THE

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LIST OF THE CONTRIBUTORS

TO VOLUME SEVEN,

WITH

REFERENCES TO THE SEVERAL ARTICLES CONTRIBUTED BY EACH.

DATES OF THE PUBLICATION OF THE SEVERAL PARTS OF THIS VOLUME.

Part 1.—Containing pages			1 to 90.	(Feb., 1891.)
,, 2.	,,	,,	91 to 126.	(June, 1891.)
,, 3.	,,	,,	127 to 220.	(March, 1892.)
,, 4.	,,	,,	221 to 483.	(June, 1892.)
,, 5.	,,	,,	484 to 578.	(Oct., 1892.)

ERRATA.

Page 146, lines 5 and 7 from bottom, *for* 6, *read* 8.
,, 169, line 4 from top, *for* FEBRUARY 17, 1892, *read* JANUARY 21, 1891.
,, 546, line 4 from top, *for* Vol. IV., Part XIV., p. 703, *read* Vol. V., Part I., p. 1.

THE

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I.

REPORTS ON THE ZOOLOGICAL COLLECTIONS MADE IN TORRES STRAITS BY PROFESSOR A. C. HADDON, 1888–1889.

LEPIDOPTERA FROM MURRAY ISLAND. By G. H. CARPENTER, B.Sc. (Science and Art Museum, Dublin).

[COMMUNICATED BY PROFESSOR HADDON.]

[Read JUNE 18, 1890.]

SIXTY-SIX specimens of Lepidoptera were brought by Prof. Haddon from Murray Island, in which twenty species and varieties are represented. None of the species are new, but the collection is of interest from the point of view of animal distribution. The following list of species is accompanied by notes on the distribution of the insects, and on some variations presented by Professor Haddon's specimens:—

RHOPALOCERA.

Danaidæ.

Danais limniace, Cram., var. *hamata*, Macl. ♂ (2):

The variety *hamata* is Australian. The type ranges from Africa to Australia.

Satyridæ.

Mycalesis blasius, Fab. (1):

This species is Indian and Malayan.

Nymphalidæ.

Messaras prosope, Fab. (2):

Australian species.

Junonia vellida, Fab. (1):

This species ranges fr Sumatra to Australia. Professor Haddon's specimen differs from the Australian specimens in the Dublin Museum in having two very distinct eye-spots on the under side of each hind-wing.

Rhinopalpa sabina, Cram. (2):

This is a Malayan species. Professor Haddon's specimens are considerably smaller than those in the Dublin Museum.

Diadema nerina, Fab. ♂ (7), ♀ (2).

D. nerina ♀, var. *proserpina*, Cram.:

This is an Australian and Malayan species. The tawny-brown patches of the wings of the female are of great interest, as an approach to the entirely brown wings of the female of the allied *D. misippus*, the well-known mimic of *Danais chrysippus*.

D. alimena, Linn. (1):

This is an Austro-Malayan species.

Pieridæ.

Terias hecabe, Linn. (13):

This species ranges from Senegal to Papua. Some of Professor Haddon's specimens are very small.

Tachyris scyllara, Macl. ♀ (2):

An Australian species.

Catopsilia crocale, Cram. ♀ (1):

This species ranges from India to Australia.

Papilionidæ.

Eurycus cressida, Fab. (♂ 1, ♀ 2):

Australian species.

Ornithoptera poseidon, Doubl. (♂ 2, ♀ 3):

This is a typical Austro-Malayan species. Very nearly allied forms occur in Northern Australia. Professor Haddon's specimens afford excellent illustration of the great variability of the species. One of his males has the green markings along the median nervures of the primary wings very conspicuous, whilst in the other male it is almost suppressed. The three females all vary in the white markings on the primary wings, as well as in the marginal spots of the secondaries.

Papilio ormenus, Guèr. (♂ 3; ♀, 3rd form of Wallace, 1):

This is a Papuan species, whose females are trimorphic. The darkest form of the female is very like the male (Wallace, *Trans. Linn. Soc.* xxv.). The specimen brought by Professor Haddon is lighter in markings than Wallace's figure of the third (lightest) form, a partial suffusion of the discoidal cells of all four wings with black, which is shown in his figure, being almost suppressed in this specimen from Murray Island.

SPHINGES.

Sphingidæ.

Hemaris hylas, Linn. (1):

This common species ranges all over Africa, South Asia, and Australia.

Zygænidæ.

Syntomis, sp. (1).

BOMBYCES.

Eucheliidæ.

Deiopeia lotrix, Cram. (6):

This species ranges from India to Australia. It is very near the European *D. pulchella*, which is a rare British insect, and has twice occurred in Ireland.

Argina cribraria, Clerck ♀ (8):

This variable species ranges over Africa, South Asia, and the Malay Islands. Professor Haddon's specimens are of interest in having the light rings round the black spots of the primary wings nearly or quite suppressed. A specimen from Java in the Dublin Museum shows the same variation.

Lipraidæ.

Artaxa lutea, Fab. ♂ (1):

Australian species.

NOCTUES.

Euclidiidæ.

Trigonodes hyppasia, Cram. (1):

This species ranges from Africa to Australia.

It will be seen that six species are typically Australian, and four Austro-Malayan. One ranges over the Malay Islands generally, three range from India to Australia, and four are species with a range extending all over the tropics of the Old World. As might have been expected, the Lepidopteran fauna of Murray Island, as shown in this collection, may be characterized as presenting us with a mixture of Australian and Austro-Malayan typical forms, with a fairly strong infusion of wide-ranging Oriental insects. My best thanks are due to Mr. A. G. Butler of the British Museum for kindly answering several inquiries.

II.

REPORTS ON THE ZOOLOGICAL COLLECTIONS MADE IN TORRES STRAITS BY PROFESSOR A. C. HADDON, 1888–1889.

THE LAND SHELLS. By EDGAR A. SMITH (British Museum).

[COMMUNICATED BY PROFESSOR HADDON.]

[Read JUNE 18, 1890.]

No special attention was given to collecting terrestrial Mollusca, as the study of marine zoology was the principal object of Professor Haddon's researches. However, a few species were collected; but, beyond adding a little to our knowledge of their geographical range, and in one or two cases exhibiting considerable variation in size, these specimens possess slight interest.

In order to give a better idea of the land shells of this district, all the forms from Torres Straits and Cape York, recorded by Mr. C. Hedley of the Brisbane Museum, in his useful "List of the Land Shells recorded from Queensland" (*Proc. Roy. Soc. Queensland*, 1888, v., p. 45), have been added, as well as the corrections noted in Mr. H. Tryon's "Errata" in the above Paper (*t. c.* p. 131).

The species collected by Professor Haddon are marked with an *asterisk;* other localities than those of Torres Straits are put within brackets.

Rhytida beddomei.

Brazier, 1876, Proc. Linn. Soc. N. S. W., i., pp. 98, 121, unfigured.

Habitat.—Cape York and Albany Island.

Elæa splendidula.

Pfeiffer, 1845, Proc. Zool. Soc., p. 128; Küster's Syst. Conch. Cab., p. 109, pl. LXXXV., figs, 1–3; Cox, Monogr., p. 10, pl. III., fig. 3; Tryon, Manual of Conch., i., p. 129, pl. XXVI., figs. 20–22; Reeve, Conch. Icon., sp. 973.

Habitat.—Cape York and Torres Straits; (Moreton Bay).

Elæa rapida.

Pfeiffer, 1853, Zeitschr. f. Malak., p. 54; Cox, Monogr., p. 19, pl. III., figs. 9*a*, 9*b*; Pfeiffer, Monogr. Helic. viv., iii., p. 633; Tryon, Man. Conch., i., p. 129, pl. XXVI., fig. 13; Reeve, Conch. Icon., sp. No. 1038; Hutton, Ann. Mag. Nat. Hist., xiii., 1874, p. 89.

Habitat.—Cape York.

Nanina villaris.

Pfeiffer, 1854, Proc. Zool. Soc. p. 146; Pfeiffer, Monogr. Helic. viv., vol. iv., p. 47; Reeve, Conch. Icon., sp. No. 1375; Tryon, Man. Conch., ii., p. 105, pl. xxxv., fig. 41; Brazier, Proc. Linn. Soc. N. S. W., i., p. 118; iv., p. 392.

Habitat.—Cape York, Albany Island, and Thursday Island.

Nanina kreffti.

Cox, 1864, Cat. Aust. Land Shells, p. 21 (= *N. villaris*, Cox, *non.* Pfr., Monogr., p. 2, pl. x., fig. 8); Pfeiffer, Monogr. Helic. viv., vol. v., p. 243; Tryon, Man. Conch., ii., p. 219, pl. LXIII., figs. 98, 99; Brazier, Proc. Linn. Soc. N. S. W., i., p. 118; iv., p. 392.

Habitat.—Darnley and Thursday Islands.

Nanina yorkensis.

Pfeiffer, 1854, Proc. Zool. Soc., p. 145; Cox, Monogr., p. 34, pl. IX., fig. 8; Tryon, Man. Conch., vol. xii., p. 81, pl. xv., fig. 59.

Habitat.—Cape York (and Palm Island, lat. 16° 23′ S.).

Polita (*Conulus*) *russelli.*

Brazier, 1874, Proc. Zool. Soc., p. 668, pl. LXXXIII., figs. 13, 14; *id.*, Proc. Linn. Soc. N. S. W., i., p. 120; *id.*, Trans. Roy. Soc. N. S. W., 1874, p. 29; *id.*, Quart. Journ. Conch., 1877, vol. i., p. 271; Tryon, Man. Conch., ii., p. 179, pl. LIV., figs. 86, 87.

Habitat.—Cape York, Bet and Darnley Islands; (Fitzroy Island, Cardwell, Home Islands, Barnard Islands).

Polita (*Conulus*) *reedei.*

Brazier, 1876, Proc. Linn. Soc. N. S. W., i., pp. 101, 120, unfigured.

Habitat.—Darnley Island.

Polita (*Conulus*) *nepeanensis.*

Brazier, 1876, Proc. Linn. Soc. N. S. W., i., pp. 102, 121, unfigured.

Habitat.—Nepean and Cocoa-nut Islands.

Polita (*Conulus*) *porti.*

Brazier, 1876, Proc. Linn. Soc. N. S. W., i., pp. 104, 121, unfigured.

Habitat.—Albany Island.

Polita (*Conulus*) *pampini.*

Cox, 1868, Monogr., p. 111, pl. XIX., fig. 9; Brazier, Proc. Linn. Soc. N. S. W., i., p. 121; *id.*, Quart. Journ. Conch., 1877, vol. i., p. 271.

Habitat.—Cape York, Albany Island; (Bowen, Wide Bay, Fitzroy, Palon and Barnard Islands).

Charopa annulus.

Brazier, 1876, Proc. Linn. Soc. N. S. W., i., p. 100, unfigured.

Habitat.—Dungeness Island.

Helix (*Trochomorpha*) *ophelia.*

Pfeiffer, 1854, Proc. Zool. Soc., p. 146; Cox, Monogr. Austr. Land Shells, p. 34, pl. IX., fig. 4.

Habitat.—Cape York.

Helix (*Planispira*) *buxtoni.*

Brazier, 1879, Proc. Linn. Soc. N. S. W., iv., p. 394, unfigured.

Habitat.—Thursday Island.

**Helix* (*Hadra*) *bipartita*, Férus.

Ferussac, 1820, Hist. Nat. Moll. terr. fluv., pl. LXXV. *a*, fig. 1 Reeve, Conch. Icon., sp. 359; Pfeiffer and Dunker, Nov. Conch., iii., pl. CVII., fig. 12; Pfeiffer, Monogr. Helic., i., p. 319; Cox, 1868, Monogr. Austr. Land Shells, pp. 54, 56, pl. V., fig. 7; Brazier, Proc. Linn. Soc. N. S. W., i., p. 124; Smith, 1875, Zool. of Erebus and Terror, ii., p. 2, pl. IV., fig. 11; Semper, Reisen. Arch. Philipp., iii., pp. 159-161, pl. XIV.; H. Tryon, 1886, Ann. Rep. Queensland Mus., p. 5.

Several forms of this well-known species are contained in the collection. Large typical specimens were obtained at Somerset, Cape York; smaller examples, referable to *H. semicastanea*[1] of Pfeiffer, were also collected at that locality and others, still more aberrant from the normal form, with the spire less elevated, and the body-whorl more compressed, were met with at Mer, Murray Islands. The aperture in this form is much more contracted and semilunate.

The distribution of this species and of its variety *semicastanea* will be found in Cox's "Monograph of the Australian Land Shells," pp. 54 and 56. Pfeiffer[2] has figured a pale unicolorous variety, but has not particularized the locality. In Cuming's collection in the British Museum there are two similar specimens from Lizard Island, collected by Macgillivray.

Habitat.—Cape York, Albany Island, C. Direction, C. Grenville, Daintree River.

H. nicomede[3] and *H. beddomæ*,[4] Brazier, from North Queensland, appear to be allied species.

Helix (*Hadra*) *arthuriana.*

Cox, 1873, Proc. Zool. Soc., p. 564, pl. XLVIII., figs. 1, 1*a*.

Habitat.—L. Island, Torres Straits. [? Long Island, A. C. H.]

Helix (*Hadra*) *mulgravensis.*

Brazier, 1872, Proc. Zool. Soc., p. 21, unfigured.

Habitat.—Mulgrave Islands.

Helix (*Hadra*) *aureedensis.*

Brazier, 1871, Proc. Zool. Soc., p. 640, unfigured.

Habitat.—Aureed Islands.

Helix (*Hadra*) *challisi.*

Cox, 1873, Proc. Zool. Soc., p. 565, pl. XLVIII., fig. 3.

Habitat.—L. Island.

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[1] Pfeiffer, 1849, Zeitschr. Malak., p. 77; Reeve Conch. Icon. sp. 1348; Cox, 1868, Monogr., p. 56, pl. v., fig. 10; Pfeiffer, Monogr., Helic. iii., p. 222; Brazier, Proc. Linn. Soc. N. S. W., i., p. 124. Islands of Torres Straits.

[2] Novitates Conchologicæ, iii., pl. CVII., fig. 1.

[3] Brazier, 1878, Proc. Linn. Soc. N. S. W., iii., p. 79, pl. VIII., fig. 6 (Cardwell, Gould Island).

[4] Brazier, *l. c.*, p. 80, pl. VIII., fig. 7.

Helix (*Hadra*) *barneyi.*

Cox, 1873, Proc. Zool. Soc., p. 148, pl. XVI., fig. 2.

Habitat.—Barney Island. [This is evidently a misreading for Darnley Island, A. C. H.]

Helix (*Xanthomelon*) *nigrilabris.*

Von Martens, Malak. Blätter, xvi., p. 79 ; *H. edwardsi*, Cox, 1868, Monogr. Austr. Land Shells, p. 139, pl. XIX., figs. 3, 3 *a* ; *H. meadei*, Brazier, 1870, Proc. Zool. Soc., p. 662.

Habitat.—Blackwood Bay (Cape York), Mount Adolphus Island.

Helix (*Patula*) *spaldingi.*

Brazier, 1876, Proc. Linn. Soc. N. S. W., i., pp. 103, 121, unfigured.

Habitat.—Cape York, Albany Island, Bet, Sue, Warrior, and Cocoa-nut Islands; var. *carinata*, Braz., t. c., iv., pp. 393 and 394, Thursday Island.

Helix (*Dorcasia*) *brevipila.*

Pfeiffer, 1849, Proc. Zool. Soc., p. 130 ; Cox, Monogr., p. 47, pl. v., figs. 2*a*, 2*b*.

Habitat.—Cape York to Brisbane.

Helix (*Dorcasia*) *funiculata.*

Pfeiffer, 1854, Proc. Zool. Soc., p. 147 ; Cox, Monogr., p. 46, pl. II., fig. 15 ; Tryon, *l. c.*, iii., p. 214, pl. XLIX., fig. 16.

Habitat.—Islands in Torres Straits.

**Helix* (*Trachia*) *delessertiana*, Le Guillou.

Le Guillou, 1842, Rev. Zool. Soc. Cuv., p. 138 ; Pfeiffer, Monogr. Helic., iii., p. 157 ; Cox. Monogr., p. 61, pl. v., figs. 8*a*, 8*b* ; Brazier, Proc. Linn. Soc. N. S. W., i., p. 123 ; iv., p. 393 ; *Helix taranaki*, Gray, Pfeiffer, Symbolæ Hist. Helic., iii., p. 19 ; *H. torresiana*, Hombron and Jacquinot, 1853 ; Voy. au Pole Sud., v., p. 10, pl. IV., figs. 24, 27.

Some specimens obtained by Professor Haddon at Deadman's Island (a very small islet on the reef at the north side of Thursday Island) are rather larger than usual, the finest example having an extreme diameter of 23 millimetres. On the contrary, another series which he collected at Mabuiag are so dwarfed, that at first I regarded them as a distinct species. Their greatest diameter is only 15 mm., and yet they are quite mature shells, having the peristome properly developed.

Habitat.—"Islands of Torres Straits, from Nogo Island on the south to Warrior Island on the north" (Cox); Warrior Island, Bet, Sue, Cocoa-nut, Dungeness, and Darnley Islands, Cape York, Thursday and Albany Islands (Brazier).

**Helix* (*Trachia*) *cyclostomata*, Le Guillou.

Le Guillou, 1842, Rev. Zool. Soc. Cuv., p. 141; Cox, Monogr., p. 61, pl. x., fig. 12; Brazier, Proc. Linn. Soc. N. S. W., i., p. 124; Pfeiffer, Monogr. Helic., vii., p. 441; Smith, 1875, Zool. Erebus and Terror., ii., p. 2, pl. iv., fig. 13; Tryon, Manual Conch.-Pulm., iv., p. 65, pl. xiv., figs. 63, 64.

Habitat.—Mabuiag (Haddon).

According to Dr. Cox, this species is widely distributed in Queensland, from Brisbane to Cape York, and in the Islands of Torres Straits.

Helix (*Trachia*) *tuckeri.*

Pfeiffer, Symbol. Helic., iii., p. 77; Brazier, P. L. S. N. S. W., i., 123; Tryon, Man. Conch., iv., p. 65, pl. xiv., figs. 63, 64; *H. strangulata*, Hombron and Jacquinot, 1853, Voy. Pole Sud., pl. iv., pp. 1–4.

Habitat.—Albany Island, Sue, and Cocoa-nut Islands; (Cape Greville).

Helix (*Trachia*) *endeavourensis.*

Brazier, 1871, Proc. Zool. Soc., p. 640; *id.*, Proc. Linn. Soc. N. S. W., i., p. 123; Pfeiffer, Monogr. Helic., vii., p. 427.

Habitat.—Mount Adolphus Island (and Endeavour River).

Bulimus beddomei.

Brazier, 1880, Proc. Linn. Soc. N. S. W., i., p. 127; iv., p. 395, unfigured.

Habitat.—Mount Ernest Island, Torres Straits [or Nagir]: (Andromache River).

**Stenogyra* (*Opeas*) *tuckeri*, Pfeiffer.

Pfeiffer, 1846, Proc. Zool. Soc., p. 30; Cox, 1868, Monogr., Austr. Land Shells, p. 69, pl. XIII., fig. 9; Garrett, 1887, Proc. Zool. Soc., p. 185 (extensive synonomy).

Habitat.—Sir Charles Hardy's Islands (Pfr.); Clarence Heads, N. S. W. Generally distributed throughout Queensland and its islands, from Brisbane to Cape York (Cox). Garrett claims for it a wider range than any other land-shell, embracing Australia, the whole of Polynesia, Eastern and Southern Asia, probably the east coast of Africa, and the West Indies, where it was accidentally introduced with the bread-fruit plants from Tahiti.

Some of the specimens obtained at Mabuiag by Professor Haddon are considerably more slender than this; variation in size, sculpture, and the acuteness of the spire has also been referred to by Cox. Neither his figure nor Reeve's (Conch Icon. Bulimus, fig. 481) is characteristic. The former has the sutures too oblique, the whorls not sufficiently convex, and the last *much* too long. In the latter the spire is too tapering, and the apex too acuminate.

**Pupa pacifica*.

Pfeiffer, 1846, Proc. Zool. Soc., p. 31; *id.*, Mon. Hel., ii., p. 309; Küster, Conch. Cab., pl. XIX., figs. 26–28.

Habitat.—Mabuiag, Torres Straits (Haddon).

The only locality hitherto quoted for this species is "Sir Charles Hardy's Island." I presume this is the "Hardy Island" given on maps, as situated off the east coast of North Queensland.

Vertigo macdonnelli.

Brazier, 1874, Proc. Zool. Soc., p. 669, pl. LXXXIII., figs. 22, 23.

Habitat.—Cape York; (Fitzroy, Barnard, and Claremount Islands).

Vertigo macleayi.

Brazier, 1876, Proc. Linn. Soc. N. S. W., i., p. 110, unfigured.

Habitat.—Bet, Sue, Nepean, Dungeness, and Warrior Islands.

Tornatellina petterdi.

Brazier, 1876, Proc. Linn. Soc. N. S. W., i., p. 109, unfigured.

Habitat.—Darnley Island.

Tornatellina grenvillei.

Brazier, 1876, Proc. Linn. Soc. N. S. W., i., p. 109, unfigured.

Habitat.—Cape York, Home and Albany Islands.

Tornatellina mastersi.

Brazier, 1876, Proc. Linn. Soc. N. S. W., i., p. 108, unfigured.

Habitat.—Darnley Island.

Truncatella ferruginea.

Cox, 1868, Monogr. Austr. Land Shells, p. 94; Brazier, Proc. Linn. Soc. N. S. W., i., p. 132, unfigured.

Habitat.—Cape York; (Cape Grenville).

Truncatella yorkensis.

Cox, 1868, Monogr.. p. 93, pl. xv., figs. 11–11*b*; Brazier, Proc. Linn. Soc. N. S. W., i., p. 132, unfigured.

Habitat.—Cape York, Warrior Island, Torres Straits. Tryon (Ann. Report, Queensland Mus., 1887, p. 4), records this species from Burpengary.

Truncatella teres.

Pfeiffer, 1856, Proc. Zool. Soc., p. 336; Cox, Monogr., p. 92, pl. xv., figs. 9–9*b*; Brazier, Proc. Linn. Soc. N. S. W., i., p. 132; *id.*, Quart. Journ. Conch., 1877, vol. i., p. 274.

Habitat.—Cape York; (Fitzroy and Barrow Islands).

Pupina bilingius.

Pfeiffer, 1850, Proc. Zool. Soc., p. 97; Ann. Mag. Nat. Hist. 1851, vol. vii., p. 492; Cox, Monogr., p. 100, pl. xvi., figs. 6–6*b*; Pfeiffer, 1852, Monogr. Pneumonopomorum, i., p. 142; Sowerby, Thesaurus Conch., iii., pl. cclxv., figs. 8–10.

Habitat.—Cape York, and Islands of Torres Straits.

Pupina pfeifferi.

Dohrn, 1862, Proc. Zool. Soc., p. 183; Cox., Monogr., p. 103, pl. xvi., figs. 9–9 *b*; Sowerby, Thesaurus Conch., iii., pl. cclxv., fig. 17.

Habitat.—Darnley Island, Torres Straits, Cape York; (Lizard Island, Rocky Island, off Cape Flattery).

Cyclophorus (*Ditropis*) *beddomei.*

Brazier, 1876, Proc. Linn. Soc. N. S. W., i., pp. 113, 129, unfigured.

Habitat.—Cape York.

Helicina reticulata.

Pfeiffer, 1862, Proc. Zool. Soc., p. 277; Sowerby, Thes. Conch., iii., pl. cclxxii., figs. 231, 232; Cox, Monogr., p. 106, pl. xvii., figs. 14–14 *b*; Smith, Zoology of Erebus and Terror, pl. iv., fig. 2.

Habitat.—Blackwood Bay, Cape York.

Helicina yorkensis.

Pfeiffer, 1862, Proc. Zool. Soc., p. 277; Sowerby, Thes. Conch., iii., p. 290, pl. cclxxv., figs. 342, 343; Cox, Mongr., p. 108, pl. xvii., figs. 16–16 *b*; Brazier, Proc. Linn. Soc. N. S. W., i., p. 131; Pfeiffer, 1865, Monogr. Pneum., vol. iii., p. 228.

Habitat.—Cape York; (and Barrow Island).

III.

A NEW READING OF THE DONEGAL ROCKS.[1] By G. H. KINAHAN, M.R.I.A., &c. Plates I. to VI.

[Read November 19, 1890.]

Introduction.

In the winter of 1883–84 the late Gerrard A. Kinahan spent some weeks in exploring the hill-country between Loughs Salt and Finn, in the barony of Kilmacrenan, Co. Donegal; and from the relations of the rocks he was led to believe that a tract of *younger rocks*, running north-eastwards from Glen Swilly to the valley of the Leannaw, lay unconformably on *older*, its south-eastern being more conspicuous than its north-western boundary, the latter being more or less obscured by drift and bog. At the time my health prevented me from investigating the subject, while subsequently my duties required that I should more especially examine the country near Lough Swilly. But during the year 1885 my examination of the rocks in that country led me to believe that my son's conclusions were right, while more extended research in subsequent years has more fully confirmed them.

From the memoirs and map recently published by the Geological Survey,[2] it is evident that Dr. Geikie and the officers working under him have been under a misapprehension similar to that of the earlier surveyors of the country in the neighbourhood of Lake Superior. These American explorers supposed that the grits

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[1] This Paper was originally written in 1886; it has since been revised, and additional facts added in confirmation of the original theory. The original Paper was not read, as the Director-General of the Geological Survey considered that it was premature, and therefore would not give the required sanction.

[2] In one of these memoirs the writer's name appears; but his description of the rocks of a portion of the Barony of Kilmacrenan has been in places so modified by the official editor that the writer cannot be held responsible for the present representation of it.

and quartzites of that country all belonged to one and the same formation, and that their lithological differences were solely due to the different amounts of metamorphism that each of them had undergone. Logan seems to have been the first to point out that this was not so; while more recently Irvine, Lawson, and others have unravelled the geology of the country north-west, west, and south of Lake Superior, proving that the great series of rocks, formerly classed together, are divisible into groups belonging to distinct periods of time, although in some cases the rocks in one group may be scarcely distinguishable, lithologically, from those in another.

In the different American reports, but especially in the admirable memoir by the late Dr. Irvine ("Classification of the Early Cambrian and pre-Cambrian Formations," by R. D. Irvine), some of the descriptions, maps, and sections are very illustrative of what may be found in the county Donegal. Of these we may mention specially the description, map, and section of the country in the district of Marquette, Michigan, as there the proofs of the distinct ages of the rocks are so similar to what may be obtained in North Donegal that one description will do for both.[1]

The *Older Period Rocks* were upheaved, contorted, and invaded by granite—(*a*) after which they were considerably altered, and then invaded by another granite; (*b*) and afterwards denuded before the *Later Period Rocks* were deposited on them.

The post-metamorphic granite veins (*b*), although frequent in the *Older Period Rocks*, never extend up into the *Later Period Rocks*.[2]

Furthermore, connected with the *Older Period Rocks* there are dykes and other intrusions of metamorphosed traps. These

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[1] It is very interesting to me to learn that the conclusions as to the Donegal rocks, suggested by the late G. A. Kinahan, and confirmed by myself, should, as above pointed out, be additionally confirmed by Irvine's recently published maps, sections, and reports of the Lake Superior district; more especially as I know of my own researches that in America, as in Donegal, the difference between the quartzites of the different formations is so slight that ordinary geologists could not detect it.

[2] In the north portion of the county of Donegal there was a still later intrusion of granitic rocks. This must have taken place at a comparatively recent time, as the courses of elvan and felstone that branch off from the granite intrudes are very little broken or otherwise disturbed: they running continuously, irrespective of the upthrusting and other vicissitudes to which the country rocks were subjected.

in places come up against the *Later Period Rocks,* but never extend into them.

The *Older Period Rocks* were faulted and displaced prior to the accumulation of the *Later Period Rocks,* and consequently none of these ancient faults, although in places very numerous, extend up into the newer formation.

The *Later Period Rocks,* in a few places, can be distinctly seen to lie unconformably on the upturned edges of the *Older Period Rocks.*

In the *Later Period Rocks* there are in places Boulder and other fragmentary beds, the boulders and other fragments being derived from the denuded portions of the *Older Period Rocks.*

It is highly confirmatory of my work to find that the facts to which I have all along appealed, as proving the unconformability in the altered older rocks of Donegal, should be exactly similar to those given by some American geologists in recent publications, as indicating the unconformabilities in Wisconsin and elsewhere in the Lake Superior region. It is also remarkable that the failure of the older American geologists to distinguish one arenaceous group from another should now recur among geologists of this country. This should not have been so, as I had pointed out to them the proofs of the difference in age of the distinct groups of quartzites; yet some of them have even gone so for as to say my proofs were "physical impossibilities."[1]

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[1] Professor Hull, after his visit to Donegal with Messrs. Symes and Wilkinson, stated he had proved an unconformability between the *Later and Older Period Rocks;* but afterwards it would appear as if he was unable to trace it out, as he allowed himself to be persuaded to say the self-evident proofs pointed out to him by me were not satisfactory. When only a short time stationed in the county, it appeared to me that there must be an unconformability between the *Later and Older Period Rocks,* while there also seems to be a second and later unconformability; the latter, however, I never had an opportunity of working out. The late Gerrard A. Kinahan, as already mentioned, made a survey of part of Kilmacrenan; and during it he came to the conclusion that there must be rocks belonging to at least two distinct ages. At the time of his first visit he had not seen the Canadian rocks; but before his more detailed survey he had done so. Before commencing this survey he was inclined to think that Professor Hull was correct in stating that Laurentian rocks were to be found in Donegal; but, after his final examination, he came to the conclusion that, although there was an unconformability, the line of this unconformability, as laid down by Professor Hull, was incorrect, and that the older rocks could scarcely be the equivalents of the American Laurentians, but that in many characters they were similar to the Western Ontario

Detailed Descriptions.

[These descriptions will refer principally to the rocks in the barony of Kilmacrenan, as this district has been more especially studied by myself; reference, however, will be made to some of the rocks in the adjoining baronies.]

For the purposes of this inquiry it seems expedient first to give a general section of the rocks of the *Older* and *Later Periods.*[1]

There is a very continuous section across the *Older Period Rocks*, in a nearly north-west and south-east line, from the valley of Lough Beagh, past Lough Akibbon, to Glen Swilly, where the rocks occur in the following order:—

(*A*) Gneiss and foliated granite series.
(*B*) Gartan schist series—
- (*a*) Mica flag series.
- (*b*) Gartan Lakes group, including the limestone-diorite series.
- (*c*) Sericite group.
- (*d*) Volcanic group.
- (*e*) Cloncarn quartzite.
- (*f*) Boheola group.

(*C*) Gregory Hill series.

(*For General Section, see* Plate I.)

The rocks of the Gregory Hill series are apparently the youngest group of the *Older Period Rocks;* but they are separated

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rocks, called at that time Huronians. Since his visit to Canada, these Western Ontarian rocks are better known, having been very minutely worked out, especially by Dr. Lawson of the Canadian Survey, the results of the inquiry being that those rocks must be newer than the Laurentians, but older than Logan's Huronians, they being the equivalents of one of the groups now called *Algonkian* by the United States Geological Survey. As pointed out by me in previous writings, if the markings in rocks in Glendowan found by Mr. M'Henry are graptolites, they suggest that such rocks may be metamorphosed Cambrians, or even rocks of a later age. But we now learn that this may not be so, as in the black shales of the Penokee Gogebig iron region (*Huronians*) markings supposed to be organic have been found. If the latter supposition proves to be correct, these Donegal rocks may possibly be pre-Cambrian, but are not of Laurentian age.

[1] In the adjoining baronies of Raphoe and Inishowen there are the previously referred to rocks, evidently newer than those which are now to be mentioned; these, when properly worked out, may be found to belong to a still later period. They

from the others by the narrow tract of the *Later Period Rocks* that extends from Mulroy Bay, south-west, to beyond Glen Swilly. To the north-west they are distinctly covered unconformably by the *Later Period Rocks;* but to the eastward the latter appear to be upthrust on to them. To the southward, in the barony of Raphoe, the junction between the two is obscured by deep drift and bog; but in some places the newer formation appears to be upthrust on to the older, while in others there is probably an ordinary unconformability.

The gneiss and foliated granite series, with groups *a* and *b* of the Gartan schist series, are cut off to the north-eastward (south of Glen) by the *Later Period Rocks*, while the rest of the group (*c*, *d*, *e*, and *f*) are cut off both to the north-east and south-west; the groups *d* to *f* occurring in a tract only a few miles long.

Series *A* consists principally of gneiss and foliated granite; but with them there are subordinate limestones and schists, with, in places, a variety of gneiss so quartzose that it may be called gneissose, or micaceous quartzite. The last is of considerable importance, as the Geological Surveyors have not been able to distinguish it from the later quartzites, and have mapped both as if portions of the one group, this, as already mentioned, being a similar mistake to that formerly made by the American geologists in the neighbourhood of Lake Superior. Attention should also be called to the pink, felsitic veins of segregation, as fragments of them are often conspicuous in the Boulder-beds of the *Later Period Rocks.* These fragments, however, may be derived from the thin, irregular veins of a similar felsitic granite in the Gregory Hill series.

To the south-west, in the baronies of Boylagh and Bannagh, the rocks of these different series appear to be severally represented, they again coming out from under the *Later Period Rocks.* But in Fanad, between Mulroy Bay and Lough Swilly,[6] but especially

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consist principally of slates, some veins being roofing slates, and finely parallel obliquely laminated sandstones. Many of the latter have the lamination so regular that the rock has the appearance as of a gigantic book while another variety is full of pebbles (*Mullaghsawnites*, Egan), generally the size of shot and peas, but sometimes larger. The enclosures are generally quartz, but in some places they consist largely of pink, felspathic fragments, the enclosures evidently having been derived from the veins in the older granitic rocks and schists.

east of Lough Swilly, at the extreme north of Inishowen, the *Older Period Rocks* largely consist of micaceous quartzites and highly quartzitic gneiss.

In the north-east portion of the barony of Kilmacrenan there is the Muckish quartzite,[1] over which is a sericitic series associated with limestones. This quartzite, and the overlying strata, seem to me to belong to the *Later Period Rocks*, but I am not in a position to speak positively, not having specially examined the district; but during a rapid traverse I found that there is an unmistakable inversion in the Muckish range, the older rocks now lying over the younger; but to the northward, in the ridge south of Dunfanaghy, they are lying in their proper order, the younger over the older.

The *Later Period Rocks* may be grouped as follows (*see* Plate II. *for the order as seen in the Inishowen promontory*) :—

(*D*) Lough Salt and Fanad quartzites, } Great quartzite.
(*D′*) *Lough Keel and Knockalla quartzites, }
(*E*) Cranford sericitic series.
(*F*) Lough Keel schist series, } Great schist series.
(*F′*) *Millford schist series, }
(*G*) Killygarvan volcanic series.
(*H*) Killygarvan and Knoclybrin grit series.
(*I*) Kintale and Lubber volcanic and limestone series.
(*J*) Barn Hill grit series.
(*K*) Manorcunningham series.

In the country to the west of Lough Swilly these different groups of rocks have undergone considerable displacements, principally by upthrusting from the south-east, the thrusting being very conspicuous in the tracts of the Great quartzite. As successive small thrusts have pushed over the north-east portions of many of these tracts on to the rocks to the northward, thus repeating the beds over and over again, so that the quartzite now appears to be much thicker than it is in reality.

A marked displacement, but of a different type, is a great downthrow to the north-west (bearing south-west and north-east),

[1] On Muckish there is possibly an unrecorded outlier of Carboniferous rocks, as their *debris* is found in the vicinity.

which has brought down the great schist series against the Lough Keel and Knockalla quartzites between Mulroy Bay and Lough Swilly. However there was, subsequently to this fault, an upthrusting from the south-east, which has pushed the Knockalla quartzites on to the younger schists, thereby increasing the complications.

The complications in the country west of Lough Swilly are so considerable and intricate, that it would be nearly impossible to determine with certainty in that district by itself, the number and the true relations of the different series of the *Later Period Rocks*. Here some facts would suggest that the Lough Salt quartzites, with their overlying schist series, were quite distinct from, and older than, the Lough Keel quartzites and Milford schist series; also that the Killygarvan volcanic series was of considerable thickness. In Inishowen, however, to the east of Lough Swilly, these rocks lie in their regular order in four or five different sections; that which is best exposed being the coast section to the north-west of Buncrana. In these sections we have a key to the complicated tract to the westward in Kilmacrenan.[1]

Before and during the accumulation of the *Later Rocks* the sea was of unequal depths. This is evident if the rocks be traversed north and south, from Knockalla to the Swilly river, as different groups of rocks are found resting directly on the *Older Period*

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[1] My first visit to the Malin promontory was under adverse circumstances, which led to a mistake on my part. At Lag, to the west of the promontory, there was evidently the basal Great quartzite; from thence for a considerable distance to the Coast Guard Station very little rocks are exposed, while further north to Malin Head the rocks evidently belong to the *Older Period*. Griffith's boundary is a little north of the Coast Guard Station; and from the road, the rocks in the little headland are seen to dip southward, while the rocks on the adjoining shore dip northward. At the time I could hardly walk, so I took Griffith's boundary to be correct. Since then I have revisited the place, and have found that at the headland, a little north of the Coast Guard Station, there is an anticlinal curve in the gneissose quartzite, while along the axis of this anticlinal there is a whinstone dyke, the anticlinal and the dyke giving the appearance of an unconformability in the cliff, as viewed from the road. During my second visit I examined the west coast carefully, and traced the gneissose quartzite with its accompanying granite intrusions southward to the Great quartzite at Lag. The latter extend nearly continuously across the promontory to the eastern coast and dip southward at a high angle, while the gneissose quartzite to the north of it is undulating, generally at low angles, thus, although of no great thickness, occupying a considerable stretch of country.

Rocks, as represented in the accompanying diagrammatic section (*see* fig. 3, Plate IV.).[1] Moreover, in places in the Great quartzite we find litoral deposits on different levels that must have accumulated in the vicinity of land, while the Great quartzite seems to be of different thickness, as it is followed from the north-east into the country to the south-west.

To the east of Mulroy Bay, at Ballyhork and Croaghan, in Fanad, there are massive Boulder-beds and finer conglomerates apparently under the Great quartzite. There is no junction between them and the *Older Period Rocks* exposed; but they evidently are made up of detritus from the latter. The matrix is always more or less greenish, and in general it is brittle, weathering freely; but sometimes it is very quartzose and hard, with the boulders few and far between. The latter are for the most part coarse granites similar to those found in the neighbourhood of Ballyhorrisky, to the north-west, and Glen Lough, to the east of Mulroy Bay. There are also finer granites, granitic gneiss, micaceous or gneissose quartzite, like that in the hill north of Ballyhork, hornblende rock (diorite), dolomite, and vein quartz. In general the largest and more abundant blocks and fragments are of granite; but in some places they are principally of the gneissose quartzite and vein quartz. In Crockmore, south of Croaghan, and in Ballyhork, there are, in the Boulder-beds, interbedded quartzites; while to the south of Crockmore the massive Boulder-bed seems to suddenly thin out and be replaced by quartzite. Under the Boulder-bed, both at Croaghan and Ballyhork, there are dolomites and limestones, some of which appear to belong to it, while others may possibly belong to the *Older Period Rocks.* But the sections are so obscure that, from my brief examination, it is impossible to say anything positive as to their age.[2]

Other Boulder-beds occur inter-stratified with the Great quartzite of the Knockanteenbeg outlier, which lies about eight

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[1] This explanation of mine has been said to be a "physical impossibility," yet exactly a similar overlap, but, of course, on a much grander scale, occurs in Central Wisconsin, U. S. A., the Potsdam sandstone lying on the Huronians at Baraboo, while due north, near the Grand Rapids, they lie direct on the Laurentians; the *absent strata* between these two localities being, in other places, thousands of feet in thickness.

