the blood, it is true, is one of its venous characters, but I suspect we are hardly yet so acquainted with its chemical and vital nature, as to deny that some of its qualities may be modified, and yet this colour remain. But, even supposing that the venous blood of diving animals is the same in quality as ours, and that it circulates, in like manner, through the cerebral arteries, where is the certainty of the position, that this must, in the same time, produce death in them as in us? We have as little reason to assume that the venous influence on them is the same in kind and degree as it is on us, as that opium or alcohol should have a similar effect on both. Can organization give a reason why one plant is wholesome food to a goat and deadly poison to a sheep?—why one animal should remain torpid for months and then revive, while a congenerous one never can assume this state?—why one species of bird can remain only two minutes under water and another eight, the seal twenty, and the whale one hundred?—why pearl-divers can, from habit, remain so much longer under water than other men? Of all these modifications of the vital principle, structure can afford us no solution; and these remarks may tend to shew, that, in the quality of the blood or susceptibility of the nervous system, at least as plausible a theory may be looked for as in peculiarity of organization, which has, on this point, so long unaccountably monopolized the attention of physiologists. The theory I ventured to propose of this phenomenon of suspended respiration in the Annals of Philosophy for August 1827, is, "that the conditions of the nervous system of aquatic animals are such, that venous blood requires a much longer period to circulate through their cerebral arteries than through those of land animals, to produce the same deleterious effects." I have seen no reason in the main to change this; it may, however, be a little extended to include the hypothesis that the venous blood of diving animals may differ in its qualities from that of land ones.

Seals, when on land, respire seldom,—perhaps every two or three minutes. It seems as if too frequent respiration induced a state of aëration in their blood, too excitable for their systems, and productive of fever, causing in them a state of disease not dissimilar to what we might experience if the atmosphere contained more than its regular proportion of oxygen. The beneficent Creator, who has assigned to these animals so great a proportion of their existence under water, has, we must believe, conjoined with this the condition of enjoyment and of health, not of suffering and disease; and, in this view, we may find a reason why aquatic animals may not long survive when the opportunities of diving are withheld from them. A sub-arterial state of their blood may be necessary for the adequate performance of their functions, and the equable and low temperature of the ocean may be required to reduce the vital heat (which in them is observed to be at a high standard), and which may be mainly produced, not only by the great comparative quantity of their red blood, but also by its venous character, and the lesser use which their habits lead them to make of the lungs, as a safety-valve for their superfluous carbon and caloric. In the beats of the heart I do not recollect any thing remarkable. Their tenaciousness of life is peculiarly great. Of this the experienced hunter is so conscious, that, unless he can be pretty certain of striking the brain, he hardly ever thinks of taking aim at them. I have known a common seal swim 300 yards under water after being pierced through the centre of the heart by a large rifle ball. Their muscular power is also very great. I know no animal of equal size approaching them in this respect.

It has been inferred, from the size and form of the cranial cavity relatively to the body and face of the *P. barbata*, as compared with the *vitulina*, that the former animal is naturally stupid and ferocious. As a general principle, admitting of many exceptions, it may be assented to, that the relative volume of the brain may indicate degrees in the scale of intellect. But we must also attend to quality, to form, and to development of certain parts, as well as to the volume of the whole, and we can hardly, I suspect, believe that we are yet arrived so far in its anatomy and physiology as to determine the respective value of each of these conditions; and these difficulties are greatly increased when we have to compare one species with another, unless we believe that every thing depends on structure—that we are accurate judges of what is and what is not perfect organization—and that there is no difference (if I may so speak) in the *anima* of each species. Thus, if in two *vitulinas* of equal age, size, sex, &c., we find one having a larger, and, in our idea, a better formed brain than the other, we may entertain the opinion, that he is likely the more intellectual; but, if we appreciate the capacities of two individuals of different species, we may err egregiously. In the comparative intellects of the great and common seal, I cannot say that long and close observation of them, either in a domestic or a wild state, has impressed me with any perceptible difference between them. Both are naturally very inquisitive; and a novel object or sound, especially if it be not too abrupt, seldom fails to fix their attention. Availing ourselves of this weak side, we often contrive to allure them within shot. Generally, I think, affectionate attachment to those who are kind to them is, in captivity, more prominent than intellect. In evading enemies they are equal; but this is evidential rather of timidity than of sagacity, else the hare must be deemed more sagacious than the hound. Of the two, the *vitulina* is perhaps the more timid and suspicious.

Dissection of the bodies of these animals seldom presents us with any marks of structural disease. I have never observed the liver but in the most perfect health. In the lungs I have seen evidence of hepatization, and in the intestines of inflammation. Of this latter disease it is that they generally die in captivity. In the highest state of condition and health, as well as in the lowest, we find intestinal worms in them. Hence a doubt may suggest itself of the accuracy of the pathological principle, which presumes that these animals are the result of morbid action. The fact would seem to be this, that certain species of parasitics inhabit the bodies of certain species of animals as their natural and only places of existence—that their ova are constantly present in, and may even be one of the essential constituents of, the fluids—and that certain circumstances, sometimes of health, sometimes of disease, lead to their development in greater or lesser numbers.—The fluids and conditions of one viscus being favourable for its becoming the nidus of one kind rather than of another, as the fluke in the liver of the sheep, and the ascaris in the great intestines. The residence of the seal is the ocean, his food fish, and his drink salt-water. Much of iodine and muriatic salts must therefore, we presume, enter his circulation ; and, connected with this, I observe, that I have never seen any appearances of tubercles or glandular disease in seals. Can this hint throw any additional light on the beneficial agency of sea air in some of those diseases to which the human frame is liable ? Muriatic and iodic exhalations must generally pervade maritime situations, as even the sense of smell suggests to us ; and to their influence may probably be ascribed not a little of the sanative efficacy of voyages by sea, or residences in its vicinity.

I have mentioned that the *Phoca barbata* may, to a certain extent, be considered monogamous ; but if we are to understand by this that one male and one female attach themselves exclusively to each other, I suspect the rule can hardly be considered a very strict one. The most perfect examples of monogamy occur in birds ; in them it seems to be the general law ; in animals, the exception. It is apparently necessary in birds for facilitating incubation ; and the union of the sexes is in them, I believe, for life, and not annual, however indisposed we may be to surrender our poetical visions of the vernal gallantries of the groves. The commencement of this attachment, especially in aquatic birds that produce only two young, seems to be literally *ab ovo ;* a male and female being in such cases always, I may say, reared in the same nest, and, when arrived at the proper age, entering into a more tender union. Almost all carnivorous birds are monogamous. Here, combats for the females would frequently be fatal, from the destructive weapons with which Nature has armed them. Most quadrupeds possess the power of propagation before they have arrived at their full size and strength ; and it is necessary, for the preservation of the races in their proper perfection, that the male parent should be adult ; and this end can be best insured by superior power in combat. But occasional dwarfishness is not of so much importance in the rapacious species, and hence polygamy is more rare among them. In gregarious and graminivorous animals, the flock requires all its perfection to withstand its numerous enemies, and all the vigilance and sagacity of an experienced and powerful leader. Such a one is to be found only in the strongest male; and he is therefore, for the most part, strictly polygamous, jealously guarding his females. I am inclined to think, therefore, both from analogy and observation, that the attendance of the male *barbata* on the female while she is nursing has a reference to the fact, that this species has more difficulty, and requires longer absence in procuring food than the *vitulina*, and hence the additional watchfulness of the male becomes necessary. The interbreeding of wild animals within the nearest degrees of affinity does not appear to produce that degeneracy, of which speculative breeders of our domestic races so much complain.

I think I have observed one or two instances of mules between the *barbata* and *vitulina*. On one occasion, a young one was shot in the month of August, accompanying a female *barbata* among a herd of the other species, which, in appearance, was a perfect mixture of the two. It was, judging from size, about two months old. Another was taken from the uterus of a female also of the Great Seal, associating in like manner with a flock of Common Seals, and the fœtus appeared to be of an age that would have been perfect in July, which at the very least was two months earlier than the regular breeding time. Both specimens were unfortunately lost. These observations occurred some years ago, and struck other individuals who witnessed the capture similarly to myself, and if they are correct (which, however, I do not insist on), they afford a curious exception to the law that proscribes procreation in the wild state between two well-marked species. Still, this law is so universal, as to form the basis of a good specific character, although the progress of natural history is daily adding exceptions to it. Domestication may produce such changes in the physiology of animals, as to allow of hybrids, and these to be prolific, neither of which circumstances might happen in the wild state; and different species that may occasionally interbreed in the wild state (or one of the sexes in the wild with one in the tame), might be subject to circumstances analogous to those of domestication; and farther, certain congenerous animals may naturally have this boundary of specific distinction less absolute and clear.

In seeking for distinct characters by which to define the different species of mammalia, the tendency has become very general to trust implicitly in the last instance to their osteology, and at length characters are not considered fixed or scientific until they have been osteologically pointed out. The remarkable genius and sagacity of Cuvier, in his splendid and successful researches into fossil organic remains, has doubtless contributed much to this extreme prepossession, which leads so many naturalists to prefer entombing themselves in the charnel-house of Nature to basking in the light of her living forms. Yet, while the warmest admiration cannot justly be withheld from that illustrious man, who, from some insignificant knob of a bone, could evoke from the wrecks of a world the perfect form of an extinct animal, we should still rather wish to see the *mastodon* and *megatherium* embodied, than have their conceptions presented to us only as trophies of science. To be able to steer safely one's way through the chaos of organic remains, demands not only great science and talent, but the intuitive-like tact of great experience; and here every naturalist cannot hope to be a Cuvier. In this department, however, a critical knowledge of osteology is essential, for one very sufficient reason, if for no other, that nothing is left of the different animals to investigate but their bones.

For defining groups of living animals, structure is also most important. In species, however, it is often deficient in that clearness and prominence which essential characters demand; and it has one main disadvantage, that it does not enable us to ascertain an animal when alive: it teaches us only what he is in death. A deer knows a dog without being obliged to hold converse with his canines; and Nature has not made external distinctions so obvious and sure to the lower animals, and shut us out from this door of knowledge, or rather opened it, only to be neglected by us. It is not external characters and habits that are so defective in providing us with specific distinctions, but their abuse that has brought their employment into such marked disrepute as contrasted with structure. The illustrious Linnæus did not thus neglect them in connection with every other circumstance from which his clear and acute understanding could elicit light; and, however much it may be the fashion to overlook the invaluable services of this Chief of naturalists in his favourite walk of science, it would be perhaps better to pause before we lightly value a means of specific distinction, so especially employed by so great a master. He is not responsible for all the errors of his followers; and with every assistance which, since his time, anatomy has been able to furnish, we must still, I suspect, be content to define many species by *tout-ensemble* comparisons with each other, in which, of course, the bones and other parts of structure will often form parts. Nothing, after all, can permit us to dispense with an accurate acquaintance with living nature; and the skill of the anatomist must often yield to that of the peasant who has the opportunity of knowing animals in their native state. A very remarkable example of this contrast occurs in what Professor Bell relates of a Swedish naturalist, M. Nilsson, mistaking the cranium of the *Phoca Grœnlandica* for that of a different species. An untutored Esquimaux having the perfect animals before him, could never have fallen into such an error; and yet this gentleman had long and assiduously studied the crania of seals, and has given evidence of his industry and zeal. Amongst the different parts of the skeleton, the teeth have been chiefly appealed to, whence to extract specific characters. I have been so long so familiar with the striking differences in external appearance and habits of the great and common seal, that I have seldom looked at their structure with a view to distinction, but chiefly in relation to their history or physiology; and it is not likely, after Professor Bell has devoted so much skill and attention to the subject, that another will improve on what he has stated as the most marked and permanent osteological characters he could detect. My observations agree in the main with his. The cranial cavity is smaller in proportion to the size of the animal and to the bones of the face in the *barbata* than in the Small Seal; the bones generally are thicker and coarser; the ridges and prominences for attachment of muscles more projecting. The cranial cavity is wider behind in the *barbata*, swelling more laterally in the *vitulina*; the distance from the frontal bone to the end of the jaw much greater in the *barbata* than the *vitulina*. In the former species considerable differences exist in size, general form, and in the development of particular parts in the crania of different individuals—hardly any two being alike. The jaw of the male is longer than that of the female; and the bones of the nose are broader, coarser, and more arched. The external aperture of the nasal bones is in this species much greater than in the other. In the teeth of the *barbata*, also, much diversity exists. In some specimens the molars are very wide asunder, in others almost in contact. The tubercles on them are in some very distinct, in others the central one only remains, giving the grinders the appearance of a row of small canines. In one example of an adult cranium in my possession, there are only four molars on each side in the lower jaw, and most obviously there never had been more. In colour the teeth are yellow; in substance soft, like the ivory of the *walrus*. This seems to account for their being, comparatively with those of the *vitulina*, so much worn and smoothed, and so varied in different crania. The fangs of the canines premorse, and not deep in the sockets. The teeth of the *vitulina* are pearly, enamelled, very hard and splintery; the canine fangs conical, long, and penetrating deep into the alveoli. As the *barbata* feeds chiefly on the larger and cartilaginous fish, the molars may require to be formed somewhat like the canines, for the purpose of giving a firmer hold; while the *vitulina*, feeding principally on the osseous fish, and possibly now and then on *crustacea*, needs this structure less, but more facility of mastication.

In the curious subject of inquiry into the practicability of domesticating seals, the remark cannot but present itself, that it is singular that so few additions have been made to the list of domestic animals bequeathed to us from remote antiquity, and herein is the excellent establishment of zoological gardens destined to make rich discoveries. Instances of individual seals being tamed are, it is true, rare, yet they are frequent enough to prove the practicability of the attempt, and to point out the likelihood of the experiment being a useful one, and at all events, the *cui bono* question may receive here the same answer as may be given it in other desiderata. Whether the animal might breed in captivity and remain reclaimed from the wild state, is yet to be learned. Almost all the instances of tame seals of which we have any account belong to the *vitulina* species, and of these we have no notice, so far as I am aware, of the processes of rearing and education. The trials I have made on these points have been equally numerous on the Great as on the Common Seal. By far the most interesting one I ever had was a young male of the *barbata* species: he was taken by myself from a cave when only a few hours old, and in a day or two became as attached as a dog to me. The varied movements and sounds by which he expressed delight at my presence and regret at my absence were most affecting; these sounds were as like as possible to the inarticulate tones of the human voice. I know no animal capable of displaying more affection than he did, and his temper was the gentlest imaginable. I kept him for four or five weeks, feeding him entirely on milk warm from the cow; in my temporary absence butter-milk was given to him, and he died soon after. Another was a female, also of the Great Seal species, which we captured in a cave when about six weeks old, in October 1830. This individual would never allow herself to be handled but by the person who chiefly had the charge of her, yet even she soon became comparatively familiar. It was amusing to see how readily she ascended the stairs, which she often did, intent, as it seemed, on examining every room in the house; on shewing towards her signs of displeasure and correction, she descended more rapidly and safely than her awkwardness seemed to promise. She was fed from the first on fresh fish alone, and grew and fattened considerably. We had her carried down daily in a hand-barrow to the sea-side, where an old excavation admitting the salt water was abundantly roomy and deep for her recreation and our observation. After sporting and diving for some time she would come ashore, and seemed perfectly to understand the use of the barrow. Often she tried to waddle from the house to the water, or from the latter to her apartment, but finding this fatiguing, and seeing preparations by her chair-men, she would of her own accord mount her palanquin, and thus be carried as composedly as any Hindoo princess. By degrees we ventured to let her go fairly into the sea, and she regularly returned after a short interval; but one day during a thick fall of snow she was imprudently let off as usual, and, being decoyed some distance out of sight of the shore by some wild ones which happened to be in the bay at the time, she either could not find her way back or voluntarily decamped. She was, we understood, killed very shortly after in a neighbouring inlet. We had kept her about six months, and every moment she was becoming more familiar; we had dubbed her Finna, and she seemed to know her name. Every one that saw her was struck with her appearance. The smooth face without external ears—the nose slightly aquiline—the large, dark, and beautiful eye which stood the sternest gaze of the human, gave to the expression of her countenance such dignity and variety that we all agreed that it really was *super*-animal. The Scandinavian Scald with such a mermaid before him, would find in her eye a metaphor so emphatic that he would have no reason to borrow the favourite oriental image of the gazelles from his Caucasian ancestors. This remarkable expressiveness and dignity of aspect of the *Haff-fish*, so superior to all other animals with which the fishermen of Shetland were acquainted, and the human character of his voice, may have procured for him that peculiar respect with which he was regarded by those who lived nearest his domains, and were admitted to most frequent intercourse with him. He was the favourite animal of superstition, and a few tales of him are still current;* these, however, are not of much interest

* The abolition of the Norse, the ancient language of these islands, has been fatal to their antiquarian and poetical lore, depending on tradition.

or variety, the leading ideas in them being these,—that the Great Seal is a human soul or a fallen angel in metempsychosis, and that to him who is remarkable for hostility to the Phocal race some fatal retribution will ensue. I can easily conceive the feeling of awe with which a fisherman would be impressed when, in the sombre magnificence of some rocky solitude, a Great Seal suddenly presented himself —for an interview of this kind once occurred to myself. I was lying one calm summer day on a rock a little elevated above the water, watching the approach of seals in a small creek, formed by frowning precipices several hundred feet high, near the north point of the Shetland Islands. I had patiently waited for two hours, and the scene and the sunshine had thrown me into a kind of reverie, when my companion, who was more awake, arrested my attention. A full-sized female Haff-fish was swimming slowly past within eight yards of my feet, her head askance, and her eyes fixed upon me; the gun charged with two balls was immediately pointed; I followed her with the aim for some distance, when she dived without my firing. I resolved that this omission should not recur, if she afforded me another opportunity of a shot, which I hardly hoped for, but which actually in a few moments took place. Still I did not fire until, when at a considerable distance, she was on the eve of diving, and she eluded the shot by springing to a side. Here was really a species of fascination. The wild scene, the near presence and commanding aspect of the splendid animal before me, produced a spell-bound impression which in my sporting experience I never before felt. On reflection I was delighted that she escaped.

The younger seals are the more easy to tame, but the more difficult to rear; under a month old they must be fed, and, especially the *barbata*, almost entirely on milk, and that of the cow seems hardly to agree with them. Perhaps their being suckled by a sow fed chiefly on fish, the giving them occasionally a little salt water, and then by degrees inducing them to eat fish, might be the best mode until they attained the age of being sustained on fish alone. In the *barbata*, to ensure rapid taming, it appears to be necessary to capture them before the period of casting the fœtal hair, analogous to what I have observed in the case of the young of water-birds before getting up their first feathers, and when they are entirely covered with the egg down. These changes seem connected with a great development of the wild habits, and attachment to, and knowledge of the localities where they have first seen the light. As the *barbata* is until this period in reality a land animal, the chief difficulty we have to surmount with it is in the quality of the milk to be given it. The *vitulina* is essentially an inhabitant of the water from its birth, yet the care of the mother is perhaps for weeks necessary to judge how long and how often it should be on land, and this we can hardly expect to imitate. In the young of this species a few days old, which we have tried to rear, a want of knowledge of this kind of management may have led to failure. I have not attempted to rear them at a greater age. The Greenland Seal is, I have been informed, occasionally kept for a month or two on board the whalers, and thrives sufficiently well on the flesh of sea-birds. This species appears to bring forth in January, and therefore has likely arrived at a hardy age before it is subjected to captivity. I know but comparatively little of its capability of being easily tamed; but this quality, of itself, is no evidence of superior intelligence. Might it not be easy to induce Greenland ship-masters to bring some of these animals to England, where they would be accessible to the observation of zoologists. One mode of attempting to tame them might be to take half-grown animals in a net, or surprize them on land, and then keep them in salt-water ponds in a semi-domestic state: if any of them were pregnant when caught, or could be got to breed, the main difficulty would be overcome. Perhaps also another means of taming applicable to them, as it might be to other wild animals, would be emasculation.

The *hunting* of the seal was formerly an object of great importance to Norway and her insular dependencies in the Northern Ocean. The skins were employed in various necessary modes, and their flesh and fat prized, and regularly consumed as food. They were, in those times, far more numerous and easy of access than they now are, and in common with horses, whales, sharks, &c., would contribute to support a population much superior to what some theoretical writers on history are in the habit of assigning to these regions. When a country, like ancient Scandinavia, consumes within itself every thing in an eatable shape which it produces;—when such a country swarms with fish, wild fowl, game, seals, and whales;—its domestic animals perhaps as abundant, and its agriculture as productive, as now; possessing in its forests, superabundance of fuel, and shelter; and from the maritime habits, and bold, adventurous, and intelligent character of its population, having at all times a ready outlet for its superfluous numbers;—we can at once conceive how easily the North could supply those swarms of heroes, who were incessantly desolating every coast of Europe, and whose descendants now give law and civilization to many of the fairest portions of the globe. In Shetland even, I know some people still alive who regularly ate the flesh of seals, but the practice is now totally disused. In the Faroe Islands they are still occasionally salted and eaten; and I believe the Icelanders continue to pay to their remains this last sad tribute of respect. The caves to which the Great Seal resorted, are arched perforations in the precipices open to the sea, and extending inwards sometimes upwards of 100 fathoms, terminating in pebbly beaches, on which the young were born and nursed. Some of these caves can only be entered under water, like the one in the Friendly Islands, described by Mariner and immortalized by Byron; and others are too winding and narrow to admit of access. When the entrance was sufficiently capacious, the sea smooth, and the seals were known to have brought forth, two boats proceeded to the cave; the one lay at the mouth; the other, attached to its second by a line sufficiently long to reach to the extremity of the tunnel, pushed inwards. On reaching the beach, some of the crew leaped out and knocked on the head as many of the old ones as they could, the rest escaping to the sea, without attempting to defend their young ones, who were then dispatched at leisure. When these dark deeds of butchery were over, the men were anxious to be quickly gone, for they observed that the blood of the seals raised the surf, and very little of this was to them a question of life and death. This effect they superstitiously ascribed to some supernatural peculiarity in the blood, resenting, as it were, the injuries inflicted on the animal; the result is, however, a real one, and arises from a quantity of oil, mixed with the blood, poured on the water in so contracted a situation. On these occasions, from ten to twenty young ones were sometimes taken from one cave; the booty belonged to the owners of the property in which the caves were situated, and a portion of it was assigned as a reward to the captors. These caves, or *Hellyers* as they are here termed, were held in strict property, and highly valued; and formal Deeds of conveyance of them, as well as of fowlings, were occasionally made, one of which I have seen. The legal doctrine of Feræ Naturæ seems, therefore, peculiar to advanced, rather than to early, stages of society, and an authority for man-traps and tomahawks may be traced up to the hunter state, when to the death the Indian maintained his Prairies * against the poachers of those palmy days, and the Viking his *Hellyers*. If it be natural to poach, it is natural to preserve. The moment the poacher becomes proprietor, he is as virulent in invective and bold in defence as he was before in attack; and the question of the natural equity of game-laws will, I suspect, at length resolve itself into this,—that he who has not wishes to take from him who has, and he who has wishes to maintain his position; and that the right to the denizens of the ocean and forest may rest on as valid a basis as any other species of appropriation. So also seem to have thought the ancient Scandinavian sages of the long robe, and their decisions are of no trifling importance; for their codes of jurisprudence, which have survived the so-called darkness of the Middle Ages, present a subtle or enlightened legislation, which can stand a comparison with the celebrated civil compilations of Justinian. Too much praise cannot be bestowed on the efforts of the northern antiquaries, especially the Danish, to extend and elucidate the knowledge to us so interesting and useful, of the ancient laws and history of the

* The theory that long since occurred to me of the origin of these illimitable meadows of the New World is, that they were the arable grounds of an ancient, numerous, and civilized people. Suggestions for this view will readily present themselves. The enormous tumuli or pyramids on them, emulous of those of Egypt—the remains of human bones, pottery, &c., which they contain, indicate a populous region; and agriculture in an extensive and advanced condition, must, in such a stage of society, have been necessary. But where else than those prairies were the fields for their agriculture? They exhibit all the appearances of long and careful cultivation, and one of these is the almost total absence of wood on them.

North. The names of Rask, Rafn, Müller, Schlegel, Finn Magnusen, and others, are here most honourably conspicuous.

Seals were also at all seasons sought for and surprised on the rocks. In the dusk of the evening, a man thus engaged in an attack upon a few females who were lying at some little distance from the water, in making a blow at one of them slipped his foot and fell; the seal anxious to get to the sea sledged herself over him; four or five others rapidly followed in her wake over the body of the prostrate Homo Sapiens, before he, oppressed by these night mares, and petrified with terror, could elevate his "frons divina." But his fears were groundless, the seals had other "fish to fry," escape not combat was their object, for they never attack man but when opposed in their retreat to the water, and this our hero was railwise facilitating rather than obstructing. A curious anecdote was related to me in Faroe of a native Waterton assailing, on the rocks, a male of the Great Seal, but not being able to detain him, actually got astride on his back, endeavouring to behead him at the gallop, and slipped out of the stirrups hardly in time to allow his *Barb*, mortally wounded, to take his leap, all alone, into the water. Lucas Debes, the old historian of those remote isles, and Donald Maclean, in his account of one of the Hebrides, make mention of the practice of hunting seals with dogs; the services of which, however, could amount only to irritating them to resistance, and thus by detaining them a little to gain time to the hunter to attack them with the club, for the strength of any dog is utterly trifling compared with that of a seal of ordinary size.

Within even the last twenty years, both species of seal have become much more rare and cautious, so that the net and the gun remain almost the only means of capture. In a few districts the net is employed for taking the Common

Seal, by being set near the rocks frequented by them, while they are absent, and lying in wait till they again approach the shore, but it is chiefly used for catching the Great Seal. The dimensions of the net are about 15 fathoms long and 5 broad, the meshes are 9 inches square, and it is made of strong cod-line. When the seals are suspected to have brought forth in a cave, the net is rapidly and silently dropped across the entrance. A man holding a rope attached to its upper ends is placed on each side, on some convenient pinnacle of rock that affords footing. Sometimes, from the shelving of the sides of the cave, the net cannot easily close it, and in this case the men hold each a long pole, with a bunch of straw or other substance at the end, keeping it constantly in motion under water, to deter the animal from escaping by means of this vulnerable part of the line of siege. When all is secured, the boat proceeds inwards as far as possible, and by firing and hallooing we endeavour to induce the seals that may be in the cave to venture out. In one instance, I remember seeing a female taken, in attempting from the outside to get to her young. Monogamous or not, the males are the first to escape. Now is the period of excitement to the hunter. None of the old ones may be within, and he looks anxiously towards the cavern, straining to penetrate even its murky recesses. Nothing is to be heard but the gurgling of the ripple on its sides, or the plaintive tones of the rock babes, expressive of their impatience for the feast of "Ubera distenta lacte," which, by them, alas! are never more to be drained. By-and-by he fancies he perceives an object in the water, and in a moment after he sees the seal darting with the velocity of an arrow under the boat, and presently he hears the welcome sound—"Fast," from the men holding the ends of the net. At the first onset they are obliged to give line;

for the seal, when he first strikes, finding an impediment, makes a turn, and if the net be then held too tense, he fails to entangle his hind-paws in the meshes, and thus often slips out. Some of them are wary, and do not immediately fasten, but swim cautiously along the lower edge of the net, surveying with all the coolness of a Wellington reconnoissance the state of the enemy's lines, and gliding through where they find a point unguarded. When fairly enveloped in the net or *masked*, as it is called, the capture is considered secure. The power of the animal is constrained, and even were it not, he has to lift a mass of wet net, with heavy weights attached, to the surface, every time he attempts to respire: only the largest and most powerful can accomplish this, but when he does, or when the water is so shallow as to render it easy, he is shot. Generally he cannot rise, and all that remains to be done is to wait patiently for his death by drowning. From the boat he may be seen making vain efforts to tear the net with his teeth—rolling on the bottom—now and then desperately struggling to disengage himself, and constantly looking up with a most striking expression of defiance and upbraiding at the boat, which he knows contains the agents of his sufferings. In about a quarter of an hour he begins to open the mouth—bubbles of air ascend to the surface, and death ensues.

There is something peculiarly cruel and cold-blooded in this mode of hunting seals:—it is taking advantage of their most interesting occupation, rearing their young, and the period that elapses between the moment of their entering the net and the last "bubbling groan," is employed in witnessing the drowning struggles of a noble animal. Few sportsmen, imbued with right feelings, can have a wish to repeat this, and the net is now nearly disused, except by those who may be actuated by mercenary motives. In this case, it is not uncommon to set a net across the entrance of a cave, fastening it by one extremity to the rock, and leaving it for some time, and this mode is often successful. Usually one only is taken at a time, unless more simultaneously enter the net, for the first that strikes displaces it, and procures a safe passage for the rest.

This net-hunting is a procedure truly like that which killed the goose that laid the golden eggs. Our ancestors of the good olden times managed matters better: they only took the goslings, and now and then a fated goose or gander, but as every season would not permit even this, the numbers were kept up at pretty much the ordinary census. Since, however, the positive and preventive checks to population, in the shapes of the net and the gun, have been so unsparingly applied, caves in which, forty years ago, fifteen or twenty young ones were annually brought forth, are now untenanted, and proprietor-sportsmen have found it necessary, in order to preserve the animal from extinction, to *taboo* the hunting of them, particularly during the breeding season, and their numbers are again in consequence increasing.

In shooting these seals, intimate knowledge of their habits, and most accurate guns, are absolutely essential. The rifle might here be supposed to be invaluable. We have tried the best specimens of American, English, German, and Norwegian rifles of all sizes, but experience has taught us that this sort of gun will not answer. Formerly when the seals were more numerous and easy of access, the kind of piece was of less importance. Large Dutch muskets, 12 or 14 balls to the pound, were chiefly used. The favourite charge was a cylinder of lead fitted to the caliber, about an inch long, above a ball: such a shot was demolishing and deadly. In animals so tenacious of life as seals are, and with bones rather spongy than splintery, a ball of a size capable of making a large wound, crushing all parts along its course, was very necessary to insure the immediate death of the game, on which its capture mainly depended. A Hottentot or a Squatter mortally wounding an animal, may track it for hours until it fall. A seal struck, and out of sight for a few seconds, and he is generally lost—his power of motion must be instantaneously paralyzed, or we have slender chances of ever shaking him by the hand. The gun, charged with one ball, which we find to be on the whole best for this sport, has a barrel of nearly 3½ feet long, and is one-eighth of an inch in thickness at the muzzle and breech, carrying 18 balls to the pound. Great thickness of metal, as far as can be compatible with rapidity of firing, the theoretical gunner, as well as practical sportsman, will easily see the advantage of in steadying the course of the ball, and perhaps diminishing the necessity of very precise attention to the quantity and kind of powder. The weight of such a piece is of course inconvenient; but as seals are not every moment to be shot at, and as the sportsman is often rendered fatigued and unsteady by crawling to within shot of his object, it is almost always the practice to rest the gun in taking aim. The percussion-lock is to be preferred—the gun with it appears to fire more rapidly through, and carry its charge forward with more celerity; but as a preventive of the animal diving on the fire, it is not very effectual—if it were, it would be peculiarly useful, for we have far more frequent opportunities of firing at seals looking at us than in any other direction, but this we now never practise; the rapidity with which for the most part they throw themselves out of the line of fire the moment the trigger is pulled, baffles all success. It is strange that in no instance have I ever certainly known one to be wounded when thus springing to aside. One might think that so bulky an animal could hardly contrive, at perhaps twenty or thirty yards, to get so rapidly all his body out of the course of the ball: perhaps guns that shoot wide of the mark would have the best chance of defeating the intention of this manœuvre, and a curious inference might then arise, novel to Manton and Oakleigh, that in shooting at swimming seals the gun must either be very good or very bad—no medium. I remember an old self-taught blacksmith remarking, that there was no gun but would shoot well with some kinds of charge; and I may add, that there is none that do equally well with all. In the kind of powder, but not so much in the quantity for a charge, we must be very precise, and sufficiently numerous trials must, as a pre-requisite, be made of its suitableness to the gun before each hunting excursion. We can never say beforehand what kind of powder or charge will suit, but often low-priced blasting or coarse cannon powder is preferable to the finest Dartford, and that sort which will admirably agree with a gun one day may in two or three days afterwards be totally unfit, and again recover its quality. This mutability may sometimes, no doubt, be ascribed to changes in the state of humidity to which this climate is so much exposed; but even when every precaution against this cause of deterioration has been taken, and the weather continues steady and serene, the powder changes in its quality. At other times, under every carelessness and all states of moisture in the air, it remains true—perhaps some minute and obscure chemical or electrical action is the cause of its variability—or perhaps, as I have sometimes thought, it is not always the powder that is at fault, but the cause of error may be found in certain states of refrangibility of the air leading to false aim, or in differences of density in different portions of air in the course of the ball's transit. A strong wind blowing across the direction of a ball also creates considerable deviation. On the whole, it is nice shooting. The head only of the seal is above water, and the mortal point to be struck is the brain, which in an adult common seal is hardly $2\frac{1}{2}$ inches in diameter. This at sixty or eighty yards is little more than a point, for we do not pretend to be able like our worthy far-sighted brother Jonathan to see and hit the head of a nail in a target at 150 yards. Yet I know of eleven seals struck in succession with single ball in one day at fair distances, and ten out of the eleven boated. On another occasion five were struck by one shot, the gun was charged with two balls, and about a dozen seals were lying on a rock within thirty yards; the one ball dipped into the brain of one, passed through the spine of another, and lodged in the body of the third:—these were all secured. The other ball mortally wounded other two, but they reached the water, and were lost. In both these cases my brother, Thomas Edmonston, Esq. of Buness, was the sportsman. He has been the most successful seal-hunter of whom we have any account in this country. In the course of little more than ten years he brought *to boat* 300 seals, great and small, losing very few that were fired at: one of those years I reckoned fifty. When killed in the water they sometimes float for a long time, but more commonly sink in a few seconds. This may proceed from various causes. The specific gravity of an adult well-conditioned seal is nearly that of salt water, in which, when floating, only a very small portion of his back is to be seen. The "ocean patriarchs" are for the most part rather meagre, and their bones compact and heavy, and they usually have an "alacrity at sinking." The females and adolescents of both sexes for opposite reasons usually float; sometimes they are shot when the lungs are inflated, sometimes when collapsed, or certain nerves controlling the glottis are injured; at other times the intestines are distended with food or flatus—a great quantity of blood may be suddenly discharged or very little. All these circumstances, or some of them, make the difference of sinking or swimming, and a very important one it is to the hunter, who is standing on the rock shouting at the full pitch of his voice to his boatmen or his dog to speed to the spot before the fallen angel descends to the coral depths : usually an active water-dog can reach the seal before he sinks. We have not had the opportunity of testing the merits in this hunt of the many kinds of dogs : on the whole, I should prefer the Newfoundland, if of a good race ; few dogs, however, have the requisite courage. They are all keen enough, but are rather timorous in promptly laying hold of the object ; if they approach it in flank their fore paws are apt to strike the body projecting under water before they can reach the small part of it, which alone is above, and thus sink it ; the more experienced dogs approach it near the head. A very fine animal of the rough water-dog breed, with a little cross of the poodle, after in vain trying to seize a floating seal I had shot, plunged under water and laid hold of one of the paws, and thus brought him to land. There is a breed of dogs indigenous to this country, and common in Norway, Faroe, and Iceland, in height fully equal to the largest spaniel ; short-haired, muzzle not very elongated, and ears somewhat pendulous ; which I think combines in the greatest perfection all the best qualities which we seek for in the dog, either as a general companion or as a useful auxiliary for all kinds of sporting. The best seal dog I ever saw was one of these, though not of the largest size ; this breed is unfortunately now in this age of cross reform very rare in Shetland. I may here remark in passing, that in our ardour for eliciting some peculiar points in the dog, we do not keep sufficiently in view his valuable qualities in combination. We have the greyhound for speed without scent, and the bloodhound with scent without speed, and so on ; but while all this is useful, why neglect cherishing any variety of this prince of the lower animals which may be found to possess the most of those attributes that fit him for general and useful companionship, though any one of them may not have a decided predominance. For this variety we must look, I imagine, to the different well-marked races of dogs which are indigenous to different countries, unsophisticated by the experiments of the fancy, or the discipline of the kennel, and we must not be too nice as to whether there is a curl in the tail, or a peak in the ear. In dogs, as well as in other animals, I suspect we shall have soon to appeal to native races to refresh the blood of our domestic animals, or we shall have masses of disease and monstrosities of habit continually to contend with.

To return to the Seal. If he have sunk, and if the water be deep and the bottom covered with sea-weed, we have a new class of difficulties by no means superficial to contend with, and a new source of excitement commences. Two important auxiliaries, the water-glass and the klam, are now put in requisition. The former is simply a large tub with a pane of glass fitted water-tight in its bottom ; the tub is immersed an inch or so in the water, and by means of this instrument, we can see tolerably clearly from 6 to 16 fathoms down, seldom more; for clear water is with us still more rare than a clear atmosphere. Many a time have I wished for those limpid waters of the North Cape, where, as travellers tell us, halibut and herring may be seen 20 fathoms deep playing at hide-and-seek amongst the submarine jungles. The use of the water-glass seems to arise from its power of preventing the rays of light proceeding through it from the bottom from being affected by any agitation on the surface. After often a long and fatiguing search the object is discovered, and the klam is had recourse to. This is a gigantic kind of forceps of peculiar construction, attached to two lines, one of which is to suspend it, the other to guide the blades; it is directed to its object by means of its help-mate the water-glass; the jaws close on the Seal, and he is quickly hauled to the surface.