[2] In general limestone does not occur at the base of the Great quartzite, but near Lag, N. N. W. of Carndonagh, in Inishowen, it does occur. Here it may also

miles to the westward of Letterkenny, near Gartan Lake. Hence the rocks lie in the following order:—

1. Micalites and hornblendites, limestones and interbedded (?) hornblende rocks (diorites), all dipping south-east, at from 50° to 60°. These belong to the *limestone-diorite series,* hereafter more especially mentioned.
2. *Unconformability.*
3. Greenish boulder-bed,
4. Flaggy quartzite,
5. Greenish boulder-bed,
6. Flaggy quartzite,
7. Greenish boulder-bed,
8. Flaggy quartzite,

(Nos. 3–8) dipping S. S. E., at 10°.

9. *Upthrust from the south-east.*

In the Boulder-beds (Nos. 3 and 5) the blocks and fragments are in general not very frequent, while the exposures are capped by slight thicknesses of flaggy quartzite (Nos. 4 and 6), the inlying blocks being principally granitic gneiss and foliated granite, similar to those found in the country to the northward. But, in addition, there were observed small pieces of gneissose quartzite, hornblende rock, &c. In the Boulder-bed (No. 7) the majority of the inliers observed were of a reddish, or pinkish, fine, nearly micaless granite, similar to the vein-rocks in the granite country to the north-westward, and also to the already-mentioned irregular, thin granite veins in the rocks of the Gregory Hill series. Associated with these are pieces—some of considerable size—of gneissose quartzite and granitic gneiss, similar to those in the country to the north-westward and northward. In this locality, as also elsewhere, the greenish matrix seems to have been made up of the *debris* of the underlying schists belonging to the *Older*

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occur; while south-east of Glen Lough, to the west of Mulroy, there is a limestone that in one place seems to belong to the Great quartzite; while miles to the south-west, in the barony of Banagh, Mr. Kilroe has found Boulder-beds which in places are similar to those described above; but others are limestones containing boulders.

These Boulder-beds of Fanad are very similar in contents and appearance to some of the shingly beaches at present existing on the western coast of the northern portion of Inishowen (Lough Swilly).

Period Rocks, the matrix in places being more or less quartzose, like as we find more or less quartzose varieties in those schists.

As the Boulder-beds in the Knockanteenbeg outlier are interstratified with the quartzites, it seems to suggest that they are littoral deposits that accumulated in the vicinity of land. (*See sectiou,* fig. 1, Plate III.)

A curious suggestion in connexion with these Boulder-beds has been made to the effect that they are of sole glacial origin, the blocks being brought considerable distances by ice from Archæan areas; it being even stated that the red or pinkish feldspathic rock is the same as the feldspathic rock so characteristic of the pre-Cambrian rocks of Erris, north-west Mayo. The feldspathic rocks of Erris, however, are of the peculiar and rare shade of pink rarely found but in limestones, and are only recorded as found here and in a foliated granite near Lackagh Bridge, Co. Donegal.

All these Boulder-beds of the Co. Donegal are totally devoid of all the peculiarities of glacial accumulations; whether on the land or in water, while they are eminently characteristic of littoral deposits; the contained boulders and fragments being nearly always well water-worn and rounded, while the matrix in which they are embedded is sand and silt; the washings or detritus of the associated older rocks.

It appears ridiculous to go hundreds of miles to look for the source of the boulders while rocks similar to them are found close at hand.[1]

Still further south-west, in the neighbourhood of Lough Finn, the basal-bed of the Great quartzite is also a greenish rock, but the pebbles in it are few and small, none of the exposures having any of the characters of a conglomerate; in fact, more pebbles were observed in some of the overlying quartzite than in it. However, still further south-west, near Glenties, the basal-beds are more or less similar to the Boulder-beds already described; while to the south-west, in the barony of Barnagh, there are the Boulder-beds—some having a limestone matrix—recorded by Mr. Kilroe. These, however, have not been examined by me.

[1] Dr. Hyland has since examined the boulders in the Croghan district, and from him I learn that the granite boulders have none of the characters of an Archæan granite; while they are identical with the granite he found *in situ* in the country to the northward.

The *Later Period Rocks* have been considerably upthrusted; and as the junction of the *Older* and *Later Period Rocks* was a line of weakness, it lying between the hard quartzite above and the softer schist below, it may be naturally expected that it would often give way, which is found to have been very generally the case, as the Great quartzite so often was pushed over the unconformability on to the *Older Period Rocks*, thus obliterating it, so that the majority of the apparent unconformabilities, now to be seen, are due, not to deposition, but to displacement along thrust planes.

Furthermore, the unconformability has also been obliterated or obscured by other causes, one being the intrusions of whinstone at the junction of the two formations, which in places have cut out or replaced considerable masses, especially of the *Later Period Rocks*, while miles of the boundary are obscured by accumulations of drift and bog; and on account of the upthrusts, ordinary faults, the intrusions, and the accumulation of superficial deposits, only a few normal unconformabilities are exposed in the south portion of the barony of Kilmacrenan.

(*For sections of the unconformabilities see* Plates I., II., III., IV.)

The unconformability between the Lough Salt quartzite and the *Older Period Rocks* is more or less due to the upthrusting from the south-east; and in no place is the basal-bed seen, except, perhaps, a mile north-east of Lough Salt, where there seems to be a limestone under the quartzite. This, however, is not quite clear, as the rocks have been disturbed by an intrusion of whinstone. A little south-west of this place, as also a few miles to the north-eastward, small pebbles of the gneissose quartzite are frequent in the Great quartzite.

To the east of Glen, and further to the north-east, southward of Carrick (sheet 4), the Lough Salt quartzite and the Older Period gneissose quartzite are nearly in contact, and have been classed by the officers of the Survey as belonging to one and the same group of rocks; but in the latter locality the older rocks are associated with courses of foliated granite, and in the former the gneissose quartzite contains numerous granite veins; and in neither localities can a trace of the granitic rocks be found in the Lough Salt quartzite.

The north-western boundary of the Lough Keel and Kilmacrenan quartzite is generally a fault line, which is a downthrow to the north-west, eastward of the Lurgy valley; while it is a downthrow to the south-east westward of that valley. North-westward of the latter portion of this fault, in a few places, the lowest beds of the quartzite are in such positions that they must be unconformable to the adjacent *Older Period Rocks.* These unconformabilities occur in the following places, viz. about a mile west-north-west of Kilmacrenan, nearly vertical micalites and argillites strike about east and west, slightly obliquely to the quartzites, which dip south-east at 40°. A vertical section, perpendicular to the unconformable boundary, is represented in fig. 1, Plate IV. A little to the south-west, in the vicinity of Doonrock, nearly similar relations exist between the *Older* and *Later Period Rocks.*

A little more than a mile south-west of Doonrock there are in several places quartzites that dip south-east at from 25° to 30°; while in their immediate vicinity are the *Older Period Rocks* that dip north-west at from 30° to 45°. A vertical section across this locality is given in fig. 2, Plate III.

The unconformability at the Knockanteenbeg quartzite outline, shown in the section, fig. 1, Plate III., has already been described. Due south of the south-west end of Gartan Lough, at the line of this section, the unconformability seems to be due to deposition; but a little to the south-west it is evident that the quartzite have been thrust over the basal-bed on to the older rocks.

In the localities that have been described the actual junction between the older and later rocks cannot be seen on account of a covering of either drift or bog; but this is not so in places along the south-east boundary of the Lough Keel and Kilmacrenan quartzite.

In the area contained in sheet 16, between Glen Swilly and Drumabogue, the conspicuous boundary seems to be a fault which has let down the *Later Period* against the *Older Period Rocks.* But on examination it is found that, in places alongside the fault, the basal-bed of the newer rocks still exists, its preservation being due to its lower portion being incorporated with the broken upturned edges of the older.

The *Older Period Rocks* are rolling in sharp curves, dipping at high angles to the north and south; while to the westward, across them, lies the *Later Period Rocks,* which dip north-west at 75°. This junction is best seen along the road near where the site of the old Roman Catholic chapel is marked on the map.

To the north-east, in the vicinity of the Treantagh Presbyterian meeting-house (sheet 10), the old rocks are perpendicular, and strike north-east at the quartzites which lie across their edges. Over two miles further north-east, to the southward of the Leannan river, there are vertical phyllites; while immediately north of them there are quartzites that dip north-north-west at from 40° to 50°. In the ravine of the Leanaun river, at Milltown Bridge, a little south-east of Kilmacrenan, the unconformability is well marked, the *Older Period Rocks* dipping south-east, at high angles, while lying on them, and incorporated with their broken edges, is a massive quartzite. The section across this junction is represented in fig. 2, Plate IV. As this junction is exposed only in the river ravine it cannot be examined except while the river is nearly dry.

In the Knockybrin district, to the north-eastward of Letterkenny, the western boundary of the *Later Period Rocks* consists, for the most part, of fault lines, along which the newer rocks have dropped down against the older; but between one and two miles north of Letterkenny (sheet 16) there is, on the west of the main fault, a small tract, and a few very small outliers, in which the quartzites were very little displaced, excepting displacements due to intrusions of later traps. In these tracts the quartzites are rolling nearly horizontally across the upturned edges of the *Older Period Rocks;* and in the latter, adjoining the small quartzite outlier to the south-west, there are dykes of diorite which can be traced up to the quartzite boundary; but there they are obliterated on account of the *Later Period Rocks* having accumulated on them.

One of the statements put forward as a proof of the non-existence of the unconformability between the *Older and Later Rocks* is, that the Great quartzite (*Lough Salt quartzite*) is not a basal group; that in every locality where it occurs in the baronies of Inishowen, Kilmacrenan, and Boylagh, it *lies in an inverted synclinal, and that the Cranford sericitic series, with its limestones that seem to lie on the quartzite, is, in reality, the Lough Salt Limestone hornblendite series brought up into this position by an inverted synclinal.*

This statement will not, however, bear investigation. *The Cranford sericitic series*, which always lies on the Great quartzite, and the *Lough Salt Limestone hornblendite series*, which, in a few places, is found below it, are quite distinct assemblages of rocks, as can be seen by comparing the accompanying plotted vertical section of the two series. (Plates V. and VI.)

The *Cranford sericitic series* is from over one thousand to one thousand five hundred feet thick, and is made up almost entirely of sericites, which have in them subordinate limestones and dolomites, with lenticular quartzites. In it the limestones and dolomites at the different localities occur on different horizons, and are from a few inches to many feet in thickness, usually not more than twenty feet, but in a few places they are massive. At Cranford there are massive limestones and dolomites, and these continue for over a mile towards the south-west; then for about two miles there is scarcely any limestone until the Golam quarries are reached, where the limestones and dolomites are again massive, but only for a short distance; and this is the character everywhere else; in one place being conspicuous, and elsewhere nearly disappearing.

This sericitic series is present everywhere in the baronies of Inishowen, Kilmacrenan, and Boylagh above the *Great quartzite.* On the other hand, the *Lough Salt Limestone hornblendite series* is always a regular alternation of diorite (*hornblendites*), limestone, and schist; and where well developed, as it is to the south-east of Lough Akibbon, it is about one thousand feet thick. It is not found in Inishowen in connexion with the Great quartzite; nor in connexion with the long exposure that extends from Ballymastoker Bay, Lough Swilly, south-west to Glen Swilly, a distance of over twenty-two miles. At Lough Salt, however, the Great quartzite has been brought into contact with this series by faults; the quartzite towards the north-east being upthrust on to it, while towards the south-west the quartzite has been let down against the limestone hornblendite series. A little south-west of Lough Salt the *Limestone hornblendite series* parts company with the quartzite, and for over eight miles towards the south-west it can be seen as a group underlying a thick schist series. South-east of Loughakibbon (*see vertical section*, fig. 2, Plate VI.) the rocks are well exposed in a continuous section, without any faults, so that by no possibility could the quartzite ever have existed here, and be now concealed by faults. South of Gartan Lake (sheet 16), the Boulder-beds in the north-east portion of the Knockanteenbeg outlier were deposited on the upturned rocks of the *Limestone* *hornblendite series;* while to the south-west quartzites were upthrust on to it. From Knockanteenbeg, for over nine miles towards the south-west, the series of limestones and hornblendite crosses the country independently, and it is not found in connexion with the Great quartzite until Lough Finn is reached, and here it is evident that the latter has been upthrust on to the former. From what has been shown it is evident that wherever the Great quartzite comes in contact with the *Limestone hornblendite series* it is purely by accident.[1]

The statement that the *Cranford sericitic series* and the *Limestone hornblendite series* are one and the same group seems to me to be quite indefensible. Even if the two groups were not so essentially different, their positions, relatively to the Great quartzite, illustrate the untenability of the statement. Everywhere the *Cranford sericitic series* lies in a regular sequence on the quartzite, while usually the *Limestone hornblendite series* is absent, and in no place does it occur in a regular sequence under the quartzite.

How, then, could a group that always has a regular position in regard to the Great quartzite be identical with one that has an abnormal position, such as is given to it by the supporters of the theory that its present position depends on upthrusting or other faults?

Probable Ages of the Rocks.

In the "Geology of Ireland" (1878) it is suggested that these Donegal rocks are probably metamorphosed Ordovicians and Cambrians; while in a more recent publication ("Palæozoic Rocks of Galway and elsewhere in Ireland, said to be Laurentians"—*Scient. Proc. Roy. Dub. Soc.*, vol. iii., n. s., p. 347, 1882) it is shown that the metamorphic rocks in South Donegal, to the westward of Pettigo, must be of the same age as the metamorphic rocks of the Pomeroy district, Co. Tyrone, and therefore possibly pre-Cambrian. In a still more recent publication ("The Economic Geology of Ireland," *Roy. Geol. Soc. Ir. Proc.*, vol. xviii.) I state that there are

[1] These details, in connexion with the rocks in the neighbourhood of Gartan Lakes, are necessary, as all account of them has been cut out of the Geological Survey Memoirs.

probably no Laurentians in Ireland, but that possibly some of the old schistose and gneissose rocks are the equivalents of the "Gap-rocks" between the Cambrians and the Laurentians, those called by Irving and others Agnotozoic, but now called by the United States Survey (after the territory in which they are best developed) *Algonkians*. Dr. Lawson, however, of the Canadian Survey, has called them *Ontarians*, which he claims to have a priority.

The older schistose and gneissose rocks of Ireland are, in general, possibly equivalent to one or other of the groups in these "Gap-rocks" (*Algonkians* or *Ontarians*).

As to the older rocks of the Co. Donegal, in the "Economic Geology of Ireland" it is stated that if the Metallic skeletons found in the black shales of Glendowan are organic remains, those rocks ought to be the equivalents of the Arenigs. Now, however, such a statement must be modified, as we learn that in the black shales of the Canadian Huronians (see *ante*, page 17) similar Metallic skeletons have been found; and if so, it suggests that in Donegal, as in Canada, the traces of organic remains may be found in pre-Cambrian rocks. Petrologically the older rocks (which provisionally may be called *Kilmacrenans*, as they are best developed in that barony), that extend round the later rocks from the Pomeroy district to Pettigo and Ballyshannon, and thence northward and westward into the barony of Kilmacrenan, are members of one system of rocks; and, if one portion is pre-Cambrian (*Algonkian*) all ought to be so also. It should, however, be pointed out that, as this area has been very unsatisfactorily examined, it is quite possible that in the Kilmacrenan rocks there is a discordance that would prove a distinct age for different groups. It can, however, be positively asserted that the "Kilmacrenans" are pre-Ordovician, and they may possibly be of pre-Cambrian age.

The granitic-gneiss, as Gneiss, is evidently nearer than the associated country rocks: that is, all the schistose rocks of the country were in existence, in some form or other, long prior to any portion being metamorphosed into gneiss. The origin of granitic-gneiss is still a vexed question, to which I hope to return in a subsequent Paper, but in this it cannot be entered into.

The granitic adjuncts of the "Kilmacrenans" belong to at least five distinct systems. *First*, there are the granites, the adjuncts of the gneiss; *second*, granite intruded into these rocks, and sheared along with them; *third* and *fourth*, two distinct granites intruded after the shearing; and *fifth*, a much more recent invasion. The lateness of the last appears from the facts, already pointed out, that the dykes and courses of elvan and porphyries from the laccoliths run continuously in the northern portion of the barony of Kilmacrenan without being affected by any of the upthrusting, and rarely by any of the faulting to which the associated country rocks have been subjected.[1]

That the strata from the base of the *Great quartzite* upwards to the *Barnhill grit series* are of a much newer age than the "Kilmacrenans" is self-evident, as the latter were contorted, metamorphosed, and denuded prior to the *Later Rocks* accumulating over them.

As to the age of the *Later Rocks* (from the Great quartzite to the Barnhill grit series) it may be suggested that they are the equivalents of the Lower Ordovician. The rocks of the higher group (*Manorcunningham series*) are still undetermined as to age. These Mullaghsawnites and their associated slates, in the barony of Raphoe evidently lie unconformably on the *Older Period Rocks;* but in the barony of Inishowen they overlap much more recent rocks (*Killygarvan volcanic series*). This overlap, as seen in the hill to the south and south-east of Buncrana, may be due to upthrusting; but I suspect it is in part, at least, due to a second hiatus or unconformability.

The *Mullaghsawnites* are pebbly sandstones or schistose rocks, containing quartz and feldspathic grains from the size of shot to that of large peas. Usually the grains are quartz, but in some places these are in a great measure feldspathic. Very similar rocks occur in the Upper Ordovicians (*Slate series*) of Cos. Clare and Tipperary, while they also occur in the supposed metamorphosed Ordovicians in the hill immediately south of Westport, Co. Mayo. In Mid-Scotland, especially in Perthshire, in rocks also supposed to be sub-metamorphosed Ordovicians, similar pebbly rocks are said to be of glacial origin; for what reason it is hard to conceive, as no modern accumulations, due to any ice, have any characters

[1] The above conclusions I came to from field observations. I learn, however, from Dr. Hyland that, after microscopical and chemical investigation, he has arrived at a classification which is very similar to, if not identical with, mine.

in common with them, while various aqueous deposits are more or less similar.

In a recent Paper by Dr. A. Geikie,[1] he says that the "Connemarians," or metamorphic rocks of Connemara (Galway), are some of the oldest rocks not only in Ireland, but also in the world. The latter statement is undoubtedly incorrect, as they evidently are metamorphosed fragmentary rocks; while I suspect that as to age, the Donegal gneissose and schistose series are the older.

Before concluding, it is necessary to mention the writings of Professor Jukes and others relative to this subject. Griffith pointed out, years ago, that there were discordances between the older rocks of Malin Head, those of Slieve Gallion, and those of the Glen Lough District, and the *Later Rocks.* Harkness said that the Malin rocks were the equivalents of the "Upper pre-Cambrian rocks of Scotland;" Jukes suggested that the Older Rocks were possibly Laurentians; while Hull has classified the older Donegal rocks as representing different groups in the Archæans.

I may again state my belief that it would be very rash to assert that any of the Irish rocks are the equivalents of the American Laurentians; but from what the American geologists have proved I now believe we may have in Donegal equivalents of some of the "Gap-rocks," that is of the *Algonkians* or *Ontarians* of those geologists.

I am now convinced that Professor Hull was correct in saying that the Great quartzite of the Lough Salt Hill and of Scraigs (Finn Valley) lies unconformably on the strata to the northward. He, however, afterwards went astray, from allowing his assistants to map the gneissose quartzite and the Great quartzite as one; and thereby missing all proofs of the unconformability. The old and new quartzite rocks, however, as already mentioned, misled the early American geologists; and now, in the county Donegal, it has been a stumbling-block to the officers of the Geological Survey, from the Director-General downwards, except, perhaps, to the Petrological Officer, who, from what he has written, seems to recognize the difference between them. The evidence for an unconformability in the rocks of the county Donegal is, however,

[1] "Recent Researches into the Origin and Age of the Highlands of Scotland and the West of Ireland."—*Roy. Inst. Gt. Brit.*, June 7, 1889.

much more plain than that between the Ordovician and Oldhamians (*Bray Head series*) in south-east Ireland.

The statement that some of the limestones in the Derryveagh district (Gartan Lake) are conglomeritic is evidently incorrect. The limestones, in which there are small pieces of quartzose and micaceous materials, are on sheared rocks, in which the original layers and partings, by shearing, have been broken up into fragments, as can be proved in Scraigs and elsewhere; while the supposed inlying granite boulders are only the granitoid concretions that are found everywhere in highly-metamorphosed limestones.

Summary.

The officers of the Geological Survey seem to have come to the following conclusions, viz.:—

All the pre-Carboniferous rocks in county Donegal belong to one series, some portions being more sheared than others.

The granitic gneiss and the foliated granite were all erupted at one and the same time.

Our conclusions are as follows:—

These Donegal rocks belong to distinct geological periods.

The Kilmacrenans (Granitic and Schist series) are possibly pre-Cambrian, and equivalents to one of the groups in the American "Algonkian."

The Kilmacrenans are undoubtedly capped unconformably by the Killygarvan series. This is shown by the fact that in the basal groups of the latter (the Great or Lough Salt quartzite) there are fragments of the Kilmacrenans. There are also other proofs of their unconformability, as above-mentioned.

The Manorcunningham series may also lie unconformably on the rocks of the Killygarvan series. This, however, has not been positively proved.

The Granitic gneiss and Foliated granite associated with the Kilmacrenans are in part metamorphic and in part intrusive.

Instead of one, there have been, at least, four or five periods of granite intrusion. One or more intrusions occurred before the

Kilmacrenans were subjected to their first metamorphism; another intrusion took place subsequently, but prior to the accumulation of the Great quartzite, as in no place does one of the granites belonging thereto penetrate it. This was followed by a very recent intrusion, later than all the great disturbances. This is evident from the fact that, in the north country, the elvans and felstones from the granite laccoliths are nearly intact.

EXPLANATION OF PLATES I. TO VI.

PLATE I.—GENERAL SECTION OF THE DONEGAL SCHISTOSE AND GNEISSOSE ROCKS.

PLATE II.—INISHOWEN. DIAGRAMMATIC SECTION.

PLATE III.—SECTION OF UNCONFORMABILITIES.

Fig. 1.—Section, Knockanteenbeg.
Figs. 2 and 3.—Section, one mile north-east of Treantagh.

(*Scale*, 6 *inches to* 1 *mile.*)

K.	Kilmacrenans.	*W.*	Whinstone.
l.	Limestone.	*β.*	Baked rocks.
s.	Sericites.	*F.*	Faults.
g.	Quartzose grits.	*UP.*	Upthrusts.
c.	Conglomerates.	*U.*	Unconformability.

PLATE IV.—SECTION OF UNCONFORMABILITIES.

Fig. 1.—Section, one mile west of Kilmacrenan.
Fig. 2.—Section, Kilmacrenan.

(*Scale* 6 *inches to* 1 *mile.*)

K.	Kilmacrenans.	*c.*	Conglomerates and breccia.
l.	Limestone.	*W.*	Whinstone.
s.	Sericites.	*U.*	Unconformability.
g.	Quartzose grits.	*UP.*	Upthrusts.

PLATE IV.—SECTION OF UNCONFORMABILITIES—*continued.*

Fig 3.—Diagrammatic section, exemplifying the overlap of the Later Rocks on to the Older Rocks (Kilmacrenans) in the Knoclybrin district, north-east of Letterkenny.

a. Kilmacrenans.
D. Great quartzite.
E. Cranford series.
F. Milford schist series.
G. Killygarvan volcanic series.
H. Killygarvan grit series.
I. Lubber limestone and volcanic series.
J. Barnhill grit series.

PLATE V.—VERTICAL SECTIONS, CRANFORD SERIES.

PLATE VI.—VERTICAL SECTIONS, HORNBLENDITE SERIES.

IV.

A STUDY IN THERMO-CHEMISTRY: THE REDUCTION OF METALS FROM THEIR ORES. By W. N. HARTLEY, F.R.S., Professor of Chemistry, Royal College of Science, Dublin.

[Read December 17, 1890.]

Notwithstanding the number of years during which Thermo-Chemistry has been investigated by Favre and Silbermann, Andrews, Berthelot, and Julius Thomsen,[1] there has been very little application of the results attained to explaining the theory of metallurgical processes. This communication contains a number of thermo-chemical equations relating to practical details of the kind.

Explanation of the Terms used.

When one substance A combines with another B, to form a third substance C, there is a certain amount of energy lost or gained. This is termed *heat disturbance*, since energy can be measured in terms of heat. The change above may be put in the form of an equation—

$$A + B = C \pm q \text{ heat-units.}$$

Here it must be understood that when A and B combine, as, for instance, when carbon combines with oxygen, they do not form AB, like C + O = CO, because the energy associated with A and B is not the exact quantity associated with the third substance. This latter C differs by $\pm\ q$ heat-units from $A + B$.

A gramme atom is an atomic weight in grammes.

A heat-unit is the quantity of heat required to raise 1 kilogramme of water 1° C.

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[1] For information on this subject, see "Ostwald's Chemistry," translated by Dr. Walker; "Thermo-Chemistry," by Pattison Muir; "Chimie Elémentaire," par A. Ditte; also Richter's "Chemistry."

The combination of mercury with sulphur may thus be represented :—

$$Hg + S = HgS + 4 \cdot 9 \text{ heat-units (Nernst, 1888).}$$

That is, 200 grammes of mercury combine with 32 of sulphur to form 232 grammes of mercury sulphide, with an evolution of heat capable of raising 4·9 kilogrammes of water 1°C.

The physical state of the reacting substances must be taken into account, and likewise the physical state—whether solid, liquid, or gas—of the products.

A reaction in which heat is evolved is termed *exothermic ;* a reaction in which heat is absorbed is called *endothermic.*

In the former the compound formed differs from its constituents by something less than the energy associated with them. In the latter case the compound differs by containing more energy than its constituents. But in the former reaction the *heat disturbance* is positive, and is denoted by a *plus* sign (+); in the latter it is a negative quantity, and is indicated by a *minus* sign (–).

For example, when hydrogen combines with oxygen to form water, much heat is evolved, and this is explained by the following equation :—

$$H_2 + O = H_2O \text{ (gaseous)} + 58 \cdot 2 \text{ heat-units.}$$

But when oxygen combines with oxygen to form ozone there is much heat absorbed, thus :—

$$O_2 + O = O_3 - 30 \text{ heat-units.}$$

Conditions of Chemical Change in Smelting Operations.

All chemical reactions take place only within certain limits of temperature. At low temperatures chemical combinations generally cannot take place; at very high temperatures chemical combinations cannot exist.

Ores of the useful metals are for the most part oxides, carbonates, or sulphides. The carbonates and sulphides are generally converted into oxides by the process of roasting.

Smelting operations are conducted either in reverberatory furnaces or blast furnaces. The fuel is first burnt to carbon dioxide (CO_2), and this gas is converted into carbon monoxide (CO) by contact with more red-hot fuel.

In either case the following functions are performed:—

(*a*) Initiation of the reducing process by heating the ore, that is by raising it to a suitable temperature.

(*b*) Reduction of the ore by carbon monoxide gas (CO).

(*c*) In certain cases, in which the reducing process consists of feebly exothermic reactions, to maintain the reducing process by the continuous supply of extraneous heat.

All reducing processes are not of the same nature, and it will be convenient to consider them in the following order:—

1. Reduction accomplished by means of furnace gases.
2. Reduction by carbon.
3. Reduction by another metal.
4. Air reduction processes, or those in which air, acting upon a sulphide, removes the sulphur as sulphur dioxide while the metal itself is reduced.

Furnace gases, which operate in reducing processes, consist chiefly of carbon monoxide (CO), and some hydrogen. The difference in the heat evolved by the combustion of various substances is considerable, as may be understood by the following equations:—

(1.) $H_2 + O = H_2O$ gaseous + 58·2 heat-units.
(2.) $C + O = CO$ „ + 28 „
(3.) $CO + O = CO_2$ „ + 69 „
(4.) $C + O_2 = CO_2$ „ + 97 „

The production of the so-called "water-gas" can take place only at very high temperatures because it involves a loss of heat; the reaction is endothermic.

$$C + H_2O = CO + H_2 + (28\text{–}58{\cdot}2) \text{ heat-units.}$$

As the heat evolved by the formation of water amounts to 58·2 units, and that of carbon monoxide to only 28 units, it follows that to bring about the oxidation of carbon and the deoxidation of water, 30·2 heat-units must be continuously supplied to the two substances.

The reducing action of carbon monoxide will be seen by equations (1) and (3) to be superior to that of hydrogen by 10·8 heat-units, inasmuch as the former evolves 69 heat-units for every atom of oxygen removed from an oxide, while the latter evolves 58·2 heat-units. Consequently it is necessary to consider the action of carbon monoxide and of carbon in smelting processes, but not that of hydrogen.

All those metallic oxides the heat of formation of which is less than 69 heat-units are capable of reduction in a reverberatory furnace.

Thermo-Chemical Equations.

(1.) Reduction accomplished by means of Furnace Gases.

Smelting of Lead Ores.—Reduction of Lead Oxide:—

$$PbO + CO = Pb + CO_2 + (69 - 51) \text{ heat-units.}$$

$$\text{Heat evolved} = 18 \text{ units.}$$

Reduction of Copper Oxide:—

$$CuO + CO = Cu + CO_2 + (69 - 38{\cdot}4) \text{ heat-units.}$$

$$\text{Heat evolved} = 30{\cdot}6 \text{ units.}$$

Reduction of Ferroso-ferric Oxide:—

$$Fe_3O_4 + 4\,CO = 3\,Fe + 4\,CO_2 + (69 \times 4 - 269) \text{ heat-units.}$$

$$\text{Heat evolved} = 7 \text{ units.}$$

The process of reducing ferroso-ferric oxide in the smelting of iron probably takes place in the two stages:—

$$(1.)\ Fe_3O_4 + CO = 3\,FeO + CO_2,$$

$$(2.)\ FeO + CO = Fe + CO_2,$$

but exact thermal data concerning these reactions are wanting.

The Smelting of Tin Ores.—Reduction of Stannic Oxide:—

$$SnO_2 + 2\ CO = Sn + 2\ CO_2 + (69 \times 2 - 135{\cdot}8) \text{ heat-units.}$$

Heat evolved = 2·2 units.

These are all exothermic reactions, and for the most part easily realized; the last, however, evolves but little heat, and so requires the highest temperature to be applied in order to begin the reaction.

(2.) REDUCTION BY CARBON.

Zinc Smelting.—In the smelting of zinc, the ore which is usually calamine, or zinc carbonate, is mixed with powdered anthracite, and strongly heated in fire-clay retorts; the carbonate is first converted into oxide, and this is reduced; the metal, being volatile, is condensed as the vapour escapes.

The reaction is as follows:—

$$ZnO + C = Zn + CO + (28 - 86{\cdot}2) \text{ heat-units.}$$

Heat absorbed = 58·2 units.

Here it will be seen that the reaction is strongly endothermic, and it probably does not take place in the zinc-smelting furnace. It necessitates a very high temperature in order that 58·2 heat-units may be supplied to each molecule of zinc oxide and charcoal. It is, however, much more than probable that the CO_2 driven off the calamine became CO by the action of excess of carbon, and the reaction is then as follows:—

$$ZnO + CO = Zn + CO_2 + (69 - 86{\cdot}2) \text{ heat-units.}$$

Heat absorbed = 17·2 units.

But

$$CO_2 + C = 2\ CO + (56 - 97) \text{ heat-units.}$$

Heat absorbed = 41 units.

The result as to heat disturbance is therefore the same, viz. absorption of 58·2 units.

(3.) Reduction by another Metal.

Certain ores are capable of reduction by being heated in contact with another metal which is more easily obtainable, or less costly, than that to be extracted.

The following are examples :—

Lead Smelting :—

$$PbS + Fe = Pb + FeS + (23{\cdot}8 - 17{\cdot}1) \text{ heat-units.}$$
$$\text{Heat evolved} = 6 \text{ units.}$$

Reduction of Mercury Ores :—

$$HgS + Fe = Hg + FeS + (23{\cdot}8 - 19{\cdot}8) \text{ heat-units.}$$
$$\text{Heat evolved} = 4 \text{ units.}$$

Special Action of Sodium.—Magnesium and aluminium are incapable of reduction from their oxides, and are therefore converted into chlorides, from which compounds they may be separated by the action of metallic sodium when the material is heated sufficiently to initiate the reaction.

Reduction of Magnesium from its Chloride :—

$$Mg\,Cl_2 + 2\,Na = Mg + 2\,Na\,Cl + (194{\cdot}6 - 151) \text{ heat-units.}$$
$$\text{Heat evolved} = 43{\cdot}6 \text{ units.}$$

Reduction of Aluminium from its Chloride :—

$$Al\,Cl_3 + 3\,Na = Al + 3\,Na\,Cl + (291{\cdot}9 - 160{\cdot}9) \text{ heat-units.}$$
$$\text{Heat evolved} = 131 \text{ units.}$$

(4.) Air-reduction Process.

It is to be observed that, in combining with sulphur, metals evolve less heat than in uniting with oxygen, and also that oxygen can decompose sulphides yielding an oxide.

If the oxide is only feebly exothermic the metal will be produced by the action of heated air upon the sulphide, thus :—

Reduction of Mercury from Cinnabar by Air :—

$$HgS + O_2 = Hg + SO_2 + (69{\cdot}2 - 19{\cdot}8) \text{ heat-units.}$$

$$\text{Heat evolved} = 49{\cdot}4 \text{ units.}$$

The reaction takes place easily because it is strongly exothermic.

The Smelting of Galena (Lead Sulphide).—A series of four equations is necessary to explain the process :—

(1.) *First Process.—The Roasting of Galena to Lead Oxide :—*

$$PbS + 3\ O = PbO + SO_2 + (51 + 69{\cdot}2 - 17{\cdot}8) \text{ heat-units.}$$

$$\text{Heat evolved} = 102{\cdot}4 \text{ units.}$$

(2.) *Second Process.—The Reduction of Galena by Lead Oxide :—*

$$2\ PbO + PbS = 3\ Pb + SO_2 + (69{\cdot}2 - 51 \times 2 - 17{\cdot}8).$$

$$\text{Heat absorbed} = -\ 50{\cdot}6 \text{ units.}$$

This reaction being endothermic, a large amount of extraneous heat must be applied, equal to 50·6 units. Hence the necessity for increasing the temperature of the furnace, which proceeding is invariable at this stage of the process.

But a third and a fourth change are also effective in lead smelting :—

(3.) *The Roasting of Galena to Lead Sulphate :—*

$$PbS + 2\ O_2 = PbSO_4 + (214 - 17{\cdot}8) \text{ heat-units.}$$

$$\text{Heat evolved} = 196{\cdot}2 \text{ units.}$$

(4.) *The Reduction of Galena by means of Lead Sulphate :—*

$$PbS + PbSO_4 = 2\ Pb + 2\ SO_2 + (138{\cdot}4 - 214 - 17{\cdot}8) \text{ heat-units.}$$

$$\text{Heat absorbed} = -\ 127 \text{ units.}$$

This change, being very strongly endothermic, requires a great increase of temperature.

So very little attention has been paid to the heat disturbance in furnace operations that I have considered it to be worth while to put these reactions on record, so that they may be readily accessible by practical men. They are of great assistance in enabling one to clearly understand the various furnace operations; and they show the difficulties surrounding the solution of various problems which have led to a waste of time and money on unattainable projects.

V.

ON THE COMPOSITION OF TWO HARD-WATER DEPOSITS.

By W. N. HARTLEY, F.R.S, Royal College of Science, Dublin.

[Read December 17, 1890.]

These two deposits, which have been formed from hard waters, have some points of interest on account of their composition being in certain respects very similar, though the waters came from entirely different districts.

No. 1.—This deposit was formed inside a service-pipe which conveyed water across "The Meadows" to a distillery on the south side of Edinburgh. It was presented to me about ten years ago by Dr. Littlejohn, the medical officer of health for that city. The internal diameter of the pipe was 6 inches. At first the supply of water was ample, but after some time it began to decrease, and at last was found to be insufficient; but this was not the fault of the well, which contained plenty of water. On breaking open a pipe, it was seen that a stony deposit, $1\frac{1}{2}$ inches in thickness, had reduced the bore from 6 inches to 3 inches.

The deposit is yellowish-grey to greyish-yellow in colour. A section of it shows a series of concentric rings of different variations in colours and varying thicknesses: the inner surface, that is to say, next to the running water, and therefore the last deposited, is somewhat slightly mammelated.

Under the microscope it presents the appearance of an aggregate of translucent yellowish crystals.

Of course the chief feature in the chemical composition of the deposit is the calcium carbonate, but that which is most noteworthy is the large amount of organic matter, nearly 20 per cent., which the dried deposit contains.

Analysis of a Crystalline Stony Deposit in a Water-pipe, Edinburgh.

Constituents.	Per Cent.
Lime,	41·64
Carbon dioxide,	35·31
Organic matter,	19·82
Sand and silica,	0·88
Ferric oxide,	0·72
Manganous oxide,	0·68
Magnesia,	a trace
Potash,	0·79
Soda,	a trace
Water,	0·20
	100·04

This analysis was made in my laboratory by Mr. J. B. Wise, Associate of the Royal College of Science, Associate of the Institute of Chemistry.

No. 2.—This deposit is interesting and instructive, inasmuch as we have accurate knowledge of the composition of the water from which it was deposited, and of the length of time it took to form.

The deposit was formed in an open wooden water-trough through which there must have been a considerable flow of water, at Messrs. Roe's distillery in Dublin. The water was canal water, and the time of formation of the deposit was eighteen months. The thickness of the deposited material is $1\frac{3}{8}$ inches; it has taken an accurate impression of the grain of the wood with all the streaks and knots in it. It is crystalline, and with the same colour and appearance as No. 1, but the crystals may be described as opaque.

Analysis of a Crystalline Stony Deposit from Hard Water, Dublin.

Constituents.	Per Cent.
Lime,	48·99
Carbon dioxide,	35·25
Organic matter,	12·08
Insoluble matter, Sand and silica,	0·56
Manganous oxide,	0·27
Ferric oxide,	0·67
Potash,	0·52
Soda,	0·87
Water,	0·74
	99·95

This analysis was made in my laboratory in 1887, by Mr. John E. Purvis, Associate of the Royal College of Science, Associate of the Institute of Chemistry.

It happened that at the time this water deposit was in course of formation the canal water was being analysed in my laboratory at the commencement of every month, and the analyses were published in the Report of the Registrar-General for Ireland. Though the canal water was supplied to the Rathmines Township at that time, it did not differ materially from that in the canal at other places nearer town as far as the *dissolved* constituents were concerned. This was shown by analyses made at the time, and it is the matter in solution only which is analysed, and which is concerned in forming these deposits. It is true that the small amount of suspended organic matter is carried down along with the mineral constituents, but it is more especially the amount of mineral matter in solution which is capable of being precipitated upon the removal of carbonic acid, to which I draw attention, and this is shown in the accompanying analyses by the total solid impurity and the temporary hardness, or that amount of solid matter which can be removed by boiling 100,000 parts of the water.

ANALYSIS OF THE WATER FORMERLY SUPPLIED TO THE RATHMINES REGISTRATION DISTRICT FROM THE CANAL.

PARTS PER 100,000 OF THE WATER.