But all this will not ensure success in the Seal hunt. It is not enough to be a good shot, to be well armed and supplied with every equipment; the sportsman must also be intimately acquainted with the habits of the animal, and possess great experience and address to avail himself of this knowledge. Many curious devices are put in practice to allure him within shot, and much patience and sagacity to steal upon him unperceived. Often we range along many miles of coast without meeting with a single Seal; but our wanderings are through scenery the most majestic. Who that has ever looked upon them, can forget these "naked" and primitive isles of the Northern Atlantic—their melancholy moors and lonely valleys—their stupendous precipices and foaming surges, lowering clouds, and rushing malströms, where the ancient lullaby of the infant Viking was the hurricane, and his play-ground the ocean; in these wild and sequestered solitudes, unbroken by the tumults of faction and the inroads of civilization, is to be found that untrammelled freedom about which philosophers reason, and poets sing; and it is well to refresh ourselves, in this agitated period of the march of matter, with those pure and ennobling sentiments which the presence of Nature in her sublimer aspects is calculated to inspire. If the fox-hunter has counties to scour, we have islands; if we want his woodlands and rivers, we have our rocks and ocean;

instead of chargers, we have boats the finest in the world, combining symmetry, safety, and celerity. Our dogs are far superior in definite attachment and versatile intelligence to the machines of the pack; if we do not enjoy the pleasure of breaking our necks in leaping hedges, we can yet prove our mortality by capering over precipices, breasting billows, and ploughing breakers; no spring-guns, fierce keepers, or game-laws, restrict the freedom of our coursing; whatever we behold either on the land or the water we can approach. Yet some there are who call themselves sportsmen, who, if they have not a partridge and pointer, a pack and a *Brush*, to look upon, consider all hunts as unworthy of attention. Not so thought such veterans as Sparmann and Cartwright, Lloyd and Waterton; for it is not the name of an object of game, whether this be fox or phoca, deer or tiger, but that which can afford best play to those faculties and associations which he loves best to exercise and to cherish, that delights the soul of the true amateur hunter. Nor can I enter into the feelings of those sportsmen whose pleasure is solely in dexterous killing: there should be the accessories of objects, such as science, utility, health, to entitle us to deprive an animal of life; we are made lords of the irrational creatures, but not to lord it over them. I have repeatedly had for half an hour, under aim of an unerring gun, a seal lying within forty yards of me, and could not find it in my heart to fire; yet I had enjoyed all the enthusiasm of the hunt up to the moment of slaying, and this unalloyed pleasure in addition, of quietly observing the drowsy Triton reposing on his ocean rock, like an ancient Sea-King in his stronghold of plunder (Pictish Brugh),* when, withdrawing

* Various considerations tend to shew that the ancient erections termed Pictish Brughs, were fortified depots of plunder of the Vikingr, but not the possessions of the aborigines of the countries where they

the finger from the trigger, I started him from his slumbers by a warning shout that sent him plunging into his native element, with a strong consciousness of his danger, and I hope a grateful sense of my forbearance. Taking it altogether, it is a soul-stirring hunt; the game is a noble one, his size, power, activity, sagacity, and vigilance, the slippery element in which he is pursued, presenting enough of dangers to face, and difficulties to overcome. The ingenious stratagems and judicious arrangements to ensure his capture, the rugged grandeur of the scenery of his favourite retreats, present a combination that includes every thing essential that charms us in the chase; and sure I am, there is no real sportsman having once experienced it, who would deny this.

Philosophers in their studies may reprobate this love of hunting, but it is not as some of them have imagined synonymous with the love of cruelty. Hunting is necessary in the early stages of society to procure food and clothing, and to overcome rapacious animals that dispute with man the sovereignty of the wilderness. But the conviction of its utility would of itself be insufficient to induce the savage to acquire the skill and to practise the courage and perseverance which it demands; a simpler, more continued, and pleasurable impulse is therefore superadded by the wise Author of existence, of which metaphysically as little explanation can perhaps be given, as of any other instinct auxiliary to reason, but of which we see the use; and it is this instinctive impulse, as well as the pleasures derived from scenery, and association, and active exercise, both physical and intellectual, to which we must look for the source of that passion for the chase which is so captivating and universal.

are found. This hypothesis, whether or not it may be considered a just one, I have ventured to maintain for twenty years past.

ON THE LAST CHANGES

IN THE

RELATIVE LEVELS OF THE LAND AND SEA IN THE BRITISH ISLANDS.

By JAMES SMITH, Esq. of Jordanhill, F.R.S.L. & E., F.G.S. & M.W.S.

The occurrence of recent marine remains at higher levels than those at which they could have been deposited by our present seas, early attracted the notice of the Wernerian Society; and its memoirs contain a valuable collection of facts illustrative of this subject. The communications of Messrs Stevenson,* Bald,† Home Drummond,‡ Blackadder,|| and others,§ furnish numerous observations respecting indications of changes in level on the eastern coasts of Scotland, whilst those of Captain Laskey¶ and Mr Adamson** record similar phenomena in the basin of the Clyde and Lochlomond.

* Wern. Mem. iii. 327. † Ib. i. 483; and iii. 125. ‡ Ib. v. 440. || Ib. v. 424, 572. § Ib. ii. 342, 348; v. 572, 575. ¶ Ib. iv. 568. ** Ib. iv. 334.

My attention was first called to the subject by the discovery of marine shells, agreeing in general with those of the adjoining seas, embedded in blue clay, at Ardincaple, the seat of Lord John Campbell, in Dumbartonshire. At that time it was usual to ascribe all such appearances to diluvial action; and although the shells bore no marks of violent transportation, the bivalves being entire, with the epidermis uninjured, and in their natural position; yet, as the distance from the sea was small, I imagined they might have been protected from injury by having been lodged in an eddy. Two of the shells appeared to differ from any known species; one of them a Tellina (*T. approxima*), is so common, as in many localities to become characteristic of this deposit. It resembles the *T. tenuis*, but is distinguished by a brown epidermis; the other resembled a *Natica*, but was destitute of the umbilicus. The only specimen procured of this shell I unfortunately broke, but not until a sketch of it had been taken.* Lord John Campbell was kind enough to order a new excavation to be made, in hopes of finding other specimens, but without success.

Soon after this, Mr Thomas Thomson gave an interesting description of a similar deposit at Dalmuir in Dumbartonshire, in the Records of General Science.† He collected twenty-nine species, which were submitted to the inspection of Mr Sowerby, who pronounced three of them to differ from any known recent British shells; one of them was said to be *Natica glaucinoides*, a crag fossil; another, *Fusus lamellosus*, which had only been observed about the Straits of Magellan; and a third, *Buccinum striatum*, an unknown species. This remarkable fact, coupled with my own ob-

* Plate XLV. Fig. 18.

† Vol i. p. 131.

servations, led me to imagine that the term "recent," which had usually been applied to such deposits, was perhaps not rigidly correct. In order to ascertain how far it was so, I determined to collect as many of the shells belonging to them as I could. In a fresh excavation I made at Dalmuir, I increased the number of species, from that locality alone, to upwards of seventy. The Rev. Mr Landsborough of Stevenston, in Ayrshire, was kind enough, at my request, to collect marine remains from the elevated shelly deposits in his parish; and Mr Witham sent me a collection from similar beds on the Yorkshire coasts. In order to render the comparison between the existing and more ancient races of *testacea* as exact as possible, I determined, at the suggestion of Mr Lyell, to avail myself of the facilities which the possession of a yacht afforded, to collect and form a catalogue of those now existing in the same seas. Amongst the shells dredged up, several new species have been discovered. I failed, however, in finding any of the unknown subfossil ones. As by far the greatest number of the shells, from the ancient deposits, have been found in the basin of the Clyde and north of Ireland, I have confined the catalogue of recent shells to those which are now to be found in the same seas; a comparison of the two catalogues will thus shew how far their former inhabitants coincide with the existing species.

In the prosecution of this inquiry, I discovered marine remains so frequently, that any attempt to describe or enumerate the localities would exceed the bounds of this paper. When once I was furnished with a clue, I found them in places where their presence had never before been suspected; sometimes in great numbers, whilst at others the very same beds were altogether destitute of them. This is peculiarly remarkable in a finely laminated clay, which I have traced to a great extent in the counties of Lanark, Renfrew, and Dumbarton. It is equivalent to the carse clay of the Forth and Tay, and must have been deposited at the bottom of a tranquil sea, at such a depth as not to have been disturbed by the agitations of the surface. The shells and other marine remains with which it abounds are almost invariably found in the lower part of this bed, a circumstance which can only be accounted for by supposing a sudden depression, which has converted a half-tide deposit into a deep-sea one. The testaceous animals have thus been entombed alive in the beds subsequently formed, and their remains are preserved with all the perfection of recent specimens. Associated with this clay, we frequently find extensive beds of pure gravel and sand also destitute of organic remains, although there can be no doubt of their marine origin. Mr Lyell has observed the same thing in similar beds in Sweden.*

We must be cautious, therefore, in concluding that alluvial beds in which we do not find such remains, are fresh-water ones; and, of course, equally so in deciding on their marine origin, till confirmed by the presence of their appropriate remains.

These deposits are much more extensive, both as to the amount of change of level and superficial extent, than has been generally supposed. We have conclusive evidence that the whole of the British islands have, at periods which, geologically speaking, are by no means remote, been subjected to changes both of depression and elevation. The submarine forests which have been observed on so many parts of our coasts, are proofs of the former kind of changes, whilst those of elevation are evidenced by raised beaches,

* Phil. Trans. 1836, pp. 11 and 15.

sea-worn cliffs and caves, stratified beds of sand, gravel, and clay, and, above all, by the marine exuviæ which they contain.

The deposits thus formed must, in Scotland at least, be intercalated between the two first groups in Mr De la Beche's classification of rocks, viz., the modern group and the erratic block group. We infer that they are posterior to the latter, from their superposition, and that they do not belong to the former, from the absence of the remains of man or of works of art. The erratic block bed, which has also been termed diluvium, has in Scotland received the provincial name of *Till*. It is very accurately described by Mr Bald,* under the name of the old alluvial cover, in his paper on the coal formation of Clackmannanshire. It generally consists of stiff unstratified clay and gravel, confusedly mixed with water-worn masses, and also with angular fragments of sandstone, shale, and coal, which have not suffered from attrition, although comparatively soft in their structure. Organic remains are excessively rare in it. Mr Bald, who remarked this, afterwards found the tusk of an elephant embedded in it in the excavation of the Union Canal; but, unwilling to draw an important inference from a solitary fact, he supposed it might have been placed in the situation in which it was found, from some accidental cause. Since that time, however, elephants' bones and tusks have been found near Kilmarnock, and at Kilmaurs, in Ayrshire. I am assured by Dr Scouler of the Royal Society of Dublin, and Dr Cowper of the University of Glasgow, who visited these localities, that, in both instances, they were embedded in the *till*. At Kilmaurs they were associated with sea-shells; and, on one occasion, I also found shells embedded

* Wern. Mem. vol. i. p. 481; vol. iii. p. 126.

in it, much broken, and deprived of their colour. Mr Trimmer, in describing the diluvial deposits in Caernarvonshire, in the proceedings of the Geological Society,* states that he found broken shells in the diluvium of the low cliff near Beaumaris. He also found broken shells *in a bed of sand*, on the summit of Moel Tryfane, 1400 feet above the level of the sea. The expression seems to imply alluvial rather than diluvial agency. Mr Trimmer, however, informs me that he ascribes their presence at so high an elevation to the latter cause, the beds having all the appearance of violent action, and the subjacent rocks worn and scratched by friction of transported pebbles. Mr Phillips also is inclined to think that in Holderness the irregularity of deposition of the shelly gravel seems to point to diluvial currents rather than to change of level. †

It is not, therefore, a necessary inference that the mere discovery of sea-shells at high levels is a proof of permanent submergence. Their fragments, like those of coal, sandstone, and shale, mark that the distance from which they have been transported is a short one. It is only when found *in situ* in regularly stratified beds that we are entitled to draw such conclusions; but their presence in diluvial beds must be held as an exception to the general rule.

Although this is not the place to offer any speculation respecting the origin of the till, I think it evident that it must have arisen from causes altogether different from those which have produced the marine alluvia. Whatever they were, they must have been violent and transitory. Of their violence we have ample proof in the size of the fragments they have transported, as well as the erosion of the rocks over which they have passed, but that they suddenly ceased

* Vol. i. p. 332. † Treatise on Geology, p. 198.

must be inferred from the confused manner in which the different parts of the till are arranged. Submarine currents might indeed have moved the largest boulders, but they must have been deposited somewhat in the order of size and gravity; the sand, clay, and smaller fragments being swept forward till the diminished velocity of the current was unequal to bear them farther, and banks of gravel, sand, and clay, would be formed. No inference can therefore be drawn from it as to the former level of the land, as rushes of water capable of producing such effects must have disturbed the alluvial covering both above and below the surface of the sea.

All observers concur in supposing that the cause which produced the diluvial covering of the great-coal field of Scotland, must have had its origin to the westward, modified, however, by the form of the ground. Near Glasgow, it is quite evident that its action must have been from the north-west. In levelling a mass of it, the workman laid into a heap all the boulders which were too large to be lifted by the spade: this afforded an opportunity to estimate the relative proportions of the different rocks, which I found to be as follows:—

White sandstone and shale,	60	per cent.
Trap, - - -	30	...
Clay-slate and greywacke,	10	...
Granite, - - -	1	...
	101	

The sandstone was evidently derived from the subjacent coal-formation, the trap boulders from the Kilpatrick hills, which are about ten miles to-the north-west, their identity being proved by the zeolitic minerals which they contained; the slate and greywacke from hills in Dumbarton and

Argyleshires, about double that distance ; the granite blocks must have been transported from still greater distances. Beyond the Kilpatrick Hills the trap and white sandstone boulders disappear, and are replaced by greywacke, clay-slate, and red sandstone, whilst those of granite and mica-slate become numerous. Near Helensburgh, twenty-three miles to the north-west of Glasgow, the granite strongly resembles that of Ardnamurchan. At Roseneath, I have seen rolled fragments of a compact reddish granite so much resembling that of Inverary, as to leave little doubt of its identity. In all of these cases, the bearing of the supposed original rocks is north-west, but in all of them the intervening space is intersected by deep arms of the sea and steep precipitous mountain ranges. It appears to me, therefore, that the till is as ancient as the period of their elevation, and was most probably caused by the violent geological action by which it was accompanied.

It is, at all events, in Scotland anterior to the marine alluvia which I am describing, and which have been observed reposing upon it in many places. It is proper, however, to observe, that in some instances we find stratified alluvium below the till. I have observed this near Glasgow, and on the west coast of Ireland ; and Mr Bald, in describing that of the Forth, remarked, that in one case, when t was cut through to the depth of 162 feet, the lower bed appeared to have been deposited in water in the most quiescent state, as it was divided into the finest laminæ. In neither of these cases were marine remains detected, but Mr Mantell has described an ancient beach as passing under the elephant bed in Sussex, and Sir Philip Egerton found a bed of shells under the ordinary sand diluvium of Cheshire.* These facts do

* Proc. Geol. Soc. vol. ii. p. 190.

not invalidate the conclusion, that the changes in the level are posterior to the deposition of the till, they only prove that it has not swept away the whole of the pre-existing alluvia. I have observed the marine beds resting on Till near Glasgow, and in the excavations of the railway from Edinburgh to Newhaven. Mr Thomson has observed it in Dumbartonshire.* At Johnstone, near Paisley, in digging a well, a marine deposit, containing the bones of fishes and sea-fowl, the claws of crabs, sea-weed, and shells, was found to rest upon a bed of it, upwards of 70 feet in thickness. Mr Robberds † and Mr Rose ‡ have observed the same order of position in the county of Norfolk.

We can, therefore, have no hesitation in considering that in these localities changes of level have occurred posterior to the deposition of the diluvial covering, although it is not improbable that in some parts of the British islands it may have been lodged on the surface subsequent to the period when the sea had become stationary at its present level. I am inclined to think that this has been the case on the west coast of Ireland; in the counties of Clare and Kerry I observed no stratified beds above the diluvium, and, on the shores of the Shannon which divides them, no terraces except those forming at present. These facts, however, seem rather to prove different periods of diluvial agency than of elevation and depression.

The changes of level must have taken place anterior to the historic period, which in this country dates from the invasion of the Romans. Diodorus Siculus,§ who wrote during the reign of Augustus, describes St Michael's Mount

* Records of General Science, i. 132.

† Phil. Mag. Oct. 1827, p. 281. ‡ Ib. Jan. 1836, p. 34.

§ Diod. Sic. Book v. Quoted in Thomson's Outlines of Mineralogy and Geology, vol. ii. p. 45.

in Cornwall under the name Ἰκτις, as an island connected with the mainland by a space covered every tide, but dry at low water,—a description which would apply accurately at the present day. In Scotland, the Roman wall, which crosses the island from sea to sea, has evidently been formed at both ends with reference to the present level. The same observation applies to British tumuli and vitrified forts, which are perhaps of still greater antiquity. It is, therefore, highly probable, that no changes of level have taken place since the British islands have been tenanted by man.

We have ample proof that traces of these changes occur in every part of our coasts. In England, the observations of Messrs Phillips,* Rose,† Robberds,‡ Sedgwick,§ &c., on the east coast; Messrs Mantell,|| De la Beche,¶ Sedgwick, and Murchison,** on the south; and Sir Philip Egerton, Messrs Murchison, Gilbertson, &c.,†† on the west, shew, that in all parts of the English coasts they are to be met with. In Scotland, in addition to the Notices in the Wernerian Memoirs, already adverted to, the Statistical Account abounds in direct or incidental notices of similar phenomena. My own observations, and those of every well qualified observer, confirm their universality in this part of the island.

In Ireland, I have seen them on the east, north, and west coasts. I am informed by Mr Griffiths, that he has observed them in Cork and Waterford, and Captain Portlock has recently found them in stratified beds at an eleva-

* Geol. of Yorkshire, vol. i. p. 23. † Phil. Mag. Jan. 1836, p. 30.
‡ Phil. Mag. March 1827, p. 223, &c.
§ Geol. Soc. Proceedings, vol. i. p. 409.
|| Geol. of Sussex, 285. Geol. Proc. ii. 203. ¶ Geol. Manual, 149.
** Proc. Geol. Soc. Dec. 1836. †† Fourth Report Brit. Assoc. p. 654.

tion of 400 feet. Proofs of such changes have also been observed in the Channel Islands and on the opposite shores of the Continent, all probably referable to the same geological epoch.

These marine beds have been discovered at every elevation, from that of the present level of the sea to a height of at least 400 feet above it; and in the solitary instance of Moel Tryfane shells have been found at the height of 1400 feet; but as the cause of their occurrence in that situation is doubtful, we may conclude that the highest elevation at which proofs of such recent changes have been hitherto discovered is limited to 400 feet.

At this height Mr Gilbertson found sea-shells in stratified beds of gravel and sand near Preston in Lancashire. Mr Murchieson,* who visited this locality, observed "similar phenomena over a very considerable tract of country occupying the ancient estuary of the Ribble. Sands, marls, and gravels, occasionally forming terraces, are spread over this great area, sometimes in finely laminated beds, but for the most part loosely aggregated, and bearing a great resemblance to the arrangement of the same materials now in the act of formation on the adjoining shores. Many of the shells found in these beds far inland, and at heights extending to 300 feet above the sea, are perfectly identical with existing species." Mr Murchison justly infers, that such appearances must be ascribed to actual elevation rather than to the action of diluvial currents. Sea-shells were found by Mr John Craig, mineral surveyor, at Airdrie about ten miles to the east of Glasgow, at the height of about 350 feet; they were found between a mass of blue till and a bed of yellow stratified clay, which rested upon it. Mr Craig was inclined to suppose they belonged to the till, the shells having

* Address to Geological Society, Feb. 1832.

been filled with blue clay; but I have observed the same thing in shells which certainly belonged to the stratified deposit, and it is easily accounted for. The action of the sea upon such a bottom would naturally stir up the clay so as to fill dead shells. Those found in this locality do not bear marks of violent transportation, and the distance from the sea is so great that it is difficult to suppose that such fragile shells as the *Mytilus edulis* and *Tellina approxima* could have been borne along uninjured by diluvial action. I am, therefore, inclined to consider, that the shells found at Airdrie belong to the alluvial beds, and have been confirmed in this opinion by having had some specimens of the *Tellina approxima*, a species which has only been found in this deposit, sent to me from the same locality.

Mr Prestwich* also found, at the height of 350 feet, in beds of sand, gravel, and clay, at Gamrie, near Banff, the following recent shells: *Astarte Scotica*, *Tellina tenuis*, *Buccinum undatum*, *Natica glaucina*, *Fusus turricola*, *Dentalium dentalis*. They were extremely friable, but perfectly uninjured.

The promontory of Brayhead, in the county of Wicklow, is formed by a cliff of alluvial strata of coarse gravel and sand, containing sea shells; it is at least two hundred feet high, and the hill of which it is a part, and which is evidently composed of the same beds, is perhaps a hundred feet higher. Here, therefore, this deposit reaches to the height of three hundred feet. At Howth, on the north side of Dublin Bay, are similar cliffs, at the height of about a hundred feet, also containing shells and other marine exuviæ.

In the Isle of Sheppey,† recent shells have been found in

* Proceedings Geol. Soc. May 3. 1837.

† Ib. vol. i. p. 410.

a bed 140 feet above the present level. In Norfolk,* and in Yorkshire,† they have been found at the height of a hundred feet. Near Berwick, Mr Milne‡ observed a tract of table land at the height of a hundred feet above the level of the sea. It consists of vertical strata, which have all had their edges worn down to a level plain, just as would have been the case if the rocks had been exposed to the action of marine currents incessantly sweeping over their edges. When the tide is far out, exactly the same appearance is presented by the vertical rocks which form the bottom of the shore for a considerable distance out from the existing cliffs, and were there to be an elevation of the coast, another table land would be formed exactly resembling, but a hundred feet above, the former.

In the basin of the Forth, beds of razor-fish (*solen*), and bones of the seal, have been found at the height of ninety feet.§ At that of seventy feet, marine remains have been found on the banks of Loch Lomond,|| on the Yorkshire coast,¶ in Devonshire,** and in the Island of Skye.†† I have found them in several localities in the basin of the Clyde, at the height of from seventy feet to the present high-water mark.

At an elevation of about forty feet there has been observed on many parts of our coasts a series of raised beaches and terraces, which, by their magnitude, indicate the prodigious length of time at which the sea level must have been stationary at this height; and if we may judge of its dura-

* Phil. Mag. Jan. 1836, p. 30. † Phillip's Geology, p. 198.

‡ Fourth Report Brit. Assoc. p. 638. § Wern. Mem. vol. v. p. 572.

|| Letter from Mr Buchanan of Arden.

¶ By Mr Witham of Laitington. Phillip's Geol. of Yorkshire.

** Geol. Soc. Proc. Dec. 14. 1836.

†† M'Culloch's Western Islands, vol. i. p. 293.

tion from the relative size of the ancient terraces with those now forming, it must have exceeded the recent period of which two thousand years is but a part, by an immense amount; but this is but one of the epochs in the history of this formation; between the great terrace and the sea several subordinate ones and beaches have been observed, each of them marking long continued periods of repose, whilst a sudden deepening, two or three fathoms below the low-water mark, is probably caused by another line of terraces now covered by the sea.

The great terrace, the base of which seems very generally to be between 30 and 40 feet above the sea, forms a marked feature in the scenery of the west of Scotland, in those parts where the violence of the Atlantic has not swept away the plateau of marine alluvia which, in the less exposed situations, is always interposed between it and the sea.

The northern part of the county of Ayr, which is composed of a coarse red sandstone or conglomerate, has been worn by the former action of the sea into a magnificent range of cliffs, in some places rising to the height of 300 feet; the two islands of Greater and Lesser Cumbra, lie opposite to it, and have corresponding terraces. The former of these islands is composed of the same sandstone intersected by trap veins; both the trap and sandstone have been worn away, but in different degrees, and the dykes are left standing out from the cliffs like ruined walls, affording no doubtful evidence of the length of time during which the sea formerly washed their bases.*

* The time is not yet gone by with geology, as it has with astronomy, when the conclusions drawn from its phenomena are supposed to be inconsistent with the word of God. I rejoice, however, to feel assured that, in yielding to evidences which it is impossible for me to resist, I am neither denying its truth, nor wresting it to my own pur-

Similar phenomena have been observed in Jura, Mull, and Isla, at elevated levels, as well as at that of our present seas, and they furnish, as Mr M'Culloch observes, "the most perfect record which geology affords of the wasting action of the sea upon the land."* After remarking that the destroying causes of such as are found on our present shores are so obvious that it would be superfluous to point them out, he offers the following speculations on the origin of those in question. "The other case, that of outstanding inland dykes, such as those of Cumbray, and the more conspicuous examples in Isla and Mull, is more difficult of explanation; it is equally evident, however, even in these two instances, that the surrounding strata must once have existed at least at the same level as the summits of the present dykes. Nor can any obvious causes now be traced by the operation of which so great a removal of land has been

poses. That interpretation, which admits, to the fullest extent, the remoteness of the "beginning," was not invented to meet a geological difficulty, but has been held by learned and pious men of all ages. To those who, unacquainted with the science, think the conclusions drawn from its investigation too uncertain, and too contrary to each other, to be worth attending to, I would say, that such discrepancies of opinion are every day disappearing as the science advances; and on the point in question, there is no controversy which deserves the name. There is, indeed, no rule without exception. At the meeting of the British Association held last year at Liverpool, I remember an elaborate paper was published to prove that the theory of gravitation was contrary to Scripture: it, of course, called forth no remark. At Newcastle, a gentleman, well entitled from his labours in one department of the science, to be listened to with respect, more especially as he did not impugn opinions differing from his own, took what I must call the sceptical side of this enquiry, by endeavouring to prove the uncertainty of geological evidence. The paper was honoured by a reply from Professor Sedgwick, whose reasonings were responded to by an audience containing a greater amount of high geological authority, than perhaps was ever before congregated under one roof, in a manner which proved that on this point at least there was no dispute.

* M'Culloch's Western Islands, vol. ii. p. 480.

effected; there are no rivers in any of the instances enumerated, to which it could be attributed, nor, indeed, could any action of a river be imagined capable of producing those effects on surfaces so irregular." He supposes they may have resulted from the tedious operation of the atmosphere, but the actual change of level affords an easy solution of the difficulty, and in each of the cases cited, we have the additional evidence of such an origin from marine remains, embedded in the alluvial strata which accompany them.

Although we have traces of changes of level on every side of the British Islands, it would be premature to say whether or not they are all universal, or whether some of them may not be confined to particular districts. There can, I apprehend, be no doubt as to the lower levels under the great terrace; the plateau at its base, except where since worn away by the action of the sea, is invariably composed of marine beds of sand, gravel, or clay; but the case is doubtful as to those at higher elevations; and if the shells at the top of the mountain of Moel Tryfane be considered as a proof of elevation, we may safely assume that it must have been a local one.* Although we do not observe any such

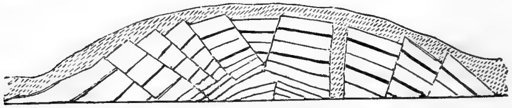
* Since writing the above, I have read with much pleasure Mr Trimmer's paper on the diluvial drift in Wales and Ireland in the Journal of the Dublin Geological Society. I agree with him entirely as to the well-marked difference between diluvial deposits and those caused by permanent submergence; and if I differ with him as to the origin of the gravels of Howth and Bray, it does not in the slightest degree affect the argument. He appears, for he has not come to that part of the subject, to consider them the result of diluvial action, whilst I agree with my friend Dr Scouler, with whom I visited them, that they are proofs of elevation. Mr Trimmer, after noticing the ready reception of the diluvial theory of Buckland, remarks, that "the interest excited by these new and striking facts (*i. e.* proofs of change of level) had now diverted the current of geological speculation into an opposite direction from that in which it had lately flowed, and from the one extreme of

marks of violence as are indicated by extensive inclinations of the stratification, or by the fractures, erosions, and unstratified deposits which have been produced by diluvial agency, it is quite evident that some of these changes must

having generalized too hastily on diluvial phenomena, geologists began to run into the other, of endeavouring to exclude diluvial action from the list of geological agencies,—to expunge the very name from geological nomenclature,—to forget all the evidence which had been collected of the passage of large bodies of water over the land, and, in every mass of transported gravel in which marine shells of existing species were discovered, to see a raised beach, or a marine formation, of gradual accumulation, regardless of the proofs which, in many cases, existed of such deposits being due to the sudden and transient action of the sea." It is impossible to examine the diluvial deposits which I have formerly noticed, without remarking the evident effects of such sudden and transient action, so perfectly resembling those which we know must have been owing to similar causes. In the summer of 1818, I had an opportunity of observing the deposit caused by the irruption of the lake which had been formed by a glacier in the Valley of Bagne, and which was spread over the valleys of the Dranse and the Rhone, before it was covered by vegetation or obliterated by cultivation. No word could so well express its appearance as "diluvium," except that the occurrence of works of art formed a prominent feature, especially below the village of Martigny, where several houses were destroyed, and where beams, hewn stones, and fragments of furniture, were confusedly mixed with gravel and clay. At Greenock, in 1834, I witnessed the effects of an inundation, caused by the breaking down of the head of a reservoir, in which upwards of thirty lives were destroyed. In its track to the sea, it exhibited all the phenomena of diluvial action. The streets and walls were marked with furrows; masses of stone, and even of cast-iron, were mixed up with clay and gravel without regard to their gravity; whilst within the houses every thing was covered with a thick layer of fine silt, exactly as in the diluvial caves. Were this covering, therefore, to occur in insulated patches, we might seek in similar causes for similar effects; but where could the lake have existed so vast as to have swept away nearly the whole of the alluvial covering of the great coal basin of Scotland from sea to sea, and lodged it in one confused mass in some places hundreds of feet in thickness? Its cause must, I apprehend, be sought for in some sudden geological action of a magnitude far surpassing any like event recorded in the short page of human history. The long continued action of submarine currents could not have been the cause of the beds in question, although I have no doubt that they often have given origin to coarse beds of gravel improperly termed diluvium.

have been sudden; and beds of testaceous animals have been entombed alive by the subsequent deposit of clay or sand from a considerable depth. This is particularly observable in the laminated clay in which marine remains are so frequently found in the basin of the Clyde. The upper parts seem quite destitute of them, and it is only when the excavations are made deep enough, such as in digging wells and coal-pits, or in the lower beds of brick-works, that they may be expected to be found. In the brick-works near Glasgow, I am often told by the workmen that they are not deep enough for shells.

Such sudden changes we know have in recent times taken place on the west coast of America, and in Cutch; and no doubt earthquakes have accompanied the ancient changes as well as those of a modern date. Fissures and dislocations are occasionally to be observed in the beds of sand and clay, produced probably by such causes. In an excavation made at Warriston in the line of the Edinburgh and Newhaven railway, in cutting through a ridge of about 400 yards long, 100 yards broad and 10 yards high, the section, which was at right angles with its length, exhibited numerous rents traversing the beds, which could only have been produced by a sudden upheaving. A horizontal section would have represented the fissures as parallel with its length, whilst the cross one shews them radiating, as it were, from a centre. The inclination of



the beds is too great to be ascribed to original inequalities in the mode of deposition. In some cases they form an angle of more than 60 degrees with the horizon. Some of them consist of fine and coarse sand or clay, and others of small fragments of coal. The section presented a beautiful miniature model of the stratification, fissures, slips, and faults of a coal-field. These beds are covered by another of gravel, which lies unconformable to them, and has evidently been deposited immediately after, filling from above some of the open fissures. It is impossible to account for these appearances, without supposing that they are the effect of a local upheaving.

Although, however, the changes in level might in some cases have been sudden and attended with earthquakes, it is probable that in others they have been slow and gradual, like those taking place in Sweden at the present day. Indeed, with the exception of the absence of works of art, nothing can more perfectly agree with the appearances of the ancient marine alluvial beds than Mr Lyell's description of similar, but more recent, ones in Sweden. I have often met with beds of shells embedded in marly clay, which had received a violet colour from the decomposition of the common mussel (*Mytilus edulis*), exactly as described by him.*

The question as to the identity of the flora and fauna of the present period, with that of submergence, is an important one. It would perhaps be premature to say with certainty, whether they are identical or not. With regard to the vegetation no observations which have yet been made shew any difference between it and the existing race of plants. But too little has been done in this department to be of any value in settling the question. The same observation applies to the remains of birds and land animals; or to those of cetaceæ, crustacea, algæ, zoophytes, and other marine remains which have been found in these deposits.

* Phil. Trans. 1835, p. 1.

I have endeavoured to institute as rigorous a comparison as I could between the testacea of the two periods, and refer to the catalogues which I have appended to this paper, for the results. It will be observed that, although the greatest proportion of the shells are identical with existing species, there is a certain proportion which differs from them.* Of those which are unknown, some may probably yet be discovered in a recent state; whilst others, in place of being specifically different from their recent congeners, may be only varieties arising from the different circumstances under which they were placed. Still, as the per-centage of unknown shells is as great as that of the newer pliocene of the Sicilian deposits, it appears highly probable, that a considerable change must have taken place in the fauna.

The organic remains belonging to these deposits have been termed Quaternery by some geologists, and Subfossil by others. Professor Phillips includes the beds in which they are found amongst the post-tertiary and modern deposits,—although with some doubt; observing, that it is difficult to "discriminate between the Sicilian tertiaries with 95 per cent. of existing species of shells and the conchiferous gravels and sands of Holderness and Lancashire, in which, among twenty species of shells now living in the German Ocean, *one* occurs which is not yet known. If the Lancashire shells are, like those of Specton, Udevalla, and the coasts of Devon and Calvados, raised beaches, and to be classed in the modern epoch, why are the Sicilian ranked

* At the late meeting of the British Association at Newcastle, I had an opportunity of clearing up some points of interest respecting the unknown species of shells belonging to these deposits, and have to acknowledge the advantage I derived from the kind assistance of Messrs Adamson and Alder, and from my visits to the Museum of Natural History, which is arranged in a manner well worthy of the scientific eputation of that splendid city.

as tertiary?"* It appears to me that Mr Lyell has solved the difficulty, by classing amongst the tertiary formations "all those geological monuments which cannot be proved to have originated since the earth was inhabited by man." The appearance of man on the surface of the earth is an event of such transcendent importance, as to justify its being used as the separating line of the recent or human period, and those which preceded it. Changes of level have occurred in every stage of the Earth's history: those of which I have been treating must have taken place during that which immediately preceded the recent period, and, of course, the organic remains belong to that division of the tertiary group, which he has named the newer pliocene. It is of great importance that every circumstance connected with this deposit should be carefully observed and recorded, as an accurate knowledge of it cannot fail to throw much light on that hitherto obscure branch of geology, the nature and origin of the different alluvial beds which compose the earthy covering of the more ancient formations; and, as it must be the object of the science to proceed from what is known to what is unknown, we cannot too minutely investigate that part of it which forms the first step in the descending series, in order that we may obtain firmer footing in prosecuting our researches into the more remote epochs of the history of the Earth.

* Treatise on Geology, p. 263.

PART II.

Since my last communication I have continued my examination of the elevated marine beds of the basin of the Clyde. Although it is not my intention to describe the different localities in which they have been observed, there are two which I cannot avoid noticing, in consequence of the very remarkable proportion of extinct or unknown shells which they contain. The first of these is in the island of Bute, which I visited in company with Mr G. B. Sowerby, for the purpose of dredging for shells. Upon landing to search the shore near its northern extremity, we found several valves of the *Pecten Islandicus*, a shell of the existence of which in a recent state in the British seas Mr Sowerby had previously expressed his disbelief. We were anxious, therefore, to ascertain whether or not these were the exuviæ of a living race, and determined to dredge for them in the Kyle, or narrow sound, which here separates the island from the main land. This we afterwards did, but without success, and the inhabitants assured us they had never seen any in a live state. Subsequent inquiry convinces me that all the specimens hitherto discovered belong to the ancient deposit.

Our doubts were at all events set at rest with regard to the shells in question, for, upon removing the stones and shingle which lay upon the beach, they were found imbedded in a finely laminated clay belonging to it, and which we observed in a section formed by a stream, passing from under the sea to a higher level; it abounded in marine shells, of which we distinguished twenty-four species, not more than one-half of which have been found in the adjoining inlet, and one-third of them are altogether unknown as British. A proportion so great I considered as altogether accidental, but having since examined a locality in which it was equally large, I attribute it in part to the circumstance of both these deposits being sea bottoms and not beaches, and consequently being in a great measure destitute of the common littoral shells which abound in them, but chiefly to the fact that the extinct or unknown species are those which occur in greatest abundance in the raised beds.

A flood in the stream had washed numbers of the fossil shells out of the clay, and left them on the shore mixed up with recent ones; a conchologist unaware of their origin must have been delighted with his success in discovering a locality which afforded so many new species.*

Amongst them Mr Sowerby found a *panopæa* which was new to him, but which he has since identified with the *P. Bivonæ*, from the elevated clay beds near Palermo. It is described and figured by Dr Philippi in the "Enumeratio Molluscorum Siciliæ." (Tab. II. Fig. 1.) Mr Wood has also pointed out to me one from the crag which is apparently of the same species.