	May.	June.	July.	August.	October.	November.	December.	Average Composition.
Total solid impurity,	33·8	30·0	24·2	23·68	32·86	32·88	33·8	30·4
Organic carbon,	·25	·332	·3109	·164	·298	·431	·349	·3116
Organic nitrogen,	·002	·0477	·0344	·018	·038	·058	·026	·032
Ammonia,	·0008	·0005	·001	·003	·002	·001	·001	·0013
Nitrogen as nitrites and nitrates,	None.	·016	·0008	·003	·001	·002	·001	·0034
Total combined nitrogen,	·0326	·064	·041	·024	·04	·062	·03	·042
Chlorine,	1·67	2·03	2·06	1·9	1·26	1·27	1·32	1·64
Hardness— Temporary,	6·4	12·1	9·49	10·3	15·27	14·13	16·29	12·01
Permanent,	4·2	5·4	4·57	4·86	5·29	5·00	6·57	5·12
Total,	10·6	17·5	14·06	15·16	20·56	19·13	22·86	17·12

One great advantage gained by Clark's process when applied to a hard water is not only the softening of the water, but its very thorough purification from dissolved and suspended organic matter.

Twenty years ago I advised the adoption of Clark's process, under the following circumstances:—

There were two sources of water—one a stream of fairly soft, but brownish peaty water, unfit for the final washing of fine linens; the other a spring of perfectly clear and colourless, but very hard water, the quantity of which was insufficient. My advice was to mix the two waters in the reservoir, and to add the necessary quantity of lime-water in the usual manner in order to complete the softening process, whereby the whole of the peaty colouring matter would be precipitated with the lime. I demonstrated the proportions which could be used, and the perfect purity of the water obtainable, but I believe this advice was not acted upon.

The analysis of these deposits shows forcibly the large proportion of organic matter which can be removed by the simple deposition of carbonate of lime.

The following figures are instructive:—

The average temporary hardness of the canal water is 12 parts per 100,000 of water.

Weight of sample of deposit formed therefrom, 1 lb. 10 oz.

Cubic inches of deposit, 25·26.

Smallest volume of the water from which this deposit could have been formed, 1354 gallons.

Volume of the water which can form a cubic inch of such deposit, 53·6 gallons.

Organic matter in one cubic inch of this deposit, 54 grains.

Therefore, one grain of organic matter can be removed from the water without softening by means of lime, and the quantity removed may easily be doubled by using the proper proportion of lime-water.

There can be no doubt that the canal water, by the application of Clarke's simple process, might be made fit for any purpose.

VI.

ON A FRAGMENT OF GARNET HORNFELS. By PROFESSOR SOLLAS, LL.D., F.R.S.

[Read December 17, 1890.]

The rock under description occurs as a thin band, not more than half an inch in thickness in the Ordovician schists adjacent to the granite of Carrickmines. The exact spot where it is exposed I do not know and cannot now discover, since Mr. Dobbin, B.E., to whom I am indebted for the fragment which came under my notice, is absent in America. The specimen was of no great size, less than an inch square measured over the bedding plane: a thin slice cut at right angles to the bedding was prepared for microscopical examination, the remainder furnished just enough material for analysis. I regret not to have had more at my disposal, as I should have liked to repeat some of the analyses.

The general appearance of the rock is that of a garnet-hornfels, light-grey in colour, speckled with minute cinnamon-coloured spots, due to included garnets. Its specific gravity as determined by Mr. Doyle, B.E., to whom I am indebted for assistance in making some of the analyses, is 2·925. It yielded to analysis the results given in column I.

	I.	II.	III.
Silica,	48·608	48·73	46·52
Titanic acid,	traces	traces	1·17
Alumina,	21·614	19·38	23·54
Ferric oxide,	10·922	2·42	1·05
Ferrous oxide,	2·261	—	0·71
Manganous oxide,	12·090	21·71	17·54
Lime,	0·514	0·28	0·80
Magnesia,	0·050	—	1·13
Potash,	trace	3·51	2·69
Soda,	3·021	1·57	0·30
Water,	2·104	2·40	3·28
Fluorine,	—	trace	—
Sulphur, &c.,	—	—	0·40
	101·194	99·88	99·13

The presence of so large a proportion of manganese is a feature of some interest, and brings to mind the "coticule" described by Professor Renard, in which this constituent is present in even greater quantity, as will be seen from the analyses given in columns II. and III. after Drs. Mark and Pufahl.[1] In our rock a part of the manganese present in the coticule appears to be represented by iron oxide. With a view to determining the distribution of this constituent, the mineral components of the rock were separated by means of heavy fluids: they fell out in the following order:—First, ilmenite and garnets (the latter of specific gravity 4·16), then manganese mica (sp. gr. from 3·01 to 2·795), next muscovite, and finally quartz and felspar. The residue of quartz and felspar was unfortunately not preserved, owing to an impression that the latter mineral was not present. This is the more to be regretted, as it is possible that an analysis of the felspar would have presented features of unusual interest.

Garnets.—These yielded on analysis the results given in column I.; in column II. these are reduced to molecular proportions, and in column III. is given the theoretical composition per cent. deduced from the formula adopted below:—

	I.	II.	III.
Silica, . . .	37·63	627	36·23
Alumina, . . .	16·43	162	17·39
Ferric oxide, . .	7·85	49	6·44
Ferrous oxide, . .	14·59	203	16·98
Manganous oxide, . .	18·55	261	17·15
Lime, . . .	3·49	62	3·38
Magnesia, . .	2·10	52	2·41
	100·64		

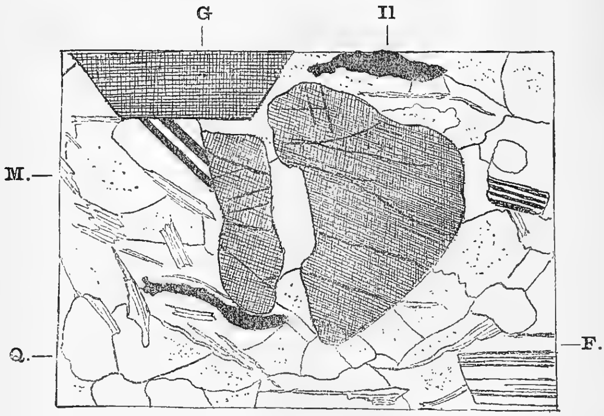
The following is the formula which most nearly agrees with the results of analysis:—

$$\begin{array}{rll} 4\,(3\ SiO_2, & Al_2O_3, & 3\ MnO) \\ 4\,(3\ SiO_2, & Al_2O_3, & 3\ FeO) \\ 3\ SiO_2, & Fe_2O_3, & 3\ MgO \\ 3\ SiO_2, & Fe_2O_3, & 3\ CaO \end{array}$$

The difference between the amount of ferrous and ferric oxide found and calculated may be due to errors of experiment; the

[1] 'Renard: Recherches sur le Composition et la Structure des Phyllades Ardennais, p. 38, 1882, sep. copy.'

same is true of the manganese, which may not have been obtained completely free from iron. As an additional explanation, we may point to the presence of minute included crystals in the garnets, which must have contributed some foreign material. Under the microscope, when examined in the thin slice of the rock, the garnets appear colourless and transparent, presenting most commonly hexagonal sections, sometimes square ones; thus pointing to the rhombic dodecahedron as the form of the complete crystal. The boundaries are frequently rectilinear and the angles sharp; but sometimes one or more corners are rounded off, and a curvilinear outline results: in some cases, when a hexagonal section is so situated with respect to the planes of foliation that a



Section through Garnet Hornfels, magnified 50 diameters.
G. Garnet; Q. Quartz; F. Felspar; M. Mica; Il. Ilminite.

diameter joining two of its opposite angles lies perpendicular to the plane of foliation, it may be noticed that the sides parallel to this diameter retain their rectilinearity, while the angles at its extremities are completely rounded off, so that the section is bounded by two parallel straight lines at right angles to the schistosity, and two curved ends conformable with it. Occasionally, all the angles are removed, and the outline of the section is curvilinear. Rounding off is generally observable where a crystal projects against a plane of minor shearing. The crystals are very generally traversed by cracks, which are sometimes straight, sometimes curved, sometimes few, sometimes very numerous, sometimes rudely parallel to the sides of the section, indicating imperfect rhombohedral cleavage, sometimes quite indefinite in direction. When two garnets touch one another very numerous cracks start from the place of contact, breaking the crystals into an infinity of fragments. Fracturing frequently occurs without noticeable dislocation, but occasionally cases may be met with in which the fragments of an originally single crystal have become separated from each other by a considerable interval, which is now filled up with the other constituents of the rock, most frequently secondary quartz. This clearly proves that the garnets had crystallized out before the cessation of the earth movements which produced the schistosity of the rock, possibly before their commencement.

Compared with the fragments which compose the quartz-felspar mosaic of the greater part of the rock the garnets are of large size. They range from 0·13 to 0·016 mm. in diameter, while the quartz and felspar fragments are seldom more than 0·009 to 0·014 mm. in length. Thus one of the larger garnets covers an area large enough to include over a hundred of the quartz and felspar fragments, yet neither these minerals nor mica ever occur as recognizable inclusions in the garnet. In one or two instances I have observed a fragment of quartz in the very middle of what had the appearance of being a crystal of garnet; but on closer examination this seemed to be not one but several garnets which had grown together, leaving the quartz in the middle. If the quartz and felspar were already differentiated previous to the development of the garnets, it is curious that we do not find them as inclusions, and we are led to suppose either that they were "eaten up" by the growth of the garnets or pushed on one side. The mica very frequently "runs at" the garnet, so to speak, but ends abruptly against it, without penetrating to the interior. Inclusions—but of a different nature—are, however, far from absent. Most of the sections are crowded with foreign particles of one kind or another—minute rods, with straight parallel sides and undetermined but crystalline terminations, frequently occur running parallel to one or more sides of the section. Sometimes these acquire a comparatively large size, and are readily recognised as prisms: they are colourless and transparent, doubly refractive, but not dichroic; they extinguish parallel to the sides of the prism. It appears to me most probable that they are some form of andalusite; in addition, very numerous grains and plates of quite irregular form are present, and occasionally cavities, which are empty or filled with air: large opaque black grains, probably ilmenite, are not infrequent inclusions.

Green Mica.—The wide range in specific gravity of this constituent (from 3·01 to 2·795) is no doubt related to differences in chemical composition, as is shown by the fact that while a gathering from one of the earlier falls (*i. e.* of higher specific gravity) gave only 6·52 per cent. of water on analysis, that from a later fall gave 7·8 per cent. The exact specific gravity of the gathering chosen for analysis was not determined; it gave the following:—

	Composition per cent.	Molecular Proportions.
Silica, . . .	35·62	594
Alumina, . .	16·21	159
Ferric oxide, . .	22·01	137
Manganous oxide, .	16·55	234
Soda, . . .	2·87	47
Water, . . .	6·52	362
	99·78	

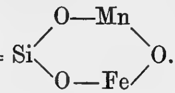
The state of oxidation as it exists in the molecule was not determined for want of material, but it was noticed that, with ignition, the mica turned a deep pinchbeck brown colour, and after losing weight, as the water was expelled, sensibly gained by the absorption of oxygen. It is possible, therefore, that, as in biotite, most of the iron is present in the ferrous state, and the most plausible formula we can frame will represent that of a mineral like biotite, in which three of the rays of the silica ring have the composition—

$$= \mathrm{Si} \left\langle \begin{matrix} \mathrm{O} \\ \mathrm{O} \end{matrix} \right\rangle \mathrm{Al—O—H},$$

and the other three—

$$= \mathrm{Si} \begin{matrix} \diagup \mathrm{O—Mn—O—H} \\ \diagdown \mathrm{O—Fe—O—H} \end{matrix}$$

two of the hydrogen atoms being replaced by sodium. This formula requires one atom more of hydrogen than was found on analysis, but probably this is due to the presence of some molecules, in which one of the rays has the formula—



In the rock slice under the microscope transverse sections of this mica appear as parallel-sided areas, with more or less jagged ends, the usual basal cleavage is well developed, but frequently much curved or distorted: the colour is bluish-green: the mineral is evidently dichroic. When the cleavage planes lie at right angles to the long axis of the polariser the colour is sage green; when parallel with it scarcely any colour is perceptible; pleochroic aureoles surround included zircons, just as in the biotite of the more normal mica schists of the district. The angle of extinction cannot be determined with any approach to certainty—partly owing to the curvature of the cleavage planes, and partly because it does not appear to be uniform; in many cases it is 0°, in others 7°, 9°, or even 14°, as measured with the trace of the cleavage planes. The flakes obtained by separation are rarely bounded by cleavage planes at the edge; usually their outline is altogether irregular. As they lie flat on the principal cleavage, many remain extinct during a complete revolution between crossed nicols, but some do not, patches being illuminated, while the rest of the flake remains dark. These optical irregularities are, doubtless, connected with the deformation of the crystals, resulting from pressure and shearing.

A good deal of muscovite is present, and it also presents curved cleavage planes and undulose extinction.

The larger part of the rock consists of a mosaic of irregular angular grains, more or less colourless and transparent, lying with their longer axes in the plane of schistosity. Some of these are quartz, with very marked undulose extinction; others some kind of felspar, in which repeated twinning on the albite, and sometimes also on the pericline plane, can be frequently detected. Though on the whole remarkably clear and colourless, yet finely granular decomposition products are usually present, and produce a more or less yellowish tinge.

In its general character, the specimen has very little of the appearance of a crushed igneous rock; on the other hand, it closely resembles the normal mica schists produced by the alteration of Ordovician slates in contact with granite, and since manganese is known to occur in large quantities in association with the Ordovician rocks of North Wales, I am strongly inclined to suspect that this hornfels has been produced by the contact metamorphosis of a manganese-bearing slate, which we have every reason to suppose was of Ordovician age.

VII.

THE ABUNDANCE OF LIFE. By J. JOLY, M.A., B.E., Assistant to the Professor of Civil Engineering, Trinity College, Dublin.

[Read November 19, 1890.]

We had reached the Pass of Tre Croci[1] and from a point a little below the summit, looked eastward over the glorious Val Buona. The pines which clothed the floor and lower slopes of the valley, extended their multitudes into the furthest distance, and among the many recesses of the mountains, and into the confluent Val di Mesurina. In the sunshine the Alpine butterflies flitted from stone to stone. The ground at our feet teemed with small black ants, as if the dead needles of the pines had come to life.

It was a magnificent display of vitality; of the *aggressiveness* of vitality, assailing the barren heights of the limestone, wringing a subsistance from dead things. And the question suggested itself with new force: why the abundance of life and its unending activity?

In trying to answer this question, the present sketch originated.

I propose to refer for an answer to dynamic considerations. It is apparent that natural selection can only be concerned in a secondary way. Natural selection defines a certain course of development for the organism; but very evidently some property of inherent progressiveness in the organism must be involved. The *mineral* is not affected by natural selection to enter on a course of continual variation and multiplication. The dynamic relations of the organism with the environment are evidently very different

[1] In the Dolomites of South-east Tyrol. So much of what follows was evolved in the course of conversation with my fellow-traveller, Mr. Henry H. Dixon, that I had wished this essay to be a joint one; but at Mr. Dixon's request, I have undertaken the authorship.

from those of the mineral. This is the subject of the present inquiry; and thus early, I ask indulgence, as one who ventures on matters to a great extent foreign to his habitual line of work.

General Dynamic Conditions attending Inanimate Actions.

It is necessary, in the first place, to refer briefly to the phenomena attending the transfer of energy within and into inanimate material systems. It is not assumed here that these phenomena are restricted in their sphere of action to inanimate nature. It is, in fact, very certain that they are not; but while they confer on dead nature its peculiar dynamic tendencies, it will appear that their effects are in some way evaded in living nature. We, therefore, treat of them as characteristic of inanimate actions. We accept as fundamental to all the considerations which follow the truth of the principle of the Conservation of Energy.[1]

Whatever speculations may be made as to the possible course of future events, or of events very distant from us in space, it appears certain that dissipation of energy is at present actively progressing throughout our sphere of observation in inanimate nature. It follows, in fact, from the second law of thermo-dynamics, that whenever work is derived from heat, a certain quantity of heat falls in potential without doing work or, in short, is dissipated. On the other hand, work may be entirely converted into heat. The result is the *heat-tendency* of the universe. Heat, being an undirected form of energy, seeks its own level, like a liquid acted on unidirectionally by gravity, so that the result of this heat-tendency is continual approach to uniformity of potential.

The heat-tendency of the universe is also revealed in the far-reaching 'law of maximum work' which defines that chemical change, accomplished without the intervention of external energy, tends to the production of the body, or system of bodies, which disengage the greatest quantity of heat.[2] And, again, vast

[1] "The principle of the Conservation of Energy has acquired so much scientific weight during the last twenty years that no physiologist would feel any confidence in an experiment which showed a considerable difference between the work done by the animal and the balance of the account of Energy received and spent."—Clerk Maxwell, "Nature," vol. xix., p. 142. See also Helmholtz "On the Conservation of Force."

[2] Berthelot, "Essai de Mécanique Chimique."

numbers of actions going on throughout nature are attended by dissipatory effects arising from the motions of proximate molecules, friction, viscosity, and electrical effects, the last of these in turn degrading into heat by the action, unknown in its nature, of electrical friction.

Thus, on all sides, the energy which was once most probably existent solely in the form of gravitational potential, is being dissipated into unavailable forms. We must recognize dissipation as one attendant on inanimate transfer of energy.

But when we come to consider inanimate actions in relation to time, or time-rate of change, we recognize a new feature in the phenomena attending transfer of energy; a feature which has before now been observed upon, although not from the present standpoint.[1] It is seen, in short, that the attitude of inanimate material systems is very generally, if not in all cases, retardative of change—opposing it by effects generated by the primary action, which may he called "secondary" for convenience. Further, it will be seen that these secondary effects are those concerned in bringing about the inevitable dissipation. Were they non-existent, the events of the universe would be accelerated, but it is hard to see that there would be any loss of availability in the class of actions to which I allude.

As example, let us endeavour to transfer gravitational potential energy contained in a mass raised above the surface of the earth into an elastic body, which we can put into compression by resting the weight upon it. In this way work is done against elastic force and stored as elastic potential energy. We may deal with a metal spring, or with a mass of gas contained in a cylinder, fitted with a piston upon which the weight may be placed. In either case we find the effect of compression is to raise the temperature of the substance, thus causing its expansion or increased resistance to the descent of the weight. And this resistance continues, with diminishing intensity, till all the heat generated is dissipated into the surrounding medium. The secondary effect thus delays the final transfer of energy.

Again, if we suppose the gas in the cylinder replaced by a vapour in a state of saturation the effect of increased pressure, as

[1] Helmholtz, "Ice and Glaciers." Atkinson's collection of his "Popular Lectures." First Series, p. 120. Quoted by Tate, "Heat," p. 311.

of a weight placed upon the piston, is to reduce the vapour to a liquid, thereby bringing about a great diminution of volume and proportional loss of gravitational potential by the weight. But this change will by no means be brought about instantaneously. When a little of the vapour is condensed, this portion parts with latent heat of vaporisation, increasing the tension of the remainder, or raising its point of saturation, so that before the weight descends any further, this heat has to escape from the cylinder.

Many more such cases might be cited. The heating of india-rubber when expanded, its cooling when compressed, is a remarkable one; for at first sight it appears as if this must render it exceptional to the general law, most substances exhibiting the opposite thermal effects when stressed. However, here, too, the action of the stress is opposed by the secondary effects developed in the substance; for it is found that this substance contracts when heated, expands when cooled. Again, ice being a substance which contracts in melting, the effect of pressure is to facilitate melting, lowering its freezing point. But so soon as a little melting occurs, the resulting liquid calls on the residual ice for an amount of heat equivalent to the latent heat of liquefaction, and so by cooling the whole, retards the change.

Clerk Maxwell[1] observes on the general principle that less force is required to produce a change in a body when the change is unopposed by constraints than when it is subjected to such. From this if we assume the external forces acting upon a system never to rise above a certain potential (which is the order of nature, irresistible forces are *not* the order of nature), the constraints of secondary actions may, under certain circumstances, lead to final rejection of some of the energy, or, in any case, to retardation of change in the system—dissipation of energy being the result.[2]

As such constraints seem inherently present in the properties of matter, it appears safe to summarise as follows:—

The transfer of energy into any inanimate material system is attended by effects retardative to the transfer and conducive to dissipation.

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[1] "Theory of Heat," p. 131.

[2] The law of Least Action, which has been applied, not alone in optics, but in many mechanical systems, appears physically based upon the restraint and retardation opposing the transfer of energy in material systems.

Was this the only possible dynamic order ruling in material systems it is quite certain the myriads of ants and pines never could have been, except all generated by creative act at vast primary expenditure of energy. Growth and reproduction would have been impossible in systems which retarded change at every step and never proceeded in any direction but in that of dissipation. Once created, indeed, it is conceivable that, as heat engines, they might have dragged out an existence of alternate life and death. Life in the hours of sunshine, death in hours of darkness. No final death, however, their lot, till their parts were simply worn out by long use, never made good by repair. But the sustained and increasing activity of organized nature is a fact; therefore some other order of events must be possible.

General Dynamic Conditions attending Animate Actions.

What is the actual dynamic attitude of the organic heat engine, the vegetable organism? I speak, here, in the first place, not of intervening, but of resulting phenomena.

The young leaf exposed to solar radiation is small at first, and the quantity of radiant energy it receives in unit of time cannot exceed that which falls upon its surface. But what is the effect of this energy? Not to produce a retardative response, but an accelerative: for, in the enlarging of the leaf by growth, the plant opens for itself new channels of supply.

If we refer to "the living protoplasm which, with its unknown molecular arrangement, is the only absolute test of the cell and of the organism in general,"[1] we find a similar attitude towards external sources of available energy. In the act of growth increased rate of assimilation is involved, so that there is an acceleration of change till a bulk of maximum activity is attained. The surface, finally, becomes too small for the absorption of energy adequate to sustain further increase of mass (Spencer[2]), and the acceleration ceases. The waste going on in the central parts is then just balanced by the renewal at the surface. By division, by spreading of the mass, by outflowing processes, the normal activity of growth may be restored. Till this moment nothing

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[1] Claus, "Zoology," p. 13.

[2] Geddes and Thomson, "The Evolution of Sex," p. 220.

would be gained by any of these changes. One or other of them is now conducive to progressive absorption of energy by the organism, and one or other occurs, most generally the best of them, subdivision. Two units now exist, the total mass immediately on division is unaltered, but paths for the more abundant absorption of energy are laid open.

The encystment of the protoplasm (occurring under conditions upon which naturalists do not seem agreed[1]) is to all appearance protective from an unfavourable environment, but it is often a period of internal change as well, resulting in a segregation within the mass of numerous small units, followed by a break-up of the whole into these units. It is thus an extension of the basis of supply, and in an impoverished medium, where unit of surface is less active, is evidently the best means of preserving a condition of progress.

Thus, in the organism which forms the basis of all modes of life, a definite law of action is obeyed under various circumstances of reaction with the available energy of its environment.

Similarly, in the case of the more complex leaf, we see in its extension in a flattened form, and in the orientation of greatest surface towards the source of energy, an attitude towards available energy causative of accelerated transfer. There is seemingly a principle at work, leading to the increase of organic activity.

Many other examples might be adduced. The gastrula stage in the development of embryos, where by invagination such an arrangement of the multiplying cells is secured as to offer the greatest possible surface consistent with a first division of labour; the provision of cilia for drawing upon the energy supply of the medium, and more generally the specialisation of organs in the higher developments of life, may alike be regarded as efforts of the organism directed to the absorption of energy. When any particular organ becomes unavailing in the obtainment of supplies, the organ, no longer preserved to heredity by the action of natural selection, in the course of time becomes aborted or disappears.[2] On the other hand, when a too ready and liberal supply renders exertions and specialisation unnecessary, a similar abortion of

[1] However, "In no way comparable with death." Weisman, "Biological Memoirs," p. 158.

[2] Claus, "Zoology," p. 157.

functionless organs takes place. This is seen in the degraded members of certain parasites.

During the coal-formation epoch of geological history, when carbon dioxide was abundant in the air, the vegetable world developed enormously, in response to the liberal supplies. A structural adaptation to the rich atmosphere occurred, such as was calculated to co-operate in rapidly consuming the supplies, and to this obedience to a law of progressive transfer of energy we owe the vast stores of energy now accumulated in our coal fields. And when, further, we reflect that this store of energy had long since been dissipated into space but for the intervention of the organism, we see definitely another factor in organic transfer of energy—a factor acting conservatively of energy, or antagonistically to dissipation.

The tendency of organized nature in the presence of unlimited supplies is to 'run riot.' This seems so universal a relation, that we are safe in seeing here cause and effect, and drawing our conclusions as to the attitude of the organism towards available energy. New species, when they come on the field of geological history, armed with adaptations irresistible till the slow defences of the subjected organisms are completed, attain enormous sizes under the stimulus of abundant supply, till finally, the environment, living and dead, reacts upon them with restraining influence. The exuberance of the organism in presence of energy is often so abundant as to lead to its self-destruction. Thus bacteria are often destroyed in their own waste products. A moment's consideration shows that such progressive activity denotes an accelerative attitude on the part of the organism towards the transfer of energy into the organic material system. Finally, we are conscious in ourselves how, by use, our faculties are developed; and it is apparent that all such progressive developments must rest on actions which respond to supplies with fresh demands. Possibly in the present and ever-increasing consumption of inanimate power by civilized races, we see revealed the dynamic attitude of the organism working through thought-processes.

Whether this be so or not, we find generally in organized nature causes at work which in some way lead to a progressive transfer of energy into the organic system. And we notice, too, that all is not spent, but both immediately in the growth of the individual, and ultimately in the multiplication of the species, there are actions associated with vitality which retard the dissipation of energy. I proceed to state the dynamical principles involved in these manifestations, which appear characteristic of the organism, as follows:—

The transfer of energy into any animate material system is attended by effects conducive to the transfer, and retardative of dissipation.

This statement is, I think, perfectly general; I cannot say that it is new. It has been, at least in part, advanced before, but from the organic more than the physical point of view. Thus, "hunger is an essential characteristic of living matter;" and again, "hunger is a dominant characteristic of living matter,"[1] are, in part, expressions of the statement. If it be objected against the generality of the statement, that there are periods in the life of individuals when stagnation and decay become inevitable, I answer, that such phenomena arise in phases of life developed under conditions of external constraint, as will be urged more fully further on, and that in fact the special conditions of old age do not and *cannot* express the true law and tendency of the dynamic relations of life in the face of its evident advance upon the earth. The law of the unconstrained cell is growth on an ever increasing scale; and although we assume the organic configuration, whether somatic or reproductive, to be essentially unstable, so that continual inflow of energy is required merely to keep it in existence, this does not vitiate the fact that, when free of all external constraint, growth gains on waste. Indeed, even in the case of old age, the statement remains verbally true, for the phenomena then displayed point to a break down of the functioning power of the cell, an approximation to configurations incapable of assimilation. It is not as if life showed in these phenomena that its conditions could obtain in the midst of abundance, and yet its law be suspended; but as if they represented a degradation of the very conditions of life, a break up, under the laws of the inanimate, of the animate contrivance; so that energy is no longer available to it, or the primary condition, "the transfer of energy into the animate

[1] "Evolution of Sex." Geddes and Thomson, chap. XVI. See also a reference to Professor Cope's theory of "Growth Force," in Mr. Wallace's Darwinism, p. 421.

system," is impossible. It is to the perfect contrivance of life our statement refers.

That the final end of all will be general non-availability there seems little reason to doubt, and the organism, itself dependent upon differences of potential, cannot hope to carry on aggregation of energy beyond the period when differences of potential are not. The organism is only partly to blame for this. It is being affected by events external to it, by the actions going on through inanimate agents. And although there be only a part of the received energy preserved, there *is* a part preserved, and this amount is continually on the increase. To see this it is only necessary to reflect that the sum of animato energy—capability of doing work in any way through animate means—at present upon the earth, is the result, although a small one, of energy reaching the earth since a remote period, and which otherwise had been dissipated in space. In inanimate actions throughout nature, as we know it, the availability is continually diminishing. The change is *all* the one way. As, however, the supply of available energy in the universe is limited (probably) in amount, we must look upon the two as simply effecting the final dissipation of potential in very different ways The animate system is aggressive on the energy available to it, spends with economy, and, miser-like, goes on putting by till death finally deprives it of all. It has heirs, indeed, who inheriting some of its gains, put them out at interest; but they, too, must die, and ultimately there will be no successors, and the whole must melt away as if it had never been. The inanimate system responds to the forces imposed upon it by sluggish changes; of that which is thrust upon it, it squanders uselessly, like one who has so little appreciation of the value of money that he neither desires to have it, nor cares to keep it. But, dropping the metaphor, it is seen that the path of the energy is very different in the two cases.

While it is true generally that both systems ultimately result in the dissipation of energy to uniform potential, it is to be observed that the organism, which does so to a great extent under compulsion, can under certain circumstances evade the final doom altogether. It can lay up a store of potential energy which may be permanent. Thus, so long as there is free oxygen in the universe, our coal-fields might, at any time in the remote future, when all has for ages been buried in darkness, strike out light and heat in the universal grave. The smallest thing may initiate the conflagration.

The phenomenon of growth is not specifically mentioned in the formal statement of the dynamic attitude of the organism. Although it underlies the general attitude of the organism towards energy, it must, from the present point of view, be considered more as a means to an end than as a primary property. The peculiar way in which the organism receives the stimulus of energy is that which appears primarily characteristic of it. We might, for the sake of explicitness, picture some kind of chemical configuration which, upon the receipt of energy, would assume such vibratory motions as would lead to combination with sympathetically vibrating molecules, even when these had to be torn by expenditure of energy from a pre-existing chemical union. And in this way, as energy is poured into the configuration, fresh power of aggregating other atoms would be conferred, that is, growth would ensue.

Thus it is to the attitude assumed by the characteristic molecular configuration upon an accession of energy that growth is to be ascribed: as this growth is on the lines of the original configuration, an increase of receptivity by the organism is the result; or, finally, it absorbs energy progressively.

It is necessary to observe on the fundamental distinction between the growth of the protoplasm and the growth of the crystal. It is common to draw comparison between the two, and to point to metabolism as the chief distinction. But while this is the most obvious distinction the more fundamental one remains in the energy relations of the two with the environment. The growth of the crystal is the result of loss of energy; that of the organism the result of gain of energy. The crystal represents a last position of stable equilibrium assumed by molecules upon a certain loss of kinetic energy, and the formation of the crystal by evaporation and concentration of a liquid does not, in its dynamic aspect, differ much from the precipitation of an amorphous sediment.[1] The organism, on the other hand, represents a more or less unstable condition formed and maintained by inflow of energy;

[1] It appears exceptional for the crystal to stand higher in the scale of energy than even the amorphous form. Sulphur is such an exceptional case.

its formation, indeed, often attended with a loss of kinetic energy (fixation of carbon in plants), but, if so, accompanied by a more than compensatory increase of potential molecular energy.

Thus, between growth in the living world and growth in the dead world, the energy relations with the environment reveal a marked contrast. Again, in the phenomena of combustion, there are certain superficial resemblances which have led to comparison between the two. Here again, however, the attitudes towards the energy of the environment stand very much as + and –. The life absorbs, stores, and spends with wisdom. The flame only recklessly spends. The property of storage by the organism calls out a further distinction between the course of the two processes. It secures that the chemical activity of the organism can be propagated in a medium in which the supply of energy is discontinuous or localised. The chemical activity of the combustion can, strictly speaking, only be propagated among contiguous particles. I need not dwell on the latter fact; an example of the former is seen in the action of the roots of plants, which will often traverse a barren place or circumvent an obstacle in their search for energy. Thus roots will find out spots of rich nutriment. It is probable that the train of stimulating energy is greatest in the direction of the rich locality; by trial this direction is found, and by increased storage and development the obstacles of the journey are overcome.

Thus there is a dynamic distinction between the progress of the organism and the progress of the combustion, or of the chemical reaction generally. And although there be unstable chemical systems which absorb energy during reaction, these are (dynamically) no more than the expansion of the compressed gas. There is a certain initial capacity in the system for a given quantity of energy. This satisfied, progress ceases. The progress of the organism in time is continual, and goes on from less to great so long as the supply of energy is unlimited, and its development unconstrained.

We must regard the organism as a configuration which is so contrived as to overcome the tendency of the *universal* laws of nature. Except we are prepared to believe that a violation of the second law of thermo-dynamics occurs in the organism, that a sorting demon is at work within it, we must, I think, assume that the interactions going on among its molecules are accompanied by retardation and dissipation like the rest of nature. That such conditions are not incompatible with the definition of the dynamic attitude of the organism, but only involve a coefficient of thermo-dynamic efficiency less than unity, can be shown by analogy with our inanimate machines which, by aid of hypotheses in keeping with the second law of thermo-dynamics, may be supposed to fulfil the energy-functions of the plant or animal, and, in fact, in all apparent respects conform to the definition of the organism.

We may assume this accomplished by a contrivance of the nature of a steam-engine, driven by solar energy. It has a boiler, which we may suppose, fed by the action of the engine. It has piston, cranks, and other movable parts, all subject to resistance from friction, &c. Now there is no reason why this engine should not expend its surplus energy in shaping, fitting, and starting into action other engines. In fact, in reproductive sacrifice, all these other engines represent a multiplied absorption of energy as the effects of the energy received by the parent engine, and may in turn be supposed to reproduce themselves. Further, we may suppose the parent engine to be small and capable of developing very little power, but the whole series as increasing in power at each generation. Thus the primary energy relations of the vegetable organism are represented in these engines, and no violation of the second law of thermo-dynamics involved.

We might extend the analogy, and assuming these engines to spend a portion of their surplus energy in doing work against chemical forces—as, for example, by decomposing water through the intervention of a dynamo—suppose them to lay up in this way a store of potential energy capable of heating the boilers of a second order of engines, representing the graminivorous animal. It is obvious without proceeding to a tertiary or carnivorous order, that the condition of energy in the animal world may be supposed fulfilled in these successive series of engines, and no violation of the principles governing the actions going on in our machines assumed. Organisms evolving on similar principles would experience loss at every transfer. Thus only a portion of the radiant energy absorbed by the leaf would be expended in actual work, chemical and gravitational, &c. It is very certain that this is, in fact, what takes place.

It is worth, perhaps, passing observation that from the nutritive dependence of the animal upon the vegetable, and the fact that a conversion of the energy of the one to the purposes of the other cannot occur without loss, the mean energy used daily by the vegetable for the purpose of growth, must greatly exceed that used in animal growth; so that the chemical potential energy of vegetation upon the earth is much greater than the energy of all kinds represented in the animal configurations.[1] It appears, too, that in the power possessed by the vegetable of remaining comparatively inactive, of surviving hard times by the expenditure and absorption of but little, the vegetable constitutes a veritable reservoir for the uniform supply of the more unstable and active animal.

Finally, on the question of the manner of origin of organic systems (into which question, however, it is not my intention to enter), it is to be observed that, while the things of the present are very surely the survival of the fittest of the tendencies and chances of the past, non-material, as well as material forms of energy, animate as well as inanimate configurations, yet, in the initiation of the organised world, a *single* chance may have decided a whole course of events: for, once originated, its own law secures its increase, although within the new order of actions, the law of the fittest must reassert itself. That such a progressive material system as an organism was *possible*, and at some remote period was initiated, may be called matter of knowledge; whether or not the initiatory living configuration was uniquely fortuitous, or the result of the general action of the law of the fittest selecting among innumerable chances and tendencies, must remain matter of speculation. In the event of the former being the truth, it is evidently possible, in spite of a large finite number of worlds, that life is non-existent elsewhere. If the latter is the truth, it is almost certain that there is life in all, or many of those worlds.

We now endeavour to trace the progressive activity of the organism in the phenomenon of sex, and as underlying the generalisations of evolution. After which, we have to notice the phenomena of old age and death.

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[1] I find a similar conclusion arrived at in Semper's "Animal Life," p. 52.

Progressive Activity and Sex.

We saw in the case of the cell how the organism got into "Physiological difficulties"[1] after it had attained to certain dimensions. It was evident that, in order to best fulfil a law of accelerated activity, some new departure in life-history was then required. This was taken in reproduction, and it appeared as if the organism had two ways of meeting the environment according as the conditions favoured anabolism or katabolism. That these, throughout nature, sum up the characteristics of maleness and femaleness, has been urged by Professors Geddes and Thomson ("Evolution of Sex"). From the present point of view, both are primarily methods for responding to the stimulus of energy in a progressive manner, and each of these is that best calculated to do so under the conditions which call it forth. Rest, assimilation, and large reproductive sacrifice in the case of the rich medium. Active exploration, involved in the reproduction of smaller and more numerous units, in the case of the poor medium.

Thus, the often wingless female aphid, in the abundance of spring and early summer, hourly carries on a parthenogenetic and viviparous reproduction; but in the poorer time of autumn the winged male aphid makes his appearance, and the less costly but more numerous oviparous sexual reproduction commences. The same order of nature is brought to view in Yung's experiments on tadpoles: *i.e.* that starvation favours maleness, abundance femaleness.[2] Sometimes the activity of the male is utilised in bringing supplies to the more vegetative female. In the case of birds, the energies of the female are thus expended on the production of the necessary amount of warmth for incubation, the male bird very generally feeding her upon the nest.

In short, reproduction may be regarded as one phase of obedience to the law of progress. It has been defined as "discontinuous growth." So that, philosophically, we view the entire succession as one organic whole. And we consider the organism as following

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[1] "The Evolution of Sex," Geddes and Thomson, p. 220.

[2] *Ibid.*, chap. iv. A remarkable instance of the action of these laws is given on p 235, in the case of a ciliated infusorian.

its law in the two methods of meeting the environment, the male method and the female method.

Consistently with this, multitudinous spermatozoa and few ova are a general condition of sexual reproduction throughout nature. And, lastly, we see in the broad fact that the rate of reproduction is in a geometrical progression—except when curbed by the failure of supplies or external constraints—the most evident manifestation of the law of accelerated activity.

Evolution and Acceleration of Activity.

The primary factor in evolution is the "struggle for existence." This involves a "natural selection" among the many variations of the organism. If we seek the underlying causes of the struggle, we find that necessity for food and (in a lesser degree) the desire for a mate are the principal causes of contention. The former is much the more important factor, and, accordingly, we find the greater degree of specialisation based upon it.

The present view assumes a dynamic necessity for its demands, involved in the nature of the organism as such. This assumption is based on observation of the outcome of its unconstrained growth, reproduction, and life-acts. We have the same right to assert this of the organism as we have to assert that retardation and degradation attend the actions of inanimate machines, which assertion, also, is based on observation of results. Thus we pass from the superficial statements that organisms require food in order to live, or that organisms desire food, to the more fundamental one that:—

The organism is a configuration of matter which absorbs energy acceleratively, without limit, when unconstrained.

This is a dynamic basis for a "struggle for existence." The organism being a material system responding to accession of energy with fresh demands, and energy being limited in amount, the struggle follows as a necessity. Thus, evolution guiding the steps of the energy-seeking organism, must pre-suppose and find its origin in that inherent property of the organism which determines its attitude in presence of available energy.

Turning to the factor, "adaptation," we find that this also must pre-suppose, in order to be explicable, some quality of aggressiveness on the part of the organism. For adaptation in this or that direction is the result of repulse or victory, and, therefore, we must pre-suppose an attack. The attack is made by the organism in obedience to its law of demand; we see in the adaptation of the organism but the accumulated wisdom derived from past defeats and victories.

Where the environment is active, that is living, adaptation occurs on both sides. Improved means of defence or improved means of attack, both presuppose activity. Thus the reaction with the environment, animate and inanimate, are at once the outcome of the eternal aggressiveness of the organism, and the source of fresh aggressiveness upon the resources of the medium.

As concerns the "survival of the fittest" (or "natural selection"), we can, I think, at once conclude that the organism which best fulfils the organic law under the circumstances of supply *is* the "fittest," *ipso facto*. In many cases this is contained in the common-sense consideration, that to be strong, consistent with concealment from enemies which are stronger, is best, as giving the organism mastery over foes which are weaker, and generally renders it better able to secure supplies. Weismann points out that natural selection favours early and abundant reproduction. But whether the qualifications of the "fittest" be strength, fertility, cunning, fleetness, imitation, or concealment, we are safe in concluding that growth and reproduction must be the primary qualities encouraged by selection. Inherent in the nature of the organism is accelerated absorption of energy, but the qualifications of the "fittest" are various, for the supply of energy is limited, and there are many competitors for it. To secure that none be wasted is ultimately the object of natural selection, deciding among the eager competitors what is best for each.