* This mixture of shells from deposits of different ages has been adduced by Mr Charlesworth as one of the sources of error in the inferences drawn from the per-centage of living and extinct species in the tertiary formations. It is no doubt a possibility which ought always to be kept in mind; but it cannot affect the present inquiry, except in the rare cases of shells which are actually extinct having been supposed to be recent species. Marine shells *in situ* in elevated beds must necessarily belong to the period when the sea stood at a higher level.

One or two valves of the *Panopæa Aldobrandi* have been found on our shores, one of which in the cabinet of Mr Falconer of Carlowrie is marked "from Yarmouth;" and in that of Mr Bean of Scarborough, there is a specimen of the same genus, *P. Glycemeris*, found on the Yorkshire coast; it is figured in the Nat. Hist. Mag. vol. viii. p. 562. It, however, differs so much in shape, and in the muscular impression, from the one in question, as to render it probable that it is a distinct species.

A single specimen of this shell was found some years ago on the opposite side of the Firth, near Largs, by Mr W. Struthers. It is possible, therefore, that it may still inhabit the adjoining sea. Mr G. Forrester of Glasgow, who had it in his possession, tells me, however, that it had no appearance of being recent, and is inclined to think that it belonged to the ancient deposit. The following is a list of the shells we picked up upon this occasion. Those which have been found recent in the Kyles of Bute are marked *R*, and those which have become extinct or are unknown are marked *E*.

Cyprina Islandica.
Crassina Garensis.
  elliptica.
  multicostata, *E*.
Tellina proxima, *E*.
Pecten opercularis, *R*.
  Islandicus, *E*.
Natica glaucinoides, *E*.
Balanus costatus.
Serpula triquetra, *R*.
Spirorbis corrugatus.
Turbo littoreus, *R*.*
  vinctus.
Modiola vulgaris, *R*.
Fusus antiquus, *R*.
Nucula margariticea, *R*.
  rostrata.
Saxicava rugosa.
  N. S., *E*.
Panopæa Bivonæ, *E*.
Mya arenaria, *R*.
  truncata, *R*.
  N. S., *E*.
Cardium edule, *R*.*
Sphenia Swainsoni, *R*.

In the line of the Greenock and Glasgow railway a section has been made in a hill between Greenock and Port-Glasgow, which exhibits, in the descending order, the following beds:—

* A single fragment.

1. Vegetable soil.

2. Coarse gravel, two feet.

3. Sand, ten feet. In these two I did not find any organic remains.

4. A series of thin beds of sand, gravel, and clay, full of sea-shells. In the course of two visits, I distinguished thirty-three species.

5. Diluvium, with boulders of unknown depth.

The shelly beds are about fifty feet above the level of the sea, but as it is a deep-water deposit, it indicates a much greater actual change of level. It will be observed by the subjoined list that the shells agree in a remarkable manner with those found in the Island of Bute, and differ in as great a degree from those of the adjoining sea marked *R*.

Cyprina Islandica.
Crassina Garensis, *R*.
multicostata, *E*.
Tellina Proxima, *E*.
Pecten Islandicus, *E*.
Natica glaucinoides, *E*.
clausa, *E*.
Balanus costatus.
Turbo littoreus *R*.
expansus, *E*.
canalis.
Modiola vulgaris, *R*.
Nucula oblonga.
minuta, *R*.
gibbosa, *E*.
Saxicava rugosa, *R*.
N. S., *E*.
Trochus inflatus, *E*.
Mya truncata, *R*.
N. S., *E*.
ovalis.
Cardium edule, *R*.
Anomia Ephippium, *R*.
Patella Virginea, *R*.
Fissurella Noachina, *R*.
Fusus Banffius.
Peruvianus, *E*.
turricolus, *R*.
discrepans.
Buccinum undatum, *R*.
Mactra striata, *E*.
Lucina undata.
Amphidesma prismaticum.

I have lately, through the kindness of Professor Jameson, had an opportunity of submitting the unknown shells to M. Deshayes. He observes that these formations are to Great Britain and Ireland, what those of Palermo are to Sicily, and correctly supposes that they contain a large proportion of the shells which still live on our shores; his remarks on the particular shells have been added to the descriptions which accompany the catalogues. It will be observed, that the whole of those examined by him which are still to be found recent, but not in the British seas, occur in northern latitudes. This strongly confirms an opinion I had previously entertained, that the indications of climate which could be gathered from the organic remains of these deposits pointed to a lower temperature than that of the present period. It was first suggested by observing the identity of many of the shells most common in them, with those found by Mr Lyell at Udevalla, and figured in his paper of the elevation of land in Sweden, in the Philosophical Transactions for 1835. Mr L. has since pointed out to me the *Fusus Peruvianus* of Lamarck, as still inhabiting the Arctic Seas. I have also had an opportunity of shewing these shells to Mr Gray of the British Museum; on a cursory examination he could not detect any of them as British, but remarked that they had all the appearance of Arctic shells. In the Clyde-raised deposits, shells common to Britain and the northern parts of Europe occur in much greater abundance than they do at present. The *Pecten Islandicus*, which has probably entirely disappeared, and the *Cyprina Islandica*, which, if found recent in the Clyde, is extremely rare, are amongst the most common of the fossil species.

We know too little of the *Flora* of this period, to be warranted in drawing any inferences respecting climate from it; but the plants known to belong to it are all, such as would agree with a lower temperature, and the Scots fir, now only indigenous in the north of Scotland and Norway, occurs in the sub-marine forests of Wales and Hampshire.

There are, however, some of the fossil shells which have been supposed to lead to conclusions of an opposite nature.

Amongst the fresh-water fossil shells, Mr Sowerby has observed, that the *Cyrena Trigonula** resembles one from the Canal of Alexandria, and another resembles the *Unio Littoralis*,† a recent shell from Auvergne; he has, however, pointed out differences which shew that they are not of the same species, and therefore furnish no evidence respecting climate. Mr Murchison has also found two extinct shells, an *Oliva* and *Bulla Ampulla*, which he thinks give indications of a warm climate.‡ But as the *Oliva* has not been identified with any recent species; the same observation applies to it as to the *Unio* and *Cyrena*.§ The *Bulla Ampulla* occurs in the Indian Seas; but, according to Deshayes,‖ it is also to be found in the European Seas. The preponderance of evidence is therefore clearly in favour of the supposition that the climate was, if any thing, colder than it is at present. It appears to me that we have similar evidence respecting that of Sicily during the newer pliocene period. According to Dr Phillippi,¶ out of ten of the fossil shells which still exist in a recent state, but not in the Mediterranean, there is one which belongs to the Red Sea, all the others are to be found in the more northern parts of Europe. According to Deshayes** twenty-seven belong to a northern, and three to a southern latitude. Slight alterations of climate are easily explained; there is ample proof of extensive changes of level having taken place in America

* Figured and described, Nat. Hist. Mag. vol. vii. p. 275; also in Lyell's Elements of Geology, p. 60, fig. 24.

† The recent shell is figured in Lyell's Elements, p. 61, fig. 27. The fossil in the Nat. Hist. Mag., Oct. 1838, p. 548.

‡ Silurian System, p. 534.

§ See note on this shell in catalogue.

‖ Vide Tables of Tertiary Shells, appended to Lyell's Geology, vol. iii. 1st edition, p. 18.

¶ Enumeratio Molluscorum Siciliæ, 4to, Ber. 1836.

** Tables of Tertiary Shells.

in times which, geologically speaking, are extremely recent; such a change as would send the gulf stream to the south of the line, or into the Pacific, would necessarily reduce the temperature of our seas, and account for the Arctic character of the shells.

The evidences of depression furnished by the terrestrial deposits, which have been called submarine forests, are not less conclusive than are those of elevation derived from the marine beds. They occur on the west coast, in the Western Islands, the Orkneys, and in several points of the east coast of Scotland. The most extensive is that of the basin of the Tay, which has been described by Dr Fleming. It has been observed in detached portions for about ten miles on the south side of that river, and also on the opposite shore, and extends through the whole of Strathearn.† It may be described as a bed of peat containing stumps of trees in the attitude of growth, resting upon beds, apparently of marine origin, and covered by others *containing marine shells.* There can be no doubt, therefore, as to its relative age. In the statistical account of the parish of Longforgan,‡ we have the following interesting description of it. "By an examination lately taken at the Braes of Monorgan and Polgavie, where the river Tay has made its greatest encroachments, and where the banks are from 19 to 20 feet perpendicular height, the following strata can be distinctly traced. 1*st*, A brownish clay mixed with sand and vegetable earth, about 1½ foot deep, forming the present prolific upper surface. 2*d*, About 4 feet deep of a brownish free clay, with a proportion of sand, but no vegetable matter. The only difference between these two is probably owing to cultivation, manure, sun, and air. 3*d*,

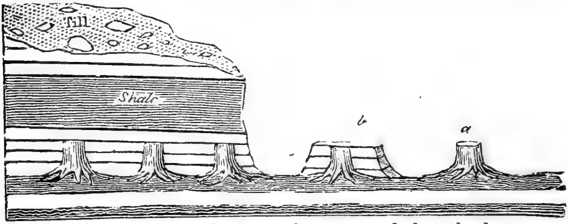
* Transactions of the Royal Soc. Edin. vol. ix. p. 419.
† New Stat. Acct. No. x. p. 60. ‡ Vol. xix. p. 556.

About 2 feet 3 inches of a poor yellowish clay without sand, *but mixed with cockle, mussel, and other marine shells*, but no vegetable substances. *4th*, A strong blue clay 3½ feet deep, *containing sea shells*, and roots of vegetables, the growth of which would seem to have been checked by the superincumbent stratum. *5th*, Also a strong blue clay with yellowish seams in it about 5 feet deep, and containing a much greater proportion of vegetable substances than the fourth stratum, but under like circumstances. The river rises to the surface of this stratum in stream-tides. *6th*, Three feet deep of the same kind of strong blue clay, mixed with more than double the quantity of vegetable roots than in the fifth stratum, but which also seems to have been borne down, and their vegetation extinguished by some superior pressure. These three are separated from each other by a small seam of sand and clay, which forms a pretty exact line of division, and through which the vegetable roots do not seem to have passed. *7th*, A real peat moss, near 4 feet deep, quite full of various kinds of vegetables, with roots, trunks, and branches of trees, the surface of which forms the bed of the Tay; in many places of which the moss can be distinctly traced perfectly entire, clean, and firm, without having received the least injury from the flux and reflux of the tide, and out of which at other places great quantities of peats have been dug at different periods, and are so still. It is very remarkable that, in this stratum, many roots of large trees are to be found, principally alders and birch, at about 13 feet from each other, perfectly upright in the same situation in which the tree had originally grown,* with their ramifications extend-

* The phenomena of these beds, of comparatively modern date, are most instructive, and throw much light on those of the earlier formations. A fossil forest agreeing most perfectly with the one above de-

ed among the moss, and some of the smaller fibres penetrating the clay below. The trunks and branches of the trees, lying horizontally, are all fresh, and have the appearance of having been borne down, and laid flat by some powerful cause; and what is also very remarkable, many of the roots seem to have had their trunks cut off about six inches

scribed, is embedded in the sandstone of the coal measures in a quarry near Glasgow. As it is within two miles of my residence, I watched the progress of its being uncovered almost daily during the time the operations of the quarry were carrying on. They were abandoned, however, after at least a dozen of trees had been laid open, chiefly on account of the difficulty of extracting building stones from amongst their roots. The trees were necessarily destroyed as the work proceeded, but, at my request, Mr Black, the proprietor, was kind enough to order two of them to be preserved, one of them, *a*, with the roots laid bare, the other, *b*, enclosed in a mass of the stone, in which they



were embedded; the first has been since removed, but the latter remains, and the truncated ends of the roots may be observed on every side. The trees were as near each other as they could have grown, the roots branching naturally out, without fracture or disturbance; the trunks, about two feet above the roots, were overlaid by a bed of stone, through which they did not pass, over this was another of shale, at least 7 feet thick. We have here all the proofs of a tranquil submergence, probably in a sheltered lagoon. The trees have been sanded up about 2 feet from the original surface, and the upper part removed by natural decay or the force of the wind, and a stratum of sand superimposed; as the water deepened, the clay which now forms the shale has been deposited, just as sand-banks are at present forming in the shallows, and beds of clay in the deep water in the Firth of Clyde. Mr Edward Forbes has observed a fossil forest agreeing in all respects with the above, in the coal formation of the county of Fife. It is near Anstruther, and has been exposed by the action of the sea.

above the original surface. *8th*, Immediately below the peat moss, is blue clay, without any mixture, and no vegetable roots or substances.

A man now living, and 72 years of age, who has sunk 23 pit wells in several parts of the Carse, says, that after he penetrated the cultivated surface, he always found 10 feet of brownish clay without vegetable mixture, under that, blue clay with vegetable roots and *sea shells*, and generally at about 19 feet he found peat-moss from 3 to 9 inches deep, then blue clay again, with vegetable roots of different depths, from 9 inches to 6 feet, and *under that, about two feet deep of moss* again, composed of oak, fir, beech, and bogie wood. He has seen taken out of this moss, deers' horns, skulls, and other bones. Below this moss, he generally found blue clay and quicksand."

In the neighbouring parish of Newburgh,* a well has been lately dug, in which the following beds were passed through :

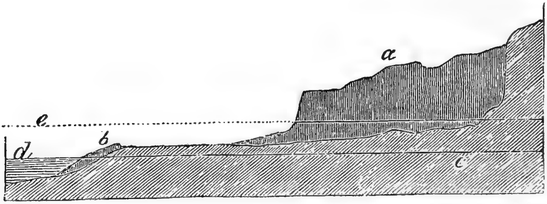
1. Carse clay, marine.
2. Peat-moss, (submerged forest).
3. Fine sand.
4. Till or diluvium, with boulders of unknown depth.

We have here the most direct proof of the place this ancient forest holds in the series of deposits, resulting from the last changes in the levels of the sea and land. It is to be regretted, that so little is yet known of its animal or vegetable remains ; but it is to be hoped, that a field so new, and so inviting, and which promises both to the Zoologist and Botanist so rich a harvest of discovery, will, ere long, attract well qualified observers.

In my last paper, I offered some remarks on the immense

* New Stat. Acct. No. x. p. 60.

length of time which it must have taken to form the ancient cliffs and terraces, compared with that which has elapsed since the sea became stationary at its present level. I have since endeavoured to form something like an estimate of the duration of these two periods, by comparing the extent of the projection of the whin dykes which stand out both from the ancient cliff, and from that which is now forming. I found, upon measuring that part of the dyke which projects from the inland cliff, that it extended 208 feet from it, whilst it only extended 13 feet from the present. Hence, it must have taken sixteen times as long to wear away the sandstone in which the dyke has been formerly embedded, in the former period of repose than in the present one. In the annexed diagram, *a* represents the ancient whin dyke, *b* the present one, *c* the former, and *d* the present sea-level.



We have here an opportunity of comparing a minute fraction of geological time with a very long one of historical time, or rather with one of which the whole of historical time is but a part,—probably a small part.

I am aware that numerical results drawn from a single observation of this nature, must be liable to great errors. But I have had no opportunities of multiplying them since this mode of comparison occurred to me, and I give it merely for the purpose of shewing how such observations may be made. I am convinced, however, that the disproportion will be found to be no less than the one above stated; and that by a careful examination of these dykes, which afford, as Dr MacCulloch remarks,* the most perfect record which geology furnishes of the wasting action of the sea, we may even attain something like an estimate of the actual time which has elapsed during their formation. Could we ascertain the rate of the wasting action of the sea, and the extent of rock removed by it, we should have the answer at once. I do not despair of arriving at a proximate value of both these elements of the calculation. In the example I have given, we have ocular evidence that the sea, when it stood at its former level, must have removed upwards of 400 feet of the sandstone rock; to this must be added the amount of what has been wasted since the sea stood at its present level. This, however, cannot be much, judging from the relative dimensions of the outstanding dykes. It will be seen that the waste of sandstone on the remaining part of the platform is not quite double that of the trap; if we assume that it has been a little more, and take 420 feet as the amount removed, at the same rate we have $26\frac{1}{4}$ feet the amount removed by the sea at the present level. This agrees very well with the shape of the ground, and is probably not far from the truth. With regard to the rate at which the sandstone of Cumbra yields to the wasting process which is continually acting, all I can say is, that it is too slow to be perceptible in the lifetime of one generation. I can appeal to my own recollections of these rocks for nearly half a century, and, except in one instance, can observe no change in their form. The one I allude to, is vividly impressed on my memory as

* MacCulloch's Western Islands.

the favourite scene of boyish amusement. I can perceive that the sea has not beat against it so long in vain; one part of it was hewn into a particular shape, the projecting corners of which are worn away, but in the body of the rock itself, no trace of loss can be perceived. A flight of steps near this have lost none of their perpendicularity, and some millstones which have formed part of a break-water for at least a century, have apparently lost none of their original thickness. The rate of waste in this locality is therefore extremely slow; but as, both from the nature of the rock, and the moderate force of the sea in a narrow sound, it must be very regular, were the spots where such observations are made carefully marked, future observations might afford something like a measure of the time requisite for producing such effects.

I formerly expressed an opinion that some change had taken place in the testaceous fauna of Britain since the last alterations of the sea-level, and that, although a large proportion of the shells were identical with those of the present epoch, some of them had become extinct. I am confirmed in this opinion, both from the observations I have since made, and from those of others. Professor Phillips states, that "among a dozen or twenty shells in the gravel of Holderness, one extinct species is met with."* On the coast of Wexford, Mr Griffiths found shells of existing, and also of extinct species, some of which appeared to correspond with those of the crag.† Mr Woodward marks the Buccinum granulatum, an extinct crag-shell, amongst the fossils of the brick-earth in Norfolk which belongs to this formation;‡ and Mr Murchison, amongst sixteen species of

* Treatise on Geology, vol. i. p. 299.
† Proceedings of Brit. Assoc. 1835.
‡ Woodward's Geology of Norfolk, p. 36.

marine shells discovered by him, found one which appears to be extinct, and one which is not known as an inhabitant of the British seas.*

It appears that a similar proportion of recent and extinct species is found to exist in the land and fresh-water shells as amongst those of the sea. The labours of Messrs Strickland, Wood, Morris, and Brown, have thrown much light upon the lacustrine and fluviatile deposits of this period. Mr Strickland found in the gravel of the valley of the Avon, amongst 24 species of shells, three which were extinct.† Mr S. V. Wood in Suffolk, one extinct, Cyrena trigonula, and two about which he was doubtful.‡ Mr Brown discovered one at Gosford in Essex;§ and Mr Morris, in describing a fresh-water deposit at Grays in the same county, observed, that though many of the shells are identical with recent ones, some few species are certainly different.|| Making every allowance, therefore, for the chances of future discovery, or for the difference of opinion of conchologists as to species, we must admit that some change has taken place in the testacea. A much greater one must, however, have taken place amongst the mammalia of the same period, of which by far the greatest number appear to have become extinct. In Scotland, the remains of the elephant, the stag, and the fallow deer,¶ all probably of extinct species, have been found in the diluvial drift or till, and in marl-

* Silurian System, p. 533.

† Silurian System, p. 555—Geol. Proc. vol. ii. p. 111.

‡ Nat. Hist. Mag. vol. vii. p. 274. § Ib. vol. ix. p. 431.

|| Ib. vol. ix. p. 264.

¶ The elephant has been found in the till on the line of the Union Canal, Wern. Mem. vol. iv. p. 58; in the parish of Kilsyth, (Stat. Acct. vol. xviii. p. 233); at Kilmarnock, the remains of which are preserved in the Andersonian Museum, Glasgow; and at Kilmaurs, associated with sea-shells, and with the horns of the deer and fallow-deer, all apparently of extinct species, they are preserved in the Hunterian Museum.

pits or marine beds, those of the rhinoceros,* the Swedish elk † (*Cervus alces*), and the Irish elk ‡ (*C. Megaceros*). It may be questioned, however, whether either of the elk species belong to the tertiary epoch. But, although, in this as in many other cases, it may not be possible to say whether certain deposits belong to the present or the tertiary periods, in theory the line of demarcation is an obvious one, viz. the difference of organic life.

The creation of man, apart from all other considerations, and regarded merely as a physical event, effected a change in the fauna; and as it is the latest with which we can be cognisant, it forms the boundary between the two periods. But, in practice, the mere absence of a single species may often lead to erroneous inferences. The earth was probably tenanted by man long before he became an inhabitant of these Islands; and therefore, the absence of his remains, or of works of art, is not of itself a proof that a deposit does not belong to the recent period.

Mr Lyell informs me, that, in future editions of his work, he means to extend the term "recent, so as to comprehend every deposit in which all the fossil-shells are of recent or living species, whether such strata can be shewn to belong to the historical period or not. This modification of my former arrangement will be found more convenient in practice, because all the subdivisions, the eocene, miocene, pliocene, and recent, will then be founded on purely conchological considerations. If any of the species of shells are extinct, even the smallest proportion, I term the strata newer plio-

* Notices of the rhinoceros in Scotland, will be found in the Wern. Mem. vol. iv. p. 582, and vol. v. p. 573. Additional notices will be found in the controversy between Drs Fleming and Buckland, respecting the animals extirpated by man, or destroyed by the deluge. Edin. Phil. Journal, vols. xi. and xii.

† There is a head and horns of the elk from a marl-pit in Perthshire preserved in the Hunterian Museum.

‡ Vid. New Stat. Acct. Ayrshire, p. 353.

cene." There can, I think, be no question as to the practical convenience of this rule, in judging of the age of a deposit. If the distinction of the tertiary beds, and those now forming, depends upon the difference of organic life, and I know of no other, and if we find a perceptible difference amongst the testacea, we may conclude *a fortiori* that there must be one still greater amongst the mammalia, because every observation hitherto made concurs in this. But whether we look to the absence of human remains or works of art, the occurrence of extinct or unknown shells, or of extinct land animals, we must conclude, that the organic remains of the deposits I have been describing belong to a different zoological era from the present—to that which Mr Lyell has termed the newer pliocene.

I shall now briefly notice, in the ascending order, the different members of this deposit as they occur in the central district, or great coal-field of Scotland.

Resting immediately on the carboniferous strata, we find,

1*st*, The stratified alluvium formerly mentioned as occasionally to be met with under the till. It consists of beds of sand, gravel, and clay, and is apparently of marine origin. No organic remains have yet been found in them, but they seldom occur in beds of pure sand or gravel such as these, and there are only a few insulated patches, the remains evidently of the alluvial covering, which has been removed by the same cause which lodged the till or diluvium on the surface.

2*d*, The diluvium or till.*

* For accounts of the diluvial deposits in Scotland, see Mr Bald's description of it, under the name of the old alluvial cover, in his observations on the coal-formation of Clackmannanshire, Wern. Mem. vol. i. p. 481, and vol. iii. p. 105, and in his notice of the fossil elephant, ib. vol. iv. p. 58. See also Colonel Imrie's paper on the geology of the Campsie Hills, in which there is an excellent description of the grooves

3d, Alluvial beds similar to No. 1 ; I have no doubt they will prove of marine origin, but no organic remains have yet been noticed in them.

4th, The submarine forests.

5th, The elevated marine beds described in this and the former paper.

Above these we find fresh-water deposits, chiefly lacustrine, containing, along with the bones of the existing races of mammalia, those of the common and fossil elk and the beaver ;† but with no such difference in the fauna as described by Mr Strickland. We cannot, therefore, in Scotland, as yet, separate them from the recent period.

and scratches caused by it, on the upper surface of the trap-rocks. Wern. Mem. vol. ii. p. 35.

Sir James Hall's papers on the revolutions of the earth's surface in the 7th volume of the Transactions of the Royal Society of Edinburgh, page 150, contain not only a most accurate and elaborate account of the "Diluvian facts in the neighbourhood of Edinburgh ;" but also, in my opinion, the most satisfactory explanation. He adopts the suggestion of Pallas, that it was owing to submarine volcanic action, and in the true spirit of philosophic induction, sought in the recorded accounts of violent earthquakes for causes which could produce similar effects ; not indeed of the same magnitude, but of the same nature, whilst, at the same time, he tested these by actual experiments. By explosions under water he produced waves resembling those which so frequently accompany earthquakes, and justly observes that "no limits could well be assigned to the magnitude to which such a wave might reach."

We are indebted to Sir Woodbine Parish for collecting the historical notices of the marine inundations which have accompanied earthquakes on the coast of Chili and Peru, and it is impossible to examine the original authorities without seeing in them causes capable of producing effects analogous to those presented by diluvium. Acosta, after describing the earthquake of 1686, observes, that "it caused the like trouble and motion at sea, as it had done at Chili, which happened presently after the earthquake, so as they might see the sea furiously to flie out of her bounds, and to run near two leagues into the land, rising above fourteen fadome."

In Mr Milne's paper on the coal-fields of the Lothians, there is an elaborate account of it under the name of boulder clay ; and also in Mr M'Laren's geology of Fife and the Lothians.

† See Dr Neill's paper on the beavers of Scotland, Wern. Mem. vol. iii. p. 207.

It is quite obvious that no single movement of elevation or of depression can account for the phenomena presented by these beds of marine or terrestrial origin. We find indisputable traces of several; some of them separated by long intervals of time. But however numerous the changes, however vast the intervals, they form but one page in the voluminous history of the earth which geology unfolds. That page has been but just opened, and the few feeble characters inscribed upon it by so early a labourer, must be necessarily imperfect.

In drawing up the following catalogues, I have adopted the arrangement of Lamarck as the one most generally known, only adding genera from other authors when necessary to include new species. I am aware that, by adhering perhaps too closely to this rule, I have in some instances separated species which ought to have been classed together. But my object being altogether geological, viz. the comparison of the ancient and modern deposits, I was anxious to make no change which could be avoided. I have, however, separated the land and fresh water shells from those of the sea, because it is only amongst the latter class that the comparison in the present instance can be of any value. The marine catalogue contains all the British newer pliocene shells hitherto discovered; but as a very large proportion of them occur in the basin of the Clyde, and as the localities of those which do not are marked, their insertion cannot be productive of mistakes. With the land and fresh water shells, the case is different; but few of the fossil ones have come under my notice, or been found in the districts to which my observations have been chiefly confined, and none which differ from the known species. I have inserted them therefore with some hesitation, for the purpose of rendering the catalogues more complete.

I have to acknowledge my obligations to several distinguished conchologists for the valuable assistance they have afforded me, in an investigation in which so much depends on the accurate distinction of species. To Thomas Brown, Esq. I am indebted for the figures and descriptions of Plate I, and to Mr Edward Forbes for those of Plate II. To Mr G. B. Sowerby I have also to express my thanks for the readiness with which he has aided me in my researches; and to the Rev. Mr Landsborough for full and accurate lists both of the recent and fossil shells of his parish and neighbourhood.

The second or fossil catalogue contains the names of all the shells hitherto discovered in the newer pliocene deposits of Britain, amounting in all to 273 species, of which 196 are marine, and 68 land and fresh water; 23 of the marine shells, and 6 or 7 of the land and fresh water, are not known as British; 15 of the marine shells appear to have become extinct, and 8 have been found recent in the Arctic Seas or northern shores of America. It will be observed, that some of them occur in the Crag and in the Sicilian raised deposits. I have in the preceding paper noticed the inferences to be drawn from these facts. It yet remains to be ascertained, whether the change in the testaceous fauna be as great in other localities as it is in the basin of the Clyde.

I.

CATALOGUE OF RECENT SHELLS IN THE BASIN OF CLYDE AND NORTH COAST OF IRELAND.

CONTRACTIONS.

Br.—Brown's Illustrations of British Conchology. 4to. Edin. 1827.

Fl.—Fleming's British Animals. 8vo. Edin. 1828. Article Conchology, Edinburgh Encyclopædia, and paper on Deluge, Jameson's Journal, vol. xiv.

Lam.—Lamarck.

Pennant.—British Zoology, vol. iv. 4to. Lond. 1777.

Mont.—Montagu, Testacea Britannica. 4to. 1803.

Turt.—Turton, Conchylia Insularum Britannicarum. 4to. 1822.

Woodward.—Synoptical Tables of British Organic Remains. London, 1830; and Geology of Norfolk. London, 1833.

Philippi.—Enumeratio Molluscorum Siciliæ. 4to. Berl. 1836.

Dentalium entalis. Common.
glabrum. Bute.
Pectinaria Belgica. Ireland.
Terebella conchilega. Bute.
Medusa. Maybole.
Spirorbis nautiloides. Common.
spirillum. Ireland.
heterostrophus.
corrugatus. Bute.
Serpula vermicularis. Common.
lucida. North of Ireland.
spiralis. Bute, Ayr.
lumbricalis. Ireland.
tubularia. Common.
serrulata, *Fl.* Bute.
filograna. Ayr.
carinata, *Mont.* Bute.
granulata. Ireland.
lobata, *Mont.* Bute.
Vermilia triquetra. Common.
Coronula diadema. Adhering to a whale. Bute.
Balanus balanoides. Very common.
costatus. Clyde.
ovularis. Ireland.
communis. Common.
sulcatus. Ireland.
rugosus. Common.
Creusia verruca. Clyde.
Xylophaga dorsalis, *Fl.* In wood.
Anatifa lævis. Ireland.
striata. Adhering to ships' bottoms.
Teredo navalis. In wood. Ireland; Clyde.
Pholas dactylus. Clyde.
crispatus. Bute, Clyde, &c.
candidus. Loch Ryan, Ireland.
Solen siliqua. Common.
legumen. Ireland.
ensis. Bute, Clyde, &c.
vagina. Bute.
truncatus. Ireland.
pigmæus. Ireland; Bute.
pellucidus. Bute, Ayr.
antiquatus.
Mya arenaria. Common.
truncata. Common.
prætenuis. Bute, Ayr; Ireland.
suborbicularis. Clyde.
Sphenia Swainsoni. Clyde.
Tellemya ovata, *Br.* Bute.
Anatina declivis, *Turt.* (Mya, *Mont.*) Bute.
prætenuis.
villosiuscula, *Br.* Bute.
arctica, *Turt.* Bute.
Lutraria elliptica. Clyde.
compressa. (Mya, *Mont.*)
Mactra truncata. Bute.
subtruncata. Bute, Arran.
cinerea. Ayr.
solida. Bute; Ireland.
stultorum. Clyde; Ireland.
turgida, *Mont.* Ireland.
Amphidesma Boysii. Arran, Bute, &c.
pubescens, *Fl.*
tenue.

Amphidesma prismaticum. Ireland.
ovale. Ayr.
convexum. Ayr.
compressum. Ayr.
Corbula nucleus. Common.
cuspidata. Bute.
Saxicava rugosa. Common.
Venerupis perforans. Ireland.
Psammobia Ferroensis. Ayr, Bute.
costulata, *Turt.* Ayr.
Tellina tenuis. Clyde, Bute.
solidula. Common.
crassa. Ayr; Ireland.
donacina. Ayr, Arran, Clyde.
punicea. Arran, Cumbra.
depressa (squalida, *Mont.*). Ayr, Bute, &c.
fabula. Bute, Arran, &c.
vespertina, *Mont.* Loch Ryan.
Lucina undata (Venus, *Pennant*). Bute, Ayr.
flexuosa. Bute, Ayr.
radula (Tellina, *Pennant*). Arran, Ayr, &c.
Donax trunculus. Clyde.
striata, *Bryce.* Ireland.
Crassina (Astarte, *Sowerby*) Danmoniensis. Ireland; Bute.
Garensis (ovata, *Br.*) Clyde.
elliptica, *Br.* Clyde, Bute, &c.
depressa, *Br.* Clyde.
corrugata, *Br.* Clyde.
striata, *Br.* Bute.
scotica. Ayr.
Withami? N. S. Bute.*
Cyprina Islandica. Common.
Cytherea exoleta. Common.
lincta, *Fl.* Ayr.
Venus pullastra. Common.
virginea. Ayr, Bute, Clyde.
fasciata (Paphia, *Mont.*). Bute.
ovata, *Mont.* Common.
gallina (Ortygea, *Leach*). Common.
decussata. Clyde; Ireland.
cancellata. Ireland.
Venus dysera. Ireland.
reflexa. Arran.
laminosa. Ireland.
aurea. Ayr; Ireland.
ænea, *Fl.* Ireland; Ayr.
cassina. Ayr; Ireland.
rugosa (Ortygea, *Leach*). Ayr.
sulcata, *Mont.* Bute.
Prideauxiana. *Leach.*
Cardium edule. Common.
aculeatum. Common.
echinatum. Clyde.
fasciatum. Ireland.
exiguum. Ayr, Bute, Clyde.
ciliare. Bute.
lævigatum. Common.
medium. Ayr; Ireland.
nodosum.
elongatum.
Hiatella arctica, *Fl.* Bute.
Arca Noe. Ireland.
barbata. Ireland.
Pectunculus glycimeris. Ireland.
pilosus. Arran, Ayr.
Nucula rostrata. Clyde, Bute.
tenuis. Bute.
margaritacea. Common.
oblonga. Ayr. *Br.*
truncata. Ayr.
nitida, *Sowerby.* Bute.
Modiola Vulgaris. *Fl.* Common.
discors. Ayr, Arran.
discrepans. Clyde.
Mytilus edulis. Common.
pellucidus. Clyde.
Pinna ingens. Ireland.
Lima tenera. Arran.
fragilis. *Br.* Bute.
sinuosa. Bute.
vitrina. Ireland.
inflata. Ireland.
Pecten maximus. Ayr, Bute, Arran.
medius. Ireland; Bute.
opercularis. Common.
varius. Bute, Ayr, &c.
Jacobeus. Ireland.
Islandicus? Clyde, Bute.†
niveus. Cumbra.
obsoletus. Clyde, Bute, Ayr.
pusio. Clyde.
nebulosus,‡ *Br.* Bute.

* One valve of this shell was dredged in deep water in Rothsay Bay, apparently the same as that found by Mr Witham in Yorkshire, and figured in Fig. 24 and 25.

† I suspect this shell is only to be found in the ancient deposits.

‡ This shell was discovered by Mr John Blythe, Glasgow, and is described in the second number of the Edinburgh Journal of Natural History, p. 9. It is almost circular; ears nearly equal, with seven broad, unequal, flattish, ribs: margin crenated; inside white, with a pearlaceous lustre; about two inches in diameter.

Pecten Landsburgii.* Ayr, N. S.
Jamesoni, N. S. Bute.†
sinuosus. Bute, Ayr.
tumidus.
Ostrea edulis. Common.
parasitica. Bute.
Anomia ephippium. Common.
squamula. Bute.
undulata. Bute.
aculeata. Bute.
cylindrica. Port-Patrick.
Orbicula Norvegica (Discina ostreoides). Bute.
Terebratula aurita. Arran.
Chiton marginatus. Clyde, Ayr.
cinereus. Clyde.
ruber. Clyde, Ayr.
lævigatus (Latus, *Lowe*). Bute.
fuscatus. Bute.
lævis. Ireland.
fascicularis. Ireland.
Patella vulgata. Common.
virginea. Bute, Ayr ; Ireland.
cœrulea. Ayr ; Ireland.
Clealandi (clypeus, *Br.*) Ireland ; Bute.
pellucida. Ayr, Bute.
Forbesii. N. S.‡
Emarginula fissura. Ayr, Bute.
Fissurella Græca. Bute ; Ireland.
Noachina, *Sowerby ;* (Sipho striata, *Br. ;* Cemoria Flemingii, *Leach.*) Clyde, Bute.
Pileopsis Ungarica. Bute, Arran.
mitrula. Ireland.
Velutina lævigata. Bute, &c.
Bulla lignaria. Ayr.
akera. Ayr, Arran, Bute.
candida (Diaphana, *Br*). Bute.
obtusa. Ireland.
cylindracea. Cumbra.
Bullina minuta, *Beck.* Ayr.
Bullæa aperta. Ayr.
Natica glaucina. Ayr, common.
Montagui. Clyde.
Alderi, *Forbes.* Common.
pallidula. Ayr.
Ianthina communis. Loch Ryan.
Sigaretus haliotiodeus. Clyde.
Haliotis tuberculata. Ireland.
Tornatella tornatilis, *Fl.* Ayr.
fasciata. Ayr, Bute.
Pleurobranchus plumula. Maybole.
Scalaria communis (Clathrus, *Fl.*) Ireland.
Turtoni. Ireland ; Ayr, Bute.

Trochus ziziphanus. Clyde ; Ireland.
cinereus. Ireland ; Clyde, &c.
tumidus. Ireland; Bute, Arran.
magus. Bute, Arran ; Ireland.
umbilicatus. Common.
crassus. Cumbra.
exiguus. Ayr.
discrepans. Ireland.
albidus. Ireland.
interruptus. Ireland.
perforatus. N. S. plate, i. figs. 3, 4. Bute.
Martini.§ N. S. plate, fig. 26. Bute, Ayr.
Turbo littoreus. Common.
rudis. Common.
quadrifasciatus. Ayr.
subtruncatus. Ayr.
cingillus (Cingula, *Fl.*) Bute, Ayr.
labiosus. Bute.
interruptus. Clyde.
vinctus, *Mont.* Clyde.
costatus. Ireland.
olivaceus, *Br.* Bute.
neritoides. Common.
zic zac. Ireland.
pullus (Cingula, *Fl.*) Ireland, Port-Patrick.
vitreus. Ayr.
striatus. Arran.
plicatus, *Mont.* Bute.
Pyramis pallidus, *Mont.* Ayr.
striatulus. Ayr.
Cerithium elegans. Bute.
Skenea depressa, *Fl. ;* Helix D., *Mont.* Bute.
Cingula cimex. Ayr.
costata. Ayr, Bute.
striatula. Cumbra.
parva. Ayr.
calathisca. Cumbra.
alba. Ayr.
subumbilicata. Ayr.
punctura. Ayr.
labiata. Ayr.
Turritella terebra. Common.
Pleurotoma sinuosa, *Fl.* Ayr.
Fusus antiquus. Common.
turriculus. Clyde, Bute, Ayr.
corneus. Common.
Islandicus. Ireland.
purpureus. Arran, Ayr.
Banffius. Clyde, Bute.
linearis. Ayr, &c.