In short, all the facts and generalizations concerning evolution must presuppose an organism endowed with the quality of progressive absorption of energy, and retentive of it. The continuity of organic activity in a world where supplies are intermittent is evidently only possible upon the latter condition. Thus it appears that the dynamic attitude of the organism, considered in these pages, occupies a fundamental position regarding its evolution.

We turn to the consideration of old age and death, endeavouring to discover in what relation they stand to the innate progressiveness of the organism.

The Periodicity of the Organism and the Law of Progressive Activity.

The result of the reaction between the aggressive organism and the environment, animate and inanimate, will be to impose different degrees of aggressiveness upon organisms. This is an unavoidable outcome of a struggle where chance of locality, &c., will be sure, sooner or later, to favour one party more than the other, and where adaptation of the organism is possible. Thus a state of equilibrium primitively obtaining between organisms would be destroyed, owing to the selective action of the inanimate environment. Later on the animate environment will probably quite as seriously, or more seriously, affect the organism. The result of these shifting conditions of equilibrium must be, that at any epoch organisms will differ in aggressiveness and in activity.

But, further, the activity of the individual will be constrained to vary at different periods of its life, ultimately resulting in a state of decline and death. This variation of the individual may be traced to its reaction, both with the animate and inanimate environment.

In the phenomena of old age and natural death we see events in the life-history at variance with the progressive activity of the organism. Was this always so? Is the organic development of the individual a process which cannot go beyond a certain period of life-history, and carries the seeds of its own destruction? For the higher organism of the present day the answer must be, yes! But was it so for the organism of the past? If we refer to the unicellular organism for an answer we see at once that if this organism had no power of reproduction by which to surmount the difficulties of overgrowth, death might have been an inherent Nemesis of growth, and the continuance of the organism impossible. The cause of death in that case would arise and work out its consummation within the individual. The reproducing unicellular organism averts this fate, and we see, in fact, that it does not die. To what causes is the natural death of the higher organism to be ascribed? It would appear as if these causes, originated in the fact of growth and reproduction, in the adaptation of the organism, and in the conditions of limited energy imposed by the environment.

Under conditions of want, it has been observed, the vegetative division of the organism gave place generally to more numerous sexual reproduction. Active male units are thus sent abroad into the environment. The effect of this is to secure, at the approach of a change in the nutritive level of its environment, its adaptation to the new conditions. For the active and more mobile male units become selectively acted upon by the various contending forces in the environment. Now it is likely that supposing many generations alive at the one time, a struggle will begin among the members of the species, for the particular form of energy most available to all its members. It is also probable that the younger units, being the more highly adapted to the change of conditions, will get the better of the older members, will in fact destroy them, if in no other way, by starvation. The struggle will, probably, be a long one but the older members must finally yield before the increasing numbers and adaptation of the younger. Here the effect on the individual is from without, and although traceable to the plasticity of the organism is not inherent in it.

It will be seen that members of the one species will each successively be assailed by death at a similar stage of development, and at a similar earlier stage will feel the pressure of the keen competition. The period of life when these conditions come about will be in general independent of the rate of supply afforded by the particular environment, but will depend on the rate of reproduction, the period required by the organism to attain to maturity, and the rate at which natural selection is operating to advance the evolution of the species. The action of the last will cause secular variation in the other factors, so that the time-limit, which eventually becomes hereditary, imposed by these factors, will doubtless slowly vary. Contending species, so far as they affect the rate of multiplication of the first species by preying upon its younger members, will also enter into the factors which are here crudely summarised as probably determining ultimately the time-limits assigned to the individual. By these factors, too, the events of life-history will be mapped out in time in an approximately constant way. How the effects of these events would ultimately become hereditary may, I think, be understood when we consider in what way they recurrently affect the successive reproducing organisms. The older members of the race continuing to reproduce themselves, and at the same time experiencing the increasing effects of want, and possibly of the attacks of the younger, will produce ever more feeble offspring, till the weakness becomes congenital, or, in other words, the germ cells ultimately responding to the effects of the restricted nourishment, evolve beings capable of but a limited span of life. Similarly the phenomena of old age will become inherent in the race, and subsequently will appear in the individual living under the most favourable conditions of supply.

It will be urged, perhaps, that there cannot be much difference in specialisation between the old who perish and the young who survive. It must be remembered, however, that a small thing will affect the result. A germ-tendency to longevity, resulting in abnormally old individuals, will be the more sternly met according as it tends to prevail. If these exceptional organisms reproduce themselves more abundantly they will have more abundant foes, and, by heredity, probably stronger foes to contend against. Slight differences in endurance, in fleetness, or in cunning, etc., will in the long run act powerfully in adjusting the time-limit of the individual. In fact the older individual has a majority of better specialised individuals to contend against, and even where the supplies of the environment are sufficiently abundant for all, yet in the crowd would have a bad chance of continued survival.

In the case of reproduction by subdivision, where this is impartial, there is a sharing of advantageous properties among the derived units; until some particular line of descent is favoured by chance of locality, all remain equally equipped in the struggle for the mastery. Nor would there in any case be progressive periodic destruction of older units by younger; for, indeed all may be considered of the same age. And so, in fact, among the unicellular organisms, which display little or no adaptation, no period of death is assigned to the individual, and, as observed before, it averts the effects of overgrowth by its subdivision.

To organisms in this state of equilibrium we must refer for the inherent dynamic attitude of life; and, as we see, it is undoubtedly one of progress. It is true that, philosophically, we may regard the higher organism and its offspring as a continuous and progressive whole; and in the growth of the offspring we see the continued growth of the parent. The individuals perishing one by one are but the aborted limbs, which under new conditions became functionless.

Professor Weismann, in his two essays, "The Duration of Life," and "Life and Death,"[1] adopts and defends the view that "death is not a primary necessity but that it has been secondarily acquired by adaptation." The cell was not inherently limited in its number of cell-generations. The low unicellular organisms are potentially immortal, the higher multicellular forms with well-differentiated organs contain the germs of death within themselves. According to Professor Weismann, however, the means by which death entered organic history are not such as I have discussed in the foregoing pages.

Briefly he finds the necessity of death in its utility to the species. Long life is a useless luxury. Early and abundant reproduction is best for the species. An immortal individual would gradually become injured and would be valueless or even harmful to the species by taking the place of those that are sound. Hence natural selection will shorten life.

According to the preceding views a periodic effect is necessary to introduce an inherited time-limit into a species, and this effect must be of such a nature as will operate on the individual so as gradually to affect the germ, and so become hereditary.

Against such a hypothesis Weismann contends, "because it involves the transmission of acquired characters which is at present improved."[2] He bases the appearance of death on variations in the reproductive cells, encouraged by the ceaseless

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[1] See his "Biological Memoirs." Oxford, 1889.

[2] "Biological Memoirs," p. 142. A somewhat similar explanation to that suggested in foregoing pages of the origin of old age and death—but differing in many particulars—was advanced by Dr. Wallace. See a note on p. 23, of the "Biological Memoirs." I had sketched out the above views before the latter work came into my hands. It is possible that Professor Weismann would classify the particular mode in which I have supposed the recurrent effect to become hereditary as not contradictory to his theory of Heredity. In a later essay ("On the supposed Botanical Proofs of the Transmission of Acquired Characters"), he appears to regard characters so impressed upon the organism as "blasto-genic." See p. 413, "Biological Memoirs."

action of natural selection, which led to a differentiation into perishable somatic cells and immortal reproductive cells. The time-limit of any particular organism ultimately depends upon the number of somatic cell-generations and the duration of each generation. These quantities are "predestined in the germ itself" which gives rise to each individual. "The existence of immortal metazoan organisms is conceivable," but their capacity for existence is influenced by conditions of the external world; this renders necessary the process of adaptation. In fact, in the differentiation of somatic from reproductive cells, material was provided upon which natural selection could operate to shorten or lengthen the life of the individual in accordance with the needs of the species. The soma is in a sense "a secondary appendage of the real bearer of life—the reproductive cells." The somatic cells probably lost their immortal qualities, on this immortality becoming useless to the species, by the cessation of the operation of natural selection. Their mortality may have been a mere consequence of their differentiation (*loc. cit.*, p. 140), itself due to natural selection. "Natural death was not," in fact, "introduced from absolute intrinsic necessity inherent in the nature of living matter, but on grounds of utility, that is from necessities which sprang up, not from the general conditions of life, but from those special conditions which dominate the life of multicellular organisms."

Into this question we cannot fully enter here; it is not so much the precise causes which may have operated to introduce death as the fact of the fundamentally immortal nature of life with which we are concerned. Of course on the assumption of the complete isolation of the germ from somatic influences the view adopted in the foregoing pages as to the cause of inherited death must be erroneous. On this view of heredity, however, authorities differ; indeed, I believe, few go so far as Professor Weismann. On the other hand, the probability of such events arising as we have supposed appears when we consider the effects of the unchecked multiplication of any organism. Even where natural death is continually removing the useless individuals the struggle between those that remain is everywhere intense—as among the ants heaped in living mounds among the pines.

Further, natural selection will in all cases favour the fertility of individuals more directly than any other quality. It is, indeed, self-favourable. The contest will therefore wax fiercer in an accelerated degree till some give up. In this struggle it is hard to see how a "tendency" to death after reproduction can be encouraged by natural selection, for the individuals who have it and those that have not got it reproduce alike, unless it can be shown that such a tendency would involve increased reproductiveness or earlier reproductiveness. On the contrary it appears as if those not having the tendency will rather produce the more abundantly, and, by hypothesis, their descent is hereditarily uninfluenced by increasing conditions of want. Again, if *no* external influences affect the germ we have to suppose tendencies corresponding to every periodic effect in nature. Thus it is very evident that the phenomenon of sleep is based on external events. It is very certain that what is now a physiological necessity originated in the periodic restraint brought by the cold and darkness of night acting upon the plastic organism since its initiation upon the earth.

In many cases, too, we can with great probability trace the time-limit of the organism to definite periodic causes. This is the case with death from climatological causes. Thus, among plants, annuals possess but a year's life, and this limited length of life often persists under artificial conditions. Again, these effects of old restraints sometimes disappear under new climatic conditions. It is probable that the time required to throw off the effects of an old restraint will depend on how far it has become physiologically rooted in the organism. Tendencies favourable to the new conditions will accelerate the changes which in some cases, possibly, would be very slow in coming about without such help. In short, it is probable the truth lies between the extremes of ascribing all to internal tendencies and all to external causes. We know the organism is not a stable configuration, as is the crystal, but one capable of extraordinary adaptation. Every part of it possesses its vitality somewhat on the conditions on which the top possesses its stability when in motion, *i.e.* by the continual inflow of energy. Viewing the organism simply as such a configuration of matter and energy, the assumption that any part of it, growing along with and at the expense of the rest, can remain isolated from the long-continued action of external forces is certainly startling.

On the inherent immortality of life, Weismann finally states:— "Reproduction is, in truth, an essential attribute of living matter, just as the growth which gives rise to it . . . Life is continuous, and not periodically interrupted: ever since its first appearance upon the earth, in the lowest organism, it has continued without break; the forms in which it is manifest have alone undergone change. Every individual alive to-day—even the highest—is to be derived in an unbroken line from the first and lowest forms."[1]

At the present day the view is very prevalent that the soma of higher organisms is, in a sense, but the carrier for a period of the immortal reproductive cells (Ray Lankester)[2]—an appendage due to adaptation, concerned in their supply, protection, and transmission. And whether we regard the time-limit of its functions as due to external constraints, recurrently acting till their effects become hereditary, or to variations more directly of internal origin, encouraged by natural selection, we see in old age and death phenomena ultimately brought about in obedience to the action of an environment. These are not inherent in the properties of living matter. The body which, in its present constitution, must perish, bears to the succession of life, which periodically gives rise to it, a more insignificant temporal relation than the leaf which withers from the oak. But, in spite of its mortality, the body remains a striking manifestation of the progressiveness of the organism, for to this it must be ascribed. To it energy is available—denied to the protozoon. Ingenious adaptations to environment are more especially its privilege. A higher manifestation, however, was possible, and was found in the development of mind. This, too, is a servant of the cell, as the genii to the lamp. Through it energy is available—denied to the body. This is the masterpiece of the cell. Its activity dates, as it were, but from yesterday, and to-day it inherits the most diverse energies of the earth.

Taking this view of organic succession, we may liken the individual to a particle vibrating for a moment and then coming to rest, but sweeping out in its motion one wave in the organic vibration travelling from the past into the future. But as this vibration is one spreading with increased energy from each vibrating

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[1] *Loc. cit.*, p. 159.

[2] Geddes and Thomson, "The Evolution of Sex," chap. xviii.

particle as origin, its propagation involves a continual accelerated inflow of energy from the surrounding medium, a dynamic condition unknown in periodic effects, transmitted by inanimate actions, and, indeed, marking the fundamental difference between the dynamic attitudes of the animate and inanimate.

We can trace the periodic succession of individuals on a diagram of activity with some advantage. Considering, first, the case of the unicellular organism reproducing by subdivision and recalling that conditions, definite and inevitable, oppose a limit to the rate of growth, or, for our present purpose, rate of consumption of energy, we proceed as follows:—

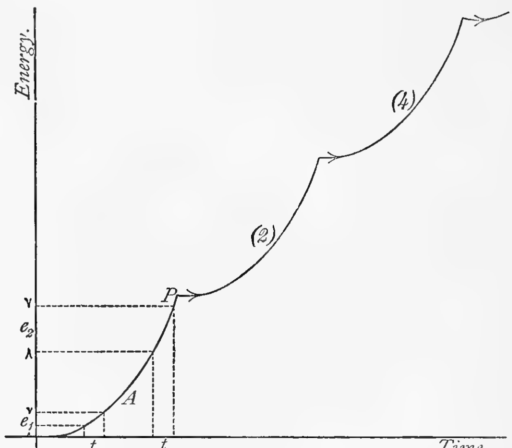

Fig. 1. Life-Waves of the Amœba.

Along a horizontal axis units of time are measured; along a vertical axis units of energy. Then the life-history of the amæba, for example, appears as a line such as A in fig. 1. This line starts at the point of origin of the axes of reference. During the earlier stages of its growth the rate of absorption of energy is small; so that in the unit interval of time, t, the small quantity of energy, e_1, is absorbed. As life advances, the rate of activity of the organism augments, till finally this rate attains a maximum, when e_2 units of energy are consumed in the unit of time. At any moment of its life, the rate of activity, $\frac{de}{dt}$, is represented by the trigonometrical tangent of the angle made with the axis of time by a line tangential to the curve at the point in question.

On this diagram a reproductive act, on the part of the organism, is represented by a line which repeats the curvature of the parent organism originating at such a point as P in the path of the latter, when the rate of consumption of energy has become constant. The organism A has now ceased to act as a unit. The products of fission each carry on the vital development of the species along the curve B, which may be numbered (2), to signify that it represents the activity of two individuals, and so on, the numbering advancing in geometrical progression. The particular curvature adopted in the diagram is, of course, perfectly imaginary; but it is not of an indeterminable nature. Its average course for any species is a characteristic of fundamental physical importance, regarding the part played in nature by the particular organism.

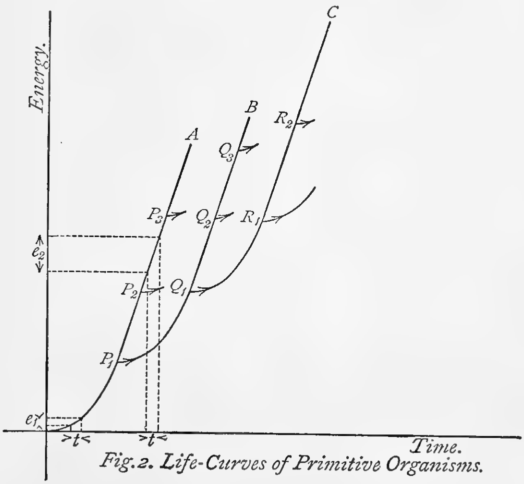

Fig. 2. Life-Curves of Primitive Organisms.

In figure 2 is represented the path of an imaginary primitive multicellular organism before the effects of competition produced or fostered its mortality. The lettering of figure 1 applies; the successive reproductive acts are marked P_1, P_2; Q_1, Q_2, &c., in the paths of the successive individuals.

The next figure (fig. 3) crudely illustrates the origination of death in organic history, that is death by animate environmental causes. I have called this "interference," for whatever hypothesis we make as to the origin of death, the fact itself is evidently the result of opposing forces bringing the activity of the organism to a close, and these forces, whether originating within the organism and fostered by natural selection or not, owe their development to the activity of the rival organisms. Thus, as the numbers increase, the earlier and more worn individuals are feeling the effects of natural selection bringing abler combatants and competitors into the field, and their rate of consumption of energy is diminishing (point *A* on the diagram). This progresses in the successive individuals according as they have been exposed to the ravages of time. Their paths ever turn more and more from the axis of energy, till

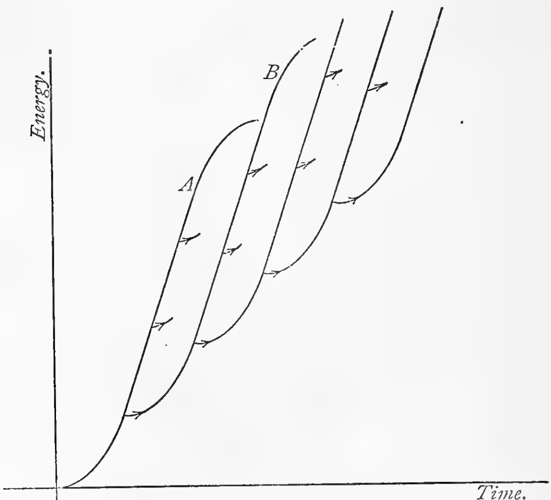

Fig. 3. Commencing interference of Primitive Organisms.

at length the point is reached when no more energy is available to the older members; a tangent to the curve at this point is at right angles to the axis of energy and parallel to the time axis. The death point is reached, and however great a length we measure along the axis of time, no further consumption of energy is indicated by the path of the organism. Drawing the line beyond the death point is meaningless for our present purpose.

It is observable that while the progress of animate nature finds its representation on this diagram by lines sloping *upwards* from left to right, the course of events in inanimate nature—for example, the history of the organic configuration after death, or the changes progressing—let us say, in the solar system, or in the process of a crystallization, would appear as lines sloping *downwards* from left to right.

Thus, upon the primitive organism, a time-limit to activity has been of necessity imposed by the activity of a series of derived units, each seeking energy, and in virtue of its adaptation each more fitted to obtain it than its predecessor. But, whatever our views on this matter may be, we have to recognise a periodicity of functions in the life-history of the successive individuals of the present day; and whether or not we trace this directly or indirectly to a sort of interference with the rising wave of life, or even leave the latter out of account altogether in the origination or perpetuation of death, the truth of the diagram (fig. 4) holds in

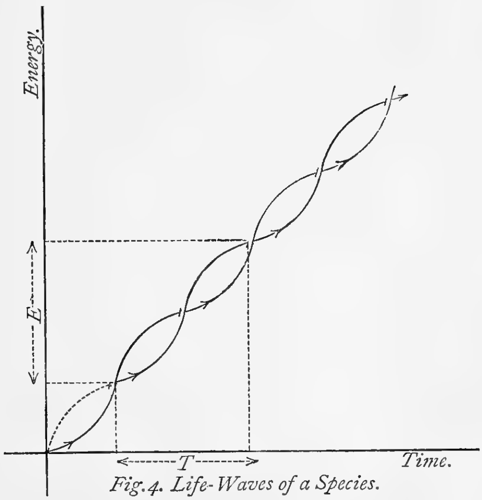

Fig. 4. Life-Waves of a Species.

so far as it may be supposed to graphically represent the dynamic history of the individual. The point chosen on the curve for the origination of a derived unit is only applicable to certain organisms, many reproducing at the very close of life. A chain of units are supposed here represented: the periodicity is not necessarily ascribable to external forces, but is inherited.

Drawing the tangent and normal at the beginning and ending of any one complete vibration the total energy consumed by the organism during life is the length E on the axis of energy, and its period of life is the length T on the time-axis. The mean activity is the quotient $\frac{E}{T}$.

If we lay out waves as above to a common scale of time for different species, the difference of longevity is shown in the greater or less number of vibrations executed in a given time, *i.e.* in greater or less "frequency." We cannot indeed draw the curvature correctly, for this would necessitate a knowledge which we have not of the activity of the organism at different periods of its life-history, and so neither can we plot the direction of the organic line of propagation with respect to the axes of reference as this involves a knowledge of the mean activity. However much of this we may know in the future, at present if I mistake not, such data are not available.

Much might be very easily done in this direction by comparative estimates of the demand at various periods of life. Thus, by supplying an individual with the same sort of food throughout its life, and assuming unit weight of this food as unit of energy on the diagram, the curvature is approximately determinable. In this way the differences in the time-energy function of male and female at the various stages of life-history might be found. Observations on the latter during pregnancy would enable the curve to be traced back to the fœtal period of life.

The group of curves which follow (fig. 5) are entirely imaginary, except in respect to the approximate longevity of the organisms. Man as the most complex and many-sided animal is drawn as if his activity was the greatest, the Dog is put above the Tortoise, for this last is a sluggish creature, except in the heat of summer, and even then its diet and its exertions are limited.

It is probable, as before observed, that to conditions of structural development, the question of longer or shorter life is in a great degree referable. Thus, development along lines of large growth will tend to a slow rate of reproduction from the simple fact that unlimited energy to supply a large number of costly reproductive acts is not procurable, whatever we may assume as to the strength or cunning exerted by the individual in its efforts to obtain its supplies. On the other hand, development along lines of small growth, in that reproduction is less costly, will probably lead to increased rate of reproduction. It is, in fact, matter of general observation that in the case of larger animals the rate of reproduction is most generally slower than in the case of smaller animals, and, as we have seen, it appears that the rate of reproduction might be expected to have an important influence in determining the particular periodicity of the organism; and were we to depict in the last diagram, on the same time-scale as Man, the vibrations of the smaller living things, we would see but a straight line (save for secular variations in activity) representing the progress of the species in time. The tiny thrills of its units lost in comparison with the yet brief period of man.

The direct influence of the rate of reproduction on the duration of the individual is, indeed, very probably revealed in the fact that

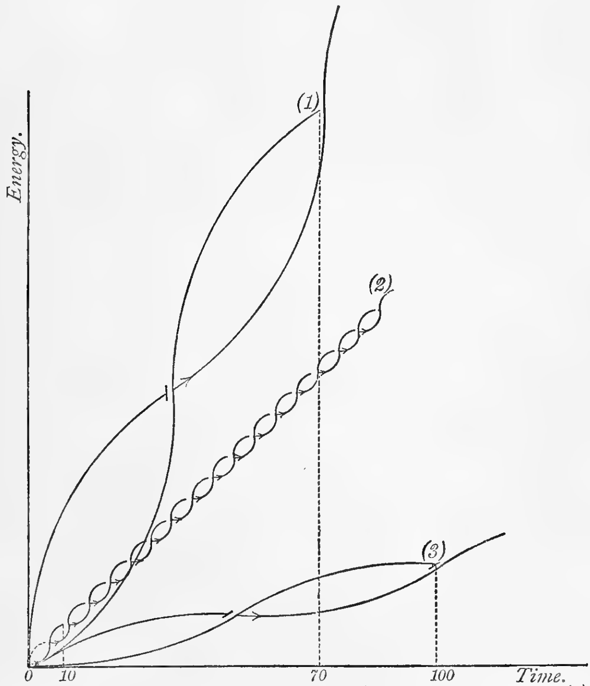

Fig. 5. Imaginary Life-Waves of Man, (1); Dog, (2); & Tortoise, (3).

short-lived animals most generally reproduce themselves rapidly and in great abundance, and *vice versa.* In many cases where this appears contradicted, it will be found that the young are exposed to such dangers that but few survive (*e.g.* tortoises and turtles, &c.), and so the rate of reproduction is virtually slow. Most insects are rapid breeders, and are short-lived. Many birds, as eagles, are slow breeders, and long lived. Elephants are very long-lived, and very slow breeders. Monkey's reproduce slowly, and are long-lived.[1] In the vegetable kingdom it appears on the whole as if a similar order prevailed. Annuals reproduce themselves profusely, while the larger and longer-lived shrubs and trees spread slowly in comparison.

I have not in the foregoing specially referred to climatological death. Death through the periodic rigour of the inanimate environment calls forth phenomena very different from death introduced or favoured by competition. But a multiplicity of effects intermediate in nature occur. Organisms will, for example, learn to meet very rigorous conditions if slowly introduced, and not permanent. A transitory period of want can be tided over by contrivance. The lily withdrawing its vital forces into the bulb protected from the greatest extremity of rigour by seclusion in the earth, the trance of the hibernating animal are instances of such contrivances.

But there are organisms whose life-wave truly takes up the periodicity of the earth in its orbit. Thus the smaller animals and plants, possessing less resources in themselves, die at the approach of winter, propagating themselves by units which, whether egg or seed, undergo a period of quiescence during the season of want. In these quiescent units the energy of the organism is potential, and the time-energy function is in abeyance. This condition is, perhaps, foreshadowed in the encystment of the amæba in resistance to drought. In the case of hibernation the time-energy function seems maintained at a loss of potential by the organism, a diminished vital consumption of energy being carried on at the expense of the stored energy of the tissues. Soo, too, even among the largest organisms there will be a diminution of activity periodically inspired by climatological conditions. Thus, wholly or in part, the activity of organisms is recurrently affected by the great energy-tides set up by the earth's orbital motion.

Similarly in the phenomenon of sleep the organism responds to the earth's axial periodicity, for in the interval of night a period of impoverishment has to be endured. Thus the diurnal

[1] I kept a small pet monkey for twenty years. She died but recently, not from old age, but from cold and dysentery. When she came into my possession she was an adult, and probably some years old. See "The Duration of Life" (Weismann) for much information on this subject.

waves of energy also meet a response in the organism. These tides and waves of activity would appear as larger and smaller ripples on the life-curve of the organism. But in some, in which life, love, and death are encompassed in a day, this would not be so; and for the annual among plants, the seed rest divides the waves with lines of no activity (fig. 6.).

Thus, finally, we regard the organism as a dynamic phenomenon passing through periodic variations of intensity. The material systems concerned in the transfer of the energy rise, flourish, and fall in endless succession, like cities of ancient dynasties. At

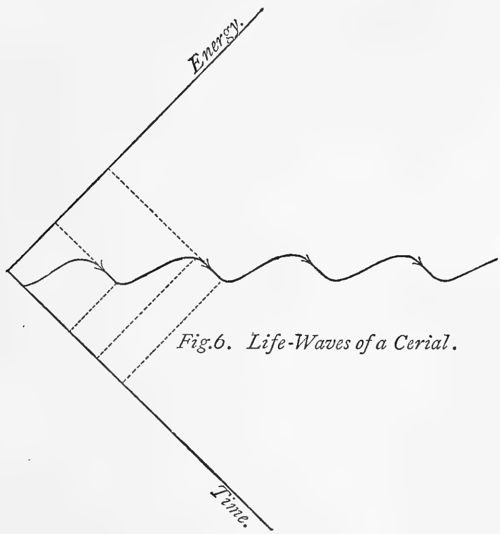

Fig. 6. Life-Waves of a Cerial.

points of similar phase upon the waves the rate of consumption of energy is approximately the same; the functions, too, which demand and expend the energy are of similar nature.

That the rhythm of these events is ultimately based on harmony in the configuration and motion of the molecules within the germ seems an unavoidable conclusion. In the life of the individual rhythmic dynamic phenomena reappear which in some cases have no longer a parallel in the external world, or under conditions when the individual is no longer influenced by these external conditions.[1]

[1] See "The Descent of Man."

In many cases the periodic phenomena ultimately die out under new influences, like the oscillations of a body in a viscous medium; in others when they seem to be more deeply rooted in physiological conditions they persist. It is possible, however, that in the span of years allotted to the higher organisms new conditions, such as civilization, may gradually effect a change.

However this turn out, the "length of life is dependent upon the number of generations of somatic cells which can succeed one another in the course of a single life, and furthermore the number as well as the duration of each single cell-generation is predestined in the germ itself." Such is the view which Weismann cautiously favours.[1] Although it is perhaps useless to try to penetrate the mystery, it seems, however, conceivable, as regards the means by which the germ regulates the number and disposition of the cells constituting the completed individual, that an initiating configuration, followed by a very stable train of events, might be sufficient to account for the persistence of the form of a species even under certain variations of conditions. There are appearances of "trial" in embryological development; and it seems hardly more requisite to ascribe to the germ the degree of directiveness necessary to regulate the disposition of the parts of the completed individual than it is to assume that the complexity of modern organic development was prefigured in the originating unicellular form, if indeed such has been the course of evolution. The "struggle among the parts" once originated, the mutual adjustment might proceed along lines of narrow possibilities till final equilibrium was attained.

And from this point of view it is hard to see any grounds for assuming the complete isolation of the germ; but, on the contrary, we might well suppose influences upon the body, oft repeated, transmitted to the germ plasma through the intermedium of the colonists composing the complex organism. For similarly, we can easily see how an important adaptive alteration arising in any particular higher species might set up such a train of events occurring among other organisms as would ultimately result in the modification of the most lowly organism. So that if the events of evolution were to occur anew this lowly organism might give rise,

[1] "Life and Death"; "Biological Memoirs," p. 146.

in course of time, to the species in its modified form: for although the train of events in the first case proceeded downwards from the high to the low organism, there is seemingly no correlation of events involved which we might not expect to be reversible in order of occurrence. The birth and growth of the individual finds, of course, its parallel in this simile, in the supposed repetition of evolution. But in the case of the time-limits of the individual we have a more complex predestination to account for; not only the life-history of each cell but a different life-history for succeeding cells; for if we do not suppose changes in the life-history of the succeeding generations of cells, why and how is the power of metabolism ultimately lost?

I confess that only in the vague conception of a harmonizing or formative force derived from the germ, perishing in each cell from internal causes, but handed from cell to cell till the formative force itself degrades into molecular discords, can I form any physical representation of the successive events of life. The degradation of the molecular formative force might be supposed involved in its frequent transference according to some such actions as occur in inanimate nature. Thus, ultimately, to the waste within the cell, to the presence of a force retardative of its perpetual harmonic motions, the death of the individual is to be ascribed. Perhaps in protoplasmic waste the existence of a universal death should be recognised. It is here we seem to touch inanimate nature; and we are led back to a former conclusion that the organism in its unconstrained state is to be regarded as a "contrivance" for evading the dynamic tendencies of actions in which matter participates.[1]

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[1] In connexion with the predestinating power and possible complexity of the germ, it is instructive to reflect on the very great molecular population of even the smallest spores—giving rise to very simple forms. Thus, the spores of the unicellular Schizomycetes are estimated to dimensions as low as 1/10,000 of a millimètre in diameter (Cornil et Babes, "Les Bactéries," I. 37). From Sir William Thomson's estimate of the number of molecules in water, comprised within the length of a wave-length of yellow light ("The Size of Atoms," Proc. R. I., vol. x., p. 185), it is probable that the spores contain some 500,000 molecules, while one hundred molecules range along a diameter.

Dr. Johnstone Stoney, in a lecture delivered before the Royal Dublin Society some years ago, suggested similar reflections.

The Abundance and Activity of Life.

We began by seeking in various manifestations of life a dynamic principle sufficiently comprehensive to embrace the very various phenomena. This, to all appearance, found, we have been led to regard life, to a great extent, as a periodic dynamic phenomenon. Fundamentally, in that characteristic of the contrivance, which leads it to respond favourably to transfer of energy, its enormous extension is due. It is probable that to its instability its *numerical* abundance is to be traced—for this, necessitating the continual supply of all the parts already formed, renders large, undifferentiated growth, incompatible with the retardative laws of matter. These are fundamental conditions of abundant life upon the earth.

Although we recognise in the instability of living systems the underlying reason for their numerical abundance, secondary evolutionary causes are at work. The most important of these is the self-favouring nature of the phenomenon of reproduction. Thus ("The Duration of Life"), there is a tendency not only to favour reproductiveness, but early reproductiveness, in the form of one prolific reproductive act, after which the individual dies. Hence the wave-length of the species diminishes, reproduction is more frequent, and correspondingly greater numbers come and go in an interval of time.

Another cause of the numerical abundance of life exists in the conditions of nourishment already alluded to. Energy is more readily conveyed to the various parts of the smaller mass, and hence where supplies are abundant, the lesser organisms will more actively functionate; and this, as being the urging dynamic attitude, as well as that most favourable in the struggle, will multiply and favour such forms of life. On the other hand, however, these forms will have less resource within themselves, and less power of endurance, so that they are only suitable to fairly uniform conditions of supply; they cannot survive the long continued want of winter, and so we have the seasonal abundance of summer. Only the larger and more resistant organisms, whether animal or vegetable, will, in general, populate the earth from year to year. From this we may conclude that, but for the seasonal energy-tides, the development of life upon the globe had gone along very different lines from those actually followed. It is, indeed, possible that the evolution of the larger organisms would not have occurred; there would have been no vacant place for their development, and a being so endowed as man could hardly have been. We may, too, apply this reasoning elsewhere, and regard as highly probable, that in worlds which are without seasonal influences, the higher developments of life, save such as are insectivorous, have not appeared; except they be evolved under other conditions, when they might for a period persist. We have, indeed, only to picture to ourselves what the consequence of a continuance of summer would be on insect life to arrive at an idea of the antagonistic influences obtaining in such worlds to the survival of larger organisms.

Hence, it appears that to the dynamic attitude of life in the first place; and secondarily to the material conditions limiting undifferentiated growth, as well as to the action of heredity in transmitting the reproductive qualities of the parent to the offspring; the multitudes of the pines, and the hosts of ants, are to be ascribed. Other causes are very certainly at work, but these, I think, must remain primary causes.

That from our moral standpoint selfishness is the prevailing vice of nature, admits of little doubt. The endeavour of each species is to multiply at all costs with absolute disregard to all other interests; and cases wherein there is an appearance of unselfishness will be found to resolve themselves into but forms of a higher selfishness.

We do nature no injustice in treating it, from the physical point of view, as a dynamic phenomenon, for the principle at work is to all appearance that of the prevailing of the greater force. Whether or no the whole in its evolution be under a Guidance, it is not within the province of physical science to inquire.

In contrast, and yet in agreement with the abundance of life, appears the "Economy of Nature." Economy is of course conducive to survival under conditions of competition. It leads to greatest activity in the end. Thus it is better for the bee to store honey than wax. There is no object in accumulating the latter, and hence the comb is typically roomy and strong at small expenditure of material, and the economy observable in the structural development of such organisms as have to contend with a niggardly, or hostile environment, reveals the same principle. On the other hand some parasitic animals, to whom economy is not so essential, grow into unwieldly dimensions. Animals living immersed in the good-conducting medium, water, in general assume its temperature; and those warm-blooded animals exposed to climatic rigour, clothe themselves with non-conducting coverings. Reckless expenditure will not do. The environment, for all the limitless ingenuity of the organism, sooner or later, fails to supply the energy which creates its own demand, and the most rigorous economy is exacted.

We well know that the abundance of the ants and pines is not a tithe of the abundance around us visible and invisible. It is a vain endeavour to realise the countless numbers of our fellow-citizens upon the earth; but for our purpose the restless ants, and the pines solemnly quiet in the sunshine, have served as types of animate things. In the pine the gates of the organic have been thrown open that the vivifying river of energy may flow in. The ants and the butterflies sip for a brief moment of its waters, which are the waters both of life and of death. On its banks we see the vision of life as of forms waxing and waning: a species victorious in the discovery of a new weapon, or by a new means of deceiving; and the equilibrium of the past is destroyed. A conquered species must yield and dwindle before a conqueror.

The old displaced by the young seek life in vain. Others fall before unpitying foes; and so, mingled with the happy murmur by the river of life, we hear that "chorus of sighs and groans of despair, such as Dante heard at the gates of Hell."[1]

It is significant to our present inquiry that these mingling voices hail the sun at his rising, sink into silence at his setting, and so pursue, as it were, his flight round the earth.

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[1] Huxley.

VIII.

A NEW SPECIES OF *TORTRIX* FROM TUAM. By GEORGE H. CARPENTER, B. Sc., Assistant Naturalist in the Science and Art Museum, Dublin. Plate VII.

[COMMUNICATED BY PROFESSOR A. C. HADDON, M.A., F.Z.S.]

[Read January 21, 1891.]

Early in June of last year (1890) Mr. D. O'C. Donelan, of Sylan, Tuam, forwarded to me some pine shoots, with small caterpillars which, he stated, had caused much damage, in the summers of 1889 and 1890, to a plantation of firs situated partly on bog and partly on upland tracts. Some of the caterpillars pupated very soon after arrival. About the middle of July three moths (all males) appeared, and my surprise was great to find that they very closely resembled *Tortrix viburnana.* My caterpillars had all by this time either pupated or died, and, wishing to preserve the larva of so interesting a form, I asked Mr. Donelan for some more. He informed me that they had nearly all disappeared; but he succeeded in finding a specimen, which he kindly forwarded in August. From this my present description and drawing are taken. It may be of interest to note that it was attacked by a dipterous larva, perhaps a species of Anthomyia.

My colleague, Mr. A. R. Nichols, kindly took one of the moths to London, and submitted it to Mr. W. Warren. A few weeks ago I was able to visit London myself, and had the advantage of looking up the subject at the British Museum, under Mr. Warren's kind guidance. He has no doubt that the insect is, as yet, undescribed.

It appears to be identical with the moth figured in Herrich-Schäffer's "Schmetterlinge von Europa," vol. iv., fig. 419, as a variety of *Tortrix steineriana*, Schiff. This figure, however, is very unlike the true *T. steineriana* (*op. cit.*, vol. iv., figs. 57–8), and the author, in his Appendix (*op. cit.*, vol. vi., p. 155), expresses his opinion that it is a distinct form. Heinemann ("Die Schmetterlinge Deutschlands und der Schweiz," vol. ii., p. 46) identifies this figure of Herrich-Schäffer's with the *Tortrix lusana* of that author; but neither the figure nor my specimens agree with this opinion. Besides, the larva of *T. lusana* is stated by Heinemann to feed on Vaccinium.

We may, therefore, conclude that, except for Herrich-Schäffer's unnamed figure, the moth from Tuam is new to science. I have much pleasure in describing it under the name of *Tortrix donelana*, as a tribute to the gentleman who discovered it.

Tortrix donelana, sp. nov.

Imago, Male (Plate VII., fig. 1).—The expanse of the wings varies from 17 to 20 mm. The costa of the fore-wing is well arched at the base, and then runs straight to the tip, which is rather pointed. The hind margin is very slightly convex, except at the anal angle. The ground colour of the fore-wings is yellowish-brown, with a bronzy appearance, which, in certain lights, gives them an olive-green sheen. Near the tip of the fore-wing is a brown costal spot, and an oblique, irregular brown band crosses the wing from the middle of the costa to the anal angle. A few thin, brown, curved lines run from the costa towards the inner margin, between the oblique band and the hind margin, towards which their convexity is directed. The distinctness of all these brown markings varies greatly, as the fore-wings of one of my specimens appear almost unicolorous yellowish-brown, with a bronzy lustre, much resembling *T. viburnana.* The hind-wings have the hind-margins decidedly concave below the tip. Their upper surface is dark grey. The fringe is silvery white. Beneath, the fore-wings are blackish, and the hind-wings whitish-grey.

The labial palps are of moderate length (fig. 2), and, together with the head and thorax, are covered with brown scales, those on the thorax being darkest. The abdomen is *short, hardly reaching the anal angle of the hind-wing.* It is clothed with dark-grey scales, and the anal tuft is light yellow.

Larva (fig. 3).—The larva is of the ordinary Tortrix type. It is olive-green dorsally, yellow laterally, and yellowish-green ventrally, with dorsal and lateral rows of yellowish-white spots, from which spring blackish hairs. Its length is 11 or 12 mm. The head and the posterior part of the last abdominal segment are yellowish-brown, marked with black.

Pupa (fig. 4).—The pupa is brownish-black. Each of the abdominal segments (except the first and the last) is provided with two half-rings of spines, by means of which the pupa can move in its cocoon (fig. 6).

Habitat.—Tuam, Co. Galway, Ireland.

Time of appearance.—Larva: April to July. Pupa: June and July. Imago: July and August.

Food-plants.—Scotch Fir and Larch.

Habits.—The larva feeds on the pine-shoots, which it seems to almost divest of their leaves (fig. 5). Mr. Donelan writes: "The caterpillar appears in two or three different ways. It fastens together two shoots, and forms a nest of web (see fig. 5); when disturbed, it creeps out at the top, and, falling to the ground, tries to hide in the heath, &c.; or some of the pine leaves are fastened together on a single shoot, and the nest of web is formed within. Sometimes a few of the caterpillars are found on the shoots without any covering; this generally happens later in the season than the former." The cocoon in which the pupa is contained appears to be formed by the closing up of the web in which the larva had sheltered. The cocoon is surrounded by a mass of scale-leaves (fig. 6).

It seems very strange that this apparently unnoticed insect should have made its appearance in such numbers as to force attention by its damage to plantations. Mr. Donelan, who has had considerable experience of pine-woods, says it is the worst pest he has seen in Ireland. Equally strange is its occurrence in such a remote district of the British Isles as Co. Galway.

Mr. Donelan tells me that the young trees on which the larvæ were found came from Scotland, and may have been originally imported from the Continent. Hence, if the identification of *T. donelana* with Herrich-Schäffer's figure be correct, we may have here an insect so rare on the Continent as to have escaped observation as a pine-feeder (no mention whatever is made of it in Kaltenbach's "Pflanzenfeinde" or Ratzeburg's "Forst-Insekten"), but which, imported to the West of Ireland, found there so favourable an environment as to become a dominant member of the insect fauna. The fact that all the modern fir-trees of Ireland have been imported (Moore and More, "Cybele Hibernica," p. 151) makes the importation of the insect highly probable.

On the other hand, may it be possible that we have had lately developed in our islands a really new species, an offshoot of *T. viburnana*, which for some unknown reason has changed its food-plant? If this view be accepted we must give up the identification of *T. donelana* with Herrich-Schäffer's figure.

In concluding this Paper I acknowledge, with many thanks, the kind and invaluable help I have received in its preparation from Mr. W. Warren. I am also indebted to Mr. W. F. Kirby for assistance in looking up the scattered literature of the subject.

EXPLANATION OF PLATE VII.

Fig. 1.—*Tortrix donelana.* Male imago, × 2.
Fig. 2.— ,, ,, ,, Head, &c., × 2.
Fig. 3.— ,, ,, Larva, × 2.
Fig. 4.— ,, ,, Pupa, × 2.
Fig. 5.—Shoot of *Pinus sylvestris*, showing habit of Larva of *T. donelana.* Natural size.
Fig. 6.—Cocoon of *T. donelana*, cut open, with Pupa within. Natural size.

IX.

ON A GEOMETRICAL METHOD OF FINDING THE MOST PROBABLE APPARENT ORBIT OF A DOUBLE STAR.

By ARTHUR A. RAMBAUT, M.A. PLATES VIII. AND IX.

[Read JANUARY 21, 1891.]

THOSE who have ever attempted to compute the orbit of a double star by the graphical method discovered by Sir John Herschel will, I think, be disposed to criticize favourably any attempt to afford an aid in drawing the apparent ellipse of the satellite.

Once the apparent orbit has been satisfactorily obtained, the construction, by which we thence deduce the elements of the real orbit, whether we follow Sir John Herschel in this step or adopt Thiele's still more elegant method, is so singularly interesting as well for the geometrical principles involved, as for the intrinsic importance of the results obtained, that one cannot but regard with regret the amount of licence allowed to the computer in drawing the apparent ellipse through the observed positions.

It is not easy to see how the most probable ellipse is to be defined. In the ordinary analytical method of solving the problem the ellipse is expressed by the general equation of the second degree, viz.

$$ax^2 + 2hxy + by^2 + 2gx + 2fy + 1 = 0\,;$$

and by substituting the co-ordinates x, y of each point successively in this equation, we get a number of equations connecting the constants a, h, b, g, f, which are then solved by the ordinary method of least squares.

The geometrical meaning of the process is, however, obscure. I have, therefore, thought that a method which enables us to determine, if not the *most* probable, at least *a very* probable ellipse, cannot fail to be of interest.

The method depends on Pascal's theorem that *the intersections of opposite sides of a hexagon inscribed in a conic lie on a right line.*

(See Salmon's "Conic Sections," Art. 267.) It follows from this that being given five points we can obtain as many other points on the conic as we wish, and so can construct for its centre and axes.

The method of doing this is exhibited in Plate VIII.

Let the five points be A, B, C, D, E. Take any one of them, E, and draw EK through it parallel to the line joining any other two, AB. Join B with one of the two remaining points, C, and let BC cut EK in α. Join DE, and let it intersect AB in β. Join $\alpha\beta$, and let it cut CD in γ. Join $A\gamma$, cutting EK in F. Then F is a sixth point on the conic, and EF and AB are a pair of parallel chords. Hence the line GG', joining their middle points, is a diameter.

Again, draw EL parallel to GG', to meet BC in α'. Join $\alpha'\beta$, and let it cut CD in γ'. Join $A\gamma'$, cutting EL in F'. Then F' is another point on the curve, and EF' is consequently a chord conjugate in direction to EF. Hence FF' is a diameter, and the point O, in which it intersects GG', is the centre of the conic passing through A, B, C, D, E. If, now, only the centre be required we may omit the rest of the construction. What we have done up to this is susceptible of great accuracy, as we have had only to draw straight lines from point to point, and to draw a pair of lines parallel to given directions. The rest of the process, however —that, namely, which is required to determine the axes—is of a more complicated nature, and consequently more liable to introduce error, although I think in most cases the axes, so determined, will be more reliable than those depending on the mere judgment of the draughtsman.

To determine the axes we draw EA (or FB) to meet GG' in X and AF (or BE) to meet GG' in Y. Then, X and Y being harmonic conjugates with respect to the curve, if we take OM ($= ON$) a mean proportional between OX and OY, the points M and N will lie on the ellipse.

Again, if through O we draw HH' parallel to EF, and draw ME (or NF') to meet HH' in X', and draw MF' (or NE) to meet HH' in Y'; then, since X' and Y' are harmonic conjugates, if we take OM' a mean proportional between OX' and OY', the point M' will lie on the ellipse, and OM and OM' will be a pair of conjugate semidiameters. It only remains, then, to draw through M'

the line PQ perpendicular to OM, and to take $M'P$ and $M'Q$ each equal to OM. We have, then, if a and b are the semi-axes of the ellipse, $a = \frac{1}{2}(OQ + OP)$, and $b = \frac{1}{2}(OQ - OP)$, while their directions are those of the internal and external bisectors of the angle POQ, as shown by the dotted lines in Plate VIII.

To apply this to the case of the secondary member of a double star, for which a number of places with regard to the primary have been determined, it would, perhaps, be necessary, strictly speaking, in order to determine *the most* probable orbit, to take every possible combination of these places, five at a time, and to take the centre of mean position of the centres so determined as the most probable centre of the ellipse, and the mean of the directions and magnitudes of the semi-axes so determined as the most probable values of these quantities respectively.

But this complete treatment of the observations, even in the case of a small number of places, would entail an enormous and utterly disproportionate amount of labour. The following method will, however, be quite sufficient for our purpose.

The observations of position-angles having been treated in the usual manner, and the interpolating curve drawn through them, the value of $\frac{dt}{d\theta}$ should be read from the curves, not at every 5th or 10th degree of θ, as is the usual custom, but at such intervals that the total number of readings may be some multiple (n) of five. With these $5n$ values of $\frac{dt}{d\theta}$, and the corresponding values of θ, we obtain, by means of the equation,

$$r = c\sqrt{\frac{dt}{d\theta}},$$

the r and θ of $5n$ points, which if the observations were free from error, would all lie on the apparent ellipse.

Having thus $5n$ points, if we take them in n groups containing 5 points each, we shall get n different determinations of the centre of the ellipse, the centre of mean position of which will be *a very* probable position of the centre. Each group of five points will also, of course, give a value for the direction, and for the magnitudes of the axes as is shown in Plate VIII; but, perhaps, some who have had experience in the art of computing double-star orbits will prefer to trust to the eye for these, except in cases where a large proportion of a revolution has been accomplished under observation, in which case the latter part of the construction (*i. e.* that for the axes) may with advantage be resorted to.

In the case of λ Cygni, which is illustrated in Plate IX., and in which an arc of only about 45° of the orbit has been described since the discovery of its duplicity, the points numbered from 1 to 10 in the figure, representing successive positions of the satellite in its orbit, lie fairly well along the curve, which such a construction has given as the apparent ellipse, and it is not easy to see how the ellipse could be altered so as to suit them better.

The centre O_1, and the axes O_1A_1 and O_1B_1 are those obtained as in Plate VIII., from the five points 1, 3, 5, 7, and 9; and the centre O_2, and the axes O_2A_2 and O_2B_2 are obtained from the points 2, 4, 6, 8, 10; while the centre O, and the axes OA and OB are the means of the former two, respectively, and are those with which the ellipse has been constructed.

X.

ON A COMBINATION OF WET AND DRY METHODS IN CHEMICAL ANALYSIS. Part I. By W. E. ADENEY, F.I.C., Assoc. R.C.Sc.I., Curator, Royal University of Ireland; and T. A. SHEGOG, A.I.C., Assoc. R.C.Sc.I., Assistant Chemist, Royal College of Science, Dublin.

[Read February 18, 1891.]

Plattner, in his work on the blowpipe,[1] states that, when the oxides of the metals are fused on charcoal with borax and sodium carbonate in the R. F., some are reducible, and some non-reducible, to the metallic state; and he has suggested a general scheme for the analysis of minerals based upon the possibility of separating the reducible from the non-reducible oxides, when so treated. Plattner's scheme involves the employment of wet as well as dry methods of analysis. About 1 decigram of the substance is mixed with about 1 part of fused borax and 1 of sodium carbonate; the whole is wrapped in a little cylinder of soda paper, and fused before the blowpipe in a hole on charcoal. As the quantity of reducible oxides is usually too small to obtain them in a single bead, about 1 decigram of metallic silver or gold should be added, in the form of a button, to take up the reduced metal as it is formed. In this way it is stated that a preliminary separation of the reducible from the non-reducible oxides may be effected. The reducible oxides are said to be those of the following metals:—arsenic, antimony, silver, mercury, copper, bismuth, thallium, lead, tin, zinc, indium, cadmium, and nickel. The volatile metals escape, either partially or wholly, during the fusion. The non-reducible oxides are those of the alkaline earths, and of chromium, aluminium, iron, manganese, cobalt (in the absence of arsenic acid, and when not present in too large quantity), molybdenum, tungsten and titanium.

[1] English Edition of Plattner's "Manual of Analysis by the Blowpipe," edited by J. H. Cookesley, pp. 116 *et seq.*

The importance of Plattner's scheme, if it be generally applicable, cannot be exaggerated, for it permits the adoption of our general method of procedure for the qualitative analysis of all minerals, and avoids many of the difficulties attendant upon purely wet methods, such for example as the solution of substances, &c.; and, owing to its comparative simplicity, it is quite possible to teach the method to students in geology and engineering, who ordinarily cannot afford to devote sufficient time to master purely wet methods of mineral analysis.

Some time ago one of us framed a complete scheme for the analysis of minerals, based upon Plattner's methods. The substance was to be fused with silver chloride, borax, and sodium carbonate on charcoal in the manner described by Plattner. In cooling the metallic end glass beads were to be carefully detached, one from the other, and separately examined by wet methods in the ordinary way.

Complex minerals, such as tin pyrites and smaltine, were analysed, as directed in this scheme by Mr. F. C. Forth, a student in the Faculty of Engineering in the Royal College of Science, with excellent results. The following are the results of his analysis of smaltine:—arsenic, bismuth, copper, nickel, cobalt, iron, aluminium, manganese, calcium, magnesium, sodium, siliceous matter, hydrosulphuric acid, and phosphoric acid.

On comparing these results with those of an analysis by the ordinary wet methods, it was found that potassium only had escaped detection.

When, however, the method was tried with iron and zinc ores, unsatisfactory results were obtained—results which were in some cases not what we had been led to expect from a perusal of Plattner's book—for instance, with the ores mentioned, the glass bead fused fairly easily, but the metallic bead immediately on reduction became quite infusible, and could not be properly separated from the glass.

Plattner, in describing his process and the results obtainable by it, makes no mention of such action. Egleston, too, in his scheme makes no reference to it.[1]

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[1] Egleston, in his scheme, confines himself almost exclusively to dry methods.

His method of preparing the glass bead is different to that employed by Plattner. He dissolves the substance in a borax bead on platinum wire, and, when saturated, On examining Plattner's work carefully, it was seen that no exact experimental evidence was given by him in support of his classification of the metals into "reducible" and "non-reducible," according to their behaviour on fusion with borax and sodium carbonate on charcoal, in the reducing flame.

It became evident to us from these and other preliminary experiments, that Plattner's method was not one by which easily reducible oxides and difficultly reducible oxides could under all conditions be completely separated. The same may be said of Egleston's method.

The results, however, obtained by Mr. Forth in the analysis of smaltine and tin pyrites were, as above stated, so satisfactory as to convince us of the value of the method if carefully worked out. We therefore determined to make an exhaustive series of experiments, in order to ascertain exactly how the various metals behave when their compounds are fused with borax and sodium carbonate on charcoal in the reducing flame in presence of silver.

We were further encouraged to make these experiments by some quantitative estimations of the nickel, cobalt, bismuth, and copper in the smaltine, made by Dr. L. Davoren, who was at that time studying in the laboratory of the Royal College of Science. Dr. Davoren determined these constituents both by the ordinary wet method and by the proposed combination of wet and dry processes. His results were as follows:—

	By ordinary wet method. Per cent.		By wet and dry processes. Per cent.
Nickel,	7·60		7·31
Cobalt,	3·73		3·92
Bismuth,	2·32	I.	3·33
		II.	3·35
		III.	3·33
Copper,	1·80		2·06

tosses it off into a porcelain dish, and repeats this operation until a number of beads have been obtained. He then treats the beads on charcoal with lead, silver, or gold in the reducing flame; separates the metallic from the glass bead, and examines each separately by dry methods. The only use he makes of the wet way is in the examination of the borax bead for chromium, titanium, molybdenum, niobium, tungsten, and vanadium.

The metals which, according to him, may be present in the metallic bead, are—nickel, copper, silver, gold, tin, lead, and bismuth (tin, lead, and bismuth being partially volatilized).

These results led us to hope that the method might (possibly with some modifications) be found capable of employment for quantitative as well as for qualitative analysis.

The questions we wished to settle by our experiments were:—

I. Whether, when fused in the reducing flame on charcoal with borax and sodium carbonate, the metals antimony, tin, lead, arsenic, silver, bismuth, copper, nickel, and zinc, could be completely reduced from their combinations with oxygen, with the volatile acids, hydrochloric, sulphuric, nitric, and hydrofluoric; and also from their combinations with the non-volatile acids, silicic and phosphoric.

II. Whether, when similarly treated, aluminium, chromium, manganese, cobalt, and iron are wholly non-reducible from their compounds; the cobalt and iron more especially from their combinations with arsenic and phosphoric acids.

III. Whether, when *complex* substances are similarly treated, the constituent metals thereof respectively behave as in simple compounds, or whether their behaviour is modified in any way.

The subject-matter of the present Paper deals mainly with questions Nos. I. and II. A considerable amount of work has also been done bearing upon question No. III., but it is proposed to deal with this, and with separations by this method, in a further paper by one of us.

Appended are Tables giving the results of some of our experiments.

Details of Manipulation.

The Charcoal Support.—The pieces should be from 12 inches to 18 inches in length, and from $1\frac{1}{2}$ inches to 2 inches in diameter, and must be tolerably free from fissures. Our first experiments were made with charcoal of a very fair quality got from Messrs. Griffin & Son, of London. Later on, some of excellent quality was obtained from Messrs. Harrington, Bros., of Cork.

The cavity into which the substance is to be introduced should be bored in the end of the stick of charcoal, and its size and shape are of importance. In shape it should be conical, the sides being slightly curved. The dimensions most convenient for the quantities we dealt with were—diameter, $1\frac{1}{4}$ inches; greatest depth, $1\frac{1}{2}$ inches. If the cavity be much larger or smaller than this, the charge cannot be worked about in the proper manner. The ratio of diameter to depth should be attended to, for if the hole be too deep in relation to its diameter, the flame will be blown back, and the charge cannot be properly heated.

The Source of Heat.—In our earlier experiments a lamp which burnt solid paraffin was used. This had the advantages of being very portable and not likely to get out of order. Later on an ordinary paraffin oil lamp was employed; but, although either of these lamps will answer perfectly, we found that when coal gas is procurable it is by far the most convenient source of heat. It can be burnt at the end of a flattened tube, and if the tube be pivoted so that it can rotate in a vertical plane it will be found of advantage in dealing with easily oxidizable metallic beads, as will be explained later.

The blowpipe used was an ordinary mouth blowpipe, furnished with a platinum jet, and fixed in a clip on a retort-stand. An indiarubber hand-blower was used for obtaining the blast.

The borax used was fused in a platinum dish and powdered. It should be kept in a dry and well-stoppered bottle.

The silver was at first used in the form of nitrate, but the troublesome deflagration which took place when this salt was heated, soon led to its use being discontinued. Silver chloride, mixed with the substance and borax before fusion, was next tried, and was found to work very satisfactorily. Subsequently it was found that with substances of a certain type, the most satisfactory results were obtained when the substance and fluxes were first fused together in a shallow cavity in charcoal, the oxidizing flame being employed. When fusion was complete the mass was allowed to cool, transferred to a cavity of the usual size and shape in a fresh piece of charcoal, the silver added in the form of wire or in a button, and the fusion continued in the reducing flame. Experiments were also made in which silver oxide was used instead of silver chloride, but no advantage was apparent. In some cases, when dealing with metals which form infusible alloys with silver, lead was added, either as litharge or as metal. The results obtained were not satisfactory, but this requires further working out.

The form in which the silver should be added depends on the nature of the substance. If the substance consist mostly of compounds of lead, bismuth, copper, arsenic, antimony or tin, silver chloride should be employed, and should be mixed with the substance and borax before the fusion. If, however, the substance consist principally of difficultly reducible oxides or oxides of nickel or zinc, then metallic silver, added after fusion, is best.

In some cases the substance and fluxes were fused together in a shallow cavity, using the oxidizing flame; cooled, powdered in an agate mortar, then mixed with silver chloride, and again fused. This is very troublesome, and the employment of the silver as wire was found to give quite as good results.

The sodium carbonate used was the ordinary dried and powdered material. After a great number of experiments its employment was discontinued, except when dealing with siliceous substances, as no advantage seemed to attend its use with other bodies.

Quantities.—The most convenient quantities to work upon generally are 3 decigrams of substance, and 12 decigrams of borax. These quantities yield beads which can be easily worked before the blowpipe in the necessary manner, in a cavity of the dimensions given above. The proportion of borax may be varied within reasonable limits (from 2 to 6 times the weight of substance taken) without injuriously affecting the fusion. In dealing with a body containing very large proportions of nickel or zinc, not more than 1 decigram of the substance should be taken.

While the fusion is proceeding, the charge must be worked round and round the cavity, the metal bead being made to run round the glass, and pick up the metals as reduced. When finished the whole charge may be allowed to sink to the bottom of the cavity, the metal bead being under the glass. This somewhat protects the metals from oxidization.

The fusion must be cooled most carefully in an atmosphere of coal gas (by directing a stream of gas into the cavity), as otherwise some easily oxidizable metals may become oxidized. This is especially necessary when arsenic, lead, bismuth, tin, or zinc are present.

We found that the compounds of nickel, cobalt, iron, zinc, and tin, with phosphoric acid and silicic acid, behave before the blow-pipe in a similar manner to the salts of these metals with volatile acids.

FIRST SERIES OF EXPERIMENTS.

(*Silver Chloride mixed with the Substance and Fluxes before fusion.*)

EASILY REDUCIBLE METALLIC OXIDES.

Metal.	Quantities of Fluxes and Substance.	Deci-grams.	Reduction.	Remarks.
1. ANTIMONY,	Tartar emetic, . .	3	Practically complete.	Fusion went well, both beads easily fusible. Assay was cooled in stream of coal-gas. A very slight trace of antimony was found in glass bead.
	Bicarbonate of soda,	3		
	Borax, ...	12		
	Silver chloride, .	12		
2. TIN, . .	Stannic oxide, . .	3	Incomplete.	Tin in fair quantity was found in both beads. Both beads were easily fusible. In another experiment silica was added, but without beneficial result.
	Bicarbonate of soda,	3		
	Borax, ...	6		
	Silver chloride, .	12		
3. LEAD, . .	Lead acetate crystals,	3	Complete.	Both beads easily fusible. Assay was cooled in coal-gas. On testing glass bead, no lead was found. With lead, the whole assay must be kept covered with a good reducing flame during the entire fusion.
	Bicarbonate of soda,	3		
	Borax, ...	6		
	Silver chloride. . .	12		
4. ARSENIC, .	Arsenic trioxide, .	1	Complete.	It will be noted that the proportions used are the same as those usually employed. The actual weights were taken small, as it was feared that the volatilisation of arsenic might be troublesome. This, however, was not found to be the case: the volatilization was very slight, and was confined to the beginning of the fusion. The fusion went easily; the assay was cooled in coal-gas. No arsenic was found on testing the glass bead, but a large quantity was found in the metallic bead.
	Bicarbonate of soda,	1		
	Borax, ...	4		
	Silver chloride, .	4		
5. SILVER, .	Silver nitrate, . .	3	Complete.	Great difficulty was experienced in getting a fusible metallic bead. The glass-bead, on cooling, became in parts white and opaque, and small quantities of metallic scale came up on its surface. On testing the glass bead, no silver was found.
	Borax, ...	12		

Easily Reducible Metallic Oxides.

Metal.	Quantities of Fluxes and Substance.		Reduction.	Remarks.
		Decigrams.		
6. Bismuth,	Bismuth nitrate crystals, .	1	Complete.	Metallic bead was very easily fusible. On testing the borax bead, no bismuth was found.
	Bicarbonate of soda,	2		
	Borax, ...	6		
	Silver chloride, .	8		
7. Copper, .	Copper sulphate crystals, .	3	Complete.	This fusion was gradually heated. The assay was cooled in coal-gas; the glass bead obtained was clear and transparent. The borax bead was tested for copper, but none was found. Experiments were tried, in which varying quantities of litharge were used instead of silver chloride, but the reduction was in all such cases incomplete.
	Bicarbonate of soda,	3		
	Borax, ...	12		
	Silver chloride, .	12		
		Centigrams		
8. Nickel, .	Nickel chloride, .	5	Complete.	With these small quantities the fusion went very well, both beads being sufficiently fusible. On testing the borax bead for nickel, none was found present. With larger quantities the results were not satisfactory. Other experiments were made without the use of arsenic, but in all cases the greatest difficulty was experienced in getting a fusible bead, even when the proportion of silver chloride to nickel chloride was 1 to 40. Litharge was tried instead of silver chloride, but though a fusible bead resulted, the fusion was not a success.
	Borax, ...	15		
	Metallic arsenic, .	15		
	Silver chloride, .	10		
		Decigrams.		
9. Zinc, . .	Zinc sulphate, . .	3	Incomplete.	Both beads were very easily fusible. The metallic bead tailed like impure mercury, and was more fusible than the glass bead. The amount of arsenic volatilized was inconsiderable. The assay was cooled in coal-gas. On testing, zinc was found in both beads. Other experiments were made without the use of arsenic, but the metallic bead was infusible in all cases except where litharge was employed. In some experiments, silica was added to the charge, but without good result.
	Bicarbonate of soda,	3		
	Borax, ...	6		
	Metallic arsenic, .	1·5		
	Silver chloride,	12		

Note.—The experiments tabulated above are those which we regard as having given the most satisfactory results in each case.

DIFFICULTLY REDUCIBLE METALLIC OXIDES.

Iron, Chromium, Aluminium, Cobalt, and Manganese.

Experiments were made with the compounds of the above-mentioned metals, as with the compounds of the easily reducible oxides. The results were somewhat surprising. In each case, the silver immediately on reduction, became infusible, or very difficultly fusible, but on heating the reduced silver for a long time, with the tip of a good oxidizing flame, it could in all cases be made fusible.

Under the conditions of the experiment, it was thought probable that these metals were, at least to a small extent, reduced. It seemed to us possible that a small quantity might become reduced before the substance could be dissolved in the borax; and if this occurred, we should expect the alloy formed to be infusible or difficultly fusible.

To avoid such possible reduction, the substances were first fused with borax alone on charcoal, in the oxidizing flame, the glass bead was then powdered, mixed with the silver chloride, and heated in the reducing flame, the results were not more satisfactory, the metallic bead in each case became infusible soon after reduction. It was found that small quantities of iron and cobalt were reduced even when their compounds were heated with borax alone in the oxidizing flame, the reduced metal was always found as a thin film or small globules on that surface of the glass which had cooled in contact with the charcoal. In each of these experiments the weight of substance taken was 3 decigrams, and of borax 12 decigrams.

Some experiments were next made with cobalt chloride, to ascertain whether by decreasing the weight of salt experimented upon, this reduction could be prevented, It was found that even when a mixture of 1 centigram of cobalt chloride, and 40 centigrams of borax were fused in the oxidizing flame, some cobalt was reduced, though only a very minute quantity.

In the experiments with cobalt, the metallic bead always became very difficultly fusible; and on solidifying it entirely lost its globular form, and flattened out in a very remarkable manner, sometimes even becoming branched. A similar flattening of the metal bead was observed in the case of chromium, and to some extent in that of aluminium.

No experiments were made on manganese in this series.

The number of experiments made with difficultly reducible oxides in this series was very large, but as the results obtained were of a negative character, we have not considered it necessary to give the details of the individual experiments.

SECOND SERIES OF EXPERIMENTS.

Another series of experiments was now made differing from the preceding ones in this respect. In all cases the substance and fluxes were fused together in a shallow cavity in charcoal, the oxidizing flame being employed, the beads on cooling were transferred to a cavity of the usual shape and size, metallic silver added in the form of a button, and the whole heated in the reducing flame.

Easily Reducible Metallic Oxides.

Metal.	Quantities of Fluxes and Substance.	Deci-grams.	Reduction.	Remarks.
Antimony, .	Tartar emetic, .	3	Practically complete.	The fusion requires great care, and must be cooled in coal-gas. A very minute trace of antimony was found in the borax bead.
	Borax, ...	12		
	Silver, ...	9		
Tin, . . .	Stannic oxide, . .	3	Incomplete.	The fusion went well, though the metallic bead was somewhat difficult to fuse. The assay was cooled in coal-gas. Although every care was taken, it was found impossible to entirely reduce the tin. The glass bead was quite transparent. An experiment was made, using the same quantities of stannic oxide and borax; but, instead of silver, 12 decigrams of metallic lead were added. This was unsuccessful, as the tin showed little tendency to alloy with the lead.
	Borax, ...	12		
	Silver, ...	9		
Lead, . . .	Lead acetate, . .	3	Complete.	The fusion went very well, but was found to require great care. It was cooled in coal-gas. The borax bead was found to contain a trace of lead, but so small as to be inappreciable.
	Borax, ...	12		
	Silver, . . .	12		

EASILY REDUCIBLE METALLIC OXIDES.

Metal.	Quantities of Fluxes and Substance.		Reduction.	Remarks.
		Deci-grams.		
ARSENIC, . .	Arsenic trioxide, .	3	Complete.	Volatilization of arsenic occurred at the beginning of the fusion, but soon ceased. The fusion went easily, and a perfectly transparent glass bead was obtained. The assay was cooled in coal-gas. The glass bead was found to contain a scarcely detectable quantity of arsenic.
	Borax, ...	12		
	Silver, ...	9		
SILVER, . .	Borax, . . .	12		The silver remained easily fusible.
	Silver, ...	9		
BISMUTH, .	Bismuth nitrate crystals, .	3	Incomplete.	The fusion went very satisfactorily. It was cooled in coal-gas. A small quantity of bismuth was found on testing the glass bead.
	Borax, ...	12		
	Silver, . . .	12		
COPPER, . .	Copper sulphate (anhydrous), .	3	Complete.	The fusion requires care. The borax bead was of a pale bottle-green colour (proved to be due to iron). On testing the glass bead with sulphuretted hydrogen a very slight colouration was observed.
	Borax, ...	12		
	Silver, . . .	9		
NICKEL :— No. 1,	Nickel chloride, .	3	Practically complete.	The fusion went fairly well, no fumes of arsenic were seen, and its volatilization could only be detected by the garlic odour observed. The metallic bead was somewhat infusible, remaining all the time in a viscous state. The glass bead was tested for arsenic and nickel, and a mere trace of each was found present.
	Borax, ...	12		
	Sodium arsenate, .	2		
	Silver, . . .	4		
		Centi-grams.		
No. 2,	Nickel chloride, .	5	Practically complete.	The fusion went well, both beads were easily fusible. The borax bead contained a mere trace of nickel.
	Borax, ...	25		
	Silver, ...	33		

NOTE.—No experiments were made with zinc in this series.

Difficultly Reducible Metallic Oxides.

Three decigrams of each substance, fused with twelve decigrams of borax in the oxidizing flame on charcoal, then nine decigrams (in the case of cobalt twelve decigrams) of silver in the form of a button added, and the fusion continued, the reducing flame being employed.

Iron (*Ferrous sulphate*) :—

The metallic bead became quite infusible, but fused when the flame was removed, a very faint trace of iron was found in the metallic bead.

Cobalt (*Cobalt chloride*) :—

The metallic bead was difficultly fusible on cooling, it flattened out in the way already described for cobalt (*see* first series of experiments). It was found on testing to contain a small quantity of cobalt.

Aluminium (*Aluminium phosphate*) :—

The metallic bead was somewhat infusible. Throughout the fusion a considerable quantity of metallic scale appeared on the glass bead. On testing the metallic bead, aluminium was found present.

Chromium (*Chromium nitrate*) :—

The metallic bead was very difficultly fusible: on solidifying, it flattened out as already described for cobalt and chromium (*see* first series of experiments). On testing, a small quantity of chromium was found present.

Manganese (*Manganous sulphate*) :—

The metallic bead was at first infusible, but became more fusible towards the end of the experiment. A good deal of metallic scale appeared floating on the glass bead, even before the silver was added. On testing the metallic bead, manganese was found present.

It now only remains for us to make a brief reference to what has been done towards the solution of the third of the questions we wished to settle, namely, whether or not, when complex substances are fused with borax and sodium carbonate in the manner described, the constituent metals behave as in simple compounds.

In Dr. Davoren's estimations of nickel and cobalt by this method, no difficulty was experienced in effecting a complete separation ; the nickel was entirely reduced, and all the cobalt was found in the glass bead. From this it was thought that the presence of an easily reducible oxide might entirely prevent the reduction of a difficultly reducible oxide. It seemed probable that if this were found to be the case with bodies so allied in chemical properties as nickel and cobalt, it would in all probability be true of the other oxides, experiments were therefore made with salts of these metals.

The salts were mixed with borax, and fused in the oxidizing flame ; no silver was used. The side of the glass bead which had cooled in contact with the charcoal was invariably found covered with a layer of reduced metal. When the proportions of nickel to cobalt in the mixture was greater than 1 to 1, the reduced metal was entirely nickel. When, however, the cobalt preponderated in the mixture, a small quantity was always reduced with the nickel.

It will be seen that a considerable number of experiments are yet required, more especially to ascertain the behaviour of complex substances when treated in the way suggested by us ; and it was our original intention to complete the necessary experiments before publishing any results of our investigation. In the midst of our work, however, one of us, having been elected to the office of Curator in the Royal University, had to resign his position in the Royal College of Science. We have since found it impossible to continue the work jointly, and we have therefore thought it advisable to publish an account of the work which has been already done.

The investigation will be carried on by one of us.

XI.

THE VARIOLITE OF CERYG GWLADYS, ANGLESEY. By GRENVILLE A. J. COLE, F.G.S, Professor of Geology, Royal College of Science, Dublin. (Plate X.)

[Read January 21, 1891.]

The remarkable rock styled Variolite, the *Lapis variolatus* of older writers,[1] cannot even yet be regarded as of wide distribution. While the doctors of the sixteenth century imported specimens from the West Indies as a cure for small-pox, collectors of later times have derived their material almost exclusively from the bed of the Durance. References to known European localities, most of them in Piedmont and the Western Alps, will be found in a recent paper[2] on the historic area of Mont Genèvre; and in 1888 I was able to write that variolite, a devitrified spherulitic glass of basic character, was as yet unrecognized in Britain.[3]

In that year, however, the rock was recorded from Ceryg (or Careg) Gwladys in Anglesey by Prof. J. F. Blake, to whose remarkable keenness of observation we are thus indebted for the discovery of a second rock new to our islands.[4] In the paper quoted below, the variolite is aptly spoken of as a "spherulitic diabase"; but in the Report presented to the British Association further petrographical details are given,[5] and a thin section of the rock is figured.[6]

Last summer, with the aid of directions given by Prof. Blake, I visited this locality in Anglesey in the company of Mr. L. W.

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[1] See Aldrovandus, "Musæum Metallicum" (1648), p. 883.

[2] Cole and Gregory—"The Variolitic Rocks of Mont Genèvre," Quart. Journ. Geol. Soc., vol. xlvi. (1890), p. 295.

[3] "On Some Additional Occurrences of Tachylyte," Quart. Journ. Geol. Soc., vol. xliv., p. 306.

[4] "On the Monian System of Rocks," Quart. Journ. Geol. Soc., vol. xliv., p. 510.

[5] "Report of the Comm. to investigate the Older Rocks of Anglesey," Brit. Assoc. Report for 1888, p. 44 of the separate Report.

[6] *Ibid.*, Pl. V., fig. 22.

Fulcher, who has kindly allowed me to use the whole of the material which he collected. Our examination of the rock in the field suggests certain comments on the earlier descriptions, and some new points are arrived at from the study of microscopic sections.

The mass of variolitic diabase forms one of the little rocky ridges and bosses which jut out above the sand-waste on the north shore of Newborough Warren. The age of these rocks is Pre-cambrian; the whole series has become fissile through imperfect cleavage, and has been in part broken up by earth-movement.

The variolite is conspicuous by its characteristic greenish white spherules, which stand out upon the weathered surfaces above the level of the dark and gray-green matrix. A common diameter for these spherulites is 3 millimetres or less, and they nowhere approach, in this exposure, the coarse proportions of those in many rocks of Mont Genèvre.

But the identity of this material with true variolite is clear to anyone familiar with the types from the Durance. Despite the partial foliation of the mass, and the consequent elongation of many of the spherulites, the rock can be seen to bear the same relation to the compacter diabase that the devitrified crusts of glass do to the spheroidal rocks of Le Chenaillet or Mt. La Plane.[1] Thus Prof. Blake has described the variolite in Anglesey as "running into the crevices and wrapping round the surface of a purple calcareous rock;" comparison with the masses of the Western Alps shows that this appearance is due to its having developed as a product of rapid cooling on the spheroidal surfaces of a lava, the decomposition of the latter having produced the "purple calcareous" material.

Prof. Blake, in a letter to the present writer, has suggested that the importance of the limestone may have been overestimated in the field, and that this material may have arisen by chemical changes in the igneous rock. This latter view I believe to be undoubtedly correct, although as Prof. Blake suggests, the carbonate of lime may have been in part imported by mineral springs.[2]

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[1] Quart. Journ. Geol. Soc., vol. xlvi., figs. on pp. 311 and 312.

[2] For notes on some of the limestones of this area, see the "Report on Rocks of Anglesey," already cited, p. 23.

But the calcite veins and aggregates play a far smaller part, even in the brecciated varieties of the rock, than would at first appear; for films of calcite have arisen along all the joint-planes and irregular surfaces of division in the decomposing lavas, so that solid lumps may be picked out, apparently of limestone, but which are in reality small joint-blocks coated completely by the calcium carbonate. The mass of the diabase effervesces only feebly with cold nitric acid, and with little more briskness in hot acid, the bubbles even then arising from local cracks, and not from the rock-fragments as a whole. It is, perhaps, remarkable that so much calcite, and so little dolomite, seems to have arisen in these lavas, rich as they are in decomposing magnesian silicates.

A more remarkable change which has taken place in the compact diabase has resulted in a true pseudomorphosis. Silica, as Prof. Blake has noted, has permeated the rock, and the purple colour mentioned by him is, as far as my observations go, connected far more often with this chalcedonic replacement than with the calcareous infiltrations. The calcite masses in the breccias are, however, often pink. This silica, which one would certainly associate with the action of hot springs, rising, perhaps, in pre-Cambrian times at the close of local volcanic activity, has actually replaced the igneous rock by a compact red or purple-red jasper. This pseudomorphic action takes place here and there along lines and veins, but often extends to the whole interior of one of the spheroidal masses of the diabase. The original crust of spherulitic tachylyte, now altered to variolite, has resisted this attack; hence we find the films of ancient glass wrapping round masses of red jasper, which latter are full of shrinkage-cracks and irregular little hollows. All stages of the pseudomorphosis may occur; but much of the material can no longer be scratched by the knife, and includes only little scattered relics of the original gray-green diabase.

While in places the jasper passes into a clearer red quartz-rock, which has a specific gravity of 2·63, in great part it is full of ferric decomposition-products, which render it opaque even in thin sections. Thus one specimen, in which the flow-structure of the original lava has been preserved, has a specific gravity as high as 3·13, considerably in excess of that of the diabase in its more normal phase of alteration.

The fact that the variolitic crusts have escaped this replacement is only another evidence that natural glass, while it may devitrify by a rearrangement of its molecules into crystalline groups, is none the less remarkably stable against the attacks of permeating waters. The included spherulites and crystals in pitchstones and obsidians are again and again found to be hollowed out, or replaced by pseudomorphs in quartz or calcite, and this even while the glass remains absolutely fresh. At Ceryg Gwladys considerable mineral changes occurred in the tachylytic crusts when they were subjected to earth-pressures; but we may well believe that the silicification of the masses on which they had developed took place at an early period, while the crusts remained still vitreous and glancing.

The variolite-crust in the present hydrated condition of its constituents has a specific gravity of 2·71; a typical specimen, with similarly small spherules, from the ridge of Le Chenaillet, Hautes Alpes, gives as much as 2·91. These, and the other determinations quoted, have been made with a Walker's Balance in the Geological Laboratory of the Royal College of Science, Dublin.

The partial replacement of a basic lava by infiltrations of silica is a far rarer occurrence than its replacement by carbonate of lime; in the latter case, moreover, the rock becomes broken down, and we have a plexus of calcite veins rather than a massive pseudomorph. But the late Mr. Charles Darwin has described a case, remarkably similar to that of Ceryg Gwladys, as occurring in the Island of Ascension.[1] The jasper in this instance is found "blending into the semi-decomposed basalt," and occurring "in angular patches, which clearly do not occupy pre-existing hollows in the rock." This observation was explained by Mr. Darwin "on the supposition that a fluid removed in those parts where there were no cavities, the ingredients of the basaltic rock, and left in their place, silica and iron, and thus produced the jasper." "I cannot doubt," he says farther on, "but that the jasper of Ascension may be viewed as a volcanic rock silicified, in precisely the same sense as this term is applied to wood, when silicified."