* *Vid.* plate ii. fig. 2. † *Vid.* plate ii. fig. 1. ‡ *Vid.* plate ii. fig. 3.
§ Discovered in Ayrshire by Major Martin, Mayville, for whom I have named it. I have since dredged up several specimens in the Firth of Clyde and the Kyles of Bute. *Vid.* plate , fig. 26, and description.

Fusus nebula. Clyde, Bute, &c.
Norvegicus. Bute.
septangularis. Ayr, Bute, &c.
costatus. Bute.
Boothii, *Br.* N. S. plate, fig. 1.
umbilicatus, *Br.* N. S. plate, fig. 2. Bute.*
Murex erinaceus. Bute, Ayr.
adversus. Cumbra.
reticulatus. Ayr.
Rostellaria pes-pelicani. Common.
Purpura lapillus. Common.
Buccinum undatum. Common.
macula. Common.
reticulatum. Ayr.
Anglicanum. Bute.
Buccinum hepaticum. Ireland.
carinatum. Bute.
Voluta bidentata, *Mont.* Bute.
denticulata.
Marginella voluta. Ayr.
Volvaria cylindrica. Bute, Clyde.
truncata. Bute.
alba, *Fl.*
Cyprea Europæa. Bute, Arran.
Miliola ovata. Bute.
Nautilus crispus. Bute.
Beccarii. Bute.
Octopus octopodia. Ayr.
Sepia officinalis. Ayr.
Loligo media. Maybole.

RECENT LAND AND FRESH-WATER SHELLS.

Cyclas cornea.
calyculata.
Pisidium obtusale.
amnicum.
pusillum.
Unio margaritifera.
elongata.
Anodon cygnea.
anatina.
Ancylus lacustris.
fluviatilis.
Limax agrestis.
cinereus.
Vitrina pellucida.
Helix nemoralis.
caperata.
hortensis.
fusca.
trochilus.
rufescens.
subrufescens?
paludosa.
hispida.
virgata.
radiata.
aspersa.
arbustorum.
ericitorum.
nitida.
sericea.
crystallina.
nitens.
fœtida.
umbilicata.
nitidula.
nitidosa.
cellaria.
Helix spinulosa.
concinna.
Pupa pygmæa.
bidentata.
quinquedentata.
sexdentata.
muscorum.
edentata.
Balea perversa.
Clausilia rugosa.
Bulimus lubricus.
acutus.
Succinea amphibia.
oblonga.
Auricula minima (Carycheum *Fl.*)
Planorbis vortex.
complanatus.
contortus.
spirorbis.
carinatus.
imbricatus.
nitidus.
umbilicatus.
albus.
Physa fontinilis.
hypnorum.
Lymnea limosa.
palustris.
fossaria.
auricularia.
putris.
octona.
ovata.
Valvata piscinalis.
Paludina impura.
vivipara. Ireland.
Neretina fluviatilis.†

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* This shell, which was exhibited to the Nat. Hist. section of the British Association, 1837, *vid.* 7th Report, p. 100, I am informed by Mr G. B. Sowerby, has since been found at Oban, by Mr Jeffreys, and named by him "Trichotropis acuminata."

† Found in a stream near Saltcoats, by Mr Stewart Ker.

II.

CATALOGUE OF SHELLS FROM THE NEWER PLIOCENE DEPOSITS IN THE BRITISH ISLANDS.

Dentalium entalis. Ireland.
dentalis. Banff.
striatum. Preston.
Spirorbis nautiloides. Ayr, &c.
corrugatus (Serpula, *Mont.*) Bute.
Serpula vermicularis. Common.
Vermilia triquetra. Common.
Balanus balanoides. Common.
costatus. Clyde.
communis. Common.
rugosus. Common.
punctatus. Ayr, &c.
tintinnabulum. *Robberd's Norfolk*, page 12.
Creusia verruca. Clyde.
Pholas dactylus. Ayr.
crispatus. Ayr.
Solen siliqua. Glasgow, Ayr, Clyde.
legumen. Ayr.
ensis. Ireland.
Panopæa Bivonæ, *Philippi*. Bute. plate ii. fig. 4.
Mya truncata. Common.
ovalis, *Turt.* Bute.
arenaria. Ayr, Clyde.
Margaritacea. *Devon.*
ferruginosa. Ireland.
Sphenia Swainsoni. Bute.
Tellemya tenuis, *Br.* Ireland.
Anatina convexa. Ireland.
ovalis (Mya, *Wood*). Ayr.
Lutraria elliptica. Ayr.
compressa. Forth, York.
Mactra truncata. Ayr, Forth.
subtruncata. Ayr, Forth.
solida. Forth, York, Preston.
stultorum. Forth.
triangularis, *Mont.* Ireland.
elliptica. Ayr.
striata. Ayr. N. S. plate, fig. 22.
Amphidesma Boysii. Dalmuir.
prismaticum. Greenock.
Amphidesma convexum, *Fl.* Ireland.
compressum, *Fl.* Ireland.
depressum. York. — *Phillip's Geol.*
Corbula nucleus. Ayr, Forth.
Saxicava rugosa. Glasgow, &c.
Saxicava pholadis. Dalmuir, Clyde.
nondescript. N. S. Bute.*
Venerupis perforans. Forth.
Psammobia Ferroensis. Preston.
Tellina tenuis. Ayr, Dalmuir, Forth,
fabula. Devonshire.
solidula. Dalmuir.
crassa. Ayr.
donacina. Banff.
proxima. N. S. plate, fig. 21.
Grœnlandica. Bute.
Lucina undata. Ayr.
flexuosa. Dalmuir, Clyde.
radula. Ayr.
Donax trunculus. Ayr.
Crassina Garensis. Common.
elliptica, *Br.* Dalmuir.
depressa. Dalmuir.
Scotica. Ayr, Banff.
minima, *Sowerby.*
sulcata.
multicostata,† *Br.* Common. N. S. pl. fig. 20.
Withami, *Br.* York. N. S. plate, fig. 24, 25.
Cyprina Islandica. Common.
Cytherea exoleta. Ayr, Dalmuir.
lincta. Dalmuir.
Venus pullastra. Clyde.
virginea. Ayr.
fasciata. Inch Marnoch.
ovata. Ireland.
gallina. Ayr.
decussata. Ayr, Paisley.
verrucosa. Ireland.
subrhomboidea. Forth.
dysera. Ayr.

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* This shell is much larger and less irregularly wrinkled than the S. rugosa.

† Mr Ed. Forbes considers this a variety of C. compressa.

Venus rugosa.
Cardium edule. Common.
aculeatum. Ayr, Forth.
echinatum. Ireland; Forth, Preston.
exiguum. Common.
tuberculatum. Worcestershire.
lævigatum. Ayr.
nodosum. Ireland.
Kellia suborbicularis.
Arca lactea. Forth.
papillosa, *Br.* Ireland. N. S. plate, fig. 19.*
Pectunculus glycimeris. Ireland.
pilosus; (arca, *Mont.*)—Ayr; Ireland.
Nucula rostrata. Common.
oblonga, *Br.* Ireland.†
tenuis. Paisley, Dalmuir.
margaritacea. Ireland; Forth, Ayr, &c.
gibbosa. N. S. plate ii. fig. 10.
minuta. Dalmuir, Paisley, &c.
Modiola vulgaris. *Fl.* Common.
discors. Ayr.
Mytilus edulis. Common.
Pecten maximus. Ayr; Forth.
opercularis. Paisley, Ayr.
varius. Ayr; Ireland.
Islandicus. Common.
obsoletus. Lochlomond.
pusio. Ireland; Clyde.
Ostrea edulis. Common.
Anomia ephippium. Common.
squamula. Ayr; Ireland.
undulata. Ayr, Clyde, &c.
aculeata. Ayr; Ireland.
Patella vulgata. Common.
virginea (parva, *Mont.*). Common.
cœrulea. Ireland.
pellucida. Dalmuir, Ayr; Ireland.
lævis. Banff.
Fissurella græca. Ireland; Clyde, &c.
Fissurella noachina, *Sowerby;* (Sipho striata, *Br.;* Cemoria Flemingii, *Leach.*) Common.
Emarginula fissura. Ireland.
Velutina lævigata, *Br.*
undata, *Br.* N. S. plate i. fig. 15. Clyde.
Bulla obtusa.
ampulla (*Murchison*).
Natica glaucina. Ireland; Lochlomond.
Alderi. *Forbes.* Common.‡
pallidula—Brick earth, Norfolk. *Woodward.*
clausa, N. S. plate, fig. 16. Dalmuir.
glabrissima. Ireland.
glaucinoides. Bute.
Bulbus Smithii, *Br.* Helensburgh. N. S. plate, fig. 18.
Trochus ziziphanus. Ireland.
cinerarius. Common.
tumidus. Dalmuir.
magus. Ireland.
umbilicatus. Ireland.
crassus. Paisley.
tenuis. Ireland.
inflatus, *Br.* N. S. plate, fig. 10, 11.
Margarita. Dalmuir, *Thomson's Records of Science*, vol. 1, page 133.
Turbo littoreus. Common.
rudis. Common.
quadrifasciatus. Ayr, Clyde.
subtruncatus. Ireland.
cingillus. Ireland.
interruptus. Ireland.
rugosus. Ayr, Dalmuir.
politus. Ireland.
unifasciatus. Ireland.
neritoides. Common.
expansus, *Br.* N. S. Dalmuir, plate, fig. 12, 13.
pullus. Ireland.
vinctus. Dalmuir. Bute.
Phasianella canalis, *Br.* Dalmuir.

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* Mr Edward Forbes considers this as the young of the A. tetragona of Turton; but it differs much in size and appearance, both from the figure given by him in his Malacologia Monensis, and by Turton in his British Bivalves.

† This shell, found by Captain Portlock in stratified beds in Ireland at an elevation of 400 feet above the level of the sea, he considers to be an unknown species.

‡ I observed a specimen of this shell in the museum at Newcastle, erroneously named N. pallidula, from the brick-earth, Norfolk. It is described and figured by Mr Forbes, Malacologia Monensis, p. 31, pl. 11. fig. 6, 7.

Pyramis discors, *Br.* Ireland.
crystallinus, *Br.* Ireland.
Cingula cimex. Ireland.
costata. Ireland.
ulvæ. Ayr, Clyde, &c.
calathisca. Wigton.
striata. Ireland.
semi-costata, *Fl.* Ayr.
ventricosa, *Fl.* Dalmuir.
Rissoa fallax,* *Br.* Ireland. N. S. plate, fig. 7, 8.
Turitella terebra. Forth, Ayr.
cingulata.† Glasgow.—Plate, fig. 23.
Fusus antiquus. Common.
turricolus. Clyde.
corneus. Ireland.
purpureus. Ireland.
Banffius. Common.
linearis. Ireland.
discrepans, *Br.* Dalmuir.
discors, *Br.* Ireland.
Peruvianus, *Lam.* (lamellosus, *Sowerby.*) Dalmuir. Plate, fig. 5, 6.
Murex erinaceus. Ireland; Clyde, &c.
tubercularis, *Mont.* Ireland; Clyde.
adversus. Ireland.
muricatus. Ireland.
reticulatus, *Mont.*
Rostellaria pes-pelicani. Dalmuir.
Purpura lapillus. Common.
Buccinum undatum. Common.
macula. Common.
reticulatum. Ayr; Ireland.
Anglicanum. Preston.
minimum. Ireland.
costatum. Ayr.
striatum, *Sowerby.* Dalmuir. N. S. plate, fig. 9.
granulatum—Brick earth, Norfolk. *Woodward.*‡
Nassa Monensis, *Forbes.* N. S.§
Volvaria cylindrica. Clyde.
Cyprea Europæa. Ireland.
Oliva. N. S. (*Murchison.*) Siluria.‖
Nautilus Beccarii.

LAND AND FRESH-WATER SPECIES.

Cyclas cornea. Stutton, Grays; Ayr.
amnica. Cropthorn.
obliqua. Stutton.
pusilla. Stutton.
Henslowana. Cropthorn.
Cyrena Trigonula (*Wood*). N. S. Grays, Stutton. *Nat. Hist. Mag.* vol. vii. p. 275, fig. 45. *Lyell's Elements*, p. 60, fig. 24.
Unio ovalis. Cropthorn.

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* "Rissoa fallax appears to be a Melania, of the sub-genus Eulima."—*Ed. Forbes.*

† Only one broken fragment of this shell has been discovered, in a brick-field, near Glasgow. I am doubtful, however, as to its being a fossil, as it was given to me by a person who may have found it accidentally, or have deceived me. None of the other unknown species are doubtful in this respect.

‡ This shell, found in the brick earth of Norfolk, which undoubtedly belongs to this formation, is a crag fossil, Sowerby, Min. Con. t. 110, f. 4. It is given from the Tables of Organic Remains in Woodward's Geology of Norfolk.

§ Found in an elevated marine deposit in the Isle of Man, by Mr Edward Forbes. It differs from the N. macula in having the spire less produced, the body whorl much more ventricose, and the longitudinal ribs fewer; it appears intermediate between the N. macula and N. ambigua.

‖ The only specimen of this shell has unfortunately been lost. From a sketch from memory sent to me by Mr Strickland, it appears to have been nearly an inch long. I suspect that both Testacea and Zoophytes, notwithstanding their limited powers of locomotion, are occasionally drifted from distant seas to our shores, probably entangled in floating substances. The Rev. Mr Landsborough has found, on the shores in his parish, Bulla striata and Nerita peleronta, and fragments of Transatlantic coral, both on the present sea-beach and in the ancient deposit; and he has in his collection a Littorina Peruviana, found by Dr Curdie on the Island of Gigha, and Oliva nana, a West Indian species, found by Miss H. Carmichael on the shore at Cumbra. The Oliva mentioned by Mr Murchison may therefore have been a straggler, and not a native of the British Seas.

Unio pictorum. Grays, &c.
antiquior (*Strickland*). N. S. *Murchison*, p. 555.
N. S. (*Morris*). Gray's, Erith. *Nat. Hist. Mag.* Oct. 1838. p. 548, fig. 27.
? (*Wood*). Stutton. *Nat. Hist. Mag.* vol. vii. p. 275.
Anodon cygnea. Gray's, &c.
anatinus. Cropthorn.
? Stutton, Suffolk. *Nat. Hist. Mag.* vol. vii. p. 275.
Ancylus lacustris. Cropthorn.
fluviatilis. Cropthorn.
? N. S. (*Morris*). Grays. *Nat. Hist. Mag.*
Limax agrestis. Maidstone.
Pisidium amnicum. Grays, &c.
Helix nemoralis. Bielbecks, Yorkshire, Port Rush.
caperata. Bielbecks.
hortensis. Stutton.
fusca. Stutton.
trochilus. Maidstone.
rufescens. Stutton.
paludosa. Stutton.
hispida. Maidstone.
virgata. Cropthorn.
radiata. Maidstone.
peregra. Thames.
complanata. Thames.
lucida. Stutton.
pura. Maidstone.
trochiformis. Thames.
pulchella. Cropthorn.
Pupa pygmæa. Cropthorn.
sexdentata. Stutton.
marginata. Stutton, Grays, &c.
Clausilia perversa. Port Rush.
Bulimus lubricus. Stutton.
Succinea amphibia. Stutton, Grays.
Succinea oblonga. Stutton, Ilford.
Auricula minima (Carychium *Fl.*) Stutton, Grays, &c.
Planorbis vortex. Stutton, Erith.
complanatus. Cropthorn.
contortus. Stutton.
spirorbis. Bielbecks.
carinatus. Stutton, &c.
imbricatus. Stutton, Cropthorn.
nitidus. Bielbecks.
corneus. Stutton, Ilford, &c.
lateralis (*Strickland*). N.S. *Murchison*, 555.
Lymnea limosa. Bielbecks.
palustris. Stutton, &c.
fossaria. Stutton.
auricularia. Stutton, &c.
peregra. Stutton, &c.
glutinosa. Copford.
auricularia. Cropthorn.
stagnalis. Copford.
Valvata piscinalis. Sutton, Cropthorn, &c.
cristata. Stutton, &c.
——— ? N. S. (*Brown*). Copford. *Nat. Hist. Mag.* vol. ix. p. 431.
antiqua. N. S. (*Morris.*) Grays. *Mag. Nat. Hist.* vol. ix. p. 264.
Paludina impura. Stutton, &c. *Ib.* Oct. 1838, fig. 26. *Lyell's Elements*, p. 62, fig. 34.
impura ? Grays. *Nat. Hist. Mag.* Oct. 1838, 544.
minuta (*Strickland*). N. S. *Murchison*, 555.
N. S. ? (*Brown*). Copford. *Nat. Hist. Mag.* vol. ix. p. 431.

MARINE SHELLS FROM THE NEWER PLIOCENE DEPOSITS, WHICH HAVE NOT BEEN FOUND IN A RECENT STATE IN THE BRITISH SEAS.

Fusus Peruvianus. Arctic Seas; Crag.
Natica clausa. Arctic Seas.
glacinoides (*Sowerby*). Crag.
Turbo expansus. Arctic Seas; North coast of America.
Bulla ampulla ? (*Murchison*).* Sicilian Pliocene.
Velutina undata. Arctic Seas.
Bulbus Smithii. Sicilian Pliocene.
Buccinum granulatum (*Woodward*).† Crag.

* Silurian System, page 533.

† Geology of Norfolk, page 36.

Panopæa Bivonæ. Crag; Sicilian Pliocene.
Crassina multicostata. Arctic Seas.
Tellina proxima. Arctic Seas.
Mya (*Sowerby*).* Arctic Seas; North coast of America.
Pecten Islandicus. Arctic Seas; North coast of America.
Buccinum striatum (*Sowerby*).†
Rissoa fallax.
Trochus inflatus.
Arca pappilosa.
Crassina Withami.
Mactra striata.
Nucula gibbosa; Sicilian Pliocene?
Saxicava.
Nassa Monensis (*Forbes*).
Oliva (*Murchison*).‡

RECENT SHELLS OF NEW SPECIES, FROM THE FIRTH OF CLYDE.

Pecten Jamesoni. Bute.
  Landsburgii. Bute, Ayr.
Trochus Martini. Bute, Ayr.
  perforatus. Bute.
Fusus Boothii. Bute.
  umbilicatus. Bute.
Patella Forbesii. Bute.
Crassina Withami. ? Bute.§

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* This Mya was considered by Mr Sowerby to differ in species from the M. truncata, both from the shape and muscular impression. Mr Lyell informs me he found it at Udevalla, and that it occurs both recent and fossil in the St Lawrence.

† Records of General Science, p. 134.

‡ Silurian System, p. 533.

§ A single valve of a new Crassina was dredged up in Rothsay Bay, agreeing in shape and size with one sent to me by Mr Witham from Yorkshire. *Vid.* pl. i. fig. 25. But the imperfect state of both the recent and fossil specimens renders their identity doubtful.

DESCRIPTION OF PLATE I.*

I. RECENT SHELLS.—NEW SPECIES.

1. FUSUS BOOTHII. N. S.—*Smith.*

Plate I. Fig. 1.

Shell strong, with eight deeply defined, well rounded volutions, tapering to an acute apex, provided with numerous slightly oblique, strong, longitudinal ribs, which, together with the interstices, are crossed by close-set, strong, spiral striæ, between most of which are finer striæ, giving the shell a lamellated aspect; suture of the spire broad, concave, and not crossed by the ribs, but spirally striate; aperture oblong-ovate, a little narrowed above, smooth, white, and furnished with two longitudinal, purple belts, leaving the margin next the outer lip white; pillar-lip white, smooth, with a slight longitudinal groove near its external margin, and furnished with a brownish-purple spot above; outer lip thick, flattened on the edge, with a zigzag groove in its centre, and a slightly rounded sinus above, at its junction with the body; outer margin crenated; canal short and wide; external surface of a deep chocolate-brown; length five and a half eighths; breadth somewhat more than a quarter of an inch.

This beautiful shell was dredged in Rothesay Bay, by James Smith, Esq. of Jordanhill, and, with it, the fragments of a shell of the same species, measuring upwards of three-eighths of an inch in diameter, so that this shell must attain the size of nearly an inch.

It differs from *Fusus purpureus* in having fewer volutions, in the spire being shorter, and not quite so taper, in the thickness and character of the outer lip, and in being destitute of the striæ inside the aperture.

Named in honour of Henry Gore Booth, Esq. In the Andersonian Museum, Glasgow.—*B.*

2. FUSUS UMBILICATUS. N. S.—*Smith.*

Plate I. Fig. 2.

Shell with seven, turreted, deeply-defined volutions, tapering abruptly to an acute apex; volutions obliquely flattened above; body provided with seven strong, transverse ribs, and the volutions of the spire with three each; ribs and interstices crossed by fine, oblique, longitudinal striæ, which are hardly visible without the aid of a lens;

* The descriptions marked *B*, I owe to Mr T. Brown, and those marked *F*, to Mr Edward Forbes.

aperture semi-ovate; pillar-lip broadly reflected on the columella, behind which is an elongated umbilicus, extending nearly to the base of the shell; outer lip thin and crenulated on the exterior margin by the ribs; length upwards of half an inch; diameter of body nearly three-eighths.—Dredged from deep water in Rothsay Bay, by James Smith, Esq.—*B.*

It has been since found by Mr Jeffreys at Oban, and named by him " Trichotropis acuminata."*

3. TROCHUS PERFORATUS. N. S.—*Smith.*

Plate I. Fig. 3, 4.

Trochus perforatus.—Brown's Illus. Conch. Britain and Ireland, 2d edition, p. 18.

Shell subconic, strong, with five slightly-raised volutions, terminating in an obtuse, perforated apex; whole surface invested by a thick, papillose, shagreen-like epidermis, of a brownish-drab colour, beneath which the shell is covered with strong, smooth, spiral striæ; colour of a greenish-ash, and ornamented by obliquely longitudinal, fine, reddish-brown lines; base of the body subcarinated, and a little rounded beneath; aperture subquadrangular, pearly within; inner lip thickened and slightly reflected over the umbilicus, which is small and penetrating to the apex; diameter at the base nearly six-eighths of an inch; height about five-eighths.

Dredged in deep water in the Kyles of Bute, by James Smith, Esq. of Jordanhill.

This shell was at first mistaken by us for a variety of *Trochus cinerarius,* but on closer examination we found it to possess very different characters. It differs from all the other British *Trochusidæ* in its being invested by a very thick epidermis; and its subcarinated form at the base, with the colour and character of its markings, and less intense by nacred reflections, distinguish it from *Trochus umbilicatus.* It is considerably more depressed than *T. littoralis.*"—*B.*

4. TROCHUS MARTINI. N. S.—*Smith.*

Plate I. Fig. 26.

Shell conical, sides of the volutions flat, well defined by the suture, and terminating in a fine pointed apex; the whole shell covered with five or six tuberculated spiral ridges, which can only be distinctly seen by the aid of a lens, the lower ridge of each volution being more prominent than the others; base imperforate, flat, and somewhat concave, furnished with numerous tuberculate, concentric

* An Trichotropis Borealis. Lowe. Zool. Journ. ?

ridges; surface citron or flesh-coloured, streaked with nearly equidistant, reddish-brown, irregularly shaped spots; aperture compressed and nacred within. Named in honour of Major Martin, Mayville, Ayrshire, by whom it was discovered.—*B.*

It has since been dredged by me in the Kyles of Bute; Mr Forbes has found it at the Isle of Man, and Mr Alder at Dublin.

II. NEW SPECIES FOUND IN THE NEWER PLIOCENE DEPOSITS.

1. BUCCINUM STRIATUM. N. S.—*Sowerby.*

Plate I. Fig. 9.

Buccinum striatum, Sowerby, Records of Gen. Science, vol. i. p. 134.

"Volutions longitudinally undulated, and transversely striated, and but slightly convex; the longitudinal ribs rather straight."

Distinguished from ***B. undatum*** by the following particulars.

"If the ***B. undatum*** be examined with a microscope, it will be found that the transverse ridges are elevated, broad, and distant, and there is between each of these ridges, in the upper whorls, a narrow and less elevated ridge, and in the lower or newer part of the shell generally about three. Now, in ***Buccinum striatum,*** the ridges are so flat that the shell may more properly be said to be spirally striated than covered, with transverse ridges. The whorls in the new shell are also much flatter than in ***B. undatum,*** and the longitudinal undations, which in that shell are considerably concave towards the mouth of the shell, are here almost quite straight."—***Sowerby.***

Found at Dalmuir by Thomas Thomson, Esq.

2. FUSUS PERUVIANUS.—*Lamarck.*

Plate I. Fig. 5, 6.

Fusus lamellosus, Sowerby, Rec. Gen. Sci. i. p. 133.

Shell strong, turreted, with six volutions flattened at top; spire abruptly tapering to an acute apex; the whole shell provided with broad, longitudinal, lamellar, unequally long ribs, which are thin, broadest above, and slightly inflected at the edges, terminating at the base of the body in front, and running to the point of the beak behind; aperture semi-ovate, rounded above and contracted below; canal of medium length, slightly twisted to the right; pillar-lip broad, white, and well defined, and replicate at its base; outer lip thin and slightly reflected; length an inch, breadth half an inch.

This is certainly not the *F. lamellosus* of Lamark, as it differs in the ribs being less numerous, and in their being more inflected.—*B.*

The above description of Mr Brown, applies to the shell in a young state, and it was named by him *Fusus imbricatus.* But the imbrications of the ribs disappear when the shell attains its full size, in which state it cannot be distinguished from the *F. Peruvianus* of Lamarck, or from the crag fossil of the same name. In Plate II. the shell is represented in its different states, fig. 5 to 9. It occurs in a recent state at the North Cape. M. Deshayes observes, that the name *F. Peruvianus* was given to it by Lamarck, in consequence of his ignorance of its habitat. It is never found in Peru. It also occurs in a fossil state in Sweden and Denmark.—*S.*

Found at Dalmuir by Thomas Thomson, Esq.

3. TURITELLA CINGULATA.

Plate I. Fig. 23.

Shell strong, taper; volutions but slightly elevated, each furnished with three strong, equidistant, depressed spiral ribs of a very deep chocolate or blackish-brown colour, with an intermediate reddish-brown, fine, thread-like line between each of them; aperture nearly orbicular; base somewhat flattened, with numerous brown, concentric lineations; pillar-lip white, and reflected on the columella.—*B.*

Found in the Clay, near Glasgow. See note p. 76.

I suspect I have been deceived in this shell, which was given to me by a workman.—*S.*

4. TURBO EXPANSUS. N. S.—*Smith.*

Plate I. Fig. 12, 13.

Shell strong, consisting of fine volutions; spire very short, well defined by the suture, and terminating in a somewhat pointed apex; aperture suborbicular; outer lip thin and much expanded; inner lip thick, strong, and slightly concave; base flattened in front; the whole shell wrought with very minute spiral striæ, every alternate line being smaller than the others, and these are thickly crossed by longitudinal lines of growth, producing an undulated appearance in the spiral striæ, which can only be seen by the aid of a lens; colour reddish-orange.

This shell may be mistaken for the young of the *Turbo rudis,* but is at once distinguished by the much greater expansion of the outer lip, and the fineness of the striæ, those of the *rudis* being much coarser and devoid of the finer intermediate striæ.—*B.*

"This variety of *Turbo neritoides, Lin.*, having a spire a little more pointed than that of our coasts, is common in all the seas of the North, in Sweden, Norway, and Denmark, and I believe it is also found fossil."—*Deshayes*. Mr Lyell informs me that it is a common recent shell in the St Lawrence.—*S.*

Found at Dalmuir, by Mr Smith.

5. RISSOA FALLAX. N. S.—*Smith.*

Plate I. Fig. 7, 8.

Shell with six gradually tapering volutions, flat on their sides, separated by a slight suture, and terminating in a somewhat obtuse apex; the whole shell ornamented with fine spiral striæ, which is not observable without the aid of a strong lens; body somewhat depressed beneath, where the striæ are considerably stronger than above; aperture obliquely subovate; outer lip plain; pillar-lip but slightly reflected on the columella, becoming wider and smooth as it descends towards the base; length somewhat more than an eighth of an inch; breadth two-thirds its length.—*B.*

Found at Port Rush, county of Antrim, by Mr Smith.

6. TROCHUS INFLATUS. N. S.—*Smith.*

Plate I. Fig. 10, 11.

Shell subconic, with five tumid, considerably inflated volutions, deeply defined by the suture; base provided with a pretty large and deep umbilicus; aperture a little quadrangular, pearly within; the whole shell covered with long, spiral striæ, with intermediate smaller ones, crossed by extremely minute, nearly obsolete intermediate striæ; on the top of each volution adjoining the suture are placed a series of indistinct tubercles; length nearly three-eighths of an inch; breadth the same.

This species may easily be mistaken for *Trochus tumidus*, but the volutions are rounded, whereas in the *tumidus*, the sides are somewhat compressed, and the body provided with a subcarination at the base.—*B.*

Discovered at Dalmuir by Mr Smith.

7. VELUTINA UNDATA. N. S.—*Smith.*

Plate I. Fig. 15.

Shell with three volutions; spiral exceedingly small, placed laterally, and sunk behind the expansion of the outer lip; apex depressed; the whole shell covered with strong longitudinal undulated wrinkles, following the lines of growth, and crossed by wide obsolete spiral striæ; aperture suborbicular, extremely large; outer lip thin; inner lip broadly reflected on the columella, distinctly relieved from the body behind, and with a semilunate broad groove in its centre; length three-eighths and a half; breadth three-eighths.

The very broad, grooved, inner lip at once marks it from the *Velutina communis* of Fleming, or *Galericulum lævigatum* of Brown's Illustrations, which we have represented at Fig. 14 for comparison.—*B.*

Found at Dalmuir by Mr Smith.

8. NATICA CLAUSA.

Plate I. Fig. 16.

Natica glaucinoides, Thomson, Rec. Gen. Sc. i. p. 133. ?

Shell glossy, with five volutions, those of the spire very slightly produced, somewhat depressed, grooved above, and well defined by the suture; upper volutions extremely small; the spire only measuring a fifth of the length of the shell; aperture oblique, semi-ovate, a little flattened on its interior side; pillar-lip broadly reflected on the columella, behind which is a semi-lunate umbilicus; callosity rounded and depressed at its base; outer lip thin; the whole shell invested with nearly obsolete longitudinally oblique striæ, following the directions of the lines of growth; length three quarters of an inch; breadth nearly five-eighths.

Found at Dalmuir by T. Thomson, Esq.

This is not the *Natica glaucinoides* of Sowerby's Mineral Conchology, vol. i. pl. 5, which we have copied for comparison, fig. 17. It will be seen that it differs from that shell in the spire being much shorter, the internal side of the aperture being flattened; in being only subumbiculated, in the callosity being totally different in shape, and *invariably* covering the umbilicus and never toothed; and in the spire being only a fifth of the length of the shell, whereas Sowerby says that of the *N. glaucinoides* is three-fourths the length of the shell. The *N. glaucinoides* has since been found by Mr Smith at Bute and Helensburgh.—*B.*

" *N. clausa*, described by Mr Lyell, on the elevation of the coast of Sweden. The living analogue of this species is still found in the North Sea as far as Spitzbergen; it also occurs in North America, as on the coast of Newfoundland," &c.—*Deshayes.*

GENUS BULBUS,—Brown.

Generic Characters.—Shell very thin, nearly globular; body very large ; spire extremely small ; aperture obliquely oblong ovate, straitened above and expanded below ; outer lip thin, not continuous ; destitute of an umbilicus.

9. BULBUS SMITHII. N. S.—*Smith.*

Plate I. Fig. 18.

Shell very thin, ventricose, subglobose, smooth, glossy, and destitute of an umbilicus ; spire consisting of three obtuse, depressed volutions, which are separated by a deep groove ; aperture somewhat semi-lunar or oblong-ovate, straitened and pointed above, and expanding widely and rounded at its base ; outer lip thin ; pillar-lip broadly reflected on the columella above, and narrowing as it descends ; colour pale reddish-brown, and livid grey ; length an inch and a quarter ; breadth an inch and a tenth.—*B.*

Found at Ardincaple near Helensburgh, by Lady John Campbell.

10. ARCA PAPILLOSA. N. S.—*Smith.*

Plate I. Fig. 19.

Shell transversely elongated ; umbones prominent, placed nearest one side and inflected ; apices separated by a broad flattened space, which is obsoletely striated transversely ; a series of divergent papillose ribs emanate at the beaks, and radiate towards the base and sides of the shell ; these are crossed by several strong lines of growth ; margins externally and internally crenated ; the centre of the valves are slightly hollowed externally ; length three-eighths of an inch ; breadth six-eighths.—*B.*

Found at Port Rush by Mr Smith.

11. CRASSINA MULTICOSTATA. N S.—*Smith.*

Plate I. Fig. 20.

Shell suborbicular, strong, rather depressed, with numerous close-set, concentric ribs, which become somewhat obsolete towards the sides ; covered with a yellowish-brown epidermis ; umbones prominent, considerably turned to one side, beneath which is a lanceolate depression ; hinge with a strong triangular central tooth in the right valve, with a slight pit on each side, for the reception of the tooth of the opposite valve ; on the edge of that next the anterior side is a thin lamellar, divergent tooth, with a very minute one in the same situation on the opposite side, beyond which is a remote lateral tooth ; in the left valve are two divergent central teeth, with an intervening pit for the reception of the larger tooth of the opposite valve, and a minute lateral tooth on the posterior slope, with a very broad flattened margin, provided with an exterior narrow rim; muscular impressions reniform and very deep; length half an inch; breadth nearly five-eighths.—*B.*

It occurs in abundance in the North Sea, and is found both in a recent and fossil state in Sweden and Norway.—*Deshayes.*

12. CRASSINA WITHAMI. N. S.—*Smith.*

Plate I. Fig. 24, 25.

Shell strong, transversely ovate and somewhat depressed; beaks nearly central and slightly turned to the posterior side, with an oblong lanceolate impression under them; external surface, irregularly, concentrically wrinkled; hinge with two strong divergent teeth in the right valve, with a large triangular pit for the reception of the central tooth of the left valve; inside with two strong, but not large, reniform muscular impressions; impression of the mantle well marked, and rather deep, which is rendered more decided by a series of oblong, shallow punctures near its centre; margin very broad, flat, and plain.

Found by Henry Witham, Esq. of Lartington, in the marine alluvia at Bridlington Quay on the east coast of Yorkshire. A single valve has recently been dredged at Rothsay Bay, apparently of the same species, by Mr Smith.—*B.*

13. TELLINA PROXIMA. N. S.—*Smith.*

Plate I. Fig. 21.

Shell transversely subovate, depressed, thin, with irregular concentric striæ; umbo small, placed near the centre, and turning slightly towards the posterior side; hinge of the right valve provided with a strong tooth next the anterior side, and a very small one on the other side, with a triangular space between them for the reception of the tooth of the opposite valve; left valve with a rather strong, prominent, bifid, central tooth, diverging slightly towards the posterior side, and near to it is situate a single tooth, obliquing slightly in an opposite direction; length six-eighths of an inch; breadth an inch.

When recent this shell has been covered with a pretty strong, fuscous epidermis, as remains of it appear on several of the specimens found at Dalmuir.

The *Tellina proxima* is a much stronger shell than the *T. tenuis.* The teeth are very different, and the fuscous epidermis are characters sufficient to distinguish it at once from that species.—*B.*

Found at Helensburgh, by Mr Smith.

"I believe a new species. I am acquainted with it as a living species, occurring in the North Sea, and as a fossil in the recent formations in Sweden."—*Deshayes*. Mr Sowerby considers it identical with a recent species from Behring's Straits. It is perhaps the most common of the fossil shells of the Basin of the Clyde, but I have not met with it in any other locality.—*S.*

14. MACTRA STRIATA. N. S.—*Smith.*

Plate I. Fig. 22.

Shell subtriangular, concave, with nearly equal sides; umbones central, and slightly turned to one side; lateral teeth prominent; inside smooth; external surface with very strong, concentric striæ; length seven-eighths of an inch; breadth an inch.

This species might be mistaken for the *Mactra subtruncata*, having, like that shell, strong concentric striæ; but it is totally different in contour, being more triangular, more equilateral, and not produced on the anterior side like that species.—*B.*

Found at Stevenston, Ayrshire, by the Rev. Mr Landsborough.

DESCRIPTION OF PLATE II.

RECENT SPECIES.

1. PECTEN JAMESONI. N. S.—*Smith.*

P. testa sub-æquivalvi, suborbiculari, longitudinaliter undulato-plicata, striata, plicis 4–5, auriculis inæqualibus. Lon. $\frac{3}{4}$ un. Lat. $\frac{3}{4}$.