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[1] "Geological Observations on the Volcanic Islands visited during the voyage of H. M. S. Beagle" (1844), p. 46.

An apt parallel is drawn between this instance and the replacement of trachytic rocks by silica in Hungary; while the source of the silica in Ascension is traced to the adjacent altered trachytes.

With this high authority for the view above put forward in explanation of the phenomena of Ceryg Gwladys, we may proceed to examine the microscopic evidence as to the process of replacement and the condition of the variolitic crusts.

Prof. Blake has kindly lent me a thin section of the variolite as described and figured in the Report to the British Association. In this an amygdaloidal structure happens to be prominent, which is more rarely seen in the eight other sections which I have had prepared from various parts of the rock-mass. Hence Prof. Blake was led to refer the varioles visible on the surface of the rock to the infilled vesicles, instead of to the spherulitic aggregations. He describes the latter, but was not in the possession of favourable means of judging as to their characters and importance. There is no doubt, however, that this Anglesey rock is a true variolite, and is not one of the amygdaloidal diabases which have been so often confused with the spherulitic types. Prof. Blake mentions "areas now composed of an aggregate of epidote crystals, and having the external form of orthoclase crystals. There are also a few small patches of augite." Certainly, there is an irregular crystal in the section which he has lent me which may be a broken pyroxene; but, with this exception, as will be seen presently, I refer all the porphyritic crystals that occur in the series of slides to the one mineral, olivine.

The general structure of the variolite precisely resembles that of the types from the source of the Durance. We have the same grouping of the somewhat irregularly bounded spherulites, first in twos and threes, then in larger groups, until they are crowded together to the exclusion of the glassy matrix (Plate X., fig. 1). Hence in many parts we have merely the fan-like radial bunches (fig. 2), composed of imperfect felspars, which are characteristic of the rapidly cooled selvages of many diabases.[1] But in this rock of Ceryg Gwladys we have also the far rarer case, where a true glass, a coarsely spherulitic tachylyte, has remained upon the surfaces of

[1] See, in addition to the compacter rocks of Mont Genèvre, the "Sordawalite," studied by Loewinson-Lessing (Tscherm. Mittheil. Bd. ix., 1887, p. 61).

cooling after the consolidation of the basic lava, and has finally resulted in the variolite.

The rock, when molten, brought up with it porphyritic crystals, which have been much corroded and penetrated by the ground-mass round them (fig. 4). They are now altered to pale green pseudomorphs, in which yellow epidote has freely developed. In places the epidote, by accumulation of granular crystals diversely orientated, replaces the original porphyritic constituent, the boundary of which is still preserved.

The six-sided form of the sections of these porphyritic crystals attracts attention, and in rarer cases evidence remains of irregular cracks traversing them, along which magnetite has developed (fig. 2). The sections have frequently four obtuse and two more acute and opposite angles, as so commonly occurs in olivine. In the latter mineral such sections arise by cutting the crystals parallel either to the vertical axis or to the base. A section parallel to the brachypinacoid will thus typically be bounded by traces of the macropinacoids and the four macrodome planes, in which case the acuter angles, formed by the macrodome, will be 76° 56′, and the obtuser, where these planes meet the macropinacoids, will be 141° 32′. A basal section may often show the traces of the macropinacoids and of the four prism planes; the two smaller angles of the elongated hexagon will now be 85° 58′, and the more obtuse angles will be 137° 1′. In the case of the porphyritic crystals under examination, the most symmetrical sections being selected, a number of measures gives the smaller angles as from 67° 30′ to 90° 40′, while the four obtuse angles measure from 134° 20′ to 144° 25′. It will be seen that these results, allowing for the frequent corrosion of the faces, and for obliquity in the direction of the sections, agree very well with those obtainable from olivine in microscopic preparations.

Moreover, in one slide an elongated example of these crystals occurs, reminding one strikingly of the olivine figured by Mr. E. S. Dana[1] from the basalts of the crater of Mauna Loa in the Sandwich Islands. This crystal (fig. 3) may form another link, however trifling, between the European variolites and the remark-

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[1] "Contributions to the Petrography of the Sandwich Islands," Amer. Journ. of Sci., vol. xxxvii. (1889), p. 446.

able lavas of Hawaii. The glassy crusts of Ceryg Gwladys, equally with those of the Western Alps, probably point to conditions of high temperature and complete fusion such as are not often met with in volcanic centres. The presence of abundant traces of olivine in the Anglesey rock shows that variolite may be produced from basalts rich in olivine as well as from the augite-andesites, and that the structure is more dependent upon conditions of original liquidity and of cooling than upon peculiarities of chemical composition.

The replacement of olivine or monticellite to so great an extent by epidote is certainly unusual, and I find no record of such a case even in Hintze's treatise on Mineralogy. But the epidote, which is also so common throughout the ground-mass, has probably been derived from materials external to the porphyritic olivines, which were originally poor in iron, produced but little magnetite, and so gave way entirely during the complete permeation of the mass.

The dusky gray spherulites are characterized by the well-known rifts or "pseudo-crystallites," which also invade the ground-mass when this is full of crystallizing material. The glass left by the concentration of this material into spherulites seems to have been fairly free from microlites, and is now altered into green isotropic areas and minute granular epidote (fig. 1). The spherulites, with more or less distinct radial structure, have included for the most part the corroded and porphyritic crystals; brown "crystal-dust" continued to gather round them from the matrix, just as cloudy masses are seen round the well-formed spherulites in the obsidian of Vulcano; between these cloudy aggregations the true tachylytic glass finally remained.

The minute fan-structure, and the still more compact and crystalline microlitic "felt," resulting from the copious development of microlites in the more slowly consolidating interior of the rock, have been beautifully preserved in those parts which have been invaded by the jasper (fig. 2). Mr. Darwin's suggestion thus receives ample verification. The veins of calcite traverse the dull purple siliceous areas, and hence have arisen subsequently to the pseudomorphic action.

Where the variolite has suffered from other causes and has become fissile and even slaty in the mass, sections show considerable distortion and fracture of the more resisting spherulites, while a filmy foliated structure has arisen in the matrix. Along some of these rude planes of foliation epidote has developed in the usual granular condition, and thus appears in the form of strings running parallel to one another across the section.

A section of the calcareous breccia associated with the variolitic series is also interesting on account of the evidence afforded of the secondary flow of the easily crushed and fissile diabase. The large lumps of pale pink calcite have become broken up at their margins and otherwise influenced by earth-movement; but at the same time they seem so intimately associated with the diabase as to suggest that they arose in cracks or decomposition-hollows within it, and were brecciated with it at a later date. Granular quartz, with very irregular boundaries, occurs freely in the calcite, and shows, like the crystals developed in so many altered limestones, numerous enclosures of solid matter. Whether this mineral has arisen *in situ*, how far the calcite patches contain secondary silicates, and the origin of the calcite lumps themselves, must be left for future consideration when a more complete examination has been made of the "limestone" in the field; but it is very noteworthy that aggregates precisely similar to these larger broken masses are found infilling the vacuoles and cracks in sections of the variolite itself. Quartz, with the same irregularity of outline and inclusion of the calcite, occurs associated with the calcite granules in these hollows; hence a breccia very similar to that actually found would result from the crushing of the igneous material which has been so widely permeated and attacked (fig. 5).

In conclusion, it is remarkable that Prof. Blake should thus have pointed out to us in Anglesey a true variolite within nine miles of the great exposure of glaucophane-schist. Both rocks here form part of the same axis, and have partaken of the same earth-movements; both are known in their finest and most massive development in a limited district of the Alpine chain. But it is difficult to believe that the association is other than accidental; and it must be borne in mind that the Anglesey variolite has distinctive features of its own, being the devitrified glass of an olivine-basalt, and hence probably a greater rarity than the well-known *Lapis variolatus* which strews the mountain-slopes around the sources of the Durance.

Note.—In connexion with the above observations, I have examined the coarsely spherulitic lava which forms an interesting feature of the summit of Aran Benllyn, near Bala. This has no external resemblance to variolite, but proves to be a spherulitic andesite similar to that of the Vashegy mountain in Hungary, but of a more highly silicated type. The glass between the microlites of the groundmass is now represented by clear green products of decomposition, as in a tachylyte already described from County Down. (*Quart. Journ. Geol. Soc.* xliv., p. 305.)

EXPLANATION OF PLATE X.

Fig. 1.—Variolite of Ceryg Gwladys, showing the relations of the spherulites and the altered glassy matrix, . . × 9

Fig. 2.—Silicified compact Diabase, retaining the original radial fibrous structure, 7 mm. from the green variolitic crust. An altered crystal of olivine, with separation of magnetite, is shown, ... × 30

Fig. 3.—Corroded crystal of Olivine, of elongated form, from the variolite of Ceryg Gwladys. The original is 3 mm. in length, and is altered into pale green products, in which yellow epidote has developed, . . × 25

Fig. 4.—Crystals of Olivine from various sections of the variolite of Ceryg Gwladys, showing corrosion and the development of epidote, ... × 30

Fig. 5.—Veins of calcite, chalcedony, and quartz, traversing the compact diabase, showing how brecciation might produce the fragmental calcareous rock which is found associated with it, ... × 9

XII.

SURVEY OF FISHING GROUNDS, WEST COAST OF IRELAND. PRELIMINARY NOTE ON THE FISH OBTAINED DURING THE CRUISE OF THE SS. "FINGAL," 1890. By ERNEST W. L. HOLT.

[Read February 18, 1891.]

The forms mentioned in the following Note, together with those found during the continuation of the survey in the current year, will be described in detail in the Society's Scientific Transactions:—

Shore Fishes.

Aphia pellucida, Nardo. 4 specimens in breeding condition. Killybegs Harbour, 24th June. *New to the Irish Fauna.*

Crystallogobius nilssonii, Düb. & Kor. Many specimens of various stages. Adults in breeding condition. Ballinskelligs Bay, 30 fathoms, 21st August. *New to the Irish Fauna.*

Arnoglossus grohmanni, Bonap. A specimen from Clifden Harbour, 11th June.

Deep-sea Fishes.

All hauls of the trawl, at depths exceeding 100 fathoms, were made on the 4th and 10th July, at from 20 to 54 miles northwest of Achill Head.

Pristiurus melanostoma, Raf. A young specimen from 144 fathoms.

Raia batis, Linn. From 220 and 500 fathoms.

Chimæra monstrosa, Linn. From 220, 175, and 144 fathoms.

Pomatomus telescopium, Risso. From 144 fathoms. *New to the British Fauna.*

Scorpæna dactyloptera, De la Roche. Adult, from 500 fathoms; and young, from 80 fathoms, off Skelligs, 19th August.

Trigla lyra, Linn. From 144 fathoms.

Gadus esmarkii, Nilsson. From 144 fathoms. *New to the Irish Fauna.*

Gadus poutassou, Risso. From surface, 175 fathoms. A large shoal observed. $5\frac{1}{2}$ to $6\frac{1}{2}$ inches.

Gadus argenteus, Guich. Adults, from 220 and 144 fathoms. Young, from 52 to 80 fathoms, off Skelligs, 19th August.

Mora mediterranea, Risso. Specimens (various stages, largest 29 inches) from 500 fathoms. *New to the British Fauna.*

Phycis blennioides, Brünn. Half-grown, from 220 fathoms. A young specimen, from 26 fathoms. Kenmare River, 16th August.

Haloporphyrus eques, Gthr. Various stages, from 500 fathoms.

Motella tricirrata (?), Bl. Mackerel midges, from the surface (220 fathoms), 40 miles from land.

Molva vulgaris, Flem. From 127 fathoms.

Macrurus cœlorhynchus, Risso. From 220 fathoms.

Macrurus rupestris, Gunner. Specimens, largest 38 inches, from 500 fathoms. *New to the Irish Fauna.*

Macrurus æqualis, Gthr. Adult and young, from 500 fathoms. *New to the British Fauna.*

Macrurus lævis, Lowe. Specimens (largest $21\frac{1}{2}$ inches) from 220 fathoms.

Arnoglossus megastoma, Donovan. From 127 and 144 fathoms.

Pleuronectes cynoglossus, Linn. From 144 and 220 fathoms.

Argentina sphyræna, Linn. From 53 fathoms, off Dingle Bay, 20th May. Young, from 52 to 80 fathoms, off Skelligs, 19th August. *New to the Irish Fauna.*

Fam.—MURŒNIDÆ.

Group—Murœnesocina.

Nettophichthys, g. n.

Scaleless. Snout much produced; depressed. Jaws and vomer, with rows of teeth, recurved in anterior region, largest in central region of vomer. Gill openings fairly wide, open. Vertical fins confluent, rather feebly developed. Pectoral fins absent. Anterior nostril on upper surface of head near end of snout. Posterior nostril on side of head in front of eye. Air-bladder present. Pyloric appendages absent.

As will be seen from the above description, this genus is intermediate between *Nettastoma*, Raf., and *Saurenchelys*, Peters, agreeing with the latter in the condition of the nostrils, and with the former in the possession of an air-bladder. In the comparatively feeble character of the vertical fins it recedes equally from both.

Type Species.

Nettophichthys retropinnatus, sp. n.

Length of head contained six times in total length (without caudal) and equal to distance between gill opening and anus. Eye large, diameter contained twice in snout, and five times in length of head. Angle of gape behind hinder margin of eye. Upper jaw slightly overhanging lower; snout broad, swollen, except where produced anteriorly into a short knob-like deflected process, at base of which is situated anterior nostril. Lower jaw slightly curved. Teeth in two rows, outer most closely set, along margin of upper jaw, small and conical posteriorly, becoming larger and recurved in anterior region. Large abruptly reflected teeth, with swollen bases, in several rows on vomer, those of central region largest. A single row of small recurved teeth on mandibles, becoming larger towards symphysis.

Body laterally compressed; greatest height, *i. e.* behind anus, nearly half length of head. Abdominal cavity extending beyond anus; peritoneum black; air-bladder long. Tail tapering, but terminating obliquely. Extremity of vertebral column not upturned, overlying triangular hypural mass. Vertical fins rather feeble, especially dorsal, which commences at a point somewhat posterior to median. Vertical and caudal fins edged with black.

Colouration, uniform sepia brown, darkest ventrally, and on snout and jaws.

A single specimen, 5 inches, much injured, from 144 fathoms

XIII.

THE ORIGIN OF CERTAIN MARBLES: A SUGGESTION.

By PROFESSORS SOLLAS AND COLE.

[Read May 20, 1891.]

Amongst the interesting collection of rocks brought home by Professor Haddon from Torres Straits are some fragments of wind-blown coral sand rock from the east side of Mèr, one of the Murray Islands. They have a deceptively oolitic appearance; and the majority of the grains being of a red colour give a prevailing warm tint to the stone, and thus render more conspicuous by contrast a number of dark green, worn, and rounded crystals of augite, which are scattered irregularly through it. The appearance of this handsome rock is sufficiently striking, but it gains greatly in interest from its suggestive resemblance to the famous Tiree marble, wherein likewise green grains of pyroxene are set in a flesh-coloured matrix of altered limestone. The comparison is confirmed and enhanced by an examination of thin slices. In the recent limestone the calcareous grains are found, as so commonly happens with these coral sand rocks, to consist of rounded fragments of calcareous algæ and worn tests of various species of foraminifera. Mingled with these are more or less rounded crystals not only of green augite, but also of olivine, felspar, and a finely crystalline glassy basalt. In the Tiree marble the green grains of pyroxene (salite) show beautifully rounded outlines, and are sharply separated from the surrounding matrix, into which they show no tendency to pass. Crystals of felspar are also present, some fairly fresh, others, and these are the majority, corroded and almost entirely replaced by calcite, only the thin outer skin of the felspar preserving a fresh appearance. In some few cases, fragments of felspar partially penetrated by salite are met with. The calcareous matrix is finely granular, possibly dolomitic, but blotched and spotted by badly-defined larger crystalline individuals of calcite, the outlines of which are sometimes obscurely rounded. Thus although no trace of organic structure can now be recognized, yet on the whole the appearances are such as might be expected to be presented by a coral-sand rock, which had suffered metamorphic changes. MacCulloch in his detailed account of this rock refers to its occurrence as an irregular mass, completely surrounded by gneiss; another white limestone occurs in the island similarly disposed.

It is interesting to speculate on the final result of pressure metamorphism acting on volcanic islands surrounded by their reefs. Thus were the ancient granite masses of Queensland and New Guinea to approach one another, moving towards the line of weakness which now forms Torres Straits, we may conceive that basic schists in great variety would arise from the rolling out of the cores and superficial deposits of the intervening volcanos, while the associated coral reefs would be converted into irregular masses of structureless limestone, and becoming involved in the surrounding schists would be irregularly dispersed through them, so as to occur in unexpected and anomalous positions.

In conclusion we would call attention to an important Paper read in 1876 before the Royal Geological Society of Ireland, by Mr. W. L. Green, Minister of Foreign Affairs to the King of the Sandwich Islands.[1] *Inter alia*, he says:—

"The Hawaiian Islands are more or less surrounded by coral reefs, the island of Hawaii less so than the others, for one reason, because the lava has kept pouring into the sea along most parts of the coast during past centuries, and has not given the coral an opportunity to form to so large an extent as in the other islands. Now it is a fact that wherever the lava runs into the sea, or wherever the waves have an opportunity of breaking against [it]... a large quantity of olivine sand is formed. The felspar, the other material of which this lava is mainly composed, gets ground up to powder and disappears—indeed it is almost always in the minutest grains to begin with—whilst the olivine, a much heavier mineral, and in grains from the size of a bean to a pea downwards, forms the main component of the sand of the seashore wherever the sea meets the lava, or else the olivine sand gets more or less mixed up with the coral sand, where the two classes of rock are in close proximity.

[1] Journ. Roy. Geol. Soc., Ireland, vol. iv., p. 140, 1877.

A great deal of the olivine sand is of the finest possible [grain]; indeed it is often so fine that although a much heavier mineral than carbonate of lime, it will often, where both are washed by the waves, settle on the top of the coral sand, and I have often scraped the almost pure fine olivine sand from the top of a coral sand beach. This mixture of the two sands is common over the group, extending 400 miles from Hawaii to Bird Island." Again, "... there is every grade of mixture from all coral to all olivine. Very often the olivine sand rock will be found to run in streaks amongst the coral sand rock, so that in the course of time, when the coral sand rock comes to be metamorphosed into a limestone or a marble, the olivine sand rock would probably suffer the change which that mineral is well-known to experience, namely into serpentine."

These views will certainly commend themselves to many of those who have come to regard Eozoon as a mineral structure. With the presumption in its calcareous composition of an organic origin, there has always existed a suspicion that some such explanation as this might eventually be found. It is interesting to note that the streakiness which Mr. Green expressly mentions as characterizing the interlamination of the olivine and coral sand rock, is so frequently an accompaniment of "Eozonal" and serpentinous limestone.

XIV.

THE NEWLY-HATCHED LARVA OF EUPHYLLIA. By A. C. HADDON, Royal College of Science, Dublin. Plate XI.

[Read March 19, 1890.]

In the early part of August, 1888, I collected some living specimens of the coral *Euphyllia rugosa* (Dana), which is abundant on the reefs in Torres Straits. One of these specimens gave birth to a number of free-swimming larvæ. I was unable to keep these alive for very long, and I never met with the larvæ again. As we know so little about the development of the Madreporaria a brief description of but a single stage of one species will have some value.

The larvæ were about 1·5 mm. in length, and of an elongated oval or slender pear-shape (Pl. xi., figs. 1 and 2), and actively swam about, owing to a uniform ciliation of their ectoderm. The yellowish endoderm could easily be seen through the colourless ectoderm: it was marked by twelve pairs of longitudinal olive-brown lines. Occasionally they floated with their aboral end uppermost, as in fig. 3. After a time they very generally assumed a flattened or cake-like form (figs. 4 and 5). The contour of the endoderm was crenulated by twenty-four sulci, each sulcus corresponding to an interval between the vertical brown lines. The ectoderm in this stage was also crenulated, the grooves being opposite to each pair of brown stripes. The ectodermic and the deeper endodermic furrows correspond with the mesenteries; the aboral disc was apparent as a small round whitish patch (*ab. d.*). Finally, they often rested on their aboral aspect on the side of the vessel, and then they had a conical appearance (fig. 6), the upper portion of their bodies being frequently marked by two annular constrictions (fig. 7). I could not keep them alive after this stage.

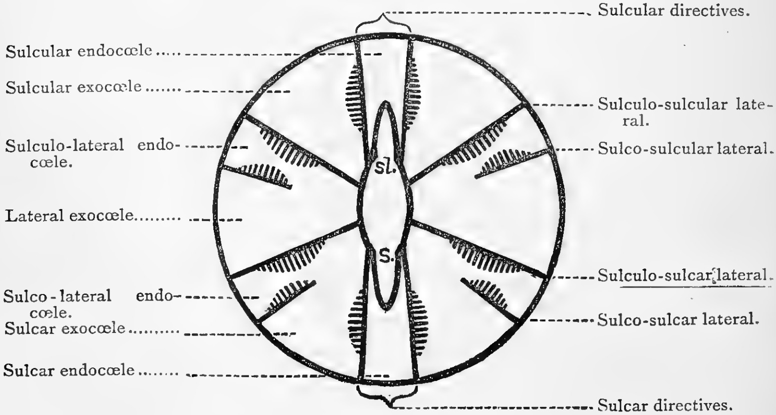
Sections made through larvæ killed at the commencement and at the close of the period during which I kept them alive show so little differences in structure that the latter may be neglected and all the forms described as belonging to one stage. The stage is that which I have described (1889, pp. 352, 354), as the fourth stage of mesenterial development.

A few years ago (1887, p. 479) I drew attention to the importance of this stage in the development of Halcampa, and the following year I described it in Peachia (1888, p. 256).

Mc Murrich (1889, p. 31) has also found this stage in the development of *Aulactinia stelloides*, and has also drawn attention to its "Edwardsian" character; but Lacaze-Duthiers was the first to observe it, though he did not discuss its significance.

In describing larvæ at this stage it is necessary to have a consistent system of terminology, and until it is replaced by a better I shall adhere to that which I introduced in my "Revision of the British Actiniæ." I there proposed "sulcus" for the "ventral," and "sulculus" for the "dorsal" grooves. The former is the more important groove: it is that which is so marked in Peachia and which alone occurs in the Zoantheæ. In those adult Actiniæ which possess but a single groove it is not, however, always possible to determine whether this is sulcar or sulcular.

Fowler's terms of "endocœle" for an intramesenterial chamber, and "exocœle" for an intermesenterial chamber are so appropriate that they are sure to be universally adopted. Hertwig's employment of the term "directive" for the pairs of sagittal mesenteries is also very happy.



The foregoing diagram illustrates the method of naming the mesenteries and chambers which I have adopted.

This terminology may be complicated, but it is definite, and I only employ two new terms, and these merely replace others.

Transverse sections show that the only difference in the mesenteries between our larvæ and the corresponding stage in many Actiniæ is that the sulcular directives, although they reach the œsophagus, are devoid of mesenterial filaments (craspeda), being in this respect in the same condition as the fifth and sixth pairs of mesenteries (Pl. xi., fig. 8).

Alternating with the mesenteries are large ridge-like vesicular outgrowths from the endoderm. At first sight these appear to be related to the future septa, but against this view it may be urged that the ridges are composed solely of endoderm, the mesoglœa scarcely entering into them (Pl. xi., fig. 10), that there is certainly no trace of calicoblasts or of any ectodermal invagination; and finally Bourne (1888, p. 28) informs us that the septa of the adult are all entocœlic.

The endoderm of the mesenteries passes gradually into these ridges; and at the angles between the mesenteries and the ridges there are numerous Zooxanthellæ. A few of the latter may be found in the mesenteries, but they mainly congregate in these twenty-four longitudinal areas; and it is these which give rise to the twelve pairs of dark longitudinal lines which are so conspicuous in the living larvæ. The algæ do not always form an unbroken line.

The mesoglœa is an apparently homogeneous jelly-like substance; whether the ectoderm assists in its formation I cannot say, but it certainly is mainly endodermal in origin.

The ectoderm of the body-wall presents three characters:—(1) At the aboral end of the body there is a disc-like patch of deep closely set cells. Owing to the absence of Zooxanthellæ in the adjacent endoderm this pole appears as a whitish patch in the living embryo, and this forms the seat of attachment of the sessile larva. (2) The ectoderm of the column is composed of a deeper granular or "nervous" layer beneath the ordinary narrow columnar cells. Between the latter are an immense number of thread cells, in a few of which the unejected spiral thread can still be seen. (3) At the oral apex the granular layer becomes so much thickened as to practically constitute the whole of the ectoderm. This layer is absent on the pedal disc (Pl. xi., fig. 10).

The columnar epithelium of the stomatodæum (œsophagus) passes down the perfect mesenteries as the mesenterial filament (fig. 10), where it is provided with nematocysts and gland cells. H. V. Wilson (1888) has given his reasons for concluding that the mesenterial filaments in *Manicina areolata* are derived from the ectoderm of the œsophagus, and my sections appear to me to indicate the same for Euphyllia. The filaments consist merely of a single lobe, no lateral ciliated tracts being present. Everywhere the ectoderm is ciliated.

The earliest account we have of the development of a coral is that of *Astroides calycularis* by de Lacaze-Duthiers (1873, p. 269). He several times points out the essential similarity between the earlier stages of this coral and those of the Actiniæ, especially those of *Actinia equina* (*mesembryanthemum*). So marked is this that he says he would not be able to distinguish between some hurried sketches which he made of both species if he had not happened to have drawn them on different kinds of paper. On p. 312 he says "the embryonic chambers ('lobes') follow an order ('loi') identical with that which I have demonstrated for the Actiniæ." I have already (1889, pp. 346–350) given an abstract of the latter. His account of the formation of the calcareous parts does not now concern us.

Von Koch (1882) studied the same coral with a view to investigating the origin of the skeleton. He does not give a description of the order of the appearance of the mesenteries, and the only point I wish to draw attention to is his discovery of prominent endodermal ingrowths into the cœlenteron of the larva between the mesenteries, and into which the ectoderm subsequently invaginates to lay down the septa.

The most complete investigation of the early stages of the development of a coral is that of *Manicina areolata* by H. V. Wilson (1888, p. 191). The following abstract is entirely given in Dr. Wilson's own words :—

The normal segmentation which goes on in the body of the parent results in the formation of a blastosphere with a very large cavity. The blastophere is markedly bilateral, and is without cilia. Delamination appears to be the exclusive means by which the endoderm is formed. The cavity of the blastosphere having been filled up by the endoderm segments a solid planula is formed.

While the embryo is still solid, the œsophageal invagination makes its appearance. At this stage it swims feebly about, the cilia having commenced to develop.

The permanent endoderm is formed from the larval endoderm by a differentiation of a peripheral layer from the central portion. The œsophageal invagination is much dilated at its base. Here the ectoderm has preserved its intimate connexion with the endoderm, the ectoderm cells not even having acquired a smooth bounding surface. In the next stage this even surface has been acquired, but at no time is a supporting lamella secreted over this area. The absence of the lamella clearly facilitates the absorption by the endoderm (or yolk) of the base of the invagination. The central portion of the larval endoderm remains as food yolk. By the time the layers are definitely established the yolk is a loose mass of vesicles, the shells of which have begun to disintegrate.

The supporting layer appears as a delicate membrane between the two layers, and is not formed by the direct metamorphosis of the ends of the ectoderm or endoderm cells. In later stages it is found in places where it can only be endodermic, and in others where it is evidently ectodermic. I am quite sure that in Manicina it is formed as a cuticular secretion.

To form the first mesentery the whole œsophagus moves laterally, until in the meridian of the mesentery there is only supporting lamella between the œsophageal and surface ectoderm. The œsophagus now grows downward in the meridian as a lobe of the ectoderm, which represents the primary filament, and which pushes the endoderm before it.

On the opposite side of the animal, along the line of the second mesentery, the œsophagus became applied to the ectoderm in the same manner, and a lobe grows down from it to form the second filament. The mesenteries, as such, are formed by the ingrowth of the endoderm between the body ectoderm and œsophagus above, and between the body ectoderm and the filaments below.

The primary pair of intermesenterial chambers is at first solid. The larger chamber acquires its cavity before the smaller, the excavation travelling from the lip of the œsophagus upward and from the first toward the second mesentery. The excavation of the primary chamber is closely followed by the reflection of ectoderm into this chamber, the reflected ectoderm running up the œsophageal wall, and driving the endoderm before it. The second pair of mesenteries appear in the larger chamber as longitudinal ridges (the supporting lamella), which cause no elevation of the endoderm.

The ectoderm reflected into the larger of the two primary chambers is pushed down by the growth of the second pair of mesenteries. From it are formed the filaments for these mesenteries, while the remainder of the original tract splits into three divisions.

The middle division (his chamber *c*), is not pushed entirely to the edge of the œsophagus; later in life, when the fourth pair of mesenteries is well developed, this tract grows once more nearly to the upper limit of the œsophagus. The lateral divisions *a* and *b* are pushed to the edge, but after the sixth pair of mesenteries has appeared they begin to grow up again.

When the mesenteries of the third pair are well advanced the ectoderm is reflected into the smaller of the two primary chambers, and runs up the œsophageal wall nearly to the top of the chamber. The mesenteries, when they begin to grow down, carry a part of the ectoderm along their free edges as very slender filaments. As the fourth pair of mesenteries continues to increase in size, the tract of ectoderm which belongs to the chamber *c* extends farther upward.

The fifth and sixth pairs of mesenteries appear simultaneously. The filaments for the fifth pair are probably formed from the lateral portions of the reflected ectoderm (termed by Wilson "lobe *x*") after it has been divided by the completion of the third pair of mesenteries. The filaments for the sixth pair, it seems, will be formed from the tracts of ectoderm which belong to the chambers *a* and *b*. These tracts were in most larvæ pushed completely back to the free edge of the œsophagus, where the second pair of mesenteries become complete. In stages with twelve mesenteries, however, they have again appeared. The growth of the various tracts of reflected ectoderm is thus seen to follow in general the order of development of the mesenteries.

From the above account it will be seen, as Wilson points out, that there is a difference in the mode of formation between the first and the succeeding pairs of mesenteries. To put it briefly, this difference consists in the fact that in the first pair of mesenteries the ectoderm of the stomatodæum applies itself directly to the body-wall, and pushing aside the endoderm comes into contact with the basement membrane (mesoglœa) of the ectoderm of the column. Thus the first formed portion of the mesentery is its filament; the mesentery proper subsequently grows out into the cœlenteron. The succeeding mesenteries first project from the body-wall, come into contact with the stomatodæum from above downward, and push before them a portion of the reflected ectoderm which has grown round the free end of the stomatodæum and up its cœlenteric surface. This band of ectoderm is carried down the free end of the mesentery in its downward growth as its filament (craspedum of Gosse).

The next stage described by Wilson is one in which there are six primary or perfect pairs of mesenteries and six secondary or imperfect pairs; they all possess filaments. It is thus highly probable that the order of appearance of the mesenteries in Manicina precisely resembles that of the typical Actiniæ. There is, however, one discrepancy between Wilson's observations and those of de Lacaze-Duthiers, as the former says :—" According to Lacaze-Duthiers, the fourth pair appears between the first and second pairs. The Hertwigs suggested (?), on general grounds of symmetry, that the order of appearance was as I have figured. As regards the fifth and sixth pairs, however, the old account of Lacaze-Duthiers holds for Manicina as against the figures given by the Hertwigs for Adamsia" (*l. c.* p. 212).

This point requires to be reinvestigated in the forms studied by the French savant. For in all the larvæ I have seen the second pair (of Hertwig and Wilson) is better developed and bears larger mesenterial filaments than the fourth pair (Lacaze-Duthiers' second pair). I have elsewhere alluded to the fact that in *Halcampa chrysanthellum* only six mesenteries bear generative organs, these being the pair of sulcar directives and the sulcular mesenteries of the two perfect lateral pairs; the sulcular directives and the sulcar elements of the perfect lateral pairs of mesenteries being sterile. The fertile mesenteries are thus the first, second, and third pairs of the new enumeration; these too are the only mesenteries which possess mesenterial filaments in our Euphyllia larva. Mark (1884, p. 44, pl. xii. figs. 28, 31) also shows that in Edwardsia the mesenteries appear in this order, "ventro-lateral," "dorso-lateral," "ventral" and "dorsal."

The only account we have of the structure of Euphyllia is that by Bourne (1888). He says: "There are no directive mesenteries, Euphyllia agreeing in this respect with Lophohelia and Mussa. Their absence is a striking fact, adding as it does another type of mesenterial arrangement to those we know already." After alluding to the arrangement of the mesenteries in the normal Actiniæ, Edwardsia, Alcyonaria, Zoanthus and Cerianthus, he goes on to say—"All these forms show a bilateral symmetry; Mussa, Lophohelia, and Euphyllia alone are perfectly radial. This may either be a primitive condition or may be connected with fissiparity, for it is impossible to conceive how two polyps can be derived by fissiparity from one with directives, yet the arrangement of directives may be carried over into the daughter polyps." Our larva proves that Euphyllia, at all events, is primitively bilaterally symmetrical; those Actiniæ which give rise to new individuals by fission are characterized by absence of directives or by irregularity in their number and position—a feature which we must now regard as secondary. The stomatodæum shows no indication in the larva of the great and complex development which characterizes the adult Euphyllia.

Finally, I would like to direct the reader's attention to a Paper recently published by van Beneden (1890), in which he describes a larval Zoantharian which is evidently allied to "Semper's larva" (1867). Van Beneden's larva is in the same stage as that described in the present communication, and as in Euphyllia the sulcular directives are short and do not bear mesenterial filaments, the difference being that in the former these mesenteries are imperfect, *i. e.* they do not reach the stomatodæum. The mesoglœa also contains cellular elements, apparently derived both from the ectoderm and the endoderm. Taking these two facts into account van Beneden not unnaturally suggests that his larva (and probably also, Semper's) may be a stage in the development of a microtypal Zoanthean. Personally I regard the cellullar inclusions in the mesoglœa as being a more important argument than the character of the mesenteries, as these appear to differ but slightly from those I have just described. In a yet more recent Paper (1891), van

Beneden, after examining two new specimens, reaffirms their Zoanthean affinity. I can only add that I think this view highly probable, but cannot admit that it is as yet definitely proved.

LIST OF PAPERS REFERRED TO.

1867. SEMPER:

"Ueber einige tropische Larvenformen."—Zeitschr. für wiss. Zool., XVII., pp. 407–428, Taf. xxii.

1873. LACAZE-DUTHIERS, H. de:

"Développement des Coralliaires, II. Actiniaires à Polypiers. Développement du Polype de l'Astroides calycularis."—Arch. de Zool. expér. et gen. II., p. 269.

1879. HERTWIG, O. & R.:

Die Actinien. Jena.

1882. KOCH, G. von:

"Ueber die Entwickelung des Kalkskeletes von Asteroides calycularis und dessen morphologischer Bedeutung."—Mittheil. Zool. Stat. Neapel. III., pp. 284–292.

1884. MARK, E. L.:

"On the Development of an Edwardsia parasitic, in its earlier stages, in *Mnemiopsis leidyi.*"—Selections from Embryological Monographs, III. Mem. Mus. Comp. Zool. IX., No. 3. Cambridge, Mass., U. S. A.

1887. HADDON, A. C.:

"Note on the Arrangement of the Mesenteries in the Parasitic Larva of *Halcampa chrysanthellum.*"—Proc. Roy. Dubl. Soc., N.S., V., p. 473.

1888. BOURNE, G. C.:

"On the Anatomy of Mussa and Euphyllia, and the Morphology of the Madreporarian Skeleton."—Quart. Journ. Micr. Sci., new ser., XVIII., pp. 21–51, pls. iii., iv.

1888. HADDON, A. C.:

"On Larval Actiniæ parasitic on the Hydromedusæ, at St. Andrew's."—Ann. Mag. Nat. Hist., ser. VI., ii., p. 256.

1888. WILSON, H. V.:

"On the Development of *Manicina areolata.*"—Journal of Morphology, II., p. 191.

1889. McMurrich, J. Playfair:

"On the Occurrence of an Edwardsia Stage in the Free-Swimming Embryos of a Hexactinian."—Johns Hopkins University Circulars, viii., No. 70, March. Baltimore.

1889. Haddon, A. C.:

"A Revision of the British Actiniæ." Part i.—Trans. Roy. Dublin Soc., iv., ser. ii., June, p. 297.

1890. Beneden, E. van:

"Les Anthozoaires pélagiques recueillis par M. le Professeur Hensen dans son Expédition du Plankton. i. Une Larve voisine de la Larve de Semper."—Bull. Acad. roy. Belgique, (3) xx., p. 55, pl. i.

1891. Beneden, E. van:

"Recherches sur le Développement des Arachnactis. Contribution à la Morphologie de Cérianthides."—Archives de Biologie, xi., p. 115, pls. iii.–v.

EXPLANATION OF PLATE XI.

ab. d.	aboral disc.	*ms.*	mesoglœa.
ect.	ectoderm.	*n. ect.*	nervous layer of ectoderm.
end.	endoderm.	*s. d.*	sulcar directives.
end. r.	endodermal ridge.	*sl. d.*	sulcular directives.
m.	mesentery.	*st.*	stomatodæum.
m. f.	mesenterial filament.	*z.*	zooxanthellæ.

Figures.

1–7. External appearance of Larvæ of Euphyllia. (Not drawn to scale.)

1, 2. First stage of free-swimming larvæ.

3. Pyriform appearance of a floating larva.

4. Aboral aspect of a cake-shaped larva.

5. Another view of the same.

6, 7. Appearance of larvæ on becoming sessile.

8. Transverse section through the middle of the body. Zeiss $\frac{2}{A}$.

9. Portion of a similar section. Zeiss $\frac{3}{B}$.

10. Vertical section of a larva corresponding to fig. 7. Zeiss $\frac{3}{A}$.

XV.

REPORTS ON THE ZOOLOGICAL COLLECTIONS MADE IN TORRES STRAITS BY PROFESSOR A. C. HADDON, 888–1889.

RHYNCHOTA FROM MURRAY ISLAND AND MABUIAG. By GEORGE H. CARPENTER, B. Sc., Assistant Naturalist in the Science and Art Museum, Dublin. PLATES XII. AND XIII.

[COMMUNICATED BY PROFESSOR HADDON.]

[Read JUNE 17, 1891.]

WHILE residing on Murray Island Professor Haddon collected a number of insects of various Orders. The Lepidoptera have already been enumerated (Proc. R. D. S., vol. vii., N. S., pt. I., p. 1). I now give a list of the Rhynchota (Heteroptera), with descriptions of some new forms. In addition to the ten species taken on Murray Island, Professor Haddon has brought home three species of Hydrometridæ from Mabuiag; a new Limnometra; a new Halobates which he found very plentiful off the coasts of that island; and a minute insect found crawling on a coral reef, for the reception of which I have to propose a new genus. Of the Heteroptera from Murray Island two appear to be new; so that, altogether, five of the thirteen species collected by Professor Haddon have been hitherto unknown.

Sub-order.—**HETEROPTERA.**

Family.—PENTATOMIDÆ.

Genus.—CHRYSOCORIS, Hahn.

Chrysocoris collaris (Wlk.).

Callidea collaris, Walker, Cat. Het. Hemipt., Brit. Mus., pt. I., p. 40.

Twenty-one adults and four larvæ of this species were taken on Murray Island. They exhibit the variations noted by Walker, for whilst in some the bands on the prothorax and scutellum are green and conspicuous, in others they are blue, and in others obsolete.