Allied to the *Pecten polymorphus* of Bronn (*Phillippi*, p. 79, tab. v. figs. 18, 21), but differs in several respects, especially in the inequality of the auricles. The longitudinal striæ vary much in coarseness; the upper valve is somewhat larger than the lower; the auricles are ribbed and striated by lines of growth; the longitudinal ribs or folds vary much in convexity, and are sometimes acutely carinated. The colour is white, with a tinge of red, especially near the beaks. Very distinct from any recorded British Pecten.—*F.*

Dredged at Bute by Mr Smith.

2. PECTEN LANDSBURGI. N. S.—*Smith.*

P. testa subæquivalvi, suborbiculari, radiis minimis longitudinaliter rugoso-striatis, striis transversis regulariter undulatis, auriculus inæqualibus. Lon. $\frac{1}{2}$ un. Lat. $\frac{5}{12}$ un.

A very beautiful species, allied to *Pecten obsoletus*, first observed by the Rev. Mr Landsborough, on the coast of Ayrshire, afterwards dredged by Mr Smith, off the coast of Bute. In colour it resembles *Pecten obsoletus*, but is somewhat more triangular in form; from that species, however, it is easily distinguished by the lineations of its surface, which is adorned by numerous regular minute rays rugosely striated, and crossed by regular undulated transverse somewhat distant striæ. The rays on the upper surface are furnished with short broad obtuse spines, crowning the convex flexure of the undulated striæ; the spines only exist towards the margin on the lower valve. The rugose appearance of the longitudinal striæ is caused by the interstices being punctate. Fig. 2.* represents a portion of the surface magnified.—*F.*

3. PATELLA FORBESII. N. S.—*Smith.*

P. testa tenuissima, pellucida, obovata, gibba, aurantia, striis longitudinalibus regularibus tuberculatis, vertice versus marginem inflexo. Lon. $\frac{2}{10}$; lat. $\frac{1}{8}$.

The regular tuberculated longitudinal striæ radiating from the submarginal apex, at once distinguish this species from any of its allies among the British Patella. In form, it resembles the *Lottia pulchella.* The margin behind the apex is truncated, and the colour of the shell is orange-yellow. When the animal shall have been examined, it may prove to be a Lottia.

Dredged by Mr Smith in Rothsay Bay, adhering to a case-bottle, in ten fathoms water. Fig. 3.* is a magnified view.—*F.*

FOSSIL SPECIES.

4. PANOPÆA BIVONÆ.—*Phillippi.*

See remarks at p. 23.

5, 6, 7, 8, 9. Various states of FUSUS PERUVIANUS.

See remarks on this shell in the description of Plate I.

10 & 10* (Magnified). NUCULA GIBBOSA. N. S.—*Smith.*

N. testa ovata, lævi, gibbosa, subinæquilatera, margine integerrimo. Lon. $\frac{2}{10}$; lat. $\frac{1}{8}$.

Very different from any of the existing British species. Its nearest ally among extinct Nuculæ is the *Nucula tenuis* of Phillippi; it is, however, not so inæquilateral as that species, but should it even prove identical with the Sicilian shell, it must still retain its name, as the name given by Phillippi is pre-occupied. The shell appears to have been covered by a brown epidermis, and the hinge has eight teeth on each side of the very prominent beaks.

From the Newer Pliocene deposit at the Greenock Railway.—*F.*

NOTICES OF THE NEWER PLIOCENE DEPOSITS IN SCOTLAND AND THE WESTERN ISLANDS.

Entering Scotland by the well-known locality of Gretna Green, evidences of the former level of the sea are noticed in the Statistical Account of the parish of Gretna,* and also in the adjoining parishes of Dornoch† and Ruthwell.‡ Lochar Moss rests upon marine beds. I suspect, however, that part of them has been silted up in modern times, as vessels and anchors have been discovered in them. In the county of Kirkcudbright there are elevated shelly beds, on the east side of St Mary's Isle,§ and in several places the fossil shells are used for manure.|| In Wigtonshire there are extensive tracts full of them.¶ At Cassincarie, in the parish of Kirkmabreck, there is a bed of littoral shells, at an elevation of 18 feet.** On the west coast of Scotland, these deposits can be observed in Loch Ryan,†† and in the Bay of Ayr. The Rev. Mr Landsborough of Stevenston, in a letter to me, thus notices the elevated beds in his parish :—

" There is a cave at Ardeer-house ; the rocks which form the walls are evidently water-worn. This cave is near the base of the eastern termination of a ridge, which, with some breaks, is continued from this to Largs, which I am convinced was once the bounding barrier of the sea. Owing to the mining operations that are going on,

* New Stat. Acct., Dumfries, p. 263.

† Stat. Acct., vol. ii. p. 18.

‡ New Stat. Acct., Dumfries, p. 220.

§ Stat. Acct., vol. xi. p. 30.

|| Ib. vol. xv. p. 82.

¶ Ib. vol. xiv. p. 473, and vol. iv. p. 139.

** Information from the Rev. Dr Lawrie.

†† Stat. Acct., vol. ii. p. 48.

we have every proof of it in this parish. Betwixt the terrace and the sea, in sinking a coal-pit, they generally have to dig through from 18 to 25 feet of sand, before they come to the stratum of clay in which the shells are found. They occur in the churchyard, at an elevation of 55 feet. The quarry where I found the shells is from 15 to 20 feet above the level of the sea at high water. The ridge at the church-yard consists of coarse gravel and sand. The shells found at the quarry were nearly all littoral."

In the account of the parish of Ardrossan, we are informed that "There are many reasons that lead us to conclude that a considerable portion of the lower grounds of this parish were under the dominion of the sea. Sub-fossil sea-shells, such as are at present found on the shore, have been found in gravel pits, and in the earthy banks of Stanley-burn, as far up as Kirkhall. They have been also found in a section of the Castlehill, pretty near the summit," &c.*

In the adjoining parish of Kilbride, the ancient sea-cliffs noticed by Mr Landsborough rise to the height of 300 feet, and continue parallel to the present coast line of the frith of the Clyde, nearly through the whole of the county of Renfrew. Whilst there are corresponding ones in the islands and opposite shores of the counties of Argyle and Dumbarton, above Dumbarton the high lands recede, and the river Clyde now flows through what must have at one time been the bottom of an extensive inland sea, of which Loch-Lomond, with its tributary valleys, formed a branch. In every part of the coasts of Argyleshire, the ancient cliffs form a marked feature. Dr Thomson† observes that, "on the west coast of Lorn, from Dunstaff-

* New Stat. Acct., Ayr, p. 194.

† Outlines of Mineralogy and Geology, vol. ii. p. 187.

nage to Gallochin, an extent of about eight miles bears unequivocal marks of having been elevated, at no very remote period. A considerable portion of this coast consists of pretty steep rocks, the summits of which are elevated 300 or 400 feet above the level of the sea. These rocks show clearly that they have at no very remote period been washed by the sea, at a height certainly more than 30 feet above the present high water mark." On the west coast of the county of Inverness, Glengarry informs me that he observes the ancient cliffs and terraces abounding with sea shells ; and at Lochalsh, in the same county, a sub-marine forest has been observed.*

Similar indications of change of level are to be met with in the islands. At Ballaugh, in the Isle of Man, Mr Forbes found them in beds of gravel and sea-sand several feet below the surface, but a greater number above the level of the sea, and from one to two miles inland. These contain sea-shells, bleached, but often tolerably perfect. They all appear to belong to the present era, with the exception of a Nassa allied to the *N. macula*, but with the spine less produced, the body short, much more ventricose, and the longitudinal ribs fewer. It is named in the catalogue *N. Monensis.* I have already noticed the occurrence of elevated marine deposits in Bute and Cumbra. I have also observed them in Arran and Inchmarnoch. In the Geological Transactions† Captain Vetch gives an account of sea-worn terraces in the Island of Jura. I am indebted to the Rev. Mr Cameron of Kilchoman for the following account of similar phenomena in Islay. " A large extent of surface has been added to this island, in

* Communicated by the Rev. Wm. M'Lean to the Rev. Wm. Smith of Inverary. See his account of a submarine forest in Tiree.—*Edin. New Phil. Journal*, 1829.

† Edin. New Phil. Jour., second series, vol. i.

consequence of the change of level. When the sea stood at the former level, Islay must have consisted of a cluster of isles. What at one time was under the dominion of the sea consists now partly of arable land, partly of banks of rolled stones, about the size of six-pound shot, partly of downs formed of broken sea-shells, clay-slate, and quartz, so minute as to be blown about by the wind—partly of morasses and fresh water lakes round the head of Lochindaal. The former sea-line is as well defined as it is in Rothesay Bay, or any part of the banks of the frith of Clyde. Islay House, with its garden, and a good extent of its ground, stands over the plateau left by the retiring of the sea. In various parts of the island, whatever form the surface of this plateau has assumed, I have found on digging, sea-sand mixed with shells of the species that still abound in the various inlets; in the parts of it converted into morasses, large oaks are to be found, which appear to have been growing on a bed of clay and sand incumbent on a bed of sea-sand and sea-shells.

The range between the traces of a former high water mark, and the present low water marks of spring tides, is, I would say, not under 40 feet, and I would almost venture to call it 45 feet. The west side of the parish presents a line of about twenty miles to the unobstructed flow and swell of the Atlantic, and it is to this line the above measurement is applicable."

In the Island of Mull the same terraces are observable, and the same marine remains are to be found. In Lismore there is a bed of shells composed of all the varieties to be found on the coasts, which has formed a concretion nearly as hard as the limestone rock which surrounds it about 7 or 8 feet above the ground.* In Tirey, the

* Stat. Acct., vol. i. p. 494.

Rev. Mr Smith has described a sub-marine forest, and in Skye Dr MacCulloch notices a series of terraces on the shore, "exhibiting precisely the same appearances which characterise the terraces that line the alluvial valleys through which active rivers have cut their way," and which, of course, owe their origin to the same causes which have in other places produced like effects.

In the Orkney Islands, submerged forests have been observed, and on the north coast of Scotland, the Earl of Caithness informs me that near Scotland's Haven there is a bed of oysters 40 or 50 feet above the sea level. His Lordship has also observed on the north-east coast, a littoral deposit between Wick and Duncansbyhead, about a quarter of a mile inland.

The ancient terraces extend from the ord of Caithness to Banff.* At Tain, Mr Jardine tells me that he found marine shells 60 feet above the sea. At Kiltearn, on the north side of the bay of Cromarty, there is a bed of shells at the height of 30 feet,† and at Dingwall, at the head of the bay, one of blue clay full of shells, in which, at the distance of three miles from the sea, there was found one of the vertebræ of a whale at an elevation of 12 feet.‡ At Inverlochy in the county of Ross, and along the shores of Moray firth, this deposit is observable.§ There is a raised beach near Kinnairdshead,|| and at Peterhead, Dr Buckland observed shells at the height of 60 feet.¶ In the counties of Kincardine, Forfar, and Fife, there are many notices of the elevated marine beds, in the Statistical Ac-

* Agricultural Journal, Dec. 1836, p. 431.

† Stat. Acct., vol. i. p. 283.

‡ Trans. R. S. Edin., vol. x. p. 105.

§ Information of Sir T. D. Lauder, and Stat. Acct., vol. xiii. p. 21.

|| Stat. Acct., vol. vi. p. 2.

¶ Jameson's Edin. Phil. Journal, vol. xii. p. 314.

counts. There are also numerous indications of them in the Lothians and Berwickshire, for an account of which I refer to Mr Maclaren's lately published work on the Geology of Fife and the Lothians, in which he gives a full and interesting account of the proofs of a rise in the bed of the Forth;* and in the paper of Mr Milne on the Mid-Lothian and East-Lothian coal-field,† much attention has been paid to the raised marine beds in this part of the Island. Mr Milne states that "he walked along the whole shore from St Abb's Head, round by Dunbar, North Berwick, Aberlady, Cockenzie, and Newhaven, to Queensferry, and traversed the greater part of the Carse district from Falkirk to beyond Stirling," and every where found traces of a change in the sea level. In his report on the Geology of Berwickshire,‡ he notices indications of a change of the sea level of about 100 feet. I have thus traced these deposits round Scotland—they occur in every one of the maritime counties, indicating changes of level in every part of the northern division of the Island. I have no doubt that marine beds belonging to the newer pliocene extend also throughout England and Ireland.

* P. 228.

† Transactions of Royal Soc. Edin. vol. xiv. p. 334, &c.

‡ 4th Report Brit. Association, p. 638.

ON THE

ASTERIADÆ OF THE IRISH SEA.

BY

EDWARD FORBES, Esq., M. W. S., &c.

No class of animals has been more neglected than the Echinodermata. Although forming a most important division of the great sub-kingdom Radiata; and though the singularity and beauty of their forms and colours have long attracted attention, little, very little, has been done towards distinguishing species, defining genera, and ascertaining the relations of the various forms one to another. In many parts of Zoology our knowledge of species is in advance of our knowledge of structure: in this our knowledge of structure is in advance of our knowledge of species. The anatomy of a common star-fish is well known, but few are able to tell the zoological relations of the commonest. Turning over the leaves of our manuals will give us but little information; it is almost impossible to decide certainly on the species of a star-fish, by means of any book with which I am acquainted. Vague indications of form and colour are all we find in works on the subject; no two descriptions coincide; on one point only do authors agree, viz. in referring us to the figures of Link for a solution of our difficulties. And what do we find on referring to Link —a rare book, by the bye, which is seldom within our reach? We find that scarcely two authors agree as to what species figured by Link is the species named by Linnæus.

What is the cause of this singular confusion? Simply this; there has as yet been no attempt made to ascertain the generic and specific value of the various organs and tissues in this class of animals. The zoological value of specific groups among the Echinodermata has also been neglected, most naturalists being content with the division of the great genus of Linnæus, Asterias (itself an Order), into two genera, Asterias and Ophiura, instead of regarding those genera in the light of families, to which rank they are undoubtedly entitled.

I have alluded to the work of Link, "De Stellis Marinis Liber singularis." In that work, though published so long ago as 1733, there is much clearer perception of the true arrangement of star-fishes than in most of the volumes since published wherein those animals are described. Link makes many genera, but unfortunately, probably in consequence of want of opportunities for studying the living animal, based his genera on a false principle, viz. the number of rays, a character scarcely even specific among a large portion of the Asteriæ, although of great consequence in the family Ophiuræ. Very lately, Professor Agassiz, who elucidates whatever he studies, has made a more successful attempt at the definition of the genera of Asteriadæ. I allude to his "Prodromus of a monograph of the Radiata and Echinodermata," published in the "Annales des Sciences Naturelles," for May 1837, a translation of which appeared last year in the Annals of Natural History. The genera into which he divides Asterias and Ophiura are most natural, though the characters he assigns to them are insufficient. A minute examination of such British species as have come under my notice fully bears out his general views, and excellent generic characters may be derived from the disposition and structure of the spines and suckers, more permanent than those derived merely from the general form of the animal. In only one instance do I find myself obliged to differ from M. Agassiz ; the grounds of that difference are, however, such as I feel confident the learned professor will himself admit. I allude to my separation of the Solastéries of De Blainville from the genus Stellonia, the Solastéries having, like all the other genera of Asteriæ, but two ranges of suckers, while the true Stelloniæ have no less than four. This important distinction is borne out by a corresponding difference of general habit.

For some time back I have collected and described such star-fishes as occur on the coast of the Isle of Man, where they are found in great variety and abundance. All the species hitherto recorded as British, with the exception of four or five, enrich the Manx fauna. Could I have placed any dependence on the descriptions and synonyms of British writers, I would have merely enumerated such as I had observed ; but as the catalogues hitherto published of British star-fishes present us only with meagre and unsatisfactory details as regards species, and extreme confusion and inaccuracy as regards the synonyms, I have thought it best carefully to revise the character of each species, and to collate the descriptions and figures of all the authors referred to, the works of whom I have been able to consult.

Professor Agassiz divides the Asteriadæ into three families, the Asteriæ, the Ophiuræ, and the Crinoideæ.—To commence with the Asteriæ.

All the British Asteriæ may be arranged under eight genera, examples of all of which I have found in the Irish

Sea. Six of these genera have been constituted by Agassiz, one (Solaster) indicated by Blainville, and one I have thought it right to constitute, for the reception of the most remarkable of all the British Asteriæ, the *Asterias rubens* of Johnston, but of no other author. The characters which may be regarded as generic in the Asteriæ are, 1*st*, The general form and flatness or convexity of the surface ; 2*d*, The number of rows of suckers ; and, 3*d*, The structure and arrangement of the spines, covering the surface and bordering the avenues. I suspect the absence or presence of eyes will also furnish a good generic character ; but, hitherto, few observations have been made on those organs in this tribe. It was Professor Ehrenberg who discovered that *Asterias violacea* possesses eyes, " shewing themselves as beautiful red points on the under surface of the extremities of the five rays." Several of our British Asteriæ have similar eyes. They may easily be seen in the common cross-fish or five-fingers (*Stellonia rubens*), and in *Solaster papposa*. In the former, I find a very remarkable provision for their protection ; each eye is placed at the extremity of the ray in the middle of a circle of spines, which opens and closes at the will of the animal, forming a most excellent eyelid. In the *Solaster papposa* the eye is not so enclosed, but at the end of the ray is a tuft of spines which seems capable of doubling back over the eye, so as to protect it. In the *Goniaster Templetoni* the eye is placed near the extremity of the ray, apparently without any spinous protection. These eyes are found in all stages of the animal's growth. They are generally, but not always, preserved in dried specimens; but, as they are not visible in the dried examples I possess of any other species (save the *Stellonia violacea*) than those I have just mentioned, it is very desirable they should be sought for in living individuals of the other British Asteriæ.

FAMILY ASTERIÆ, Agassiz.

I. *ASTERIAS*, Ag.—*Body* stellate; *rays* flat, with a series of marginal plates; *avenues* bordered by numerous unequal spines; *suckers* biserial.—Pl. III. Fig. 1.

I. A. aurantiaca, *Linn.**

Two specimens of this species (so well described by Dr Johnston, in the paper above referred to), are in the collection of Mr Wallace, Douglas Museum, Isle of Man. They were taken off Douglas Head. It is very probable that the *A. bispinosa* of Otto has been confounded with the *A. aurantiaca* on the British shores.

II. *GONIASTER*, Ag.—*Body* pentagonal, gibbous, thick, not spinous, bordered by a series of laminæ edged with spines; *avenues* bordered by transverse rows of spines; *suckers* biserial.—Pl. III. Fig. 2.

I. G. Templetoni, *Thomson MSS.*—Pl. IV. Fig. 1, 2.

The body of this species is convex, of a bright scarlet colour, when fresh quite smooth, when dry granularly reticulated, and here and there covered with minute cartilaginous flattened furrowed spiculæ. The margin is furnished with a row of tubercles, each bearing three or four blunt spines. The borders of the avenues have transverse rows of longer and more conical spines, four or five in a row. The intermediate triangular spaces are smooth and tessellated; tesselæ oblong. The madriporiform tubercle is small, striate, and placed at some distance from the margin, with which it seems to communicate by a furrow or canal.

Dredged off the coast of Ballaugh, Isle of Man. Rare. The largest specimen taken measured three and a half inches across.

This beautiful star-fish is related to the Asterias eques-

* Johnston in Mag. Nat. Hist. vol. ix., p. 298, f. 43.

tris and Asterias Johnstoni* of British authors, but is very distinct from those species. It is the "*A. equestris?*" of Templeton (Mag. of Nat. Hist. vol. ix. p. 237), and has been named after that naturalist by my distinguished friend, Wm. Thomson, Esq. of Belfast. Dr Coldstream has found it in Bute.

III. *PALMIPES*, Link; Agassiz.—*Body* pentagonal, flat, thin, covered above and beneath with fasciculated spines; *avenues* bordered by longitudinal fasciculi of spines; *suckers* biserial.—Pl. III. Fig. 3.

1. Palmipes membranaceus.†

Body pentagonal, above white, with five red rays and a red border, entirely covered above with small rounded tubercles, bearing bundles of minute spines. Spinous tubercles most numerous, and scattered in the red rays and margin, arranged in regular rows on the white portion. Beneath the tubercles are elongated and ridge-shaped, and are arranged in a similar manner. Avenues bordered by longitudinal fasciculi of larger spines; those immediately around the mouth most developed. Madriporiform tubercle small, flat, striated, subcentral.

Frequent in deep water on the Manx coast. The largest specimen I ever took measured five inches across.

IV. *ASTERINA* (Nardo), Agassiz.—(*Pentaceros*,—Link.)—*Body* pentagonal, gibbous, thick, covered above and below with short spines; *avenues* bordered by a row of spines; *suckers* biserial.—Pl. III. Fig. 4.

* This name must be changed. There is an *Asterias Jonstoni* (allied to *A. aurantiaca*) described and figured by Della Chiagi. Memorie, vol. ii. p. 356. It is the "*A. aurantiaca*" var. 2, of Lamarck.

† Link, t. i., f. 2. *Asterias membranaceus*. Retz. Linn. *Asterias placenta*, Pennant. (Br. Zool. 4, 62. No. 59, t. xxxi.). *Asterias cartilaginea*, Fleming, Brit. An., p. 485.

1. Asterina gibbosa. *

Body pentangular, gibbous, thick; reticulated and closely covered above with short thick spines, arranged in pairs. Beneath similar spines are arranged in regular rows. The margins of the avenues are bordered by a single row of short spines.

This species is found at several places on the British coast. In the Isle of Man it is rare, occurring in pools in the rocks at very low water. It measures an inch across from angle to angle.

V. *LINKIA* (Nardo), Agassiz.—*Body* stellate; *rays* rounded, covered, as well as the disk, with oblong reticulating spiniferous tubercles; intermediate spaces porous; *avenues* bordered by two sets of lateral spines; *suckers* biserial.—Pl. III. Fig. 5.

1. Linkia oculata.†

Rays five, rounded, nearly four times as long as the breadth of the disk; covered (as well as the disk) with oblong reticulating spiniferous tubercles; spines short, rough, numerous; spaces between the reticulations porous. Avenues bordered by two sets of spines: the first or inner consisting of oblong tubercles, bearing fasciculi of from four to six spines: the second or outer of regular transverse rows of from three to five strong rough spines. Madriporiform tubercle lateral.

Very common in deep water on the coasts of the Isle of Man. Largest specimens three and a half inches across. Colour dark red, or deep purple.

VI. *SOLASTER*, Forbes.—(*Solastéries*, Blainville).—*Body* stellate, multiradiate, covered with fasciculated spines; *avenues* bordered by three sets of spines; *suckers* biserial.—Pl. III. Fig. 6.

* *Asterias gibbosa*, Pennant, 4, 62; Fleming, p. 486. *Asterias exigua*, Lamarck, 2, p. 554. *Pentaceros plicatus*, Link, t. 36. No. 62.

† *Asterias oculata*, Pennant, 4, 61, No. 56, t. xxx. f. 56; Fleming, p. 487; Link, t. 36, No. 62. *Asterias multifera*, Lamarck, 2, 565?

1. Solaster endeca.*

Rays nine to eleven, shorter than the breadth of the disk. Disk and rays thickly and irregularly covered with elevated tubercles, crowned by a circle of short rough spines, generally surrounding a similar central spine. Three sets of spines bordering the avenues: first or inner consisting of fasciculi of spines on tubercles, like the ordinary spines of the rays, but thicker: second, transverse narrow compressed ridges bearing two rows of spines; and third, transverse rows, of from five to ten spines webbed together towards the base. Madriporiform tubercle lateral, striate.

Rather scarce on the Manx coast, but occasionally dredged in deep water. Colour deep purple. Largest specimen taken measured six and a half inches across.

2. Solaster papposa.†

Rays thirteen, one-half as long as the breadth of the disk. Rays and disk covered by bundles of spiculiform striated spines, eighteen or twenty in each fasciculus, irregularly arranged in five longitudinal rows. Avenues bordered by three sets of spines: first (or inner) consisting of from eighteen to twenty fasciculated spines, placed on a broad compressed articulated base; second, of about eight long striated spines, placed on transverse ridges; third (or outer) consisting of longitudinal fasciculi of spines, four or five in each fasciculus. Madriporiform tubercle lateral, punctate. Disk red; rays white, tipped with red. Measures eight inches across. Very common in deep water.

VII. *STELLONIA* (Nardo), Agassiz.—*Body* stellate, few-rayed, rays rounded, covered with simple or coronated spines; *avenues* bordered by three sets of spines; *suckers* quadriserial —Pl. III. Fig. 7.

1. Stellonia rubens.‡

Rays four to six, three and a half times as long as the breadth of

* *Asterias endeca*, Linn.; Link, tab. 15 and 16, No. 26 and tab. 17, No. 27; Flem. p. 487; Lam. ii. p. 560, No. 28; Johnston, Mag. Nat. Hist. vol. ix. p. 300, fig. 44. *Stellonia endeca*, Agassiz.

† *Asterias papposa*, Linn; Lamarck, ii. p. 559; Fleming, p. 487; Link, tab. 17, fig. 28 and tab. 22, fig. 52. *Asterias helianthoides*, Pennant, Brit. Zool., v. iv. p. 66, No. 72. *Stellonia papposa*, Ag.

‡ *Asterias rubens*, Linn.; Fabr. Fauna Grœnlandica, p. 369; Lamarck, ii. p. 562; Link, p. 7, fig. 9, p. 11, fig. 15, pl. 14, fig. 23, pl. 15 and 16, fig.

disk, lanceolate, covered as well as disk with clavate spines, encircled towards their bases with a corona of from ten to fourteen spinules. Among these spines are interspersed small, conical, flattened, furrowed spinules. The spines in the centre of the rays form an irregular ridge. Avenues bordered by three sets of spines: first, ordinary spines arranged in pairs; second, thick spines arranged in threes, surrounded and separated by bundles of spinules; third, a double row of long, simple, smooth spines. Madriporiform tubercles, striate, lateral.

The commonest of all British Asteriadæ, but involved in great confusion as regards synonyms. There can be no doubt, however, as to its being the true *Asterias rubens* of the older authors, among whom Otho Fabricius describes it with great accuracy. The *Asterias rubens* of Fleming is strangely enough compounded of this and *Solaster endeca!* That of Johnston is the *Luidia fragilissima*. Blainville is correct in his references. The arms of this species, especially of a common variety, in which the primary spines are fewer, and somewhat larger than ordinary, are apt to come off on handling roughly, but the animal has no power of casting them off voluntarily, though the next species probably possesses that faculty. *Stellonia rubens* is the "cross-fish" and "five fingers" so much dreaded by oyster fishermen as a depredator of oyster beds. *Stellonia violacea*, *Stellonia hispida*, and perhaps *Stellonia seposita*, occur on the coasts of Scotland, and have been confounded with this species, but are easily distinguished by their proportions, (which are constant in all ages of animals of this genus), and by the structure of their spines. In the very young specimens of *Stellonia rubens* there are no spinulæ. The colour is also generally purplish; in the full-grown animal it is yellow, or orange-red. Large specimens are more than a foot across.

13, pl. 30, fig. 50, pl. 34 and 35, fig. 58, pl. 36, fig. 67, pl. 40, fig. 70. *A. glacialis*, Fleming, p. 487; Penn. 4, p. 60, No. 54; Junior; *A. clathrata*, Penn. iv. p. 61, No. 55.

2. Stellonia glacialis.*

In this species, which is common in the Irish Sea, the rays are pentangular, the angles bearing rows of large produced spines, which arise from tubercles thickly studded with small spines. The disk is more strongly marked than in *Stellonia rubens*, and the rays do not taper so gradually. A specimen in the collection of Mr Wallace was of a bright red colour when taken. This is the star-fish I described at the Liverpool Meeting of the British Association as *Asterias spinosus.*

3. Stellonia hispida.†

A small species, having short broad rays, as long as the breadth of the disk; the surfaces covered with numerous spines, which are generally simple. An inch broad. Found at Castletown, Isle of Man, by Dr Coldstream. I have taken it in the Hebrides, adhering to stones at low water.

VIII. *LUIDIA*, Forbes.—*Body* stellate; *rays* flat, covered above with spiniferous tubercles; *avenues* bordered by two sets of spines; *suckers* biserial.—Pl. III. Fig. 8.

1. Luidia fragilissima.—*Forbes.*‡

Rays seven, flat, five times as long as disk, covered (as well as the disk) with tubercles, each bearing a radiating circle of from six to eight sub-clavate papillose spines, generally with from one to three short clavate spines in the centre. Border of the avenues formed of an inner row of four or five long thick sub-clavate spines, placed in regular transverse ridges, which are covered with small slender spines; innermost spines thickest, and forming a fringe to the flattened arms, and of an outer or under row of long, slender, angular spines, also placed in transverse ridges, two rows of very long suckers in each avenue. Madriporiform tubercle extremely lateral, almost marginal, reticularly striate. Above dark red, beneath straw colour. Measures two feet across.

* Link, t. 38 and 39. *Asterias angulosa*, Mull. Zool. Dan. ii. p. 1, t. 41. *Asterias glacialis*, Linn.; Lam. p. 861, No. 26. *Asterias echinophora*, Della Chiagi Mem. vol. ii. p. 356, pl. 18, f. 5.

† *Asterias hispida*, Pennant, vol. iv. t. xxx. fig. 58; Link, pl. 9, fig. 19; and pl. 35, fig. 39.

‡ *Asterias rubens*, Johnston, Mag. Nat. Hist. v. ix. p. 144, fig. 20.

It is strange that this, the largest and most remarkable of all the British star-fishes, should so long have remained unnoticed, and still stranger that when first described it should have been referred to *Stellonia rubens*, and with a query to *Asterias hispida* and *Asterias spinosus*. Its claim to rank as the type of a separate genus cannot be doubted; for by no stretch of character can it be united with any of the preceding. Its wonderful power of not only casting off its arms entire, but breaking them voluntarily into little pieces, with great rapidity, and with quite as much facility as an Ophiura, has defeated all my attempts to preserve a specimen entire. It is rare; but I have taken it several times in deep water on the Manx coast. Dr Johnston obtained it at Berwick-on-Tweed.

I have named my genus after Luid, one of the earliest and most judicious observers of the British Radiata.

FAMILY II. OPHIURÆ.

In the second family of Asteriadæ, Professor Agassiz includes those star-fishes which have hitherto been arranged under the genera Ophiura and Euryale. It seems to me that the latter should form a separate family. The recent species of Ophiura he arranges under two genera, Ophiura and Ophiocoma, separating them on the ground of the different forms of the brachial spines. On examining our British species, however, I am convinced that this is but a secondary character, and can scarcely be regarded as a true ground of generic distinction. The two genera are most natural, and good permanent characters may be derived from the mode of insertion of the arms, and the form of the five scales or plates which separate their origins beneath. When the species of Ophiuræ shall have been better investigated, it is probable the mode of insertion of the brachial scales will assume a generic, or at least subgeneric, importance.

1. *OPHIURA*, Linn.; Agassiz.—*Rays* simple, squamose, prolonged into the disk superiorly, and separated at their origins beneath by large fiddle-shaped plates. *Brachial spines* appressed.

Two species of this genus, which is restricted to the lacertose Ophiuræ, are found in the Irish Sea. One only is recorded by British authors, and the two I here describe, though very distinct, have probably been hitherto confounded, both on the continent and at home.

1. Ophiura texturata.*—Pl. IV. Fig. 3, 4.

Disk imbricated above by smooth unequal scales, those of the centre very small and rosulate; two large scales with diverging apices at the base of each ray; pectinated scales clasping the base of the rays laterally with above twenty teeth. Intermediate inferior plates hollowed out at the sides. Rays covered superiorly by transversely-oblong, narrow plates, beneath by ovate plates. Sides, with lateral plates, bearing about seven short, blunt, appressed spines on their superior margins. Rays not three times as long as the breadth of disk. The disk of the largest specimen I have taken is nine-tenths of an inch broad.

Rare in the Irish Sea; dredged off Douglas, Isle of Man. Apparently frequent on the east coast of Scotland. Colour either brown or flesh-colour.

2. Ophiura albida,† *Forbes.*—Pl. IV. Fig. 5, 6.

Disk imbricated above by smooth unequal scales, a large one in the centre, surrounded by five others of the same size; two quadrangu-

* Lamarck, v. ii. p. 542, *Asterias ophiura*, Linn. *Asterias lacertosa*, Penn. Brit. Zool. 4, 130, pl. 34, fig. 1. *Ophiura brachiata*, Fleming, p. 488. *Stella lacertosa*, Link, p. 2, No. 4; Johnston in Mag. Nat. Hist. vol. viii. p. 465, fig. 41. *O. aurora*, Risso, vol. v. p. 273, fig. 29.

† *An Ophiura texturata.* 2. *Eadem minor albida*, Lamarck, vol. ii. p. 542?

lar scales nearly as large at the base of each ray; pectinated scales clasping the rays with fewer than sixteen teeth; intermediate plates beneath with straight sides. Rays covered superiorly by transversely ovate hexagonal plates, beneath by transversely ovate plates. Sides with lateral plates bearing four or five short appressed spines. Rays three times as long as breadth of disk. Disk of the largest specimen I have met with half an inch broad. Colour generally paler than that of the last species, sometimes almost white.

Common both in deep and shallow water in the Irish Sea, and probably on all our coasts.

II. *OPHIOCOMA*, Agassiz.—*Rays* simple, squamose, with erect lateral spines, not prolonged into the disk superiorly, and separated at their origin beneath, by small pentangular scales.

1. Ophiocoma neglecta.*—Pl. IV. Fig. 7.

Disk round, flat above, imbricated with small smooth scales; two large oblong scales at the base of each ray; beneath intermediate scales small, pentangular. Rays covered superiorly by square scales, beneath by longitudinally oblong scales. Sides with transverse ridges bearing four or five conical smooth spines, which are equal in length to the breadth of the ray. Rays more than three times as long as the body. Colour grey. Disk two-tenths of an inch broad.

Very rare. One specimen dredged off Ballaugh, Isle of Man, in September 1838.

2. Ophiocoma bellis.†

Disk sub-pentangular, convex, covered by small rounded scales regularly arranged and rosulated in the centre, the intermediate spaces rough with short blunt rough spines. A cordiform depression at the base of each ray. Rays covered above by transversely ovate scales, separated and surrounded by small quadrangular plates. Ray-plates beneath quadrangular, as well as rays punctate. Sides of rays with prominent transverse ridges, each bearing five conical blunt thick spines. Ridges punctate, intermediate spaces smooth. Spines not equal to the breadth of ray. Rays not three times the breadth of disk. Disk six-tenths of an inch broad. Colour reddish.

Common in deep water.

* *Ophiura neglecta*, Johnston, Mag. Nat. Hist. viii. p. 467, fig. 42.

† *Ophiura bellis*, Fleming, Brit. An. 488.

3. Ophiocoma granulata.*

Disk rounded or sub-pentangular, flat, thickly covered by very short rough blunt spines; no scales. Rays covered by transverse lens-shaped scales; beneath by oblong hexagonal plates. Sides with numerous transverse ridges, each bearing four or five long straight sharp spines, which are larger than the breadth of the rays. Breadth of disk three-fourths of an inch; rays three times as long as the disk is broad.

Frequent in deep water. Disk black, orange or variegated; rays dark, with pale or bluish spines.

4. Ophiocoma rosula.†

Disk rounded or angular, covered with small rough spines, mingled with long sharp spines; two large triangular smooth plates at the base of each ray, their apices approximating. Rays covered above by triangular imbricated scales; beneath by quadrangular punctate plates. Sides of rays with transverse ridges, each bearing five long sharp rough spines. Ridges punctate. Spines one and a half times as broad as the breadth of the rays. Breadth of disk six-tenths of an inch. Rays four times as long as the disk is broad. Colour various, generally of a dusky rose colour. The arms white with pink spots, occasionally with dusky arms spotted with bright yellow.

Exceedingly common in deep water.

5. Ophiocoma minuta,‡ *Forbes.*—Pl. IV. Fig. 8.

Disk pentangular, flat, covered with short rough trifurcated spines; two triangular rough scales at the base of each ray. Rays imbricated above with triangular scales, below the square plates. Sides with transverse ridges, each bearing four or five long sharp pectinated spines, one-fourth of their length longer than the breadth of the ray. Disk two-tenths of an inch broad. Rays more than six times as long as the breadth of the disk. Colour various.

Under stones at low-water spring-tides, Ballaugh, Isle of Man. This is probably the "*Hirsuta* seu *stella grallatoria vel macrosceles* Luidii" of Link, p. 50, found by Luid near Tenby, and named *Asterias minuta* by Pennant.

* *Ophuria granulata*, Fleming, p. 488; Link, p. 26, fig. 43. *O. echinata*, Lam. ii. p. 543. *Asterias nigra*, Mull. Zool. Dan. 20, t. xciii. fig. 1—4.

† *Ophiura rosula*, Flem. p. 489; Link, p. 37, fig. 65, and pl. 26, fig. 42. *Asterias fragilis*. Muller. *Asterias pentaphylla*, *varia*, *aculeata*, *hastata*, *fissa*, *nigra*, Penn. Br. Zool. iv. 131 to 133. *O. ciliaris et fragilis*, Lam. ii. p. 545.

‡ *Asterias minuta*, Penn. iv. p. 63. No. 61?

FAMILY III. CRINOIDEÆ.

1. Comatula rosacea,* *Lamarck.*

Not rare on the Manx Coast, in deep water. The *Phytocrinus Europæus* (*Pentacrinus Europæus*, J. V. Thompson), has not yet occurred on the Manx Coast, though found on the opposite shores of Ireland not unfrequently.