The larva of this insect is shortly oval in shape. The abdomen, not yet covered by the backward growth of the scutellum, is of a bright red colour, except for a broad central metallic blue band, and marginal spots of the same hue above, and dark central and lateral patches on each segment below.

The British Museum specimens are from various Austro-Malayan islands.

Genus.—Dictyotus, Dall.

Dictyotus transversus, sp. nov.

(Pl. xii., fig. 1.)

Head ochreous, densely punctured with black; the three lobes of equal length, a forwardly-directed spinous process on either side in front of the eyes. Eyes steel-gray. Ocelli reddish. Antennæ with first, second, and third joints ochreous; the two distal joints brown. Pronotum ochreous, with numerous black punctures, which are, however, absent from a transverse patch which is situated near the hinder margin, and occupies almost the whole width of the prothorax; two blackish markings near the anterior border. Scutellum ochreous, with black punctures which leave central and lateral clear patches at the anterior border and an apical clear patch posteriorly. Elytra ochreous, with numerous black punctures, and suffused with brown centrally; membrane black-brown. Legs ochreous, spotted with brown. Abdomen beneath dark chestnut-brown, mottled with creamy yellow, and each segment yellow laterally.

Length, 8 mm.; breadth, 4·5 mm.

A single example was taken on Murray Island. It is very closely allied to *D. lineatus*, Wlk., from South Australia, but can be readily distinguished by the clear yellow transverse stripe on the pronotum.

The genus Dictyotus is typically Australian; several species occur in Tasmania and one in New Zealand.

Genus.—CEPHALOPLATUS, White.

Cephaloplatus spurcatus (Wlk.).

One specimen of this North Australian species was found on Murray Island.

Genus.—PLAUTIA, Stal.

Plautia affinis (Dall.).

Pentatoma affinis, Dallas, List Hemipt. Insects, Brit. Mus., pt. I., p. 252.

A single example of this Australian species was captured on Murray Island.

Genus.—MEGYMENUM, Lap.

Megymenum affine (Boisd.), (*M. crenatum*, Guèr.).

One individual of this species was taken on Murray Island. It occurs both in New Guinea and Australia.

Family.—LYGÆIDÆ.

Genus.—DIEUCHES, Dohrn.

Dieuches leucoceras (Wlk.).

Rhyparochromus leucoceras, Walker, Cat. Het. Hemipt., Brit. Mus., pt. v., p. 101.

One of the specimens from Murray Island seems to me to be identical with Walker's type from Ceylon, in the British Museum.

Dieuches obscuripes (Wlk.).

Rhyparochromus obscuripes, Walker, Cat. Het. Hemipt., Brit. Mus., pt. v., p. 104.

There is a single example of this species from Murray Island. Walker's type in the British Museum is from New Guinea.

I am strongly of opinion that these two will prove mere colour varieties of a single scarce but widely-spread species.

Genus.—PHYGADICUS, Fieb.

Phygadicus australis, sp. nov.

(Pl. XII., fig. 2.)

Head triangular, black, punctured, and covered with numerous short, pale hairs. Eyes reddish-brown. Ocelli red. Antennæ with the third and fourth joints equal, each slightly shorter than the second, yellowish-brown. Pronotum black, straight in front, constricted slightly at the sides, and with hinder margin sinuate and yellow; its surface with numerous punctures and short pale hairs. Scutellum black, punctured and hairy, with yellow apex. Thorax beneath black, punctured and hairy, with a clear yellow mark on either side, between the middle and hind legs; acetabulæ pale-yellow. Corium and clavus hyaline with longitudinal rows of black punctures; clavus with yellow inner margin; corium with costal and central black spots, and large brown triangular patch, with black transverse band and apex, at junction with membrane. Membrane clouded across middle. Legs with femora thickened, cream-coloured, each with a broad chestnut-brown band, tibiæ and tarsi cream-colour with dark-brown annuli. Abdomen deep brown beneath, alternately black and creamy at margins. Length 6 mm.; breadth 2 mm.

Two examples of this species were taken on Murray Island. It is, I believe, the first Phygadicus recorded from the Australian region. It resembles *Ph. urticæ* in general aspect, but the hairs on the head and thorax are less coarse; the distinct brown and black markings on the corium also distinguish it. The second and third cells on the margin of the membrane are not so clearly defined as in *Ph. urticæ.*

Family.—PYRRHOCORIDÆ.

Genus.—DYSDERCUS, Am. and Serv.

Dysdercus papuensis (Dist.).

One specimen was obtained on Murray Island agreeing with Mr. W. L. Distant's description of this species (Trans. Ent. Soc., Lond., 1888, p. 484). He records a specimen from this very island. Five other specimens in Professor Haddon's collection appear to be a variety of this insect. They differ from the type in having the pronotum orange, instead of black, and in wanting the large triangular black marking on the corium. Most of them, however, show traces of this marking in small blackish patches on various portions of the area which is totally black in the type.

Dysdercus cingulatus (Fab.).

Five specimens of this insect, which ranges from India to Papua, were taken on Murray Island, besides larvæ in various stages of development. Three of the imagos are the ordinary orange form, one the scarlet variety, and one the small pale variety, *solenis,* Herr.-Schäff.

Family.—HYDROMETRIDÆ.

Genus.—LIMNOMETRA, Mayr.

Limnometra lineata, sp. nov.

(Pl. XII., fig. 3.)

Head black, covered with fine pubescence, with two yellow longitudinal streaks above, and a yellow marking over each eye; eyes black; head beneath whitish. Rostrum creamy yellow, with black terminal joint. Antennæ black. Pronotum with its front margin slightly convex; sides slightly constricted not far behind the head, angularly prominent at the broadest part, whence the sides converge to a point forming the triangular shield; pronotum black, with fine brown pubescence; a thin yellow margin all round, except in front; two short longitudinal yellow lines just behind the head, and a long central one reaching from opposite their ends to the hinder end of the shield. Mesothorax with a whitish longitudinal line on either side, and metathorax with two similar yellow lines. Thorax with silvery pubescence beneath. Elytra and their veins sooty. Legs fuscous. Abdomen with brown lateral margins and silvery pubescence beneath.

Length, 8·75 mm.; breadth, 3·5 mm. Length of middle femur, 7 mm.; of hind femur, 7·5 mm.

This species is represented by a single individual from Mabuiag. It is allied to Mayr's *L. minuta*, but differs in its black colour and yellow markings. The last antennal joint of the specimen is, unfortunately, missing.

Genus.—HERMATOBATES,[1] g. n.

(Pl. XII., figs. 4–8.)

Body elongated, oval; the entire insect clothed with long, fine hairs. Head broadly triangular, rounded in front. Eyes rather small, facets large. Ocelli absent. Antennæ as long as body, four-jointed, first and second joints sub-equal, third and fourth shorter and sub-equal; a minute jointlet between the second and third, and third and fourth joints. Rostrum four-jointed, first joint long, broad; second joint the shortest, ring-like; third joint long, tapering; fourth joint narrow and pointed. Thorax, with its three divisions fused together, extending backward above, below, and at sides of abdomen, which it largely conceals; pro-, meso-, and meta-nota forming an oval, moderately convex, dorsal plate; pro- and meso-sterna forming a large and flat ventral plate; the abdomen, as viewed from above, is embraced laterally by what appear to be reflexed, backward prolongations of the thoracic epimera; only hinder edge of meta-sternum visible. Elytra and wings absent. Front acetabulæ near the central line, middle and hind acetabulæ situated laterally, the latter far back. Front legs very stout, moderately long; coxæ much thickened; trochanters thickened and bent; femora very greatly thickened, toothed; tibiæ thickened, toothed, bent at right angles from their insertion; tarsi three-jointed, proximal joint very short, distal joint thickened, with claws inserted beneath, midway in its length. Middle and hind legs of nearly equal length, longer than front pair; coxæ of both pairs very long and broad, those of hind pair reaching backward nearly as far as the extremity of the abdomen; trochanters of both pairs thickened and bent; femora of middle pair slender, of hind pair spindle-shaped; tibiæ and tarsi slender in both pairs, the latter with claws inserted just beneath their extremities. All tarsi with three claws, two stout and one fine.

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[1] ἕρμα, a reef; βάτης, one who treads.

Abdomen much reduced; four segments visible above, the last (male (?) genital) being button-shaped. Below, four segments at least are visible: the button-shaped terminal segment, the penultimate segment, which is visible on either side, embracing the ante-penultimate segment, which appears rounded, and as broad as long, and is embraced on either side by the segment next in front (Pl. XII., fig. 5).

The insect on which I have founded this genus was taken on a coral reef off the island of Mabuiag. Unfortunately only a single specimen was obtained. It is to be hoped that sufficient material will hereafter be forthcoming to enable the details of structure to be carefully worked out. Very possibly the description given above of the meso- and meta-thorax and abdomen will then require revision.

In general aspect the insect resembles Halobates and Halobatodes, but it is readily to be distinguished from them by its shorter and stouter legs, three-jointed tarsi, and differently constructed rostrum and abdomen. The legs seem more adapted for clinging or climbing on rocks than for skimming over the surface of water, though the insect is probably able to progress also in the latter way. The shape of the rostrum seems very peculiar among the Hydrometridæ.

My thanks are due to Dr. F. Buchanan White, who has kindly examined my rough sketches of the insect, and confirms my opinion that it is generically distinct from all described Hydrometridæ. It must probably be referred to a special subfamily.

I have pleasure in appending Professor Haddon's name to the type species, described below.

Hermatobates haddonii, sp. nov.

(Pl. XII., figs. 4–8.)

Head and body covered with long, pale hairs. Head yellowish-brown, blackish in front. Eyes black. Antennæ fuscous with proximal part of first joint yellow. Pronotum with anterior margin yellow, and an indistinct central longitudinal yellow stripe; all the rest of the thorax blackish-brown above, except the margins of the reflexed portions on either side of the abdomen, which are paler. Abdomen deep-brown dorsally, except the last (button-shaped) segment, which is clear yellow. Beneath, the head is brown, the prosternum blackish-brown, and all the rest of the insect dusky-yellow. Front acetabulæ, coxæ, and trochanters very pale; femur brown, yellowish beneath, with a sharp prominent black tooth at its proximal inner edge, a row of fine teeth along the edge, and a large double one near the insertion of the tibia; tibia with one strong and two small black teeth on its inner edge, and a comb-like row of bristles near its distal end. Middle and hind legs brown; middle femur with row of spines along its inner edge. All legs with numerous long pale hairs.

Length 3·3 mm.; breadth 1·3 mm. Length of anterior femur, 1·8 mm.; of middle femur, 2·3 mm.; of hinder, 2 mm. Total length of a leg of the second pair, 5·4 mm.

Genus.—Halobates, Eschs.

Halobates regalis, sp. nov.

(Pl. xiii., figs. 1–8.)

Oval; broadest behind the middle; deep blue-black above, and at sides, but with dense silvery pubescence; creamy yellow below. A pair of distinct light yellow triangular markings on the head, towards its hinder margin. Eyes rich-brown when in spirit; black when dry. Antennæ black, with proximal part of first joint light yellow; fourth joint slightly longer than third, but shorter than second. Legs black (but the femur of the first pair in the female has a clear, orange-yellow, longitudinal mark above at its proximal end, and is creamy yellow for the proximal third of its length beneath). Front tarsus with the second joint nearly twice as long as the first (Pl. xiii., fig. 5). Middle tarsus with its first joint three and a-quarter times as long as the second (Pl. xiii., fig. 6).

Male (Pl. xiii., figs. 1, 2). Length, 5 mm.; breadth, 2·25 mm. Length of front femur, 2 mm.; of middle femur, 5·5 mm.; of hind femur, 5 mm. Total length of a leg of middle pair, 13 mm.

The segments of the abdomen (Pl. xiii., fig. 2) are deep blue-black above; but those which are visible show a light yellow posterior margin. The last (third genital) segment is deep blue-black, with a rounded point, and light yellow lateral margins and prominences. All the abdominal segments are of a light-yellow hue beneath. The sixth has its anterior and posterior margins straight centrally, and oblique laterally, embracing the seventh (first genital). This latter occupies about a third of the length of the whole abdomen as seen from beneath. The eighth (second genital) has its horns symmetrical and divergent, and tipped with black.

Female (Pl. XIII., figs. 3, 4). Length, 6 mm.; breadth, 3 mm. Length of front femur, 2 mm.; of middle femur, 5 mm.; of hind femur, 4 mm. Total length of a leg of second pair, 11 mm.

The female resembles the male in colour and markings, but is larger. The first genital segment (Pl. XIII., fig. 4) has a small central process on its hinder edge.

In both sexes the hairs of the fringe on the tibia and tarsus of the middle pair of legs are somewhat short.

Larva.—A good series of larvæ of this species in various stages has fortunately been secured; and I hope to be able to work out some details of the metamorphosis at a future time. The young larva is of a nearly uniform yellowish-brown colour. Later, the dark chitinous plates described by Dr. Buchanan White ("Challenger." Zoology, vol. vii., No. 3, p. 72) are apparent: three on the head and two on each thoracic and abdominal segment (Pl. XIII., fig. 8). The front femora of the immature individuals are yellow for the proximal two-thirds of their length. The front tarsi (as in other Halobates larvæ) have but one joint.

A number of specimens of both sexes were collected by Professor Haddon off the shores of the island of Mabuiag. The majority were obtained in October, 1888.

This species seems quite distinct from all the known species of Halobates. The female is slightly longer than the male, as well as broader, and seems the largest Halobates hitherto recorded. This species may be distinguished at a glance from the other large species (*H. wüllerstorffi*, Frauenf., *H. princeps*, White, *H. flaviventris*, Eschs., and *H. splendens*, Witl.), by the front tarsus which has its second joint nearly twice as long as the first, whilst in those species the two joints are sub-equal in length. It seems to resemble more nearly in structure *H. hayanus*, White, from the Red Sea, but is decidedly larger than the latter, and differs from it in the shape of the genital segments of the male.

The shortness of the fringe to the tibiæ and tarsi of the second pair of legs in this littoral form supports Dr. Buchanan White's suggestion (*l. c.*, p. 75) that shore species have the fringe shorter than those found on the open ocean.

It will be seen that in the insects already recorded from other localities, Austro-Malayan, and Australian forms are about equally mixed.

EXPLANATION OF PLATES.

PLATE XII.

Fig. 1.	*Dictyotus transversus*, × 3.				
Fig. 2.	*Phygadicus australis*, × 3.				
Fig. 3.	*Limnometra lineata*, × 3.				
Fig. 4.	*Hermatobates haddonii*, × 6.				
Fig. 5.	,,	,,	(under surface), × 12.		
Fig. 5A.	,,	,,	head and rostrum, × 12.		
Fig. 6.	,,	,,	front tarsus (magnified).		
Fig. 7.	,,	,,	middle	,,	,,
Fig. 8.	,,	,,	hind	,,	,,

PLATE XIII.

Fig. 1.	*Halobates regalis*, ♂, × 4.			
Fig. 2.	,,	,,	,, abdominal segments from beneath, × 6.	
Fig. 3.	,,	,,	♀, × 4.	
Fig. 4.	,,	,,	,, abdominal segments from beneath, × 6.	
Fig. 5.	,,	,,	front tarsus (magnified).	
Fig. 6.	,,	,,	middle ,,	with part of tibia (magnified).
Fig. 7.	,,	,,	hind ,,	(magnified).
Fig. 8.	,,	,,	larva (well-grown), × 4.	

XVI.

IMPROVEMENTS IN LIGHTHOUSE LIGHTS, WITH AN EXHIBITION OF THE PROPOSED NEW BURNERS AND THEIR FLAMES. BY J. R. WIGHAM.

[Read APRIL 15, 1891.]

THE gas used at present in lighthouses is made from cannel coal, and necessitates the use at each station of three kinds of coal, *Cannel*, *Slacking-coal*, and *House-coal*. It is evident that if gas made from common Newcastle or Wigan coal could be used it would save much trouble and expense; one kind of coal would then suffice both for gasmaking and house use, the coke produced in the manufacture of the gas being available for heating the retorts.

We are all aware that cannel gas has higher illuminating power than gas made from ordinary coal, and unless the light from the latter could be increased so as to equal that from cannel, the economy and convenience above referred to would be too dearly purchased, for I need hardly say that for lighthouse purposes the maintenance of the highest possible illuminating power is of supreme importance. But upon this vital point my mind was soon at rest, for being aware, *first*, that gas made from common coal lends itself to what is termed the regenerative process, with better result as to increased illuminating power than cannel gas (the process consisting in using the heat produced by the burner for the purpose of supplying to it an atmosphere of very hot air to assist the effective combustion of the gas which is also itself intensely heated); and *second*, that the application of hydro-carbons to the flame of common gas produces in combination with it a greater amount of light than is obtainable from the richest cannel. I devised a novel method of burning common gas in which I combined both these methods of procedure, the hydro-carbon which I used being solid naphthaline, a perfectly safe and inexpensive material. I named my new burner the "Intensity" burner, and having made many experiments, I found that its illuminating power was 100 per cent. greater than that of its predecessors: practically double that of the most powerful gas light now used in lighthouses.

You will doubtless consider that this statement is one of much importance, deserving careful investigation. I am glad that by the experiment which I will show you I can prove it to demonstration, for by means of the 30-foot photometer which I have fixed across the Lecture Theatre you can ascertain the fact for yourselves. At the left-hand end of the photometer I have a gas burner of the kind now used in lighthouses, and at the other end the new burner which, as you see, is somewhat similar in construction.[1] When the burners were first lighted I did not add to the new burner the improvements to which I have referred, and therefore you have seen that both burners were practically the same, consuming the same quantity of the same kind of gas, and having the same illuminating power; so far we had equality of light, but when I shall add the means by which the superior light of the new burner is produced an enormous increase of illuminating power will be the result. I may mention, in passing, that it is a singular fact that when this improved burner is at full power there is a slight decrease in its consumption, due, I believe, to the slower flow of the richer gas. [The lecturer having added its improvement to the Intensity burner, and having placed the disc of the photometer at an equal distance from each light, it showed that the side next the new burner was more illuminated than the other, proving that the new burner was the more powerful. As he moved the disc towards the less powerful light each side of the disc did not become equally illuminated until it stood at the figure 4; which meant that the new burner was further from the disc in the proportion of one to two, and had therefore four times the illuminating power of the other light. At the lecturer's request, Mr. Moss stepped forward and verified this by inspecting the disc of the photometer. At the

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[1] The Lecturer here showed a Lighthouse burner of the kind used in Irish Lighthouses, fixed at one end of the Photometer, and at the other end one of his new "Intensity" burners, but without its improvements. Both lights were the same in illuminating power.

conclusion of the lecture the audience had an opportunity of making the experiment for themselves.]

The cannel gas now used in lighthouses has an illuminating power of 27 to 29 candles, or, roughly speaking, nearly double that of ordinary Newcastle coal (16 candles), consequently if I had used cannel gas in the left-hand burner, the new light, instead of being four times its power would be only twice its power. This statement seems obvious, and I have practically proved its correctness many times in the Photometer room of Edmundson's works, where I have the means of making and storing both cannel gas and common gas—that is, I made the same experiment as that at which you have been looking, but with cannel gas at one end of the photometer and the new burner at the other. I had recently the pleasure of doing this in the presence of a number of scientific gentlemen and others, amongst whom were some of the Commissioners of Irish Lights, Sir Robert Ball, F.R.S., their scientific adviser, and Mr. William Douglas, Engineer to the Commissioners, and proving to them that the new burner was of twice the illuminating power of the most powerful lighthouse burner consuming cannel gas.

The highest illuminating power yet reached by any gas burner is that recorded in Parliamentary Paper C. 1151, page 42, for the 108 jet Wigham burner (Tory Island type), viz. 2923 candles.

The next is that recorded at page 42 of the Trinity House Report for the Douglas 10-ring burner (Bull Rock type), 2619 candles.

The new burner, at which we have been looking, by which the intensity of the flame is doubled, while its volume is in no way diminished, represents therefore an illuminating power of close to 6000 candles, more than twice the highest power recorded of any burner, and this, in quadriform, as at Galley Head, would bring up the illuminating power to about 24,000 candles.

Another improvement in lighthouse illumination which I have suggested is that lenses should be so placed as to form a quadrilateral or a trilateral figure. Heretofore lenticular apparatus for lighthouses have been hexagonal, octagonal, or even sixteen-sided, but the quadrilateral form admits of the use of lenses of much larger illuminating surface and of much longer focal distance than is possible with six or eight-sided lenticular apparatus, and thus gives effect to the whole of the light of the burners of large diameter which are used under the gas system; hence the illuminating power of the lighthouse is enormously increased. The same applies to the trilateral form.

So long ago as 1872 I advocated in this room the great advantages which large lenses would give if used with the large gas burner which I had then introduced, and subsequently, in papers read before the British Association and elsewhere, I continued my contention, but it was not till 1885, when the eminent Engineers to the Board of Northern Lighthouses, Messrs. Stevenson, represented the matter to the authorities at South Foreland that an experiment was permitted to be made there with a large lens of long focal range. So successful did it prove that similar large lenses have since been placed at several important lighthouses, notably at Tory Island.

Last year I read a paper before this Society, explaining a system of double lenses which, by the use of two burners, would give precisely double the illuminating power of Tory Island; mentioning the refusal of the Board of Trade even to give it a trial. Since that time I have been in communication with the eminent optical engineers, Messrs. Barbier & Co., of Paris, and while the advantages of the double system are undoubted, yet it was evident that if lenses of sufficient size could be made to give a flash equal in power to the compound flash of the double system much economy would result. At my request, therefore, Messrs. Barbier designed lenses for the quadrilateral and trilateral systems to which I have above referred. Each of the lenses of the quadrilateral has an axial intensity of about 800,000 candles, or more than twice that of the great lenses which I erected in triform for the Irish Lights Commissioners at Tory Island. A still more powerful light may be obtained from the trilateral apparatus, each lens of which has an axial intensity of about 1,000,000 candles.

On a future occasion I hope to have the pleasure of explaining the details of these systems of lenticular arrangement, and will only now repeat that the illuminating effect of the quadrilateral is about $2\frac{1}{2}$ times that of Tory Island, and of the trilateral more than 3 times, an increase of power which may be of incalculable benefit to navigation.

I will ask you also to remember that if with lenses of this enormously increased power we use burners such as that at which we have been looking to-night, their illuminating effect will be absolutely doubled, and thus will be placed at the disposal of the lightkeeper lights respectively five times and six times as powerful as the flash of Tory Island, the largest in the world, respecting the great power and distinctiveness of which, especially in thick weather, the testimony of seamen has been of the most unequivocal character.

XVII.

ON HOMOTŒCHUS (*ARCHÆOCIDARIS HARTEANA*, BAILY), A NEW GENUS OF PALÆOZOIC ECHINOIDS.

By PROFESSOR W. J. SOLLAS, D.Sc., F.R.S.

[Read June 17, 1891.]

Literature.—Harte, A. "On a new Echinoderm (Spatangoid) from the Yellow Sandstone of Donegal." Journal Royal Geological Society of Ireland, vol. I., p. 67, Pl. V. 1867. Baily, W. H. "Remarks on the Palæozoic Echinidæ, *Palæchinus*, and *Archæocidaris*," op. cit., vol. IV., p. 40, Pl. IV., 1877.

The remarkable fossil which forms the subject of the present communication has already been twice brought before the notice of the Royal Geological Society of Ireland; on the first occasion by its discoverer, Mr. Harte, C.E., who gave a faithful account of its most important characters, accompanied by drawings which, though somewhat diagrammatic, serve sufficiently well for purposes of identification. Whatever deficiencies there might be in Mr. Harte's drawings were subsequently supplied by Mr. Baily's artistic figures, which give a very truthful representation of the general features of the fossil, and as near an approximation to truth in detail as can be expected from the subject, since the fossil is merely a hollow cast of the exterior of the organism preserved in a very fine grained sandstone. Considering this, it is indeed a marvel that so much of detail, down to the number of pores in the genital plates, can still be discerned in it. Mr. Baily greatly added also to our knowledge of the specimen, which he recognized as representing a new species, to which he assigned the name "*Hartiana*," at the same time provisionally attributing it to the genus "*Archæocidaris*."

Mr. Harte's description is sufficient, however, to make the species his own, and it certainly, therefore, much rather deserves to be called "*Hartii*" than "*Hartiana*." This, however, in passing; much more important are certain of the characters of the fossil itself. These were not overlooked by Baily, but to me they seem to remove the species from *Archæocidaris* and to render necessary the institution of a new genus for its reception. The chief of these characters are the triserial poriferous zones, the square ridge running down the middle of each ambulacrum, and the absence of large tubercles, except on some of the adambulacral plates.

Genus Homotœchus[1] (new).

Test spherical, regular, apex not depressed. Ambulacra nearly straight, poriferous zones depressed, triserial, interporiferous area an elevated steep-sided ridge bearing two rows of small tubercles or granules, one to each plate, indicated by suture on the summit of the ridge; to each plate, which is composite, correspond three pairs of pores in the adjacent poriferous zone. Interambulacral areas about three times as broad as the ambulacral, composed of five rows of plates where broadest, hexagonal, except where adjacent to the ambulacra, then pentagonal: of the pentagonal plates some, but not all, bear a large perforated tubercle. Apical disc regular, five genital plates (basalia), large, multiperforate, four of them with a prominent centrally placed tubercle, the fifth, which is the madreporite, without a tubercle, five ocular plates (radialia) very small.

A single species, *Homotœchus Hartii* (Baily).

Horizon, Calcareous Grit, Lower Carboniferous System.

Locality, Western Shore of Lough Esk, about six miles from Donegal.

The large perforate tubercles of the interambulacral plates, adjacent to the ambulacra, are present on the second and fourth pairs; the first pair, which abut on the basalia, the third, fifth, and sixth are devoid of tubercles. The series is not clearly preserved beyond the sixth plate.

Excepting the very small first pairs, the interambulacral plates are large and approximately equal in size, with a swollen dome-like surface, suggestive of a scrobicula without its tubercle, and giving a characteristic quilted appearance to the test. The plates bear no resemblance to those of *Archæocidaris Urii.*

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[1] ὁμώτοιχυς, well plaited.

The affinities of *Homotœchus* are naturally with the Palæ-echinoidea, the multiperforate character of the basals, and the presence of more than two rows of plates in the interambulacra involve so much; but were these features not present we should, on the evidence before us, prefer to refer the genus to the Glyphostomata rather than to the Cidaridæ. The ambulacra, though in some respects peculiar, forcibly remind us of the Glyphostomata. It is not simply that they are broader than in the Cidaridæ and with more numerous rows of pores—in the Melonitidæ we find these characters—nor that they are depressed on each side of a tuberculated ridge, somewhat similar to that of, say, *Goniopygus*, but the resemblance lies rather in the closeness of the pore triplets to one another, and their union into a composite ambulacral plate, reminding us of the composite ambulacral plates of such a form as *Stomechinus*, and offering very little resemblance to those of any Palæozoic Echinoid, or of any Cidarid, not excluding *Tetracidaris*.

There is no evidence of imbrication of the plates of the corona, of which, however, only the apical half is preserved; in this there is every indication that the plates abutted against one another.

Amongst the Palæ-echinoidea the place of *Homotœchus* is with the order Perischoëchinoidea of M'Coy, but from the information at present in our possession it is not possible to certainly place it in any of the recognized families of the order.

My friend, Mr. Sladen, to whose authority I willingly defer, informs me that in his opinion its affinities are closest with the Melonitidæ, to which family he would, at least provisionally, relegate it.

XVIII.

CALLOSITIES OF *NITOPHYLLUM VERSICOLOR*, HARV. (A NEW MODE OF VEGETATIVE REPRODUCTION OF FLORIDEÆ). BY T. JOHNSON, D. Sc., F.L.S., Professor of Botany in the Royal College of Science, Dublin. (PLATE XIV.)

[Read NOVEMBER 18, 1891.]

Nitophyllum versicolor, Harv., is one of the rarest of the ten[1] species of the genus Nitophyllum, Grev., known to occur on the coasts of the United Kingdom. Harvey[2] says of it: "Very rare; thrown up probably from deep water; annual; June to August; Ilfracombe, Miss Hill (1800) and Mrs. Griffiths. Youghal; Miss Ball (1834)." The plant occurs on the coast of France, and is said by J. G. Agardh[3] to be found "In Atlantico ad littus Europae temperatae."

N. versicolor, Harv., is characterized by a change of colour from rosy red in salt to golden orange in fresh water, but more especially by the presence of peculiar swellings described by Harvey as "ciliiferous calli" (Pl. XIV, fig. 1 c.). These callosities occur as thickenings on the tips and lateral margins of the frond. From their outer edge cellular, simple, or branched filaments project. From the cells of the callosity, when cut open, Harvey found minute granules escape in great abundance, bearing "no resemblance to spores of any description." Harvey further stated that the fructification of *N. versicolor*, Harv., was unknown, unless the swellings were of the nature of fruits. Greville,[4] writing of the callosities, says: "A curious appearance of what might be called pseud-fructification has been detected upon *Delesseria Bonnemaisoni* [*N. versi-*

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[1] E. M. Holmes, and E. A. L. Batters: "Revised List of the British Marine Algæ," in Annals of Botany, v. 1890.

[2] W. H. Harvey: Phyc. Brit. Pl. IX.

[3] J. G. Agardh: Sp. Alg. III., p. 471.

[4] R. K. Greville: "Crypt. Flora," Vol. VI., Pl. CCCXXII.

color, Harv.] . . . . . I can only conjecture it to be a morbid enlargement of the part from some unknown cause."

In the summer of 1889, when engaged in the Laboratory of the Marine Biological Association in an investigation of the flora of Plymouth Sound, I was fortunate enough to dredge a scrap of *N. versicolor*, Harv. Examination of the material suggested to me an explanation of the callosities which I was enabled to test by the discovery in the summer of 1890, of a locality in Plymouth Sound from which material could be obtained at will by dredging in five to seven fathoms.[1]

Structure of Callosity.—On making a microscopic examination of a cross section of a callosity, the cells composing it are seen to be very regularly arranged in vertical rows as though the cells in a row had a common origin (Pl. XIV., fig. 3). There may be as many as 20 to 30 cells in a row. By examination of suitable material, all stages in the formation of a callosity can be followed, from the primary division into two of the single layer of cells of the thallus. I have not been able to make out any definite layer of cells from which the cells of the rows may take origin. Apparently the thickening takes place from within—*i.e.* the youngest cells are most internal. Each cell is seen to be full of granular bodies which prove, on treatment with suitable reagents, to be starch grains, and crystalloids (Pl. XIV., fig. 5). The callosities are thus reservoirs of reserve material (carbohydrate and proteid), formed on the thallus by a kind of "secondary thickening." The root of the plant (unknown to Harvey) is simply a slight enlargement of the fleshy-cartilaginous stalks. Examination of a cross section of the stalk shows the same regularity of arrangement of the cells as in a callosity. The cells are, however, comparatively empty; they have no stored contents. It is important to note, too, that the stalk is not, as described, cylindrical; it is biconvex in cross section, the two edges are broken, and here and there show traces of the thallus (Pl. XIV., fig. 6).

Function of Callosities.—Taking into account the similarity of structure of the callosity and of the stalk, the presence of reserve food products in the cells of the callosity, their absence in the stalk cells,

[1] The dredge should pass clear of the moorings of the Duke Rock buoy, on the west side, in a direction parallel to Staddon Heights. The plants will be found growing on muddy stones generally.

the entanglement of the cellular filaments of the callosities in the mud, &c., of the sea bottom, and the absence of the usual reproductive organs of the Florideæ, I think there is everything to indicate that the callosities are organs for the vegetative propagation of the plant, functionally comparable to the gemmae of a Liverwort. A plant of *N. versicolor* of one season dies down, the callosities, well protected by their thick-walled superficial cells, lie dormant, to develop in the following spring into new plants. The cellular filaments of the callosities (of which filaments there are traces on the root) serve to give anchorage. In the process of germination the food matter stored up in the callosity is used up, leaving the emptied cells of the stalk.

Affinities.—Greville, in the Scottish Cryptogamic Flora[1], considered our plant a form of *Delesseria Bonnemaisoni*, Ag. In the Algæ Britannicæ[2], Greville altered his opinion so far as to place *N. versicolor* in the species *Nitophyllum Gmelini*, Grev. It seems to me, in the light of the knowledge just gained of the nature of the callosities, that *N. versicolor* is in reality not a distinct species, but a gemmiferous state of *Nitophyllum Gmelini* or *N. Bonnemaisoni*. Judging from the description and illustration by Batters of the form *crassinerva*[3] of *N. Bonnemaisoni*, Grev., I believe we have a strong indication in it of the closest connexion between *N. versicolor*, Harv., and *N. Bonnemaisoni*, Grev.

The structure of the callosities of *N. versicolor* has an important bearing on the structure of the thallus of the Florideæ in general. Schmitz[4] considers the thallus of a red alga to consist of a system of branching filaments, each filament growing by means of an apical cell from which segments are cut off in succession by the formation of horizontal walls. New filaments arise by a kind of budding, an irregular apico-lateral division of a parent cell, the cell so cut off becoming the apical cell of the new filament. The segments cut off from the apical cells never divide into two by a

[1] R. K. Greville: Sc. Crypt. Fl. s. 6, Pl. CCCXXII, figs. 2 and 3.

[2] R. K. Greville: Alg. Brit. p. 81.

[3] E. A. L. Batters: List of Berwick Algæ, Pl. XI. fig. 12.

[4] F. Schmitz: "Untersuch. ü. d. Befruchtung d. Florideen 1883." (See translation by W. S. Dallas in Ann. Mag. Nat. Hist. vol. XIII. 1884.)

vertical or horizontal median wall. Schmitz applies this theory to the whole of the Rhodophyceæ, the broad leaf-like thallus of a *Nitophyllum* or *Rhodymenia* being due to the cementing together of the branching filaments. It will be seen that this mode of formation of the thallus is altogether different from that in the higher plants in which true tissues are formed from the meristem by divisions in all directions. So far does Schmitz apply his view that he excludes the group Bangiaceæ from the Rhodophyceæ, partly because their thallus does not conform, in its mode of development, to that of the rest of the Florideæ. A comparison of the cross-section of the callosity or stalk of *N. versicolor* with that of the stalk and midrib of *Dictyopteris polypodioides*, Lamx.[1] will show the greatest possible similarity. The production of the thickening of the midrib of the Brown Alga, *Dictyopteris*, Lamx., is admittedly of a parenchymatous nature, comparable to the thickenings of a *Dracæna* stem, and it seems to me that the thickenings of *N. versicolor* must be so regarded. Before Schmitz can apply his theory to the whole of the Florideæ, and before he can exclude the Bangiaceæ, because of their want of conformity to the theory, it will be necessary to explain the apparently anomalous condition of *N. versicolor*, Harv., and the mode of formation of all thickenings of Floridean genera—*e.g.* the "veins" in other species of *Nitophyllum*, Grev., in which there are indications of a parenchymatous nature.

Summary.

1. The root of *N. versicolor*, Harv., is comparable to that of other species of the genus, merely a slight discoidal enlargement of the base of the sub-cylindrical stalk.

2. The callosities consist, as seen in cross-section, of 20–30 vertical rows of cells, each cell containing abundance of reserve material in the form of starch grains and crystalloids.

3. The stalk has exactly the same structure as a callosity. Its cells are, however, without reserve products.

4. There is everything to indicate that the callosities are organs of vegetative propagation, comparable in function to the gemmæ

[1] T. Johnson: Journ. Linn. Soc., Bot. xxvii, 1891, p. 463. The systematic position of the Dictyotaceæ, with especial reference to Dictyopteris, Lamx.

of a Liverwort. The cellular filaments of the callosity serve to give anchorage to the germinating callosity. The callosity forms the stalk of the new plant, the emptiness of the cells of the stalk being due to the consumption of the food matter in sprouting. So far as I know no such condition of things is known in any other Floridean.

5. Accepting this view of the nature of the callosities *Nitophyllum versicolor*, Harv., is, in all probability, simply a gemmiferous state of *N. Bonnemaisoni*, Grev.

6. The mode of formation of the callosity does not agree with Schmitz's views as to the structure of the Floridean thallus. This, as far as it goes, favours the retention of the Bangiaceæ in the Florideæ.

EXPLANATION OF PLATE XIV.

FIG. 1.—(After Greville's figure 3 in Sc. Crypt. Flora Pl. CCCXXII.) Natural size. *c.* callosity with cellular filaments.

FIG. 2.—Callosity in surface view. *t.* thallus. Slightly magnified.

FIG. 3.—Cross-section of callosity. Slightly magnified.

FIG. 4.—Same. $\times 80$.
t. thallus ; *c.* callosity ; *c. f.* a cellular filament.

FIG. 5.—A cell of callosity showing reserve products. $\times 240$.

FIG. 6.—Cross-section of stalk, outline. Slightly magnified.

XIX.

ON A METHOD OF PREPARING SCHIZOMYCETES, SACCHAROMYCETES, AND HYPHOMYCETES AS MUSEUM SPECIMENS, WITH A DEMONSTRATION OF ILLUSTRATIVE CULTIVATIONS. By E. J. M'WEENEY, M.A., M.D.

[Read December 16, 1891.]

We possess here in Dublin a magnificent Natural History Museum replete with specimens illustrative of almost every division of the animal and vegetable kingdoms: it does not however contain, so far as I am aware, any naked-eye specimens of the lowest fungi. This fact might not at first sight seem a grave defect—if indeed at all a defect—in a natural-history collection. It might be said, and not without a show of reason, that these minute plants are not of sufficient importance to entitle them to a place in a museum, and that their dimensions are not large enough to admit of their being displayed without the aid of the microscope. I hope in the following remarks to show that the former proposition is erroneous, and that the latter, though undoubtedly true of the individual members of the species, may by suitable *technique* be invalidated.

Commencing with the most highly-organized of the fungi that I have selected as the subject of this paper—the Torula-like Hyphomycetes can hardly claim, as a body, sufficient general interest, to entitle them to a place in most museums—especially as they are mostly believed, and some are known, to be only forms of fungi which may assume, under suitable conditions, a much higher degree of differentiation. There are, however, certain species which grow parasitically on human skin and hair, and on similar organs in the lower animals, and give rise to much discomfort, the most usual conditions to which they give rise being termed "ringworm" and "favus." Without entering upon medical or pathological territory, I think it may safely be said that these curious plants which live upon the surface of the human body are, to everyone, of sufficient interest and importance, to entitle them to a place in natural-history collections.