DESCRIPTION OF PLATES.

Plate III.—*Generic Characters of Asteriæ.*

I. Asterias.—*a,* general form—*b,* upper surface of a ray, shewing the marginal plates—*c,* a spine.

II. Goniaster.—*a,* general form—*b,* marginal plates—*c,* border of avenue, (the round dots represent the suckers)—*d,* a spine.

III. Palmipes.—*a,* general form—*b,* fasciculus of spines from dorsal surface—*c,* ditto from ventral surface—*d,* border of avenue.

IV. Asterina.—*a,* general form—*b,* surface spines—*c,* ditto magnified—*d,* border of avenue.

V. Linkia.—*a,* general form—*b,* border of avenues—*c,* surface spines and pores—*d,* a spine magnified.

VI. Solaster.—*a,* general form—*b,* surface spines of *Solaster papposa* —*c,* ditto of *Solaster endeca*—*d,* border of avenue (*Solaster papposa*) —*e,* ditto (*Solaster endeca*).

VII. Stellonia.—*a,* general form—*b* and *c,* surface spines—*d,* marginal avenue spines—*e,* border of avenue.

VIII. Luidia.—*a,* general form—*b,* surface spines—*c,* border of avenue.

Plate IV.

1. *Goniaster Templetoni*—2. the same, under surface (part of)—3. *Ophiura texturata* (upper surface)—4. ditto (under surface)—5. *Ophiura albida* (upper surface)—6. ditto (under surface). The disk only, with a small portion of the rays of these two ophiuræ is represented—7. disk and one of the rays of *Ophiocoma neglecta*—8. ditto of *Ophiocoma minuta.*

* 1. *C. rosacea,* Flem. p. 490, Link, p. 55, tab. 36, No. 66. *Comatula Mediterranea,* Lam. ii. p. 535. *Asterias bifida,* Penn. p. 65, No. 70.

METEOROLOGICAL JOURNAL

FOR THE YEAR 1838,

Kept at the Manse of the Parish of Abbey St Bathans, Berwickshire, Lat. 55° 52′ *N., Long.* 2° 23′ *W., at the Height of about* 450 *Feet above the Sea.* By the Rev. JOHN WALLACE.

JAN.	THERMOMETER. 9 A.M.	10 A.M.	3 P.M.	10 P.M.	HYGROMETER (Leslie's). 9 A.M.	10 A.M.	3 P.M.	10 P.M.	BAROMETER at 32° of Fahrenheit. 9 A.M.	10 A.M.	3 P.M.	10 P.M.	Rain in inches weekly.	Direction of Wind at 10 A.M.	REMARKS.
1	° 40½	° 40¾	° 42	° 39½	° 0	° 0	° 0	° 0	29.296	29.272	29.266	29.208		E. by S.	Gentle wind, A. M. drizzling rain, P. M. fleecy clouds on blue sky, evening rain.
2	35	36	36¼	35	0	0	0	0	29.129	29.146	29.015	29.917		SE.	Gentle wind, sky spread with heavy clouds, evening strong wind and rain.
3	38¼	39½	41	34¾	0	2	0	0	28.699	28.693	28.683	29.033		SE. by E.	Brisk wind, clear sky with a few detached clouds, evening cloudless.
4	33½	34	34	29½	0	0	0	0	29.235	29.199	29.332	29.446	.488	E. SE.	Gentle wind, sky veiled with heavy clouds, evening cloudless.
5	36¾	38	40¼	40¾	0	0	0	0	29.555	29.541	29.586	29.637		SW.	Gentle wind, cloudy and lowering.
6	37	39½	37	32	0	0	0	0	29.702	29.668	29.667	29.796		SW.	Gentle wind, cirrostratus prevalent, evening dense fog.
7	29½	32	33½	32	0	0	0	0	29.808	29.804	29.781	29.849		SE. by E.	Calm, hoar frost, sky veiled, evening light snow showers.
8	31	31	30	28¼	0	0	0	0	29.937	29.936	29.920	29.997		E.	Gentle wind, A. M. cloudy tending to snow, P. M. frequent snow showers.
9	30	29½	29¼	29	0	2	6	0	29.928	29.940	29.880	29.920		N.NE.	Gentle wind, cloudy, frequent slight snow and hail showers.
10	29½	30½	29	27¼	0	0	0	0	29.806	29.790	29.698	29.620		NE.	Gentle wind, same as yesterday.
11	29¾	31	29	30¾	0	0	0	0	29.484	29.535	29.495	29.614	.908	W.	Gentle wind, ditto.
12	28¼	28½	31	28¾	0	0	0	0	29.854	29.861	29.889	29.928		E.	Gentle wind, ditto.
13	26½	26¾	26¼	23¼	0	0	0	0	29.764	29.731	29.686	29.664		E.	Gentle wind, A. M. frequent snow showers, P. M. dense fog.
14	21½	22½	20½	9¼	0	0	0	0	29.579	29.550	29.399	29.296		NW. b.W.	Gentle wind, blue sky beautifully overspread with cirri.
15	3¾	6	20¾	24	0	0	0	0	29.217	29.264	29.216	29.290		N.	Gentle wind, sky overspread with thick haze.
16	25¾	27¼	22	10¾	0	0	0	0	29.426	29.442	29.497	29.611		W. by W.	Gentle wind, hazy clouds.
17	18¾	23¼	22¼	24¾	0	0	0	0	29.795	29.836	29.850	29.846		NW.	Gentle wind, ditto.
18	29¾	29¾	27	23	0	0	0	0	29.679	29.657	29.551	29.476	.913	E.	Gentle wind, cloudy, frequent showers of hail and snow, evening clear.
19	22¾	24	23¼	16½	0	0	0	0	29.322	29.301	29.287	29.370		NE.	Gentle wind, ditto.
20	6¼	8½	11¼	-1¾	0	0	0	0	29.367	29.373	29.342	29.369		NE. by E.	Gentle wind, hazy clouds.
21	20¾	20	25	26¾	0	0	0	0	29.241	29.205	29.048	28.996		N.NE.	Brisk wind, snow and drift.
22	30	32	34	35¼	0	0	0	0	29.006	29.030	29.064	29.184		N.NE.	Brisk wind, fog and drizzling rain.
23	34	34	32¼	31¾	0	0	0	0	29.272	29.275	29.329	29.430		NE.	Gentle wind, A. M. slight snow, P. M. frequent snow and hail showers.
24	25	25¼	25¼	23¼	0	0	0	0	29.546	29.523	29.445	29.341		NE. by E.	A. M. gentle wind, showers of snow, P. M. brisk wind, continued snow and hail.
25	24¾	25¾	25	11	0	0	0	0	29.135	29.114	29.020	28.979	.262	E.NE.	Gentle wind, sky veiled with hazy clouds.
26	26¼	29	29½	28	0	0	0	0	28.933	28.938	28.921	28.888		NE.	Gentle wind, almost continued dropping of snow.
27	30	31	32¾	29½	0	0	0	0	28.768	28.757	28.777	28.852		E.	Gentle wind, A. M. slight snow, P. M. fair, hazy clouds.
28	31	31¾	32¼	32¼	0	0	0	0	28.933	28.924	28.937	28.982		E. by N.	Brisk wind, cloudy, frequent showers of snow.
29	33	33	30¾	31	0	0	0	0	28.992	29.002	29.011	29.047		E. by E.	Brisk wind, nearly continued snow.
30	32¼	32¼	31¾	31¾	0	0	0	0	29.093	29.092	29.111	29.213	.754	N.	Brisk wind, ditto.
31	31¾	31	31½	30¾	0	0	0	0	29.351	29.347	29.402	29.528		N. by E.	Brisk wind, ditto.
Means	28.1	29.1	29.5	26.7	0	0.1	0.2	0	29.382	29.379	29.358	29.397	3.325		Means for the month, Therm. 27°.9, Hygrom. 0°.05, Bar. 29.888 in. Mean temperature of spring water 46°. Mean point of deposition 27°.7. Moisture in a cubic inch of air = .00118 grs.

FEB.	THERMOMETER. 9 A.M.	THERMOMETER. 10 A.M.	THERMOMETER. 3 P.M.	THERMOMETER. 10 P.M.	HYGROMETER (Leslie's). 9 A.M.	HYGROMETER (Leslie's). 10 A.M.	HYGROMETER (Leslie's). 3 P.M.	HYGROMETER (Leslie's). 10 P.M.	BAROMETER at 32° of Fahrenheit. 9 A.M.	BAROMETER 10 A.M.	BAROMETER 3 P.M.	BAROMETER 10 P.M.	Rain in inches weekly.	Direction of Wind at 10 A.M.	REMARKS.
1	27°	25¼°	27°	26¼°	0°	0°	0°	0°	29.643	29.655	29.667	29.769		E. by S.	Gentle wind, detached cirrocumuli on blue sky, evening sky clouded.
2	13	14	20	24¼	0	0	0	0	29.820	29.841	29.808	29.831		W.	Gentle wind, A. M. intense frost, clear sky, P. M. large fleecy clouds, evening cloudy.
3	26	27¼	29¼	23½	0	0	0	0	29.863	29.903	29.880	29.937		E.	Gentle wind, A. M. clear sky, P. M. occasionally overcast, evening cloudless.
4	31	32½	33	32	0	0	0	0	29.958	29.953	29.918	29.929	.565	W.NW.	Gentle wind, A. M. partially cloudy, P. M. light showers of snow.
5	31	33¾	36¼	33	0	0	0	0	29.879	29.839	29.760	29.708		E.	Gentle wind, A. M. blue sky with fleecy clouds, P. M. overcast.
6	33	33½	29¾	32	0	0	0	0	29.499	29.519	29.371	29.149		SE.	Gentle wind, ditto.
7	26	28	33½	32¾	0	0	0	0	28.850	28.801	28.637	28.492		SE. by E.	Gentle wind, A. M. slight snow, P. M. overcast, evening rain.
8	35¼	35½	35¼	34¾	0	0	0	0	28.258	28.263	28.217	28.255		E.	Gentle wind, dense fog and slight rain.
● 9	34½	34¼	33¼	27¼	5	10	10	0	28.262	28.287	28.376	28.528		NE.	Brisk wind, a stormy sky.
10	24	25	28	24	0	0	0	0	28.571	28.580	28.586	28.677		N.	Gentle wind, partially cloudy.
11	23½	24	26¼	23	0	0	0	0	28.817	28.811	28.837	28.967	1.130	E.	Gentle wind, ditto.
12	22	23	26	12¾	0	0	0	0	28.897	28.991	28.978	28.992		SE.	Gentle wind, sky overspread with hazy clouds, evening clear.
13	15½	18	24½	15	0	0	0	0	29.002	29.011	29.067	29.131		SE. by E.	Gentle wind, nearly cloudless, evening clear.
14	11¼	12¼	24	9	0	0	0	0	29.198	29.209	29.165	29.194		E.	Gentle wind, ditto.
15	6½	9	27¾	31	0	0	0	0	29.175	29.201	29.164	29.180		N.	Gentle wind, thick haze, evening slight snow.
16	32¼	32¼	32	29	3	3	0	0	29.150	29.181	29.211	29.256		N. by E.	Brisk wind, hazy clouds.
17	29	30¾	32¾	31¾	0	0	0	0	29.210	29.187	29.155	29.253		E.	Brisk wind, cirrostratus prevalent.
18	32¼	34	33¾	29	5	2	0	0	29.573	29.546	29.572	29.647	.024.	SE.	Gentle wind, detached fleecy clouds on a blue sky.
19	29¾	30¾	32	31¾	0	0	0	0	29.549	29.528	29.486	29.377		SE. by E.	Brisk wind, overcast.
20	25	28	32	29	0	0	0	0	29.155	29.128	29.080	29.208		S. by E.	Gentle wind, A. M. clear, P. M. cloudy, evening overcast.
21	34½	36	35	32	1	2	0	0	29.221	29.217	29.211	29.125		NW.	Gentle wind, sky veiled with thin clouds.
22	33½	35½	39	32	5	9	12	0	29.239	29.243	29.180	29.121		NE.	Gentle wind, ditto.
23	32¾	33¾	34	30½	2	6	1	0	28.978	28.969	28.890	28.779		SE. by E.	Gentle wind, blue sky, partially clouded.
○ 24	29¾	30½	29	29¾	0	0	0	0	28.589	28.543	28.398	28.261		NE. by E.	Strong wind, continued snow and drift.
25	34½	35	35	33¾	0	0	0	0	28.184	28.211	28.281	28.546	.801	N. by E.	Brisk wind, thick fog, nearly continued sleet.
26	30	29	27¾	27½	0	0	0	0	28.770	28.744	28.791	28.800		E.	Brisk wind, frequent showers of hail.
27	31	32	32	31¼	0	0	0	0	28.797	28.779	28.719	28.738		E.	Brisk wind, frequent snow and hail showers.
28	32	33½	34	32¼	0	2	0	0	28.726	28.698	28.752	28.723		NE.	Brisk wind, ditto and fog.
Means	27.4	28.4	30.8	27.8	0.7	1.2	0.8	0	29.101	29.101	29.077	29.091	2.520		Means for the month, Therm. 28°.1, Hygrom. 0°.6, Bar. 29.096 in. Mean temperature of spring water 45¾°. Mean point of deposition 27°.5. Moisture in a cubic inch of air = .00114 grs.

MARCH.	THERMOMETER. 9 A.M.	THERMOMETER. 10 A.M.	THERMOMETER. 3 P.M.	THERMOMETER. 10 P.M.	HYGROMETER (Leslie's). 9 A.M.	HYGROMETER 10 A.M.	HYGROMETER 3 P.M.	HYGROMETER 10 P.M.	BAROMETER at 32° of Fahrenheit. 9 A.M.	BAROMETER 10 A.M.	BAROMETER 3 P.M.	BAROMETER 10 P.M.	Rain in inches weekly.	Direction of Wind at 10 A. M.	REMARKS.
	°	°	°	°	°	°	°	°							
1	34	35	35¾	35	0	0	0	0	28.624	28.643	28.585	28.662		SE.	Gentle wind, dense fog, P. M. slight showers of rain.
2	35½	36	35¾	34	0	0	0	0	28.679	28.669	28.667	28.722		W.	Gentle wind, ditto.
3	33½	34¼	36½	34	0	0	0	0	28.702	28.699	28.712	28.669		NE.	Gentle wind, dense fog, tendency to rain.
4	34¾	35	36	35	0	0	0	0	28.609	28.613	28.640	28.813	.570	E. by S.	Gentle wind, ditto.
5	36	36½	37½	33½	0	0	0	0	29.093	29.137	29.188	29.046		NW.	Gentle wind, ditto.
6	35½	36½	37¼	37½	0	0	0	3	28.803	28.793	28.762	28.685		SW.	Brisk wind, blue sky partially covered with cirri, with fleecy clouds.
7	38¼	38¼	38	35	3	3	4	2	28.996	28.960	28.993	29.173		S. by W.	Brisk wind, detached cirrocumuli on a blue sky.
8	36¾	37½	40	35	3	6	14	1	29.493	29.543	29.590	29.696		W.	Gentle wind, blue sky with cirri and cirrostratus.
9	35	38¾	42	32½	17	10	12	0	29.674	29.690	29.614	29.469		E.SE.	Gentle wind, cirrostratus in different forms, evening cloudy.
10	35	36¼	38¾	35½	1	2	3	0	29.293	29.303	29.196	29.123		E. by S.	Brisk wind, A. M. hazy clouds, P. M. slight rain.
11	36¼	37	39	37	0	0	0	0	29.066	29.070	29.181	29.293	.671	SE.	Brisk wind, continued slight rain and sleet.
12	37¾	40¼	42¼	36¾	3	5	15	0	29.577	29.561	29.568	29.519		SE.	Gentle wind, A. M. fleecy clouds on blue sky, P. M. cirrostrat. general, thaw and flood.
13	41¼	43¼	46¼	40¼	0	1	7	0	29.277	29.264	29.190	29.249		NW. b. W.	Brisk wind, A. M. cirrostratus of cymoid formation, P. M. large masses of clouds.
14	43	47	47½	35½	0	0	0	0	29.265	29.195	29.069	29.087		S.	Gentle wind, fog and overcast, evening rain.
15	37½	38¾	42½	35¼	10	7	15	0	29.280	29.234	29.215	29.315		SE.	Brisk wind, A. M. partially clear, P. M. cloudy.
16	39	38	40¼	32	0	0	10	0	29.117	28.877	28.743	28.687		S.	Brisk wind, frequent sleet and snow, hazy clouds.
17	33	34¼	36¼	34	2	3	9	0	28.659	28.621	28.635	28.809		NW. by N.	Brisk wind, cloudy, hail showers.
18	29½	35¼	39¾	39½	5	10	17	0	28.977	28.952	28.949	28.999	1.562	SW.	Gentle wind, sky partially veiled with cirrocumuli.
19	38¼	40	42½	36¾	0	2	12	0	28.895	28.890	28.866	28.773		E.	Gentle wind, ditto, evening soft snow.
20	40	41½	42½	36½	0	0	0	0	28.172	28.193	27.999	28.202		E.	Brisk wind, nearly continued rain, evening strong wind and rain.
21	33½	34	32½	33½	0	0	0	0	28.555	28.545	28.714	28.816		N.	Boisterous wind, continued snow and drift.
22	32¼	33½	34	31¼	0	0	0	0	29.180	29.184	29.204	29.130		N. by W.	Strong wind, stormy clouds, frequent snow and hail.
23	32¾	34	34½	31½	0	0	0	0	29.041	29.043	29.067	29.014		E. by N.	Brisk wind, cloudy, frequent showers of snow.
24	34¼	35	37¼	32	0	0	5	0	28.855	28.875	28.830	28.875		SW.	Gentle wind, blue sky nearly veiled with large white clouds.
25	35	36¼	40¼	33	0	2	13	0	28.993	29.052	29.222	29.383	.250	NW. by N.	Gentle wind, detached clouds on a blue sky, evening clear and frosty.
26	38	40½	42	48¾	5	7	3	0	29.470	29.422	29.437	29.508		E.	Gentle wind, overcast, tendency to rain.
27	45	44¼	50	41¾	1	2	10	1	29.666	29.667	29.719	29.814		W.NW.	Gentle wind, sky overspread with cirrostratus.
28	46½	49½	56	43	5	11	23	9	29.908	29.893	29.909	29.961		W.	Gentle wind, ditto.
29	47	52	54	41	10	15	15	0	29.995	29.969	29.962	29.942		SW.	Calm, sky veiled and lowering.
30	48½	49¾	55½	43	8	12	30	10	29 815	29.751	29.665	29.701	.025	W. by N.	Gentle breeze, detached cirrocumuli on a blue sky.
31	32¾	33	32	28½	6	10	0	0	29.675	29.690	29.623	29.658		W. by N.	Brisk wind, stormy clouds, a few snow showers.
Means	37.2	38.7	40.7	36.1	2.5	3.5	7.0	1.0	29.142	29.129	29.119	29.154	3.078		Means for the month, Therm. 37°.4, Hygrom. 2°.25, Bar. 29.141 in. Mean temp. of spring water 45¾°. Mean point of deposition 31°.7. Moisture in a cubic inch of air = .00131 grs.

APRIL.	THERMOMETER.				HYGROMETER (Leslie's).				BAROMETER at 32° of Fahrenheit.				Rain in inches weekly.	Direction of Wind at 10 A. M.	REMARKS.
	9 A.M.	10 A.M.	3 P.M.	10 P.M.	9 A.M.	10 A.M.	3 P.M.	10 P.M.	9 A.M.	10 A.M.	3 P.M.	10 P.M.			
1	32°	33°	35°	30°	0°	3°	15°	0°	29.652	29.655	29.599	29.502		NW.	Gentle wind, sky veiled with stormy clouds, slight snow showers.
2	35	35¼	37	32	0	6	15	0	29.232	29.278	29.332	29.343		NW. by N.	Gentle wind, ditto.
3	37	41¾	44½	41½	5	7	4	3	29.257	29.240	29.126	29.020		SE. by S.	Gentle wind, stormy clouds.
4	45	45¼	47¼	43	4	5	3	3	29.131	29.146	29.158	29.187	1.687	W. by N.	Gentle wind, cloudy, slight showers, evening boisterous wind.
5	45½	47	49¾	40¼	0	0	0	0	29.038	29.057	28.908	28.968		W.	Strong wind, A. M. cloudy, frequent showers, P. M. cirri and cirrostratus prevalent.
6	45¼	46¼	46¼	35½	13	17	16	0	28.962	28.956	29.019	29.010		W.	Gentle wind, thin fleecy clouds on a blue sky.
7	40½	42	38	32	0	0	0	0	28.743	28.701	28.528	28.396		E.	Gentle wind, dense fog and continued rain.
8	34	34¾	32½	32	0	0	0	0	28.608	28.652	28.686	29.025		N. by E.	Strong wind, continued snow.
9	38½	39	42¾	35¾	3	3	10	0	29.207	29.210	29.249	29.221		E. by S.	Gentle wind, large masses of clouds overspreading the sky.
10	46	48¼	51	46	0	0	0	0	29.163	29.142	29.284	29.308		S.SE.	Gentle wind, A. M. partially cloudy, P. M. overcast, evening thick fog.
11	48	48¼	47	38	0	0	0	0	29.261	29.254	29.100	29.140	.660	SW.	Strong wind, A. M. hazy clouds, P. M. cloudy showers.
12	44	45	47	38	5	10	32	9	29.284	29.331	29.445	29.573		W.	Gentle wind, white fleecy clouds on a blue sky.
13	42	41½	47	41	22	24	28	0	29.564	29.560	29.414	29.343		N.NW.	Gentle wind, ditto.
14	48	47	48	41	8	12	16	0	28.275	29.299	29.237	29.064		W.	Gentle breeze, A. M. fleecy clouds, P. M. partially overcast, even. brisk wind and rain.
15	46	45¼	38	33	19	18	0	0	28.752	28.746	28.748	28.743		NW.	Strong wind, hazy clouds, frequent showers of snow and hail.
16	36	37½	38	33	5	20	17	0	28.810	28.814	28.783	28.855		NW.	Strong wind, ditto.
17	40½	42	41	32½	12	15	16	0	28.871	28.913	29.002	29.096		W. by N.	Strong wind, ditto.
18	32½	34½	35½	31	0	2	2	0	29.129	29.147	29.226	29.264	.527	N.	Strong wind, nearly continued snow.
19	34	34½	34½	34	0	0	0	0	29.240	29.228	29.217	29.269		NW.	Strong wind, ditto.
20	38½	38½	40¼	33¾	0	0	9	0	29.265	29.268	29.246	29.174		W.NW.	Gentle wind, sky partly spread with large fleecy clouds.
21	41	43	48	33	20	25	30	2	28.921	28.887	28.751	28.646		S.SE.	Gentle breeze, ditto.
22	40½	42	42¼	39¾	5	6	2	0	28.581	28.598	28.678	28.737		S.SE.	Gentle wind, overcast, a few showers.
23	40¾	40½	44¾	49¼	0	0	10	0	28.730	28.743	28.757	28.855		S.SE.	Gentle wind, dense fog, A. M rain, P. M. cloudy but fair.
24	40	41	44	38½	0	0	0	0	29.114	29.100	29.261	29.366		E. by N.	Gentle wind, fog, ditto, ditto.
25	39¼	39	43	39½	0	0	0	0	29.497	29.587	29.507	29.561		N.	Gentle breeze, A. M. fog, and tendency to rain, P. M. sky veiled.
26	41	41½	40½	39	0	3	10	0	29.715	29.715	29.689	29.665	1.125	N.NW.	Brisk wind, sky occasionally clear, evening calm.
27	41¼	41½	40¾	36	5	7	9	7	29.601	29.609	29.596	29.592		N.NW.	Brisk wind, clear sky, evening calm.
28	43½	45½	42½	35¾	13	20	5	5	29.429	29.406	29.328	29.334		NW. by W.	A. M. ditto, sky sometimes clear sometimes overcast, P. M. stormy wind, even. clear.
29	38¼	38¾	39¼	34¾	7	19	11	0	29.252	29.217	29.140	29.051		N.	Brisk wind, sky generally overcast, snow showers, evening calm.
30	36½	37½	40	34¾	0	4	12	0	28.901	28.898	28.887	28.964		N.	Gentle wind, cloudy, evening clear.
Means	39.0	41.2	42.1	36.7	5	8	9	10	29.139	29.145	29.130	29.142	3.799		Means for the month, { Ther. 38°.9 Hygr. 9°. Bar. 29.143 in. } Mean temperature of spring water 46°. Mean point of deposition 32°.8. Moisture in a cubic inch of air = .00136 grs.

MAY.	THERMOMETER. 9 A.M.	10 A.M.	3 P.M.	10 P.M.	HYGROMETER (Leslie's). 9 A.M.	1 A.M.	3 P.M.	10 P.M.	BAROMETER at 32° of Fahrenheit. 9 A.M.	10 A.M.	3 P.M.	10 P.M.	Rain in inches weekly.	Direction of Wind at 10 A.M.	REMARKS.
	°	°	°	°	°	°	°	°							
1	45½	46	47	34¾	11	26	19	0	29.057	29.062	29.028	29.095		W.SW.	Calm, cumuli on a blue sky, evening cloudless.
2	43	46	47¼	43½	3	5	0	0	29.191	29.191	29.181	29.197		SE. by E.	Calm, morning clear, day cloudy, P. M. rain.
3	56	57	55	45	2	7	15	3	29.099	29.106	29.196	29.375		SE.	Brisk wind, cumuli abundant, evening calm and cloudy.
4	50	53	51½	46½	7	8	10	0	29.500	29.513	29.541	29.638	.250	E. by S.	Calm, cloudy, sometimes overcast.
5	50	51	52½	36	15	21	33	0	29.704	29.804	29.851	29.909		NE.	Calm with clear sky, evening deposition.
6	47¼	47½	53¼	39¾	2	8	19	0	29.933	29.933	29.900	29.897		S. by E.	Calm, cirri on a clear sky, evening cirrocumuli prevalent.
7	58¾	59	66	47½	44	48	82	12	29.893	29.890	29.872	29.891		E.	Calm, cirri on a clear sky, evening cloudless.
8	67	69	71¾	56	65	63	68	36	29.851	29.845	29.789	29.767		W.	Calm, cloudless sky.
9	63	59½	48	40	32	26	0	0	29.736	29.736	29.809	29.894		NW. by N.	Gentle wind, morning clear sky, gradually overcast, occasionally foggy.
10	47	48	50	36	12	15	17	0	29.980	29.986	29.966	29.954		NE.	Calm, cumuli abundant on a blue sky, evening cloudless.
11	53½	54½	59¾	41	33	33	38	4	29.859	29.854	29.785	29.749	.312	NE.	Calm, sky nearly cloudless.
12	53	55	55	43	28	28	13	0	29.529	29.511	29.387	29.268		NW. by W.	Brisk wind, cirrostratus, rain in evening.
13	44¼	44½	39½	37½	10	14	0	0	29.195	29.171	29.196	29.213		NW.	Brisk wind, frequent showers, evening cloudy.
14	39	39	41	34	13	11	21	5	29.228	29.224	29.202	29.245		N.NW.	Gentle wind, cumuli on a blue sky.
15	39	39½	43¾	32¼	18	21	26	0	29.286	29.293	29.277	29.310		N.NW.	Do. do.
16	42	44	40¾	34	15	24	0	0	29.282	29.282	29.264	29.279		NW.	Calm morning, do. gradually overcast, occasional showers.
17	41	40	37	31¾	5	9	7	0	29.361	29.420	29.422	29.424		NE.	Calm, cumuli and cirrostratus on a blue sky, evening nearly cloudless.
18	42½	44	46	32½	19	21	21	0	29.426	29.426	29.415	29.451	1.757	E. by N.	Calm, sky nearly cloudless.
19	47	47¼	42½	35¾	18	20	10	0	29.384	29.368	29.310	29.209		E.	Calm, A. M. sky gradually overspread with cirrostratus, P. M. wind and rain.
20	45½	46½	46	43½	0	0	0	0	29.084	29.084	29.051	29.043		SE.	Brisk wind, A. M. overcast, P. M. rain, evening fair.
21	47	48	50	45½	0	0	0	0	28.968	28.960	28.938	29.015		SE.	Calm, A. M. fog and rain, P. M. overcast.
22	48½	48½	44¾	42¾	0	0	0	0	29.015	29.015	28.976	29.007		SE.	Calm, fog, and almost incessant rain.
23	43	43	42¼	41¾	0	0	0	0	29.195	29.217	29.315	29.416		NW.	Gentle wind, with fog and rain.
24	45	48¼	48¾	42½	0	2	2	0	29.548	29.565	29.600	29.638		NE.	Calm, cloudy or overcast, evening foggy.
25	49¼	50	52	42¾	7	7	19	0	29.641	29.641	29.648	29.673		E.	Gentle breeze, cirri prevalent, evening cloudy.
26	53½	55¼	55	40	21	24	24	0	29.703	29.703	29.719	29.606		E.	Calm, cirri on a blue sky.
27	50½	52½	49¾	44	15	19	7	0	29.636	29.618	29.575	29.453	1.312	NE.	Brisk wind, A. M. cloudy, P. M. overcast.
28	50½	51¾	53	44¾	0	22	5	0	29.362	29.343	29.302	29.266		E.	Brisk wind, cirri and cirrostratus prevalent on a blue sky, evening calm.
29	50	51	47¾	44¼	0	2	0	0	29.131	29.127	29.124	29.150		E.	Calm, A. M. overcast, P. M. foggy.
30	47¼	48¼	51½	43	0	3	12	0	29.260	29.275	29.295	29.334		E.	Calm, cumuli abundant on a blue sky.
31	49¾	51½	49	43¾	14	16	15	0	29.395	29.398	29.424	29.476		E.SE.	Calm, and cloudy or overcast.
Means	48.7	49.6	49.6	40.8	13	16	16	2	29.433	29.437	29.431	29.447	3.631		Means for the month: Therm. 45°.2, Hygrom. 9°, Bar. 29.442 in. — Mean temperature of spring water 46°. Mean point of deposition 40°.5. Moisture in a cubic inch of air = .00178 grs.

JUNE.	THERMOMETER.				HYGROMETER (Leslie's).				BAROMETER at 32° of Fahrenheit.				Rain in inches weekly.	Direction of Wind at 10 A. M.	REMARKS.
	9 A.M.	10 A.M.	3 P.M.	10 P.M.	9 A.M.	10 A.M.	3 P.M.	10 P.M.	9 A.M.	10 A.M.	3 P.M.	10 P.M.			
1	42°	41°	41°	42°	0°	0°	0°	0°	29.505	29.501	29.451	29.369		E. by N.	Calm, overcast, occasionally rain, in the evening brisk wind.
2	50¾	51½	54	47¾	0	0	7	0	29.226	29.228	29.181	29.172		SW.	Calm, overcast, frequent heavy showers.
3	54	55¼	54	48½	12	18	5	4	29.138	29.134	29.109	29.112		SW.	Calm, frequent heavy showers with thunder, evening clear.
4	58	58½	60½	51¼	22	22	25	5	29.095	29.092	29.100	29.184	1.314	SE.	Calm, thunder frequently heard, occasional showers.
5	53¼	54	53	46¼	10	12	16	7	29.322	29.343	29.392	29.487		NW. by N	Calm, overcast, occasionally lowering.
6	53	53¼	50	44	26	27	20	9	29.560	29.562	29.576	29.592		NW. by W	Calm, cumuli abundant.
7	48	49	46	41¼	27	28	10	12	29.617	29.604	29.622	29.685		NW. by W.	Calm, cloudy, P. M. occasional showers.
8	46	47	52	41	20	22	22	3	29.755	29.760	29.713	29.680		NW. by W.	Calm, cumuli abundant, evening clear, copious deposition.
9	55¾	57¼	54	49	29	33	26	8	29.553	29.535	29.455	29.308		SW.	Gentle wind, cloudy or overcast.
10	51½	52½	54	49	5	5	9	0	29.123	29.106	29.058	29.074		SE.	Brisk wind, A. M. overcast, P. M. rain.
11	57½	61½	54¼	46¾	14	20	8	2	29.131	29.133	29.126	29.208	1.037	E.	Gentle wind, A. M. cloudy, P. M. foggy with some rain.
12	53¾	53	53	46¾	19	16	12	0	29.300	29.316	29.342	29.342		NE.	Brisk wind, clear sky, P. M. cirrostratus prevalent, wind falling.
13	50	53½	53¼	46¾	5	10	22	2	29.342	29.326	29.315	29.260		NE.	A. M. calm and cloudy, P. M. brisk wind, cirrostratus prevalent.
14	46	46	48	50	0	0	0	0	29.103	29.087	29.068	29.096		NE.	Brisk wind, A. M. rain and fog, P. M. overcast.
15	58	57½	61½	52½	25	22	29	0	29.092	29.092	29.067	29.044		SW.	Calm, cloudy, P. M. slight showers.
16	59	60	63½	54¾	14	15	28	0	29 148	29.154	29.184	29.204		SW.	Calm, cloudy, P. M. slight showers.
17	63	63½	63	55	21	21	14	0	29.217	29.228	29.257	29.279		SW.	Calm, cloudy, occasional showers, evening cloudless, deposition.
18	51	52	53¼	51	0	0	0	0	29.209	29.201	29.181	28.978	0.896	E.	Calm, thick fog, with drizzle.
19	54½	52½	54	52¼	1	1	6	12	28.807	28.810	28.884	29.050		W.	Brisk wind, frequent showers.
20	57¼	58¼	59½	54½	21	26	24	0	29.057	29.047	28.949	28.714		W.	Brisk wind, cloudy, P. M. heavy rain.
21	54¼	56	60	48	27	32	29	3	28.742	28.747	28.728	28.820		W.	Brisk wind, cumuli on a blue sky, evening calm.
22	56	56	56½	51	22	24	16	9	28.947	28.960	29.000	29.230		SW. by W.	Brisk wind, frequent showers, evening nearly cloudless.
23	57¼	58½	63½	53½	28	36	27	13	29.476	29.485	29.490	29.486		SW. by W.	Brisk wind, frequently cloudy, evening calm.
24	63½	64½	63½	54¼	24	27	26	7	29.383	29.372	29 345	29.391		SW. by W.	Gentle wind, P. M. lowering, with tendency to rain.
25	58½	59¼	60	53	19	25	23	0	29.492	29.503	29.535	29.540		W.NW.	Calm, overcast and lowering
26	61¾	62¾	61½	52½	14	16	18	0	29.481	29.467	29.401	29.370	1.380	E.	Calm, A. M. overcast, P. M. gradually clearing.
27	58¼	60	63¾	51	8	9	31	0	29.352	29.354	29.354	29.363		SW.	Calm, cloudy, with tendency to rain.
28	54¼	58	56	48¼	24	27	26	0	29.413	29.419	29.421	29.447		SW.	Calm, A. M. cumuli on a blue sky, P. M. overcast and showery.
29	55¼	53¾	50¼	47½	8	0	0	0	29.496	29.493	29 476	29.347		NE.	Calm, overcast, occasional showers, in the evening strong wind, rain
30	56½	59¼	61¾	51¾	10	13	25	0	29.293	29.308	29.360	29.402		SW.	Brisk wind, cirrostratus prevalent, evening calm and cloudy.
Means	54.6	55.5	55.9	49.3	15	17	17	3	29.279	29.279	29.271	29.274	4.627		Means for the month, { Therm. 52°.4, Hygrom. 10°, Bar. 29.276 in. } Mean temperature of spring water 46°. Mean point of deposition 48°.4. Moisture in a cubic inch of air = .00228 grs.

JULY.	THERMOMETER. 9 A.M.	10 A.M.	3 P.M.	10 P.M.	HYGROMETER (Leslie's). 9 A.M.	10 A.M.	3 P.M.	10 P.M.	BAROMETER at 32° of Fahrenheit. 9 A.M.	10 A.M.	3 P.M.	10 P.M.	Rain in inches weekly.	Direction of Wind at 10 A. M.	REMARKS.
	°	°	°	°	°	°	°	°							
1	55	57¼	56	49¾	3	6	6	0	29.472	29.480	29.508	29.616		E.	Gentle wind, hazy clouds prevalent, with occasional fog.
2	50¾	50¾	53	52½	0	0	0	0	29.615	29.615	29.578	29.600		NE.	Gentle wind, thick fog, and drizzle.
3	62½	64¾	65¼	52¼	14	16	27	0	29.597	29.604	29.604	29.621		E.	Calm, cumuli and cirrocumuli on a blue sky, evening cloudless.
4	64	66	66¾	54½	23	32	45	15	29.626	29.645	29.711	29.615	0.437	E.	Gentle wind, P. M. cirrostratus and cirrocumuli prevalent, evening calm.
5	65	67	70	60¾	32	33	39	0	29.569	29.568	29.554	29.448		SE.	Gentle wind, A. M. nearly cloudless, P. M. thunderous sky, in the evening some rain.
6	68½	69½	64¾	56½	25	26	12	0	29.458	29.444	29.356	29.259		SE.	Brisk wind, A. M. cumuli prevalent, P. M. frequent heavy rain, evening calm.
● 7	59¼	60	59	52¾	20	24	24	0	29.177	29.058	29.201	29.217		SW.	Brisk wind, cumuli prevalent, occasional showers, evening overcast.
8	59¾	62	65½	56	17	21	36	11	29.220	29.235	29.309	29.401		W.	Brisk wind, cirrostratus prevalent, P. M. solar halo, evening calm.
9	62½	63	65¼	57	12	13	15	3	29.374	29.379	29.379	29.381		SW. by W.	Strong wind, light clouds driving over a blue sky, upper stratum calm.
10	59	60¾	61	56¼	8	12	12	5	29.349	29.341	29.328	29.356		SW. by W.	Very strong wind, overcast, occasional showers.
11	64	62½	64½	58½	12	7	5	4	29.389	29 375	29.346	29.306	0.187	SW.	A. M. brisk wind, cloudy, occasional showers, P. M. cirrost. prevalent, evening calm.
12	62½	63¼	63	57½	10	12	17	5	29.298	29.298	29.341	29.377		SW. by W.	Gentle wind, cloudy, or overcast.
13	62	62¼	63	58	10	12	19	2	29.334	29.326	29.278	29.176		SW.	Calm, cloudy or overcast, occasional showers.
14	60	59	57	55	17	15	17	5	28.975	28.988	28.876	28.697		SW.	Calm below, brisk wind above, cloudy and showery.
15	58	58½	56	51½	24	19	27	5	28.783	28.809	28.916	29.088		SW.	Strong wind, cumuli prevalent, evening calm.
16	60	61¼	63¼	49¾	22	26	36	6	29.201	29.213	29.335	29.510		W.	Strong wing, cumuli prevalent, evening calm.
17	58¾	58	53	50¾	25	20	4	0	29.516	29.519	29.470	29.426		SW. by W	Calm, overcast, P. M. frequent showers.
18	56	57½	60¾	51½	21	26	22	0	29.589	29.578	29.555	29.636	0.125	SW. by W	Calm, A M. cumuli prevalent, P. M. overcast, evening tending to rain.
19	55¼	57	60½	53½	4	7	17	10	29.445	29.404	29 293	29.312		SSW.	A. M. strong wind, slight showers, P. M. cirri and cirrostratus prevalent, evening calm.
20	56¼	57	60	50¾	28	33	37	11	29.295	29.303	29.318	29.327		W.	Strong wind, cumuli on a blue sky, evening cloudy.
21	54½	52½	54½	47¾	25	19	23	12	29.575	29.588	29.606	29.653		N.	Brisk wind, cloudy, slight showers.
⊙ 22	50	53½	55	46¼	18	22	27	4	29.664	29.676	29.671	29 659		NW.	Calm, cumuli prevalent, evening cloudy.
23	54¾	56	53	40½	24	27	17	2	29.567	29.542	29.481	29.488		NW.	Calm, cloudy, tendency to rain, in the evening copious deposition.
24	50	51	53	45	21	22	23	0	29.488	29.488	29.488	29.475		NW.	Calm, cloudy, with occasional sunshine.
25	51½	52½	55¼	43½	21	27	31	0	29.457	29.457	29.447	29.416		NW.	Calm, cloudy, with occasional sunshine.
26	55	56¾	54	50	18	21	0	0	29.239	29.274	29.100	29.089	0.500	W.	A. M. gentle wind, cloudy, P. M. rain.
27	55	57	60	51	20	26	30	11	29.110	29.110	29.096	29.104		NW. by W	Brisk wind, cumuli on a fine blue sky.
28	55¾	58¾	55¾	45	18	22	8	0	29.080	29.069	29.045	29.022		W.	Calm, A. M. lowering, P. M. heavy rain, evening partially clear, deposition.
29	55	54½	56	44¾	8	12	22	0	28.991	28.977	28.977	28.992		W.	Very calm, cumuli in large masses on a blue sky, in the evening copious deposition.
30	54	55	56½	51¾	14	10	19	16	29.060	29 072	29.092	29.103		N.	Very calm, cumuli in large masses, slight showers.
31	55	56	61¾	50¾	9	13	27	9	29.140	29.156	29.223	29.322		NW. by W.	Brisk wind, cloudy, slight showers, P. M. gradually clearing, evening cloudless.
Mean.	57.7	5 .7	59.4	1.7	17	19	21	4	29.344	29.342	29.338	29.345	1.249		Means for the month, { Therm. 55°2, Hygrom. 12°, Bar. 29.343 in. } Mean temperature of spring water 46°. Mean point of deposition 47°.4. Moisture in a cubic inch of air = .0022 grs.

AUGUST.	THERMOMETER.				HYGROMETER (Leslie.)				BAROMETER at 32° of Fahrenheit.				Rain in inches weekly.	Direction of Wind at 10 A. M.	REMARKS.
	9 A.M.	10 A.M.	3 P.M.	10 P.M.	9 A.M.	10 P.M.	3 P.M.	10 P.M.	9 A.M.	10 A.M.	3 P.M.	10 P.M.			
1	°56¼	°56¼	°56½	°51¼	°18	°16	°15	°0	29.430	29.431	29.416	29.301		E.	Gentle wind, cloudy, P. M. sky thinly veiled with cirrostratus, solar halo.
2	59¼	61	61¼	56¼	0	4	0	0	29.051	29.020	28.950	28.886		SW.	Calm, A. M. very soft, P. M. heavy rain.
3	59¼	58¾	62¼	54¾	11	10	21	3	28.917	28.921	28.980	29.022		SW.	Brisk wind, A. M. cloudy, P. M. cumuli and cirrostratus on a blue sky.
4	62	63½	64¾	57	3	7	20	3	28.912	28.900	28.873	28.820	1.510	S.	Gentle wind, cloudy, evening overcast
5	60	60	56	52½	25	23	4	0	28.841	28.847	28.813	28.737		SW.	Gentle wind, A. M. clear, P. M. cloudy, with frequent heavy showers.
6	60	58½	59½	54	15	9	8	1	28.704	28.702	28.719	28.823		SE.	Calm, A. M. some peals of thunder, frequent very heavy showers.
7	57½	56½	53	57	14	9	3	0	29.032	29.057	29.185	29.30		N.NE.	Calm, overcast, frequent heavy showers.
8	52	52	57¾	47¼	12	17	27	0	29.457	29.461	29.504	29.579		N.NE.	Calm, cloudy or overcast.
9	50	50¾	60	58	0	0	0	1	29.418	29.388	29.273	29.275		SE.	Brisk wind, constant rain till 2 P. M., overcast but fair afterwards.
10	59	60	60	55¾	18	19	25	0	29.236	29.237	29.257	29.202		NW.	Calm, cloudy, in the evening rain.
11	64	65	63	55	18	27	15	4	29.189	29.203	29.274	29.310	0 370	W.	Brisk wind, A. M. cumuli on a blue sky, P. M. cirrost. prevalent, even. calm and clear.
12	59	62	61½	53¼	16	16	12	5	29.359	29.359	29.361	29.370		W.	Brisk wind, cirrostratus prevalent, evening calm and overcast.
13	56	58	59½	49¼	24	27	17	6	29.317	29.317	29.410	29.528		W.	Very brisk wind, cumuli on a blue sky, evening cloudless.
14	54¼	56	59	49	12	13	28	6	29.551	29.551	29.522	29.511		NW.byW.	Brisk wind, cirrostratus abundant on a blue sky.
15	50¼	51¼	51	42¾	21	22	24	0	29.619	29.619	29.704	29.593		NW.	Calm, cumuli on a blue sky, in the evening copious deposition.
16	52	49	54¾	44¾	12	3	28	1	29.514	29.514	29.526	29.580		E.	Calm, A. M. lowering and tending to rain, P. M. cumuli and cirrostratus on a blue sky.
17	53¾	54½	56¾	45	14	14	11	0	29.633	29.627	29.623	29.638		NE.	Calm, cumuli and cirri on a blue sky, evening cloudless.
18	58¼	60¾	61½	53½	17	17	12	0	29.611	29.595	29.540	29.427	0.170	NW.	Calm, A. M. lowering, P. M. cirrocumulus overspreading the sky, evening overcast.
19	58	57½	60	48¼	0	0	15	0	29.175	29.157	29.081	29.047		W.	Brisk wind, A. M. rain, P. M. sunshine with passing clouds, evening calm.
20	56	59¼	59	53	8	12	17	0	28.970	28.986	28.843	28.589		SW.	Brisk wind, cloudy or overcast, occasional slight showers.
21	58¼	59¾	57	49¼	12	17	17	0	28.485	28.463	28.416	28.400		SE.	Brisk wind, A. M. frequent heavy showers, P. M. sunshine, in the evening rain.
22	56	55½	55	50	5	7	16	0	28.322	28.330	28.454	28.641		E. by S.	Gentle wind, heavy clouds, with frequent showers, in the evening the wind rising.
23	51	54½	55	49¾	2	4	12	12	28.928	28.961	29.112	29.274		NW.	Strong wind, A. M. heavy clouds, occas. showers, P. M. gradually clearing, even. calm.
24	50	50¼	52½	46¼	19	26	25	1	29.428	29.440	29.458	29.531		NW.	Gentle wind, cloudy or overcast, evening calm.
25	54	54¾	55¾	52¼	14	15	19	4	29.456	29.456	29.364	29.370		SW. by S.	Calm, overcast and gloomy.
26	56¾	57½	58¼	55½	14	15	22	11	29.373	29.365	29.363	29.356		W. by N.	Gentle wind, cirrost. prevalent, light clouds floating below, in the evening wind rising.
27	58¾	61½	65	58¼	22	22	17	4	29.396	29.396	29.396	29.444	0.141	W. by N.	Gentle wind, cirrostratus and cirrus prevalent, evening calm.
28	63	63¾	58½	55	5	6	0	0	29.328	29.304	29.210	29.124		SW.	Gentle wind, cloudy or overcast, P. M. rain.
29	48	50	51	41¾	26	27	22	2	29.445	29.454	29.511	29.588		SE.	Strong gale, cumuli on a blue sky, evening calm and clear, with copious deposition.
30	49¾	52	60	52	18	21	12	3	29.546	29.540	29.528	29.561		NW.	Gentle wind, cumuli on a blue sky, evening calm and cloudy.
31	55	58	60	54¼	10	14	13	0	29.500	29.500	29.447	29.426		SW.	Gentle wind, cloudy or overcast, evening calm.
Means	56	57	58.2	51.7	13	14	12	2	29.230	29.229	29.230	29.234	2.191		Means for the month, Therm. 54°.3, Hygrom. 8°, Bar. 29.232 in. — Mean temperature of spring water 46°. Mean point of deposition 51½°. Moisture in a cubic inch of air = 00251 grs.

SEPT.	Thermometer 9 A.M.	Thermometer 10 A.M.	Thermometer 3 P.M.	Thermometer 10 P.M.	Hygrometer (Leslie's) 9 A.M.	Hygrometer 10 A.M.	Hygrometer 3 P.M.	Hygrometer 10 P.M.	Barometer at 32° of Fahrenheit 9 A.M.	Barometer 10 A.M.	Barometer 3 P.M.	Barometer 10 P.M.	Rain in inches weekly.
	°	°	°	°	°	°	°	°					
1	56¼	57½	60¼	47½	26	32	38	3	29.398	29.398	29.416	29.460	
2	54	56	54	47½	19	24	17	18	29.430	29.435	29.454	29.519	
3	53¾	55½	56¾	49¾	17	26	28	0	29.519	29.501	29.470	29.450	
4	52¾	54	53	50½	0	0	0	0	29.374	29.362	29.312	29.272	3.750
5	52½	53	50¾	50	0	0	0	0	29.086	29.065	28.951	28.866	
6	52	52½	52¾	46¼	0	0	0	0	28.740	28.722	28.639	28.710	
7	45½	45½	47¾	44½	5	4	12	8	28.841	28.858	28.954	29.088	
8	46½	47¼	50	42	14	21	20	7	29.244	29.256	29.343	29.455	
9	44¾	46¾	48½	36¾	13	17	16	0	29.613	29.649	29.685	29.772	
10	49	51½	51½	38¾	14	17	17	0	29.859	29.859	29.875	29.931	
11	53	56¼	57¼	50	6	8	9	2	29.908	29.897	29.837	29.795	0.187
12	56¾	57¼	55	53¼	8	8	0	0	29.742	29.742	29.728	29.735	
13	57¼	56½	57¾	55	0	0	2	2	29.619	29.624	29.604	29.491	
14	56½	57¾	58¾	53½	3	6	12	2	29.468	29.465	29.429	29.477	
15	56¼	57½	65	56¼	3	5	19	0	29.505	29.520	29.502	29.538	
16	61¾	63½	61½	52	5	8	26	0	29.522	29.522	29.517	29.576	
17	52¼	53½	52¼	47	9	12	12	7	29.662	29.664	29.655	29.669	
18	48	49½	48½	45¼	2	6	9	7	29.605	29.602	29.530	29.515	0.406
19	48	50¾	55	50½	7	13	9	0	29.403	29.387	29.282	29.175	
20	51¾	52½	54½	41	11	14	18	0	29.165	29.157	29.182	29.215	
21	49¾	52½	52	38½	7	13	9	0	29.298	29.307	29.321	29.377	
22	48	52½	53	52	7	10	14	5	29.335	29.295	29.240	29.189	
23	55¼	57¼	55½	47¼	9	12	0	0	29.144	29.158	29.182	29.225	
24	50¾	53¼	55	47½	7	10	8	0	29.332	29.329	29.326	29.361	
25	50	50	48¾	48¼	0	0	4	0	29.375	29.405	29.431	29.448	
26	53¼	56	57½	50½	0	0	12	0	29.393	29.378	29.394	29.441	0.562
27	52½	55	55¾	43¾	10	12	11	0	29.425	29.419	29.356	29.357	
28	57¾	59	62½	53¾	10	12	15	0	29.421	29.431	29.476	29.526	
29	56	58¼	59	48½	0	0	0	0	29.506	29.500	29.466	29.538	
30	56	57¼	56¼	51	2	5	12	0	29.668	29.689	29.733	29.842	
Means	52.6	54.2	54.8	47.9	7	10	12	2	29.420	29.420	29.410	29.434	4.906

SEPT.	Direction of Wind at 10 A. M.	REMARKS.
1	W.	Gentle wind, cirrus and cumulus on a blue sky, evening cloudless.
2	W.	Gentle wind, sky for the most part clear, evening cloudless.
3	W. by N.	Gentle wind, A. M. sunshine, P. M. gradually overcast, in the evening rain.
4	SW.	Calm, constant rain until 4 P. M., evening overcast.
5	E.	Strong wind, fog and rain, in the evening the clouds breaking up.
6	NE.	Brisk wind, fog and rain.
7	NW. by N.	Brisk wind, overcast, frequent showers.
8	NW. by N.	Brisk wind, heavy masses of cloud on a clear blue sky, evening calm.
9	W. by N.	Gentle wind, cumulus and cirrus prevalent, even. calm, sky overspread with cirrocumul.
10	SE.	Calm, A. M. heavy masses of cloud forming, P. M. clearing, evening cloudless.
11	SW.	Calm, cirrostratus prevalent, evening cloudless.
12	W. by S.	Gentle wind, A. M. overcast, P. M. rain.
13	SW.	Gentle wind, A. M. light rain, P. M. overcast.
14	SW.	Calm, A. M. cumuli on a blue sky, P. M. overcast, evening tending to rain.
15	SW. by W.	Calm, cumuli on a blue sky, evening cloudy.
16	SW.	Calm, occasional sunshine, but frequently cloudy.
17	E.	Calm, cumuli on a blue sky, evening cloudy.
18	SE.	Calm, overcast and lowering.
19	E. by S.	Calm, A. M. cumuli on a blue sky, P. M. cloudy, in the evening rain.
20	W. by N.	Gentle wind, large masses of cumulus, P. M. showery, evening cloudless.
21	W.SW.	Calm, large masses of cumulus, evening cloudless.
22	S.	Gentle wind, A. M. cirri with light clouds below, P. M. overcast, tendency to rain.
23	S.	Brisk wind, cloudy, P. M. frequent showers.
24	S. by W.	Calm, overcast, evening lowering.
25	N.	Calm, A. M. occasional rain, P. M. constant rain.
26	SE.	Calm, A. M. fog and rain, P. M. occasional sunshine, evening overcast.
27	S.	Calm, A. M. fog, P. M. hazy clouds floating, evening clear.
28	W. by N.	Calm, cirri and cumuli prevalent, evening cloudy.
29	SE.	Calm, cirrostratus prevalent, sunshine through haze, evening cloudy.
30	W. by N.	Gentle wind, cloudy but occasional sunshine, evening calm.
Means		Means for the month, Therm. 51°, Hygrom. 6°, Bar. 29.427 in. Mean temperature of spring water 46°. Mean point of deposition 48½°. Moisture in a cubic inch of air = .00231 grs.

OCT.	THERMOMETER.				HYGROMETER (Leslie's).				BAROMETER at 32° of Fahrenheit.				Rain in inches weekly.	Direction of Wind at 10 A. M.	REMARKS.
	9 A.M.	10 A.M.	3 P.M.	10 P.M.	9 A.M.	10 A.M.	3 P.M.	10 P.M.	9 A.M.	10 A.M.	3 P.M.	10 P.M.			
	°	°	°	°	°	°	°	°							
1	50½	51	51¼	47¾	10	13	14	3	29.961	29.975	29.976	30.001		N.	Gentle wind, cumuli on a blue sky.
2	48¾	48	48¼	45½	0	0	0	4	30.067	30.067	30.084	30.094		NE.	Gentle wind, A. M. tending to rain, P. M. cloudy.
3	48	48¾	48½	34½	12	13	12	0	30.118	30.118	30.066	30.014		N. by E.	Gentle wind, cumuli prevalent, evening calm and clear.
4	41½	48¾	56¼	33½	4	15	27	0	29.957	29.943	29.903	29.917	0.000	W.	Calm, nearly cloudless, evening clear.
5	39¼	46¼	48¼	34½	0	2	18	0	29.911	29.900	29.903	29.907		E.	Calm, nearly cloudless, evening clear.
6	46½	53	55½	49¼	5	17	23	9	29 893	29.891	29.906	29.931		NE.	Calm, A. M. cloudless, P. M. cloudy, evening overcast.
7	50	51½	50½	46	7	13	18	2	29.895	29.887	29.842	29.849		W.	Calm, overcast, often lowering, evening clear.
8	49	51	53	46	15	17	15	0	29.901	29.904	29.872	29.863		NW.	Calm, A. M. sunshine, P. M. cloudy.
9	48½	51	52½	49½	11	16	10	3	29.800	29.794	29.744	29.677		NW.by W.	Calm, A. M. sunshine, P. M. cloudy, evening overcast.
10	51	53	54¼	46	18	14	13	0	29.523	29.524	29.437	29.432		W. by N.	Brisk wind, cumuli on a blue sky, evening cloudy.
11	48	49¾	50½	41½	12	13	19	17	29·143	29.046	28.600	28.808	0.156	SW. by W.	Strong boisterous wind, A. M. cloudy and tending to rain, P. M. nearly cloudless.
12	37½	38½	37	32½	18	21	13	9	29.024	29.042	29.098	29.126		W.N W.	Strong wind, troubled sky, P. M. heavy hail showers, evening calm and clear.
13	35	36¼	40	34½	11	15	29	4	29.256	29.286	29.323	29.230		N.	Brisk wind, disturbed sky, evening overcast.
14	40	40½	49¼	45	0	0	10	15	29.012	28.914	28.619	28.604		S.	Strong wind, A. M. rain, P. M. clearing, evening cloudless.
15	48	49¾	53½	47	11	9	15	0	28.781	28.756	28.666	28.680		W.	Brisk wind, sunshine, with occasional showers.
16	54½	55¼	55½	48¼	3	0	4	11	28.665	28.661	28.478	28.340		W.	Brisk wind, frequent showers.
17	46¾	46¼	45¾	37½	7	12	14	12	28.438	28.479	28.588	29.012		NW by W.	Brisk wind, occasionally boisterous, frequent showers.
18	36¾	38¾	47¾	46½	2	2	2	10	29.218	29.187	28.837	28.792	0.718	SW.	Strong wind, troubled sky, frequent showers, evening cloudless.
19	45½	47	45¾	44¾	12	14	9	7	29.167	29.216	29.357	29.237		W.	Brisk wind, sunshine, evening cloudy and tending to rain.
20	51	51¾	52	47¼	18	22	19	15	29.243	29.240	29 306	29.486		W.	Strong wind rising in sudden gusts, nearly cloudless.
21	48¾	52½	57¾	50	0	0	16	0	29.560	29.560	29.545	29.553		SW. by W.	Calm, fine, cirri prevalent on a blue sky, evening overcast.
22	54¾	55½	55	54	2	6	8	0	29.407	29.381	29.345	29.372		S. by W.	Strong wind, soft clouds obscuring the sky.
23	56	57¾	57¼	52	5	8	9	0	29.234	29.209	29.113	29.018		S.	Calm, sky overspread with soft clouds, in the evening rain.
24	50	50¾	52½	44½	3	7	9	4	29.019	29.019	29.094	29.327		SW.	Gentle wind, A. M. cloudy, P. M. clearing, even. calm & cloudy, with copious deposition.
25	43¼	45	48½	48¼	2	4	9	0	29.434	29.407	29.205	29.014		SE.	Brisk wind, cloudy or overcast, in the evening rain.
26	51	51¼	48½	39¾	3	15	14	7	28.834	28.873	29.038	29.204	0.175	W.	Brisk wind, light clouds floating over a blue sky, evening calm and cloudy.
27	46½	46¾	48¼	42¼	2	2	0	0	28.942	28.906	28.752	28.817		SE.	Strong wind, A. M. rain, P. M. overcast, evening calm and clearing.
28	39¾	41½	43	36½	5	7	11	3	28.926	28.904	28.915	28.804		SW.	Gentle wind, sunshine, floating cumuli, in the evening sky veiled with cirrostratus.
29	39½	40¼	43¾		0	5	12		28.613	28.631	28.631			NW.	
30															No further observations taken this month.
31															
Means	46.4	48.2	50.0	43.7	7	10	13	5	29.343	29.335	29.281	29.325	1.049		Means for the month, Therm. 46°, Hygrom. 7°, Bar. 29.330 in. Mean temperature of spring water 46°. Mean point of deposition 42°.5. Moisture in a cubic inch of air = .00189 grs.

NOV.	THERMOMETER. 9 A.M.	10 A.M.	3 P.M.	10 P.M.	HYGROMETER (Leslie's). 9 A.M.	10 A.M.	3 P.M.	10 P.M.	BAROMETER at 32° of Fahrenheit. 9 A.M.	10 A.M.	3 P.M.	10 P.M.	Rain in inches for the month.	Direction of Wind at 10 A. M.	REMARKS.
24	38½°	39°	38¾°	34½°	10°	17°	19°	0°	29.320	29.347	29.380	29.477		E.NE.	Brisk wind, overcast, evening calm and tending to rain.
25	30¼	32½	35½	34	0	0	0	4	29.552	29.562	29.541	29.475		W.	Calm, occasional sunshine, slight snow showers, evening overcast.
26	34½	35	32	26¾	10	9	8	5	29.405	29.408	29.360	29.296		SE. by E.	Brisk wind, sky nearly cloudless, evening calm.
27	30¼	31¼	35	37½	0	5	9	0	29.000	28.969	28.820	28.740		SE. by E.	Brisk wind, sky overspread with cirrostratus, in the evening rain.
28	38¾	39	41¼	43¼	0	0	0	0	28.491	28.425	28.129	27.778		SE. by E.	Brisk wind, foggy, P. M. boisterous wind with rain.
29	43	43¾	44¾	44½	0	0	0	4	27.648	27.640	27.602	27.666		S.	Strong wind, rain.
30	46¼	46¼	45	44	9	9	7	7	27.851	27.912	28.114	28.387		W.	Strong wind, fine blue sky, cumuli.
Means	37.4	38.1	38.9	37.8	4	6	6	3	28.752	28.752	28.706	28.688	5.031		Means for the week, { Therm. 38° Hygrom. 4° Bar. 28.720 in. } Mean temperature of spring water 46°. Mean point of deposition 35½°. Moisture in a cubic inch of air = .00147 grs.

N.B.—Circumstances prevented any observations being taken from October 29. until November 24. The quantity of rain, however, which fell during that time was about 5.031 inches.—J. W.

DEC.	THERMOMETER. 9 A.M.	10 A.M.	3 P.M.	10 P.M.	HYGROMETER (Leslie's). 9 A.M.	10 A.M.	3 P.M.	10 P.M.	BAROMETER at 32° of Fahrenheit. 9 A.M.	10 A.M.	3 P.M.	10 P.M.	Rain in inches weekly.	Direction of Wind at 10 A. M.	REMARKS.
● 1	42½°	42½°	44½°	47¾°	3°	3°	4°	0	28.735	28.747	28.666	28.386		W.	Calm, A. M. overcast and lowering, P. M. rain, wind rising.
2	44	46¼	44	44	3	4	0	0	28.477	28.460	28.478	28.512		SW.	Strong and boisterous wind, troubled sky, with frequent showers.
3	42¾	44	42¾	40½	0	0	3	0	28.536	28.559	28.537	28.601		SW. by S.	Brisk wind, occasional showers, evening calm and cloudy.
4	37¾	40	39½	39¾	2	5	2	0	28.803	28.825	28.852	28.955	0.562	SW.	Brisk wind, sunshine, with occasional cloudiness.
5	42¾	43	42¾	34¼	6	7	6	0	29.266	29.322	29.461	29.565		NW. by W.	A. M. brisk wind, cirri and cirrostratus prevalent, evening calm and clear.
6	37	38¾	43½	45	0	0	0	7	29.579	29.573	29.472	29.492		SW.	Brisk wind, overcast, with occasional showers.
7	40	40¾	42	35½	7	7	6	7	29.668	29.677	29.721	29.832		W.NW.	Gentle wind, P. M. for some time cloudy, evening calm and clear.
8	37¼	38¼	38½	37½	3	4	4	1	29.903	29.916	29.918	29.882		W.NW.	Gentle wind, sky veiled with cirrostratus (cynoid formation), even. calm and overcast.
9	40¼	41½	40¼	39¼	7	8	7	6	29.831	29.823	29.748	29.706		W.	Gentle wind, A. M. sunshine, P. M. cloudy (cirrocumulus), even. calm and overcast.
10	42¾	44	45¼	35	3	4	2	7	29.534	29.516	29.528	29.670		W.NW.	Gentle wind, cloudy with occasional sunshine, evening calm and clear.
11	31½	32¾	33¾	38¼	0	2	2	0	29.770	29.796	29.733	29.726	0.118	W. by S.	Calm, sunshine, P. M. sky gradually veiled with cirrostratus, evening overcast.
12	42¾	43¾	43¾	40¼	0	0	0	0	29.639	29.650	29.611	29.611		W. by S.	Calm, cloudy overcast, evening clear.
13	41	44¼	44½	42¼	5	8	0	0	29.571	29.562	29.638	29.757		W. by S.	Brisk wind, cloudy or overcast, evening showery, calm.
14	29¾	30¼	33½	26¾	0	0	0	0	29.923	29.942	29.912	29.844		W. by S.	Calm, sky cloudless.
15	34½	35½	37½	37½	0	0	0	0	29.785	29.779	29.743	29.723		S.	Calm, masses of soft clouds prevalent, evening overcast.
16	34½	37	41½	39¼	2	3	3	0	29.738	29.763	29.778	29.816		W. by S.	Calm, sunshine, sky frequently cloudy, evening overcast.
○ 17	37	35¾	33¾	31	0	0	0	0	29.789	29.798	29.761	29.779		W. by S.	Calm, masses of soft clouds, sunshine, evening overcast.
18	29¼	29¾	31¼	30	2	3	0	0	29.702	29.700	29.658	29.626	0.190	W.	Calm, sunshine, evening clear.
19	28	29	32¼	33	0	0	2	3	29.508	29.486	29.497	29.441		W. by S.	Calm, cirri prevalent, evening cloudy.
20	38	39	39	38¾	0	0	0	0	29.489	29.525	29.719	29.768		NW. by W.	Brisk wind, A. M. showery, P. M. cloudy, evening overcast.
21	37¼	36¼	34¾	33¼	0	0	0	0	29.774	29.779	29.718	29.550		SE.	Brisk wind, cloudy, evening overcast.
22	35¾	36	34	33¼	0	0	0	0	29.455	29.451	29.439	29.293		W.	Calm, A. M. sunshine, P. M. fog, in the evening fog more dense.
23	38	38¼	40	39¾	0	0	0	0	28.941	28.922	28.834	28.864		SE.	Strong wind, overcast and gloomy, occasional rain and fog.
24	39½	39¾	39	35¾	0	0	0	7	28.968	29.000	29.033	29.108		SE.	Gentle wind, foggy, with occasional showers.
25	33¼	34¼	34½	32¼	2	7	0	0	29.346	29.363	29.410	29.453		NE.	Calm, large masses of black cloud, with snow showers.
26	31¼	32	34½	36	3	0	0	5	29.046	28.955	28.732	28.796		S.	Brisk wind, overcast, A. M. frequent snow showers, P. M. rain.
27	34½	35	34¾	34	5	5	4	3	28.994	29.010	29.156	29.354	0.655	NW. by W.	Gentle wind, sky nearly cloudless.
28	36¼	37	36	38½	14	11	3	2	29.609	29.637	29.623	29.489		W.	Calm, A. M. sunshine, P. M. cloudy or overcast, wind rising.
29	43	43¾	44½	42	0	0	0	0	29.259	29.238	29.340	29.472		SW.	Strong wind, sunshine, but sometimes cloudy, in the evening wind falling.
30	46¼	46¾	42	36¼	0	0	0	0	29.049	29.021	29.097	29.202		SW.	Boisterous wind, with troubled sky, frequent showers. [strong wind.
● 31	34¼	35	35¾	40¾	5	10	7	8	29.720	29.770	29.871	29.633		NW. by W.	Gentle wind, A. M. cirrost. prevalent, solar halo, P. M. nearly cloudless, even. overcast,
Means	37.5	38.4	38.8	37.3	2	3	2	2	29.400	29.405	29.409	29.416	1.425		Means for the month, Therm. 37°.8, Hygrom. 3°, Bar. 29.410 in; Mean temperature of spring water 46°. Mean point of deposition 36°. Moisture in a cubic inch of air = .001527 grs.

Summary of Observations of the Barometer, Thermometer, &c.

1838. MONTHS.	THERMOMETER.						HYGROMETER (Leslie's).						BAROMETER (at 32° of Fahrenheit).						Temp. of Spring Water.	Mean point of Deposition.	Grs. of Moisture in a cubic inch of Air.	Relative Humidity.	Rain in inches.
	10 A.M.	10 P.M.	Mean.	9 A.M.	3 P.M.	Mean.	10 A.M.	10 P.M.	Mean.	9 A.M.	3 P.M.	Mean.	10 A.M.	10 P.M.	Mean.	9 A.M.	3 P.M.	Mean.					
Jan.	29.1°	26.7°	27.9°	28.1°	29.5°	28.8°	0°	0°	0.°	0°	0°	0.°	29.379	29.397	29.388	29.382	29.358	29.370	46°	27.7	.00114	1000	3.325
Feb.	28.4	27.8	28.1	27.4	30.8	29.1	1	0	0.5	1	1	1.	29.101	29.091	29.096	29.101	29.077	29.089	45¼	27.5	.00114	983	2.520
Mar.	38.7	36.1	37.4	37.2	40.7	39.0	4	1	2.5	3	7	5.	29.129	29.154	29.142	29.142	29.119	29.131	45¾	31.7	.00131	826	3.078
April	41.2	36.7	38.9	39.0	42.1	40.5	8	10	9.	5	9	7.	29.145	29.142	29.144	29.139	29.130	29.135	46	32.8	.00136	816	3.799
May	49.6	40.8	45.2	48.7	49.6	49.1	16	2	9.	13	16	14.5	29.437	29.447	29.442	29.433	29.431	29.432	46	40.5	.00178	860	3.631
June	55.5	49.3	52.4	54.6	55.9	55.2	17	3	10.	15	17	16.5	29.279	29.274	29.276	29.279	29.271	29.275	46	48.4	.00228	878	4.627
July	58.7	51.7	55.2	57.7	59.4	58.5	19	4	11.5	17	21	19.	29.342	29.345	29.344	29.338	29.338	29.341	46	47.4	.00221	777	1.249
Aug.	57.0	51.7	54.3	56.0	58.2	57.1	14	2	8.	13	12	12.5	29.229	29.234	29.232	29.230	29.230	29.230	46	51.5	.00251	911	2.191
Sept.	54.2	47.9	51.0	52.6	54.8	53.7	10	2	6.	7	12	9.5	29.420	29.434	29.427	29.420	29.410	29.415	46	48.5	.00231	926	4.905
Oct.	48.2	43.7	46.0	46.4	50.0	48.2	10	5	7.5	7	13	10.	29.335	29.325	29.330	29.343	29.281	29.312	46	42.5	.00189	893	1.049
Nov.	38.1	37.8	38.0	37.4	38.9	38.2	6	3	4.5	4	6	5.	28.752	28.688	28.720	28.752	28.706	28.729	46	35.5	.00147	922	5.031
Dec.	38.4	37.3	37.8	37.5	38.8	38.2	3	2	2.5	2	2	2.	29.405	29.416	29.410	29.400	29.409	29.404	46	36.0	.00153	943	1.425
Means	44.8	40.6	42.7	43.5	45.7	44.6	9	3	6.	7	10	8.	29.246	29.246	29.246	29.247	29.230	29.239	46	39.2	.00174	895	
																			Amount for the Year				36.830

For the Year.	Mean height of Thermometer.	Mean height of Barometer at 32° Fahr.	Mean point of Deposition.	Mean relative Humidity.	Quantity of Rain in inches.
1835	45.2	29.309	38.5	818	32.56
1836	43.9	29.238	40.0	883	37.21
1837	43.9	29.351	41.4	926	31.82
1838	42.7	29.246	39.2	895	36.83
Means,	43.9	29.286	39.8	880	34.6

Mean barometric height at the level of the sea = 29.82 inches, } its Log. = 1.4745

Log. 29.286 = 1.4667

.0078

1000

Height of the place of observation must be somewhere about . . . . } 78 fathoms, or 468 ft.

ON THE

GEOGNOSY OF THE ISLE OF EIGG

BY

R. J HAY CUNNINGHAM, Esq. M.W.S., &c

(Read 9th March 1839.)

Eigg, which is about seven miles from the mainland at Arisaig, exhibits examples of both the stratified and unstratified classes of rocks; all of which agree in the great details of relative position, mineral characters, and organic contents, with phenomena observable in Morven, Skye, Mull, and several of the smaller islands which skirt this part of the west coast of Scotland. Speaking generally of the structure of Eigg, it may be described as a mass of trap which rises through, overlies, and sends parallel veins into, an alternating system of oolitic sandstone, limestone, and shale. When viewed from the sea, all the rocks of the Island exhibit a very distinct dip to the south. Thus the rock which, on the northern extremity, occurs at the surface and several hundred feet above the sea, sinks into it at the other; the angle at which the several strata are inclined being so small that it is hardly discernible if the observer is in their immediate vicinity. At no great distance from the coast, however, especially on the east side of the island, this fact is most distinctly evident, and the inclination appears not to exceed an angle of seven or eight degrees.

As the geognostical account of this island, which we now lay before the Society, was the result of a somewhat detailed examination, we shall endeavour to notice the several rocks of the district both individually and collectively,—individually as their mineral and organic characters are concerned; collectively, as relating to the modes by which they are connected with each other.

The secondary strata, which we shall first describe, are only visible in the cliffs which skirt the island from the neighbourhood of Kildonan* on the east, to the Bay of Laig on the west. Generally, they are much obscured by their own debris and that of the associated trap-rocks; sometimes, however, good sections may be obtained, and the several strata examined with accuracy over a considerable space. The sandstone of this island is white, being composed of grains of quartz held together by a basis of calcareous matter through which iron-pyrites is abundantly disseminated. It is distinctly granular, and forms beds, in many instances, of very considerable thickness.† Asso-

* Kil Donan,—*i. e.* the Tomb of Donan, the tutelar saint of Eigg.

† In mineral characters the oolitic sandstone differs nothing from the sandstones of the independent coal-formation. Composed, therefore, as it is, almost entirely of quartz particles, and remembering the invariable sameness in the characters of both of these sandstones though differing in geological age, over Britain, Continental Europe, and from areas of immense extent, it becomes a subject of interest to ask, whence has this enormous mass of quartz been derived? To this question no satisfactory answer can be given. Knowing the white sandstones as of a derivative origin, and not as of an original formation, it would be desirable to fix upon some primordial or older derivative quartz-deposits from the breaking up and erosion of which they may have been formed.

ciated with this sandstone, sandstone-flag is to be observed they alternate and pass into each other by distinct gradations, containing in several places very imperfect vegetable relics, with layers of carbonaceous matter. The only circumstance which renders the sandstone of Eigg interesting to the geologist is, in its exhibiting a most remarkable and striking instance of the globular concretionary arrangement, a kind of structure first observed in the same sandstone in the Island of Skye, and afterwards in coal-sandstone in Dumfriesshire, by Professor Jameson. In diameter, the concretions of sandstone vary from 3 or 4 inches to 3 or 4 feet; and though, in general they are globular, in a few instances they become elliptical;

If we consider quartz in regard to the abundance of its distribution over the globe in strata of an older date than coal or oolite, it will perhaps be found, that there are no deposits of an extent so great as to justify us in believing, that from them the secondary white sandstones were derived; and farther, the question as to where is the original formation of quartz, is rendered still more obscure, from finding that the oldest stratified quartz-rocks evince, by various characters, both structural and geognostical, that they have been formed from still more ancient quartz. In regard to these, however, and we refer especially to the quartz associated with mica and clay slates, it will invariably be seen, that, if rounded masses of quartz are imbedded in a base of smaller fragments, these consist of perfectly massive quartz, and exhibit a structure having the aspect of an immediate resultant from a state of fluidity. No deposits of massive quartz, however, exist, of an extent sufficient to render it likely, that from them the quartz which enters into the transition quartz strata, or the greywacke and the secondary sandstones, has been derived. As beds and veins in the older strata it does occur; but these are far too insignificant ever to allow us to imagine that they have, in any considerable degree, contributed to the formation of the strata we have mentioned. This is not a proper place to enter into any details connected with the question, from what formations have the derivative rocks been derived? It is one, however, of difficulty, and deserving the attention of geologists, and may, perhaps, lead some to believe, that whole formations have disappeared, whose original existence can only be inferred from finding their relics entering into the composition of newer deposits.

in position relative to each other or to the stratum in which they occur, they preserve no regularity, but are either dispersedly scattered through a stratum at considerable distances from each other, or are in immediate contact, forming then concretionary layers arranged either parallel to the direction of the strata, or inclined at various angles to their planes. An examination of the interior of the concretions affords no determinate arrangement, and they only differ from the sandstone in which they are included by the circumstance of being more compact. Though, in external aspect, the globular sandstone of Eigg may appear similar to that globular concretionary structure observable in the trap-rocks, still there is much to render it probable, that these appearances have been produced by the action of completely distinct causes. When a globular trap-rock is exposed to the action of the weather, its disintegration is produced by the exfoliating of concentric layers. This character is universal, but is never to be seen in the sandstone of Eigg; and further, the balls of trap are not irregularly scattered through the trap basis. In a trap-rock the globular structure is generally exhibited over many yards, or throughout the whole mass; while, in the case of the sandstone, one concretion only may be found in a stratum. From the circumstance of the laminæ of the sandstone, in some instances, not terminating at the surface of the concretion, but, on the contrary, extending through them, it is evident that the cause which produced this arrangement operated after the deposition of the strata. There was a tendency to effect a symmetrical appearance; but what generated this we are ignorant of, and though the agents may have been of a similar nature, yet they are as obscure as those which have awarded one or two lines of cleavage to many slates. Impossible, however, though it may be, to explain the immediate actions by which this change has been effected, still it appears in some degree likely, that the presence of trap-rocks is connected with this structure; for here, as in every other place where we have observed it, these are abundantly developed.

Limestone, which, after sandstone, is the most universally distributed stratified rock of Eigg, is of a compact structure, of a bluish-grey colour, and has a conchoidal fracture. It alternates with the sandstone, and contains the usual belemnites, gryphytes, and ammonites of the deposit; but, on the great scale, exhibits nothing requiring farther detail. The slate-clay, which is associated with the sandstone and limestone, is soft, and of a grey colour, and includes, in many places, numerous scales of mica. None of the three rocks, however, which form the stratified system of Eigg, severally hold any definite place in the series; but, on the contrary, alternate regularly with each other, constituting a deposit, the formation of the several individuals of which has been strictly contemporaneous.*

Having briefly noticed the stratified or Neptunian rocks

* The stratified rocks which we have described as occurring in Eigg, are in many other of the Hebrides connected with strata which differ from these, both in mineral and fossil characters. Little examination is required to convince that they form only one series, and that to subdivide them into distinct groups, is, since nature has made no separation, a work of little utility. Though we could refer every stratum to its analogue in any other country, say to those of England, nothing would be gained, for as there the several members of the series, though they have distinct names attached to them, belong to one great geognostical group, and present only insignificant mineral and fossil differences, so here the same is evident, and entitles us to consider that there is no necessity to parcel out, into minute classes, the rocks of a stratified deposit, which expresses, when its members are viewed collectively, a system which had been formed uninterruptedly during a well-marked epoch of the world's ancient history.

of Eigg, we shall next, in the same way, examine those unstratified or Plutonic masses which are connected with them. The igneous rocks, which form the most of this island, belong to the trap family; they are composed of augite and felspar, and constitute all that part of the island to the south of a line extending from Kildonan on the east to the opposite shore at Laig; while, to the north of this boundary, the trap rests upon the oolitic strata which we have just noticed. The most usual manner in which the trap is connected with the sandstone, limestone, and shale, is as veins which run parallel to the almost horizontal strata, many of which indeed conform so strictly to the aqueous deposits, that, if the mere form of the mass within a limited extent be alone considered, an observer might imagine them as examples of true stratification. On prosecuting the examination of these masses (filons couches) farther, it will, in almost every instance, be found that all depart from their parallelism, and either cross the upper or lower strata; or if the bed-like masses continue their course, they send off smaller veinous bodies which ramify into the sandstone.

In regard to the trap, which alternates with the several Neptunian deposits, relatively to the trap-rocks lying southwards of the line we have referred to, it must be remarked, that a thick covering of alluvial matter prevents us from arriving at any perfect knowledge. That it is connected at one extremity with a central body, can, we imagine, never be doubted, as it is supported by phenomena observable in other quarters, where similar masses, alternating and running parallel with stratified rocks, may be examined throughout their whole extent. Besides the parallelly intruding veins of trap which traverse the strata, there are others which rise more or less vertically through them examples of these may be observed near Laig: they do not, however, require any particular notice. The effects which trap-rocks produce on the strata are here never very conspicuous; where junctions are, however, to be observed, they exhibit the usual appearances in a more or less marked manner, the sandstone becomes quartzose, and the limestone crystalline. Near the Bay of Laig the latter has a fibrous structure, which, from our only noticing it in that part of the stratum in contact with a trap-vein, is, in all probability, to be considered as having been produced by it. The fibres of this limestone never exceed more than three inches in length, are at right angles to the strata, and are separated from the compact limestone by a well-defined line. This appearance is difficult to explain, inasmuch as the changed rock might be expected to pass gradually into that which is unaltered. The absence of a transition of what, in accordance with Plutonic doctrines, are considered altered rocks into those which can only be viewed as unaltered, is, in many localities in Scotland, in no small degree remarkable; and the fact that they occasionally alternate is a phenomenon which is inexplicable in the existing state of our knowledge of the laws which regulate subterraneous actions. Near the Ru Stoir Scalleadh, which forms the most northern part of the island, there are several examples of envelopment, masses of the shale being completely included in the trap, and converted into flinty slate; the usual fossils are present, and may be traced from an incipient to an almost perfect obliteration. The indurated shale of Eigg, as that of other points in Scotland, acquires a dull aspect after a fresh fracture is exposed to the air for a length of time.

The trap of Eigg occurs under the various forms of greenstone, basalt, amygdaloid, and tuffa. In structure, the two first are met with in all stages between an amorphous state and a regular columnar arrangement, affording not unfrequently examples of the globular concretionary disposition. Like the trap-rocks of the other western islands, those of Eigg contain several simple minerals: fibrous amethyst, cubicite, calcareous spar, mesole, mesotype, and stilbite occur, lining drusy cavities, some points presenting specimens of the latter little inferior in beauty to the well-known masses of Iceland and Feroe. Small groups of quartz-crystals, associated with stalactitic and botryoidal calcedony, are also abundant in the amygdaloid. When noticing the simple minerals of Eigg, it may here be remarked, that, though the contrary has been stated by Dr MacCulloch, calcedonic veins traverse the columnar porphyry of the Scuir; these, when a few inches broad, containing cavities lined with crystals of quartz.

The only other rocks which require notice are those examples of pitchstone and pitchstone-porphyry, which so eminently distinguish Eigg from the other Hebrides. Three instances of this rock have been described by Professor Jameson as occurring in Eigg, viz. two veins which traverse the basalt on the southern shore of the island, not very far from the well-known Maclean's Cave; and the pitchstone-porphyry which rises into the singularly-shaped rock of the Scuir, and which runs across the island as an immense dyke, having a NW. and SE. direction. The pitchstone veins are separated from each other by a distance of about twelve feet, and do not appear to exceed three feet, or three feet and a half in breadth. Both traverse vertically a dark blackish-blue basalt, and, though preserving a general parallelism to each other, exhibit a few slight bendings in their course. They are, in the central parts, of a dark olive-green colour, and pass, as they approach the basalt, into a blue pitchstone, highly compact and lustrous, and which is rendered porphyritic by the presence of crystals of glassy felspar. The fact of this pitchstone becoming more compact as it approaches the traversed rock, is, in its nature, similar to those appearances which the greater number of veins and overlying masses display at their junctions with stratified or older deposits, and is to be referred to the same cause, viz. to a quicker cooling of the rock, from being in contact with one previously consolidated. This circumstance implies that igneous action continued to exist in the district for a considerable length of time, and that Plutonic matters were discharged at least two epochs apparently distant from each other, and separated by a period sufficient for the refrigeration of those bodies of greenstone and basalt which form the greater part of the island. How long these trap-rocks took to consolidate cannot be estimated. If, however, we remember that a sub-aërial lava has been found to retain a high temperature ten years after its eruption, how much longer time must that rock take which flowed over the bottom of a deep sea, or between previously elaborated strata? Both the veins of pitchstone are shifted, thus evincing, that, even after their eruption and cooling, disturbing causes had acted. The largest vein of pitchstone is remarkable from being broken through in its upper part by a rock of porphyritic compact felspar, which contains, in several places, imbedded fragments of the pitchstone; it is, indeed, not at all improbable that the outburst of the felspar has been contemporaneous with the shifting which we have mentioned as occurring here.* Plate V. fig. 1. Liquid bitumen fills, in several

* Dr MacCulloch, in his description of the Western Islands, has denominated this rock "Chert;" our reason for not adopting the same or a similar title was, that we could not find in this mineral any character which could justify us in giving it a place in the quartz family.

places, small vesicular cavities in the felspar, and as to such the pitchstone owes its colour, the formation of both must have been of the same general description.*

The only other pitchstone which was formerly known to exist in Eigg is that which, from the name of its eastern extremity, may be styled the range of the Scuir. It forms a lofty and, to the south, precipitous wall, which crosses, with little interruption, the southern part of the island, presenting an outline of a very striking character, and totally different from the mountainous and wild eminences of the highlands of Rume and Skye. In regard to the relations of the pitchstone-porphyry of the Scuir and the trap-rocks with which it is connected, it can, after a most careful examination around the whole mass, be confidently asserted, that it exists as a great vein which has been erupted through the older Plutonic rocks, thus agreeing in age with all the other pitchstones of the island. At the eastern extremity of the Scuir, its posteriority to the trap is most distinctly visible, inasmuch as it cuts through perfectly horizontal beds of basalt and amygdaloid which

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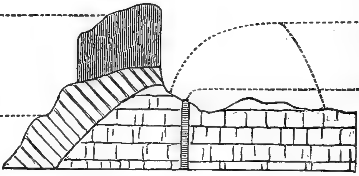
* So early as the year 1808, Professor Jameson, in his Mineralogy of the Scottish Isles, vol. i. p. 48, says, when describing the Arran pitchstones, "When pounded it emits a bituminous smell, which renders it probable that it may contain inflammable matter." Chemical analysis has since verified this conjecture. The pitchstone of Newry, in Ireland, described in the Transactions of the Royal Society, was found by the Hon. G. Knox to contain the following components:—Silica, 78.800; alumina, 11.500; lime, 1.12; protoxide of iron, 3.036; soda, 2.857; water and bitumen, 8.500; = 99.813.—*Ed. Phil. Jour.* vol. viii. p. 190. The pitchstone of Planitz, in Saxony, contains bituminous matter, and, according to some chemists, the pitchstone of Potschappel, in Saxony, contains, besides the usual ingredients, three parts of Lithion.—*Ib.* p. 190.

In the Lothians, and other parts of Scotland, we have found some trap-rocks to be highly charged with bituminous matter. May not this be, in some way or other, connected with the chemical composition of the sedimentary strata through which they have been protruded?

are also traversed by a vertical vein of compact basalt.



The western extremity of the porphyry range presents phenomena similar to those afforded at the eastern: it there, in a lofty coast section, sinks through the usual trap-rocks, the several beds which occur on the one side of the porphyry coinciding, in position and mineral character, so strictly with those on the other, that their former continuity can never be called in question. The pitchstone-porphyry of the Scuir alternates several times with a porphyritic felspar. From the whole of their relations, however, it is evident that they are of one and the same age.

Strictly speaking, the rock of Scuir Eigg cannot be considered as a true pitchstone-porphyry, inasmuch as the base of it, as Professor Jameson originally remarked, appears to be intermediate between basalt and true pitchstone: it may be better, however, still to view it as a pitchstone-porphyry, than, by changing a received name, endeavour to raise a mere variety into a distinct species. To the eye, when unassisted by the lens, the base of this rock appears perfectly homogeneous; sometimes, however, it is minutely granular, and of a black colour, with a slightly dull, resinous lustre. The fracture is irregular and approaches to conchoidal. Before the blow-pipe, it fuses into a semi-transparent greyish glass, and, when breathed upon, emits an argillaceous odour. The porphyry-base has a lower degree of hardness than true pitchstone, and affords to the knife a greyish-white streak. Small veins of magnetic iron-ore occur imbedded in this rock. The crystals, which produce the porphyritic structure, consist entirely of a brownish or yellowish-white, and highly lustrous glassy felspar, varying in abundance in different places; they fuse under the blow-pipe into a transparent glass. The structure of the pitchstone-porphyry, on the great scale, is most regularly columnar. The position of the columns which form the highest parts of the mountain approaches to verticality; nearer the base, however, they become inclined, and afford numerous beautiful examples of bent groups. At the eastern extremity of the Scuir, a bed of inclined pillars is included between pillars having a perpendicular arrangement. This is very striking, and may be seen though the observer be at a considerable distance from the base of the hill. In the number of their sides much variety may be observed in the columns; and amongst the debris which is accumulated at the foot of the range, it is easy to discover differently-shaped pentagons, hexagons, eptagons, and octagons, with others of irregular, quadrangular, and triangular forms. In regard to these columnar concretions, there are two characters, which, though very generally evinced by greenstone and basalt, are never to be detected in the pitchstone-porphyry, viz. in no instance do the pillars afford that internal structure which is known by the name of "ball and socket," or appear arranged in globular distinct concretions:* associated with the rock of the Scuir,

* Necker de Saussure, when speaking of the rock of the Scuir, states, that Professor Jameson has, in his opinion, improperly styled it a porphyry with a base of pitchstone. This is an error, for the Professor, in his Mineralogical Travels, page 47, vol. ii., affirms, that the porphyry has "a basis intermediate between basalt and pitchstone," a description which most exactly describes its aspect.

we in several places find a rock of a conglomerated character; angular-shaped masses of pitchstone-porphyry, the same as that of the Scuir, with fragments of trap appearing to be imbedded in a base of yellowish or reddish-white earthy claystone. In the already published accounts of Eigg, this rock is described in some instances as a conglomerate, and in others as a trap-tuffa. Its fragmentary character, however, we view as entirely deceptive, both from the circumstance of its almost passing into the great mass of the Scuir, and from the fact, that the apparently imbedded fragments, when a fresh fracture can be obtained, make a transition into the containing base: in short, we consider it as one of those pseudo-tuffas which we have observed in many other parts of Scotland. Dr MacCulloch states, that fossilized wood is met with in the rock we have just noticed. This, however, we must dissent from, for, though this wood has never been found *in situ*, it is evident from the point where its fragments may be obtained, that its matrix is the rock of the Scuir; and this is farther proved, from its always being found in greatest abundance after atmospherical agents have loosed a portion of the columnar rock. The internal structure of the wood has been examined by Mr Nicol of Edinburgh.*

* This minute observer remarks, in the Edinburgh New Philosophical Journal, vol. xvi, p. 154, that "The Eigg fossil in the transverse section presents annular layers well defined, and displays the coniferous reticulated texture in great perfection throughout the greatest part of the surface. In some few parts, towards the outer edge, the texture is very much distorted, and in one part nearly obliterated. The obliterated part is replaced by small translucent circular portions of sparry matter, which in some parts are distinct, but in other parts completely confluent. Portions of this small circle of spar casually occur in the perfectly reticulated part, which some have considered as lacunæ; but those towards the outer side not only become larger, but gradually approximate each other, and at last entirely obliterate the meshes. That the whole are not lacunæ, may also be inferred from this circumstance,

namely,

In the Mineralogy of the Western Islands, Professor Jameson states, that to the south of the sandstone which occurs on the eastern side of the island, he observed

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namely, that in the centres of some of the circles, portions of the reticulated texture may be distinctly seen.

Some dislocations have taken place in this specimen, without the parts having been separated from each other. Of these some are in the direction of the radii, others in a concentric direction. The former are discernible merely in consequence of the edges of the layers on one side of the slip being opposite the middle of the layers on the other side, and the latter, in consequence of the medullary rays in one layer not passing through the slip into the adjoining layer.

In the longitudinal section parallel to a radius, this fossil shews no indication of discs of any kind. The partitions of the vessels are very much crowded together, greatly distorted, and the vessels furnish nothing of a characteristic kind."

Mr Nicol states further, that this fossil has been described in Lindley and Hutton's "Fossil Flora," under the title of Pinites Eggensis, and that the authors of that work have considered it as differing "essentially from any of the coal coniferæ." This variance of opinion he accounts for, by supposing that "their observations must have been confined to the few fossil trees that have been found in the vicinity of Newcastle." Mr Nicol remarks that these are destitute of annual layers, and that, in that respect, they certainly differ from the Eigg fossil; but he adds that he found from examining specimens in the possession of Professor Jameson, examples of fossilized wood derived from the great coal-formation of New Holland, "so closely resembling that from Eigg, that few could have distinguished the one from the other." On our visit to Eigg, we procured several fine specimens of the fossilized wood; those, however, which we obtained are far inferior in size to a mass which we observed at the farm-house of Kildonan (Mr Macdonald's); the one to which we refer was about one foot in length, by one foot four inches in circumference, and exhibited in one place a mark which was, in our opinion, identical with the scar, which the breaking off of a branch would have effected. Connected with the trap-rocks of Bloody Bay near Tobermory in Mull, we found, in 1834, a wood-stone presenting much of the external aspect of that of Eigg. These specimens we also subjected to the notice of Mr Nicol, who microscopically examined them, and published in Edinburgh New Philosophical Journal, vol. xviii, p. 335, the result of his observations. After giving a minute description of the external characters of these fossils, Mr Nicol describes their structures as bearing on botanical details. He states that the several specimens are to be referred only to one species, "that the medullary rays are very similar in number, breadth, and extent, to those in some of the "several pieces of black pitchstone, much resembling that found in the islands of Arran and Mull." Dr MacCulloch, in his Description of the Western Islands, remarks, that "on the beach near Eilan Chastel, rolled stones of a black pitchstone-porphyry," differing in aspect from the other pitchstones of the island, present themselves. On examining this part of Eigg, we noticed numerous boulders of the same rock, and at last were so fortunate as to discover, *in situ*, the mass from which they had been derived. This pitchstone cannot be examined throughout its whole extent; but it appears to be one of the ends of a great vein traversing the basalt; the removal of the absent portions having been effected by the united actions of the waves and atmosphere. In one place, a portion of the basalt seems to be entangled in the pitchstone. The external characters of this rock are as follows:—Colour, very dark bluish-black; lustre, resinous; structure, imperfectly slaty and slightly porphyritic, from containing crystals of glassy felspar; fracture, slaty in the large, and small conchoidal in the small; transparency, none.* This vein is represented on Plate V. fig. 2.

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the recent species of acer." The vessels are stated to be numerous, and much compressed, and to have the elliptical or circular form of most dicotyledonous woods. The cellular structure cannot be discerned, and all the sections which this observer made, presented, where the vascular structure is visible, well-defined annual layers. Mr Nicol concludes by remarking, that the specimens of wood from Mull were the only examples of dicotyledonous plants which he had seen from rocks of the secondary class. (The rocks from which the wood of Mull is derived belong to the oolitic group.)

* Viewing pitchstone as a member of the trap and porphyry series, it must be considered as a rock of rare occurrence, when compared with the other members of these great natural families, and in Scotland, if we except the instance of the Scuir, one which is never met with in masses of a size sufficient to constitute mountains, but is invariably found as veins. As this rock is one of interest in a geognostical point of view, and desired by the mere collector of specimens,

we

Besides this pitchstone, we have recently detected another, it occurs on the side of the road between Kildonan and

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we subjoin a list of the principal points in Scotland, where it is known to be met with.

ARRAN.

1. Caim-na-Cailleach,	Vein in granite.	*Jameson.*
2. Corygills.	Vein in red sandstone.	*Do.*
3. Old road to Lamlash.	Vein in red sandstone.	*Do.*
4. Glen Cloy.	Many boulders.	*Do.*
5. Brodick Wood.	Vein in red sandstone.	*Do.*
6. Glen Jorsa.	Boulders.	*Do.*
7. Tormore.	Four veins in red sandstone.	*Do.*
8. Shore near Torylin.	Boulders.	*Do.*
7. Stream which enters the sea at the southern end of the village of Lamlash.	Two veins.	*Cunningham.*
10. Road to Lamlash north of Glen Cloy.	Vein in red sandstone.	*Do.*

LAMLASH.

East side.	Vein of basalt passing at its sides into pitchstone.	*MacCulloch.*
South end.	Small veins in syenitic greenstone.	*Cunningham.*

SKYE.

Ben-na-Cailleach.	Pitchstone like that of Arran, in veins; in some instances the veins contain also layers of greenstone.	*Jameson.*
Glamoscard.	Boulders of Pitchstone.*	*Do.*
Side of Garsven.	Boulders of pitchstone passing into basalt.	*MacCulloch.*
Beal near Portree.	Pitchstone passing into basalt.	*Murchison.*

RUME.

Beach near Scuir More.	Pitchstone in boulders.	*MacCulloch.*

MULL.

Southern coast.	Boulders of pitchstone.	*Greenough.*
Loch Scriden.	Boulders of pitchstone.	*Jameson.*

DUMFRIESSHIRE.

Tods Hill. Watch Craig. Wat Carrick.	Pitchstone resting on greywacke, and passing into basalt and clinkstone.	*Do.*

AYRSHIRE.

* This pitchstone has been discovered here *in situ* by Oeynhausen.

Cleathel, and not more than half a mile from the latter place ; indeed, on proceeding from the west to the east side of the island, it is almost the first rock which presents itself. This pitchstone has a green colour, is very similar to that of Arran, and contains small imbedded nodules of common opal. When first fractured it is very tender ; on exposure to the air, however, for a few days, it, like many other rocks, acquires a greater power of resistance to the hammer. Associated with this pitchstone, both trap and porphyry occur,—the former of which, indeed, traverses it in the form of a vein, of about four inches in breadth. The nature of the ground, however, precludes the possibility of making out the more intimate connections of the several rocks, but from what can be seen, we are inclined to believe, that the whole are of a contemporaneous formation. The porphyry, which is associated with the pitchstone, is identical with that which, in Arran, is connected with the same rock. It in some places becomes highly quartzose, and is then always encrusted with botryoidal calcedony.

Before leaving the subject of the trap-rocks of Eigg, it does not appear to us irrelevant to notice the very general reference of thése rocks, as well as other similar masses of the Hebrides, to a volcanic series instead of a Plutonic group. To some it may appear a matter of little consequence whether, since both classes are similarly produced

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	ARGYLESHIRE.	
Ardnamurchan.	In trap.	
	ABERDEENSHIRE.	
Cairngorm.	In granite.	*MacCulloch.*
	LANARKSHIRE.	
Cumberhead.		*Jameson.*

(the differences between them being almost of an accidental nature), the intrusive rocks of Eigg and the Hebrides be considered as elaborated only under the pressure of the atmosphere, and be this strictly volcanic, or whether they have been poured forth under the compressing forces of water or of rock and thus be Plutonic, in the original and unchanged meaning of the term. That looseness in describing, however, which styles every unstratified rock volcanic (if this term means what Faujas St Fond and the original volcanic school intended), we cannot vindicate, inasmuch as we feel assured, that, although both classes are ignigenous, there are distinctions between them both in form and mineral character which render their separation at once natural and apparent. As regards form, the chief feature which distinguishes the two series is, that none of the basaltic greenstone or pitchstone ranges can ever be viewed as examples of consolidated mineral streams which have issued from a crater. Boué, throughout his interesting "Essai Geologique sur l'Ecosse," has noticed the greater number of the rocks of the Hebrides, and those of several other points of Scotland, as volcanic, and designated the external aspect of the generality of trap-masses under the term "Coulees," that is, streams which have flowed from a volcano in the open air, and this opinion has been restated in various works, both German, French, and English; with it, however, we can never agree, but, on the contrary, must maintain that no one of the so-called basaltic streams affords, in their form, any evidence which can ever allow us to imagine that they had been erupted under circumstances fitted for so free a motion of their inherent particles, as obtains when a rock has been protruded solely under the pressure of the atmosphere. Besides the absence of this feature in the trap-rocks of the district, there is also the total want of that vitreous appearance which eminently distinguishes true lavas; further, in no instance do any of the basaltic or greenstone rocks present unfilled cavities. We are aware that both basalt and greenstone may be found in a cavernous state; such, however, is a mere effect of weathering, and entirely disappears, if the rock is examined beyond the reach of atmospheric agents. That this is a character by which a Plutonic or trap-rock may be separated from a volcanic formation, is stoutly denied by Dr MacCulloch. In his System of Geology, vol. ii. p. 113, he states, that "It has often been said by those who have written so much on what they do not know, that the cavernous structure was a test to distinguish between the trap and the volcanic rocks. But it is not so, unless the Little Cumbray be supposed the remains of a volcano. Had even the rock of Edinburgh Castle been examined by those who wanted no opportunities, this assertion could never have been made." To this statement little is requisite to be said; that authoritative style which declares "It is not so," may, however, be allowed to those who are of a different opinion from this geologist; and an examination of Edinburgh Castle rock, as the other members of the trap series of Scotland, will enable them to declare that "It is so," and that with no small degree of confidence in the accuracy of their statement.

Of all the rocks of Eigg, the pitchstone is that which approaches most to those of a true volcanic origin, both in aspect and chemical composition. That this even has been erupted under no inconsiderable pressure, is indicated from the pumiceous and cavernous substance which it forms, when it is subjected, without pressure, to a heat sufficient to fuse it. Necker de Saussure, in his work on Scotland, invariably describes the pitchstones of Eigg as obsidian, and, in regard to the porphyry of the Scuir, says, vol. ii. p. 457, "Je la nommerai Obsidienne lithoide, pour la distinguer de l'obsidienne vitreuse, dont elle seroit une sous-espece." A confusion of pitchstones and obsidians is always unaccountable : they may be almost the same in origin and chemical compositions ; but they belong to two different series, are of distinct relative ages when viewed generally, and have each well marked distinguishing characters. We now conclude this part of the subject by merely stating, that, from the facts which we have mentioned in regard to the geology of Eigg, there appears reason to draw the following inferences, which are almost recapitulations of what we have already said, viz. that there must have occurred, 1st, The horizontal disposition of the oolitic strata. 2d, The protrusion of those rocks which constitute the great trap-formation of the island. 3d, The eruption through these of the pitchstone masses. 4th, The invasion of one of these by a mass of felspar, to which is probably due the shifts, to which, in several places, they appear to have been subjected to. Plate V. fig. 3, exhibits a section of Eigg, partly ideal, and is intended to shew the probable relations of the several rocks.

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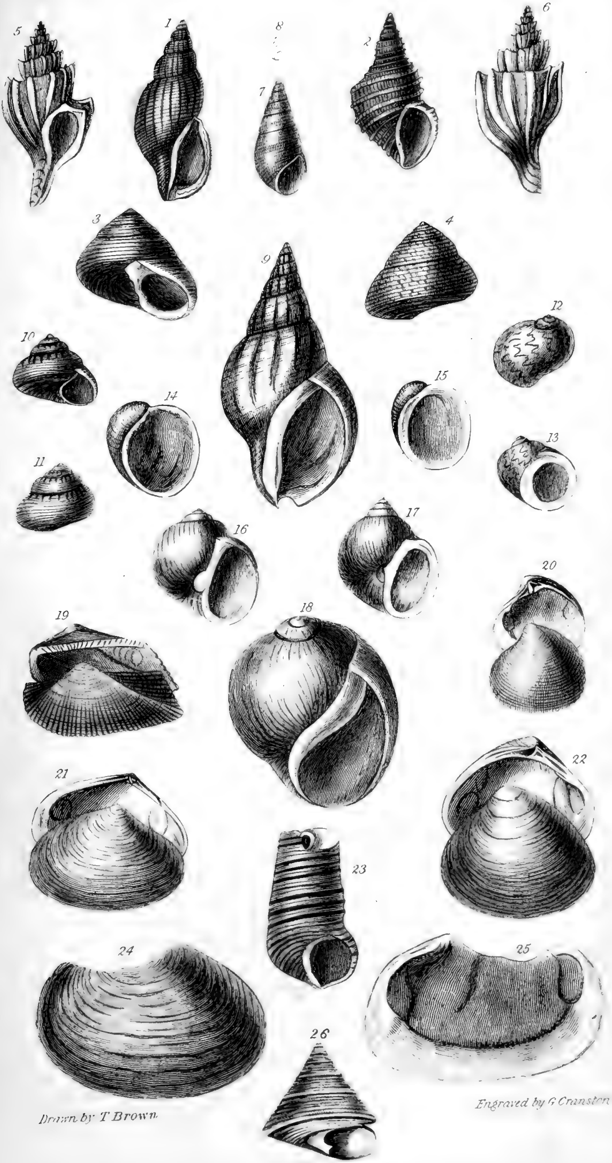

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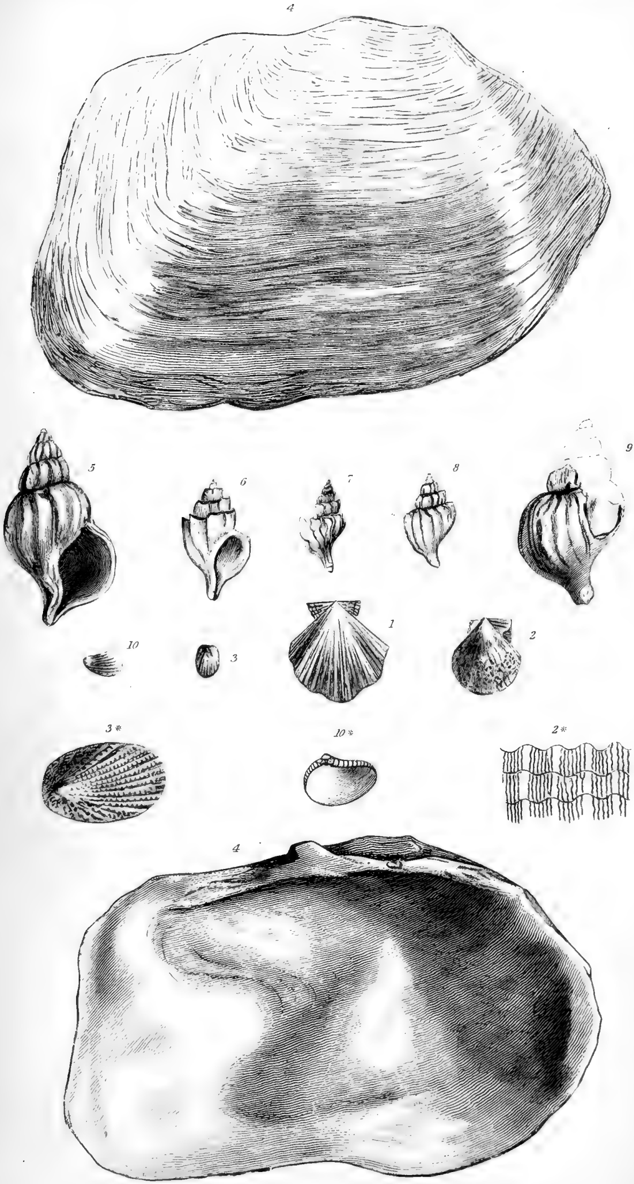
PLATE II



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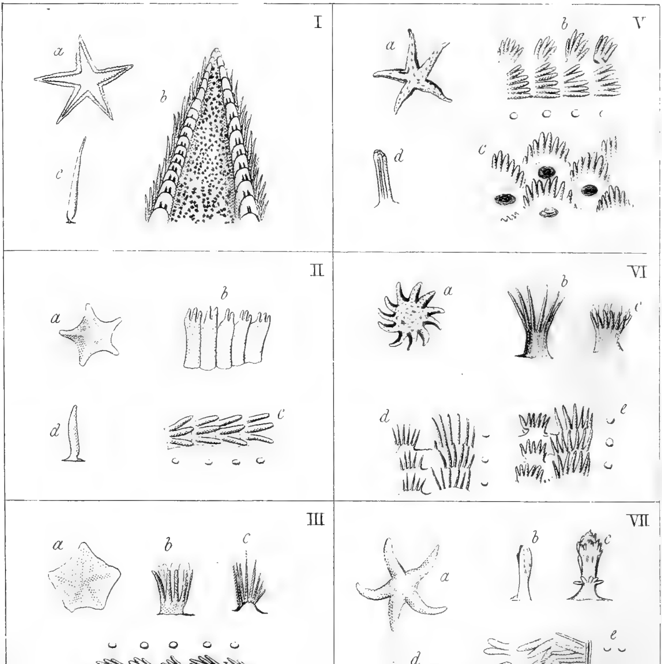

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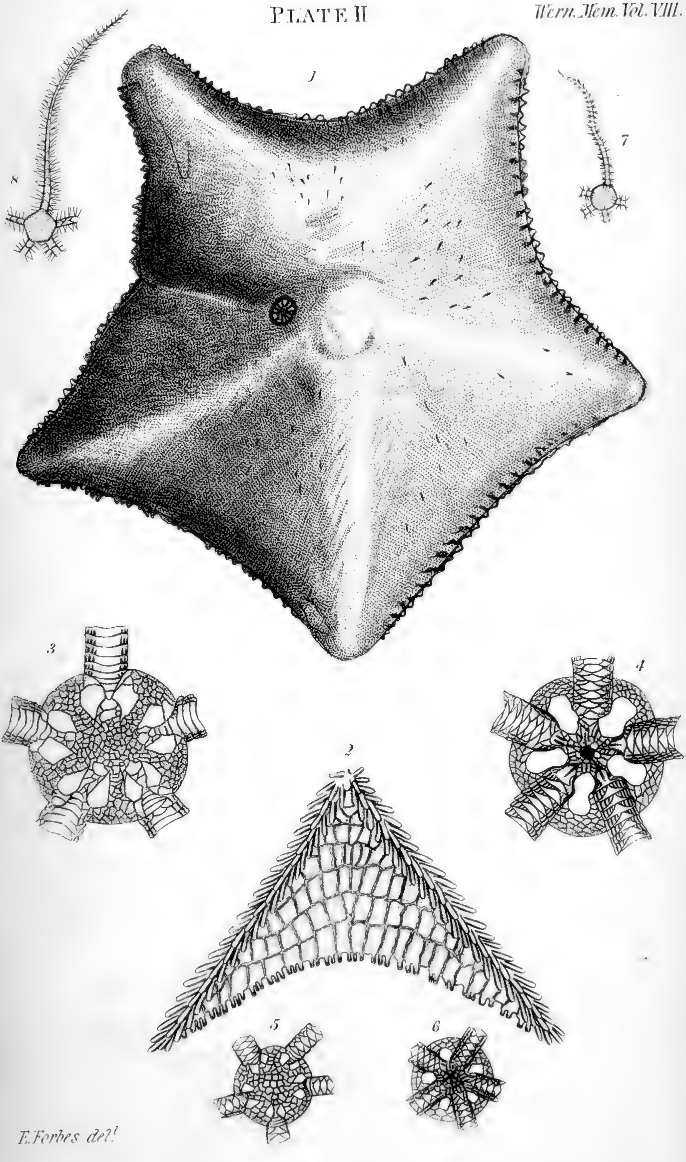

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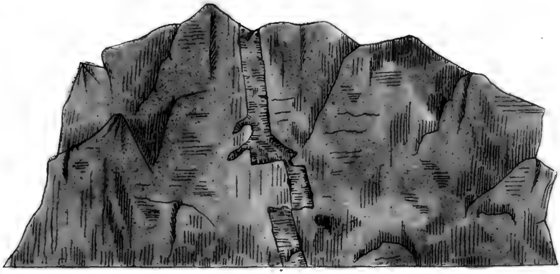
Fig. 1.

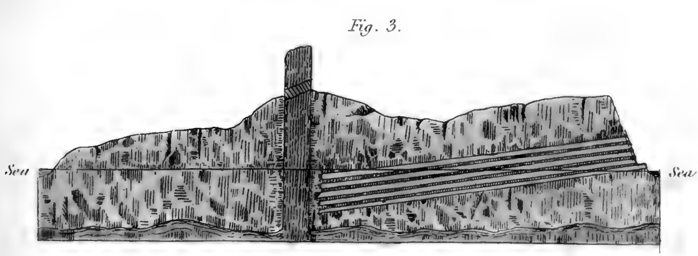


Vein of Pitchstone traversing Basalt, Eigg.

Fig. 2.

Pitchstone traversing Basalt, opposite Eilan Chastal, Eigg.

Fig. 3.



Section shewing the probable relations of the Rocks of Eigg.

Drawn & Etched by R. J. H. Cunningham.