Coming now to the yeasts or Saccharomycetes, when we reflect that it is to the activity of these minute plants that we owe all our fermented liquors, beer, porter, wine and vinegar, we cannot fail to recognize their vast economic importance. The scientific study to which the various processes that make up the brewing and wine industry have been subjected on the Continent, under the leadership of Pasteur and Hansen, has demonstrated that most of the failures in the course of the manufacture of those articles, due to the appearance of muddiness, of bitterness, of viscidity or other objectionable qualities in the wine or beer, are to be attributed to the action of "wild" species of Saccharomycetes. These species have been isolated and studied, and it is no exaggeration to say that the genus *Saccharomyces* as now constituted is one of the very highest economic importance and general interest, and surely ought not to be omitted from our natural-history collections. As for the fission fungi or Schizomycetes, it may at once be stated that they surpass every other class of living beings in the closeness of their relations to the human species, and in the personal importance to the human individual of the nature of their relations to him. For, as is well known, most, if not every one, of the infectious diseases of which so many men die annually, and of which the epidemic of typhoid at present devastating this city is an excellent example, are directly traceable to the parasitism in the human economy of various species of fission-fungi: a parasitism surpassing in intimacy that which obtains in the case of what are generally known as intestinal worms, and of far more sinister import to the host. In addition to the numerous disease-producing organisms, the class of Schizomycetes comprises numerous species, the function of which is commonly termed putrefactive. By the process of putrefaction we now mean a coexistence of various fermentative activities, usually giving rise to foul-smelling products and ceasing only with the complete decomposition of the substratum. The substratum usually consists of the bodies of dead animals and plants or the products of their bodies. The complex organic molecules are taken to pieces, and the elements reduced to simpler (so-called inorganic) compounds, which are once more capable of serving to build up new plants and animals. Were it not for this destructive work, accomplished by the Schizomycetes, all the available carbon and nitrogen would long since have been absorbed into organic complexes, and life have probably ceased to exist on the planet. Again, it is not merely the life processes of those fungi which influence humanity; the by-products of these life-processes are in many cases organic compounds of relatively high stability, and capable of exercising the most intensely poisonous effect on the economy of the higher animals. We gaze with interest on the plant *Strychnos Nux-vomica*, growing at the Botanic Gardens, because we know its cells have the power of calling into existence a virulent poison. Why should we not have it in our power to examine with equal closeness the *Bacillus tetani*, a vegetable which grows in every field and every garden, and which elaborates a substance of which it is safe to say that it is much more poisonous than strychnine, and causes annually far more deaths? We can study at will *Atropa Belladonna*, the Deadly Nightshade: but the plant which produces the far more virulent diphtheria-poison is not cultivated in this country, save indeed in the bodies of those whom it attacks. Apart altogether from the economic interest attaching to the Schizomycetes for the reasons just alleged, there is a purely biological feature possessed by some of the species, of so extraordinary a character, as to justify their exhibition, as part of any fairly complete collection of natural-history objects. As is well known, since the researches of Pasteur, many Schizomycetes can, and do, live and thrive in the complete absence of free oxygen: while some there are to which the presence of that gas is insupportable. It is not that their life processes are different from that of all other living organisms, for they do consume oxygen, but obtain it by decomposing the organic molecules with which they are in contact, instead of, like all other plants and animals, taking it from the atmosphere.

Sufficient reasons have, I think, been now adduced why thread-fungi, yeast-fungi, and fission-fungi should be included in museums. The hitherto insurmountable objection to their exhibition has been their exceeding smallness, and the main purpose of this paper is to show how this drawback can be obviated and the species made accessible to the naked eye of the untrained observer. The method I propose is to show, not the individual organisms separately, but the complex formed by a vast number of individuals aggregated in pure cultivation on suitable substrata ; these aggregations possessing, in almost every case—when developed from an originally small number of inoculated individuals—peculiarities sufficient to claim attention, and in many cases to ensure identification without the use of the microscope.

It is not my intention in this Paper to recapitulate the various methods by which a given organism may be obtained and preserved in a state of pure cultivation. The manuals of bacteriology, now so numerous, contain descriptions of the manipulations, all of which are founded upon the famous plan, first conceived and practically worked out by Robert Koch, and which consists in the employment of transparent gelatinous substrata, solid at ordinary temperatures, but capable of liquefaction at a temperature equal to or beneath 100° C. I do intend, however, to describe such modifications of Koch's original method as are specially appropriate for the production of such museum preparations as I have at present in view. The *substrata* which have proved most valuable for this purpose are 10 per cent. nutrient gelatine, nutrient agar-agar, potato, turnip, and what is known as Soyka's milk-rice medium.

The vessels ought always to be of the finest glass, and consist of test tubes differing from those in common laboratory use in this, that they are flattened instead of being cylindrical in shape, and that they have a glass foot fused on to one end, enabling them to stand without support. (Specimen shown.) Another kind of vessel which has proved very useful in this class of work is a circular flattened glass, shaped something like two very large and deep watch-glasses fastened together, with their concavities turned towards one another so as to enclose a space, which is put into connexion with the external world, by the glasses being drawn out at one point into a sort of spout or small tube. Lastly, there are glass pots of various sizes provided with glass lids fitting accurately down on to a lip cut in the exterior wall. Now, as to the method of using these substrata and vessels so as to make museum-specimens of the contained cultures.

The flattened test-tubes are two-thirds filled with either nutrient gelatine or agar-agar, according as the organism for the reception of which they are destined, is capable of growing at temperatures below 20° C., or requires to be incubated at 37°. It is a matter of importance that these substances should be as nearly colourless as may be, and the best way to arrive at this result in the case of gelatine, seems to be to shorten the period of boiling as much as possible, after the addition of the peptone during the preparation of the medium. To obtain a clear agar-agar has at all times been a difficult matter, and I do not purpose entering here upon the various plans in vogue in different laboratories; they are well known to practical men who take in the German "Centralblätter" which are devoted to bacteriology. The selection of a tube so flattened as to contain but a thin layer of the substratum will, even with an indifferent agar, ensure sufficient transparency, provided the specimen, when finished off, be placed in a favourable illumination. After the liquid medium has been placed in these flattened tubes, the cotton-wool plug, with which of course they have been provided, and which, together with the tube, has been sterilised with dry heat (180° C. for twenty minutes), is replaced, and the tube with its contents is sterilised in a current of steam for ten minutes on three consecutive days, and is then ready for inoculation. This is accomplished by means of the usual *thrust* or *stab* procedure, and in order that success be achieved—in other words, that a perfectly typical culture be the result—it is necessary to pay attention to two points: the inoculating needle must be of stiff platinum wire, so as not to bend in the process, and so as to give a perfectly straight inoculation channel; and the number of germs introduced must be small. If a bouillon-culture be employed as the germ-source, it is well to have a series of drops of sterilised water ready, and having introduced a minute quantity of the bouillon into the first, inoculate the second from it, and so on. A previous check experiment will show the degree to which the dilution ought to be carried. After inoculation the tube is set aside to develop under suitable conditions of temperature, light-access, &c.; and lastly, when a perfectly typical development has taken place, the upper part of the tube is hermetically closed, by fusion of the glass at the blowpipe flame.

I will now show a few examples of pathogenic organisms cultivated in this manner.

The *Diplococcus pneumoniæ* of Fränkel, of which I show you a tube, grows along the inoculation track in the form of small, white, perfectly discrete granules. The surface growth is but slight.

Here is a totally different appearance. The specimen I now hand round is a thrust culture of the *B. tetani*, an organism which is a constant inhabitant of the upper layers of field and garden earth. The growth along the line of inoculation is ornamented with beautiful, radiating processes, like rootlets growing from a tap root, and the substratum is permeated with gas-bubbles which are produced by this obligate anœrobic organism, as part of its metabolism. The appearance is at once ornamental and characteristic. We have here a culture of "Symptomatic Anthrax," which is likewise an anacrobic organism; the characters are much the same as those of the tetanus culture, but there is an absence of the delicate processes. It is exceedingly instructive to observe that the thickest part of the growth is at the bottom of the tube, where the organism is as far away from the atmosphere as the depth of the tube will allow.

Another exquisite example of the naked-eye differentiation obtainable by this method is afforded by the *Bacillus murisepticus*, or organism of mouse septicæmia, which I now hand round. The bluish-gray clouds—to use Fränkel's expression—surrounding the inoculation thrust are distinctive of the organism. Examples might be multiplied; but I have adduced sufficient, I think, to confirm my statement that Schizomycetal vegetation produced in this way, and petrified, so to speak, by the closure of the tube, offers instructive and characteristic appearances. It must, of course, be borne in mind that there are very many species which do not lend themselves readily to this mode of preparation for museum purposes. Such are those which liquefy gelatine, and do not produce very characteristic appearances in agar-agar. In these cases it might be possible to fix the vegetation at a given stage, by the introduction into the tube of antiseptic substances; or perhaps by filling it with some gas such as H or CO_2 preparatory to sealing. The majority of such species are, however, sufficiently characterized by their growth on potato, and other opaque substrata.

I come now to the cultures made in the flattened vessels, which I mentioned a few moments ago. These are charged with a small quantity of agar-agar, which is allowed to solidify on one of their flat surfaces; and after the usual sterilisation, they are inoculated with (if possible) one germ only—or (at most) a very small number of germs, by means of a platinum needle. Or, the agar-agar may first be infected with a very few germs, and then poured into the vessel, which is at first merely plugged with sterilised cotton-wool, and, when suitable development has taken place, is sealed. The appearances thus brought to view are those peculiar to the organism in what is called plate cultivation, and if the glass wall of the vessel be of a certain thinness, it is possible to make out very characteristic details under a low microscopic power. But even to the naked eye the colonies present peculiarities which are easily seized and often quite distinctive. We have here, for instance, the peculiar outlying streamers of this *Cladothrix* species: the ringed and mouldy looking colony formed from the Ringworm-fungus, *Trichophyton tonsurans*, and the pellucid dots of *Actinomyces* with the characteristic yellowish, opaque, stellately arranged mass already making its appearance in the middle of some of the most advanced. The Tubercle bacillus forms extremely characteristic colonies on agar-agar; but unfortunately I have not a specimen to show you here to-night.

We now turn to the museum-cultures on potato and turnip or beetroot. Here the difficulties in the course of preparation are very slight, indeed; anyone accustomed to bacteriologal manipulation can obtain magnificent cultures of most organisms on these vegetable substrata, and enclose them free from contamination in vessels suitable for museum purposes. Here is a series on slices of potato which have been placed in small glass pots, sterilised and inoculated, and the lids fastened down with liquid paraffin. And here is a remarkable collection of cultures on red turnip, which show an extremely luxuriant and in many cases characteristic development. The various species of *Saccharomyces* and the pathogenic hyphomycetes and moulds grew splendidly on potatoes and turnips; witness amongst others the preparations of *S. albus*, *S. glutinis*, *Achorion Schönleinii*, *Trichophyton tonsurans*, *Aspergillus niger*, *A. fumigatus*. But it is the chromogenic bacteria which form specially beautiful museum specimens on these opaque substrata, particularly on potato, which, when properly manipulated, may be made to offer an almost pure white background. I need only allude to the bright red layer of *B. prodigiosus*, the brick-red of *B. indicus ruber*, the brownish-red of a well-known water bacillus, and the violet of another species from the same source; the peculiar greenish discolouration caused by *B. pyocyaneus.* The beautiful greenish-yellow tinge which permeates the gelatine, in, or on, which the fluorescent water-bacilli are grown, appears on potato as a dirty yellowish brown. A form apparently intermediate between the yeast-fungi and the Torulas, known to the Germans as Rosahefe, forms a beautiful pink colour.

A collection of permanent preparations of the various chromogenic organisms on appropriate substrata, would certainly form an attractive and beautiful feature in our natural-history museums. Although we have numbers of specimens illustrating the pigment-producing powers of the higher plants and animals, I am not aware that, in the Dublin museums at least, there are any preparations illustrating this curious power as exercised by the lowly Schizomycetals.

I now come to the last portion of my subject: a short statement of the advantages to be gained by the acquisition for our museums of such collections of permanent bacterial preparations as that which I have laid upon the table for your inspection. These advantages may be thus briefly summed up: to the unskilled or general public, the unusual appearance of these specimens is in the highest degree calculated to excite interest; and, in my view, one of the chief functions of a public museum is, by exciting interest in the specimens exhibited, to lead the observer to procure instruction. Correct ideas on the *rôle* of these lowly organisms are very valuable, for they would naturally lead their possessors to the practice of greater cleanliness and a more intelligent hygiene. To educate the people on these points would, in my opinion, be very desirable; knowledge of the nature of putrefaction, and correct appreciation of the danger of filth, might go some way to remove that reproach of uncleanliness with which our people have—and not unjustly, I fear—been branded. To the trained observer or specialist, the importance of having such a collection to refer to, would be almost inestimable. The resemblance of individuals belonging to different species, is often so great as to mislead the most experienced. The best workers will decline to say, for example, whether a given specimen, viewed under a magnification of 1000 diameters, is the typhoid bacillus, or a perfectly harmless water-saprophyte. It is the sum-total of biological and cultural characteristics which form the criterion; and a large amount of this sum-total is taken up by the naked-eye appearances of cultures on various nutrient substrata; in other words, by a careful study of such appearances as are exemplified in the specimens I show here this evening. It is easy, then, to see how important it must be to anyone working at this subject to have access to an authoritative collection of naked-eye specimens for comparison and reference. They can be still further utilized, however. It is to be borne in mind that such specimens keep alive and capable of development for many years, and that, with a little skilful manipulation of the blowpipe, it is possible to open any of these tubes, &c., so as to allow of a few germs being withdrawn—under suitable antiseptic precautions—without contaminating or injuring the specimen. The germs could then be sown on suitable substrata or inoculated into animals, and questions of identity speedily and finally settled. Such an operation would of course require to be confided to a skilful hand. But supposing an important investigation affecting public health were in progress, the advantage of having at hand so decisive a means of settling a debatable point is at once obvious.

It now only remains for me to give credit where credit is due, and it is to my esteemed correspondent, Dr. Král, of Prag, Bohemia, that I must give the credit for having worked out the problem how to prepare these lowly organisms for museum purposes. The specimens I show this evening have been prepared by him, and he is at all times ready to supply such collections. I am at present working at some Schizomycetes which have lately created some excitement by their ravages in this city—the bacillus of typhoid, and that which, entering the system during an attack of influenza, is the most fertile cause of a fatal termination to that malady—Fränkel's *Pneumonia Diplococcus*. I have succeeded in obtaining them both in pure cultivation from the bodies of persons who have succumbed to these diseases, and I purpose adding them as the first Irish specimens to this collection of Continental bacteria. I very much doubt, however, whether it will be possible for me to produce such good results as Dr. Král. Here are his specimens of these two organisms. (Specimens shown). And I may add in conclusion, that I shall be glad, at any time, to receive information or material that may enable me to add cultivations of organisms that produce infectious disease in our horses, cattle, pigs, or other domestic animals, to the nucleus which I have had the honour of laying before the Royal Dublin Society this evening.

ERRATUM.

Page 169, line 4 from top—

For FEBRUARY 17, 1892, *read* JANUARY 21, 1891.

XX.

ON THE STRUCTURE AND ORIGIN OF THE QUARTZITE ROCKS IN THE NEIGHBOURHOOD OF DUBLIN. By PROF. W. J. SOLLAS, D.Sc., LL.D., F.R.S. (Plate XV.)

January 21, 1891.
[Read ~~February 17, 1892.~~]

The earliest reference to the Cambrian Quartzite of this district that I have met with is by Dr. Fitton (1), who thus early (1811) calls attention to the characteristic conical form presented by quartzite mountains like the well-known "Sugar Loafs" of Wicklow, and suggests that it is "in some measure characteristic of mountains composed of this rock."

Weaver, (2) in his excellent description of the South-east of Ireland, gives a good lithological description of the quartzite. In colour it is "white, usually light yellowish or grayish white, sometimes more or less deeply stained yellow, red, and brown. Its exterior is often of a glazed brilliant white, as if a solution and reconsolidation of the surface had taken place." We may here observe that the last sentence apparently refers to slickensided surfaces, though it is curious that so acute an observer does not also mention the striæ and grooves so invariably associated with such surfaces. Its "structure varies from the perfectly compact splintery to the close-grained granular; sometimes it contains small, well defined, rounded grains of quartz, which are frequently of a different colour from that of the base, even pale pink or purplish, as for example in the peaks of the two Sugar Loafs and Bray Head; it contains, very rarely, rounded and angular grains of felspar and a few scattered minute scales of mica. The pure clay slate is yellowish. . . . These two rocks are interstratified, not only on the large, but on the small scale."

"All these rocks are more or less traversed by small contemporaneous veins of pure white quartz, which in their range frequently follow the line of the dip. Quartz rock in particular is scarcely ever free from them, and they are sometimes almost innumerable."

"Quartz rock when in mass is unstratified."[1]

"The quartz rock of Shankill on the north side of the Dargle is immediately connected with the granite, and judging from the structure of this granite it probably passes into it; but on the eastern side of Shankill the quartz rock appears to be associated with clay slate, the shingle of the latter being observable in the fence which ascends the hill on that side."

"In the great quarry at Howth are found iron pyrites, copper pyrites, arsenical pyrites, and galena, gray ore of manganese, brown iron-stone, and earthy black cobalt ore on the S. W. side."

In a short account of the local geology drawn up for the visit of the British Association in 1835, we find the distinction of the quartzite into two kinds previously hinted at by Weaver, more expressly stated in the following:—"The quartz rock exists in two states, either alternating with the schist, and in that case decidedly stratified, or destitute of all foreign intermixture, and in these examples the stratification is very indistinct. The chief masses of quartz are at Bray Head and Howth, in which it alternates with schistose strata: Shankill and the greater and lesser Sugar Loafs, in which no schistose strata occur."

That the quartzite does not always behave exactly as might be expected from a stratified rock appears to have repeatedly impressed itself on geologists; but the most exact and searching study of its irregularities we owe to Mr. John Kelly (4), who demonstrated by numerous observations in the field that the beds of quartzite, instead of maintaining an unbroken conformity with the beds of slate with which they are associated, frequently cut across them much after the fashion of intrusive igneous rocks.

Mr. Kelly does not doubt that the quartzite was originally a stratified rock, but he infers and rightly "that the quartz rocks of the Sugar Loafs and Howth are not in their original position with regard to the adjacent rocks." Mr. Kelly then proposes an explanation in which he suggests that after its deposition the quartz rock was rendered plastic by heat and then forced under great

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[1] This is not quite correct; obscure traces of bedding seldom fail, even in the most massive quartzite.

pressure into the overlying slates, which it penetrated like an igneous intrusion, sometimes running between the bedding planes of adjacent beds of slate, so as to deceptively appear as though in its original position ; but at length, when traced far enough, cutting across them, and so revealing its truly intrusive character.

On the occasion of the second visit of the British Association to Dublin in 1878, Mr. Close (5) drew up an account of the geology of the district in which he states that, though "generally conformable," the quartz rocks "sometimes assert their independence of the stratification in a way that is not easy to explain."

Mr. Kinahan (6) pushed the argument in favour of an eruptive origin of the quartzites a step farther; and in his Geology of Ireland they are treated under the heading of eruptive rocks. In the preface to this work (p. vii) they are termed quartz rock to distinguish them from other recognised varieties of quartzite or quartz-schist. In a footnote on the same page Mr. Kinahan adds: "In the counties of Wicklow, Dublin, and Wexford I have found quartz rock in unaltered Cambrians, in the county of Wexford in unaltered Cambro-Silurians, in the county of Mayo in unaltered Silurians, and in the counties of Clare and Galway in the Old Red Sandstone, and these facts alone ought to demonstrate that quartz rock should not be included among the metamorphic rocks, and that it is a distinct rock from quartzite or quartz schist, the latter being a true metamorphic rock."

Again, on page 194 (*loc. cit.*), we find the following :—"In the Cambrians at and to the S.W. of Wexford town (Forth Mountains) are dykes and cake-like masses of quartzite that are [? not] metamorphosed quartz rocks. Such cakes of quartz rock appear to have been deposited from springs or some such accompaniment of feeble vulcanicity, the cakes being surrounded and eventually covered up by the deposition of the contemporaneous sedimentary rocks, while the dykes mark the sites of the passages through which the mineralized waters found egress. To the northward and eastward of the Cambrian rocks are other masses of quartz rock in the Cambro-Silurians. These are especially numerous to the south-westward near Bannow, where some of them are felsitic, and graduate into rocks like petro-silex and fine elvan." Further on, page 196, as follows:—"In the Cambrian rocks of the counties of Wicklow and Dublin are protrusions, dykes, and cakes of quartz rock. In the country north of Aughrim and eastward to the valley of the Avonmore are masses of quartzite, evidently metamorphosed quartz rock the age of which . . . is uncertain, but probably they are in the Cambrians. North-west of Wicklow town, especially in Carrick Mountain, are long, more or less continuous cakes of quartz rock; near Kilcoole, and at Bray Head, and in the country to the west thereof, are dykes and protrusions of quartz rock. One of the principal quartz rock dykes in Bray Head runs south-west from the Brandy Hole, and the junction between it and the other rocks is well exposed at the path above the railway. It breaks up through the Cambrian rocks, and those to the north of it seem to be altered, being very much mineralized, still not so much as to destroy the fossils, this being a locality for Oldhamia. Of the protrusions the largest and most remarkable constitute the Great and Little Sugar Loafs. Another remarkable hill of quartz rock is that called Shankill or Carrickgollogan to the north-west of Bray."

Mr. Gerard Kinahan (7), although offering no opinion as to the origin of the quartzite rocks, provides a more satisfactory explanation of their apparently discordant position amongst the surrounding slates: this will be readily understood by reference to the map which he gives of the country about Bray Head, in which the beds of quartzite are represented as broken up into a vast number of dislocated blocks by repeated faulting. It is interesting to compare the map given by this author of the bed of quartzite extending inland from Brandy Hole with that of Mr. Kelly.

In 1887, at the meeting of the British Association at Manchester, the author (8) stated that after examining the quartzite with the help of the microscope he was convinced that it was a slightly altered quartz grit, and he explained its deceptively intrusive character as resulting from differential movements during the folding of the country under pressure. Professor J. F. Blake (9) suggested, in 1888, a different view in explanation of certain masses of quartzite in Anglesey termed by him "quartz knobs." I quote the following:—"They . . . occur as isolated knobs of greater or less size, surrounded on all sides by shale or schists, in whose orientation they take no part, and produce no interference. They have in fact no orientation either on the large or on the microscopic scale, and they show no signs of contortion.

Hence their stratigraphical relations in no way suggest, but on the contrary strongly oppose, the idea of their being brought into their present position by the folding of any bed. They are for the most part entirely composed of quartz; only one or two, which must be referred to the same group, contain a trace of other minerals. By this character they are completely cut off from all the other rocks of quartz, even the whitest quartzite in a bedded form, such as the Porth-y-gwalch, being much less pure. . . . . From the banding of portions of the rock, from its purity, and from the mode of its occurrence, it has been suggested that such a knob represents the underground base of a hot spring of the period." When the quartzite contains evidently rounded grains, the presence of which Professor Blake admits in certain cases, he asks: "Have these been worn by the very water from which the matrix has derived its silica? and has the attrition taken place not in streams on the surface, but in circulating currents underground?"

Again, in Professor Blake's account of the "Monian" system of rocks (10) we find the same views expressed; thus on page 475 the following occurs:—"The quartz knobs are the most remarkable features of all the Anglesey rocks, and their origin is a matter of great difficulty. In their characteristic form they stand up as isolated hummocks on the surface of the country, and are often nearly as high as they are long or broad. They may be low mounds or may rise as high as a house, or form a good-sized hill. Usually they are elliptical in outline, but may be narrow and long, though it is doubtful whether we should refer the latter to the same category or consider them as ordinary veins. In structure they may possess scarcely any clastic elements, or they may contain many very rounded pebbles of pure quartz, the whole or the remainder being composed of clear quartz in dusty-looking polygons of growth separated by clear lines, the dusty appearance being due to excessively fine cavities, the largest of which may possess fluid enclosures. The only impurity is a little occasional sericite which may form round the larger pebbles where the matrix is not quite close. The purity and structure of the rock, together with its mode of occurrence, force me to the conclusion that it has been formed on the spot where it is now found, though the pebbles may have been brought there along with the formative material.

They are not veins in form or in structure, but may have had a similar origin. The only suggestion I can offer is that they are the result of the cooling of hot water which has bubbled up and eaten away the rock into a cavity, then deposited quartz on the sides; in some cases has broken up again the first deposits and rounded the fragments into pebbles, and has finally filled up the cavity by the deposition of its quartz. In other words they are the bases of pre-Cambrian geysers which may or may not have succeeded in reaching the surface and erupting." The quartzites of Howth and Bray are treated of with greater caution on page 535 of the same communication. Their general character however is, as Professor Blake informed me when examining them, identical with that of the quartz knobs of Anglesey.

Prof. Bonney (12) subsequently examined a thin slice from one of the Anglesey quartz knobs; his conclusion is that if it does not represent a quartzite, he has never seen one.

It is clear from the foregoing history that the division of opinion which, from a very early period, manifested itself in regard to the origin of the Leinster quartzites, has by no means been removed by the newest investigations aided by the refinements of microscopic investigation. In the following inquiry I shall first attempt to show that the quartzites of this district are of normal aqueous and clastic origin, and next to explain the abnormal position in which they frequently occur amidst the surrounding strata.

1. Histological. *Carrickgologan.*—The presence of rounded grains of quartz as much as a quarter of an inch in diameter has been already recorded by the older observers; in the course of half an hour's ramble over Carrickgologan a good many such grains may be observed; it is frequently possible to extract them from the parent rock, and they are then seen to resemble minute pebbles. They certainly are water-worn, and suggest therefore a sedimentary origin for the rest of the rock. This suggestion is in every way confirmed by an examination of thin slices of the rock under the microscope: even without the aid of polarized light one can clearly distinguish the separate grains of quartz of which the greater part of the rock is composed, their margins being well defined by a thin layer of minute transparent colourless flakes of a mineral which I take to be sericite, the refractive index of which is

sufficiently different to that of quartz to render the latter very conspicuous. Sometimes the sericite is replaced by a layer of white opaque earthy matter which by transmitted light appears as a black line round the quartz grains. The quartz is colourless and transparent, like much of that which enters into the composition of the granites of the district, from which, however, it cannot have been derived, as these are of later age. The outlines are more or less irregular, but at the same time usually rounded: very many of the grains are oval or even approximately circular in section, and this sometimes when the grain is so minute as to measure no more than 0·13 mm. in width by 0·11 mm. in breadth (Plate xv., fig. 2): no one accustomed to the microscopic examination of rock-slices could hesitate for a moment as to their clastic nature. The rounding of the grains is positive evidence of great value, the irregular outlines which sometimes occur are not in contradiction to it, since irregular and even angular outlines are common in grits of acknowledged sedimentary origin, *e. g.* in the Old Red Sandstone grit of Kiltorcan, of which I give an illustrative sketch (× 30 diameters) below (fig. 1).

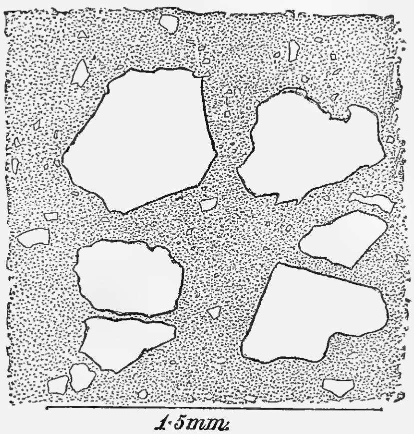

FIG. 1.—Section of Grit from Kiltorcan (*camera lucida* tracing).

If, while viewing a slice of the quartzite from Carrickgologan (Plate xv., fig. 2), the analyzer be pushed in, its appearance undergoes a singular transformation (Plate xv., fig. 1),[1] the rock no

[1] The figures 1 and 2 (Plate xv.) are reproductions of photographs of the same field of view—fig. 2 as seen by ordinary, and fig. 1 by polarized light. They are placed

longer appears to consist almost entirely of individual grains of quartz, but of a few larger and more conspicuous ones imbedded in a fine-grained matrix. The greater visibility of the sericite due to its polarizing in brilliant colours does not wholly account for this, much more is it due to an optical heterogeneousness in the apparently homogeneous quartz grains; some of the smaller of these are resolved into a mosaic, the separate fragments of which are mortised into one another, while the larger are scalloped round the edge with inlet granules of different optical orientation. The whole appearance is similar to that with which we are familiar in the crushed quartz of the foliated granite of the district, and there can be little doubt that under the pressure to which the Cambrian rocks have been more than once subjected, very considerable crushing has taken place, breaking many of the smaller grains to

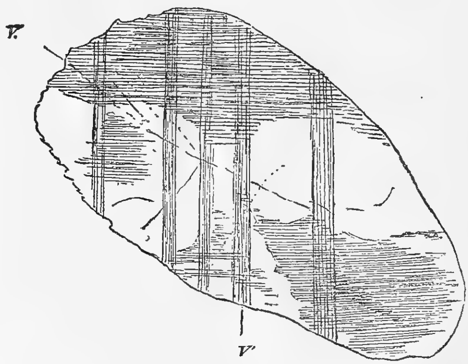

Fig. 2.—Section of a grain of quartz from the quartzite of Carrickgologan. Seen with polarised light, and highly magnified. *V. V.'* lines of vapour cavities. The areas extinguished in the upper and lower parts of the section are not so clearly arranged in bands in this as in some other specimens.

powder and detaching parts of the exterior from the larger: a cementation of the fragments has followed upon the crushing, restoring to the several grains their original continuity. The pressure which thus transformed the original material of the rock has left other traces of its action; the unbroken mass of the larger grains seldom extinguishes between crossed Nicols like the quartz of an

side by side for comparison, but unfortunately are differently orientated: the elongated rounded fragment in the S.E. corner of fig. 2, and the N.W. of fig. 1, is the same in both, from which it will be seen that a rotation of 180° in the plane of the paper will bring fig. 2 into a corresponding position to fig. 1.

uncrushed rock; undulose extinction is common, but in many cases this is of such a nature that it would be better termed "banded" extinction, since on rotating the stage of the microscope not merely one wave of darkness passes over the quartz grain but several separated by intervening bands of light, and reminding one, save for the vague indefinite boundaries, of the bands of the synthetic twinning in felspar (fig. 2). In some cases in addition to this vague banding there is another and more sharply defined running in another direction, the two sets of banding making frequently more or less right angles with each other.

A good deal of the quartz contains fine hair-like crystals which I think must be rutile; they possess a high, apparently metallic lustre, and though apparently opaque, yet when of unusual thickness they give bright colours between crossed Nicols. These prisms evidently grew with the quartz, and they have since shared in its deformation, since in some cases one finds a long prism disjointed into a succession of short lengths which neither touch one another nor lie along the same straight line nor even maintain a perfectly constant direction.

In addition to quartz an occasional flake of muscovite may be sometimes observed; frequently it seems to have almost entirely escaped the effects of crushing, but now and then the remains of a crystal which has been squeezed to an indistinguishable wirr of fragments is encountered. Very rarely a stray zircon or a rounded crystal of tourmaline may be identified: felspar appears to be entirely absent.

Kilrock Quarry, Howth.—The remarkably compact quartzite excavated at this quarry is certainly the one I should be inclined to select as the most likely to show but few traces of its original structure, so homogeneous is it and fine-grained. Thin slices, however, show very much the same features as the preceding rock; there is, perhaps, not quite so much sericite and somewhat fewer rounded grains of quartz, but the evidence for a clastic origin is just as striking. Planes of vapour cavities traverse many of the grains, and sometimes a set of planes may be observed with a common direction, which they may pursue through as many as five or six consecutive grains, thus indicating the formation during crushing of cracks extending through the rock, which afterwards healed up. In some cases banded extinction occurs, with the bands at right angles to the direction of the cracks. In this rock a good deal of magnetite is disseminated in small crystals, in one instance a crystal was observed inclosing a small grain of quartz; it would appear, therefore, to have been formed in place. There are not so many signs of crushing in this rock as I expected to find, but traversing one slice is a zone of granulitic quartz which I take to indicate a line of yielding and consequent crush. One or two grains of decomposed felspar were noticed.

The grains lie with their largest faces looking in one direction, so that in section the long axes of the approximately elliptical outlines will be found running parallel to each other. In connexion with the banded extinction is the anomalous axial figure given by many of the grains, which is evidently that of a biaxial mineral, from which we may conclude that the pressure to which the quartz has been exposed has thrown it into a state of permanent strain.[1]

Red Rock, Howth.—In addition to white, gray, and yellowish quartzite, red or liver-coloured beds are met with as at Red Rock and other parts of Howth. The presence of red ferric hydrates, earthy matter, and a little more sericite than occurs in the previously described quartzites, renders the grains of quartz (which still constitute by far the larger part of the rock) very sharply defined; many are remarkably round, so that the thin slice under the microscope sometimes reminds one of the polished face of a piece of Herefordshire pudding-stone. The ferruginous earthy matter and the sericite are drawn out along lines of flow which bend round the quartz grains like stream lines round a boat (fig. 3), just as one also sees around the eyes of a crushed igneous rock, or in garnet schists where the mica flows round the fractured garnet crystals. Were the Old Red Sandstone conglomerate to become converted into quartzite by pressure, as no doubt in many places it has, it might be expected to produce on a grand scale just such a rock as this is on the minute.

Signs of crushing do not seem to be quite so common as in

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[1] [Note added in the Press.—I have since ascertained that a good deal of this rock consists of large quartzite pebbles, some as much as six inches in diameter. The purity of the rock has led to its conglomeritic nature being overlooked.]

some of the other quartzites, but occasionally one meets with a microscopic quartz pebble which, though it looks homogeneous enough in ordinary light, yet reveals its composite character between cross Nicols. All the other quartzites of the district, those from Bray, as well as those of Loughereen, Howth, present similar characters to the foregoing; all are obviously clastic rocks which differed when first laid down as sediments in no distinguishable particulars from a typical quartz sandstone: subsequent pressure, aided in some cases by percolating siliceous waters, is

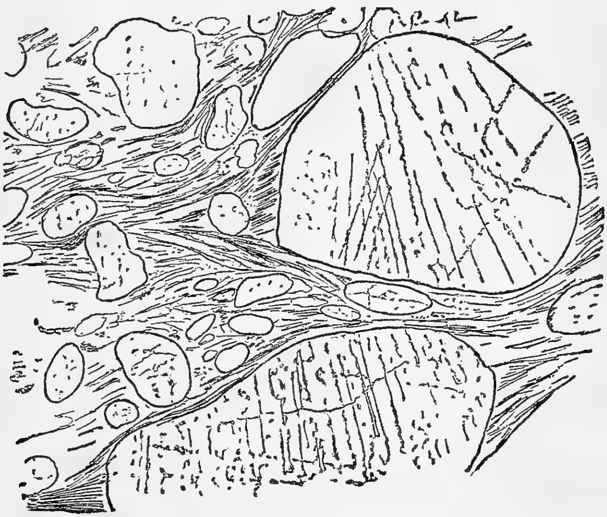

Fig. 3.—Section of red quartzite from Red Rock, Howth. Highly magnified.

fully competent to account for the changes they have since undergone.

How it is with regard to the so-called "quartz knobs" of Anglesey one would hesitate, without detailed examination, to decide, but fortunately I have in my possession a fragment of one of these quartz knobs which Professor Blake pointed out to me as a typical example of the kind. This, which comes from near Amlych, I have had cut, and the thin slice prepared from it shows, in my opinion, the characters of an altered sandstone. Its general appearance differs somewhat from that of the quartzites which occur in our vicinity; at first sight one does not recognize without the aid of polarized light, the individual grains of which the rock is composed, but with a careful adjustment of the sub-stage condenser these are clearly distinguishable. That they are not seen at once is owing to the absence of earthy impurities and to a reduction in the quantity of sericite present between the grains, this mineral occurring in only the thinnest possible films, and frequently being entirely absent over certain areas in the slice. The quartz grains frequently come into actual contact, and thus form a mosaic similar in some respects to, but markedly different in others, from the quartz mosaics of such igneous rocks as granite. Restricting our attention, first, to those grains which are plainly margined by sericite, one readily detects in them rounded outlines of the most unmistakable character. Professor Blake has himself admitted the presence of rounded pebbles in the quartz knobs, and though he seeks to explain their formation in an exceptional manner, I see no reason for regarding them as other than ordinary water-worn grains; their presence suggests a similar origin for the remaining constituents of the rock. In the next place, it is to be observed that most of the grains are clouded by a vast number of liquid and vapour cavities, frequently collected together along planes. These are far more numerous than in our Dublin

Fig. 4.

Fig. 5.

Figs. 4 and 5.—Section of quartzite from near Amlych, showing secondary growth of quartz on rounded grains. Fig. 5.—Somewhat more highly magnified (the striæ on the left-hand border indicate sericite).

quartzites, and give a very marked appearance to the section. They are of importance to us in this study since they serve in some instances to mark out the original outline of a grain that would otherwise have been lost, and this outline is rounded. By the fortunate preservation of the original outlines of the grains, either by a sericite border or by the dotting of the included area, we are enabled to explain the irregular mosaics into which parts of the slice at first seem to be resolved, for within one of the constituent areas of such a mosaic we can sometimes discern a rounded grain as a nucleus over which a subsequent growth of silica, distinguished by being free from included cavities, has proceeded, till the interspaces between the grains have been filled up. The percolation of waters containing silica in solution may thus be admitted, but this is nothing more than has already been shown by Bonney and Phillips to have occurred in the case of many much younger sandstones and grits.

But the alteration of the rock has not by any means been altogether accomplished by the exclusive agency of percolating waters: pressure has played a considerable part. Its effects are recognised at once in the undulose and banded extinction of the quartz grains, and in the cracks which bound the areas of different optical orientation coexisting in the same grain. Its action in consolidating the rock has been various, sometimes it has broken a grain across, and forced the parts asunder, the gaps being afterwards healed with a deposition of silica; sometimes it has crushed the grains, but the effects of crushing appear to be restricted to certain lines, and of general marginal crushing there appears to be scant evidence. The most general result of the pressure has been, I believe, a slow yielding of the compressed grains, a viscous flow having taken place by which the interstices between the grains have become entirely obliterated. This is suggested by the curious manner in which the small end of an egg-shaped grain may be seen projecting into the broad side of a larger, rounder one, against which it has been forced, thus repeating in miniature precisely the same kind of adjustment which must be familiar to everyone who has carefully studied the relations of the pebbles in the pebble-beds of the Trias. It is further borne out by the curious, often fan-shaped, fields of extinction which directly arise from the region where the one grain intrudes into the other, an effect of pressure which could not have arisen had the two grains been always from the first accurately fitted together, as they would have been had they been deposited in place from solution.

A further argument for the clastic origin of the rock lies in the occasional occurrence of a quartz grain different in character from the rest; thus, sometimes one finds a grain of exceptional clearness and transparency bounded by rounded outlines, and surrounded on all sides by the dusty grains which compose the mass of the rock; sometimes, on the other hand, a peculiarly "dirty" grain may be met with, in equally striking contrast to its clearer neighbours, or one in which long prisms (of cyanite?) occur, its neighbours being all devoid of them. Such contrasts as this do not occur in the true quartz mosaics of granitic rocks.

Of additional minerals I have only observed an occasional rhombohedron of iron-carbonate and a few minute cubes of iron-pyrites, and these are without bearing on the question of origin.

I admit that this is a difficult rock to explain in all its details, but the preponderance of evidence, derived from its microscopic characters alone, appear to me to lie wholly in favour of its clastic origin.

This conclusion is in harmony with the results obtained from a study of the Dublin quartzites, where the evidence is of the clearest nature, and since the general mode of occurrence of the rock is the same on both sides of the channel this is a result we might naturally have expected.

Lamination.—The quartzites of our neighbourhood frequently exhibit in the field a curious striping, which is particularly obvious on weathered faces; the stripes are very narrow bands, from about a twentieth to an eighth of an inch in breadth, of a slightly darker colour than the rest of the rock, than which they weather somewhat more rapidly. To the unaided eye they suggest planes of original deposition, and such I shall show they undoubtedly are. In the quartzite quarry on Carrickgologan, where I first pointed them out to Professor Blake, I searched long for some planes having a definite direction, which might give one some idea of the stratigraphical position of the rock; joint planes preserving a general direction for considerable distances there are, which most deceptively suggest bedding, but these do not correspond with the direction of the dirt bands (as we may term them), which are less conspicuous features: once seen, however, there is no difficulty in tracing them over considerable distances, and in the Carrickgologan quartzite I find them maintaining a strike with great constancy over the whole ridge in a direction which is almost exactly due north and south. Professor Blake remarks that since this makes a very large angle with the direction of the ridge itself we must assume, on the hypothesis that they indicate bedding, a very extensive faulting on all sides of the quartz mass. This, to my mind, is by no means an objection, but harmonizes very well with what one would expect in the case of an isolated mass, which can be best explained, like the mass of Howth, as a "horst," which remains standing above the sea-level, while the rest of the country has been gradually let down to "the depths."

Although I first noticed these bands in Carrickgologan (and specimens preserved in the Geological Museum of Trinity College show that they must have been observed before, probably by Professor Haughton), they are equally well or perhaps better displayed

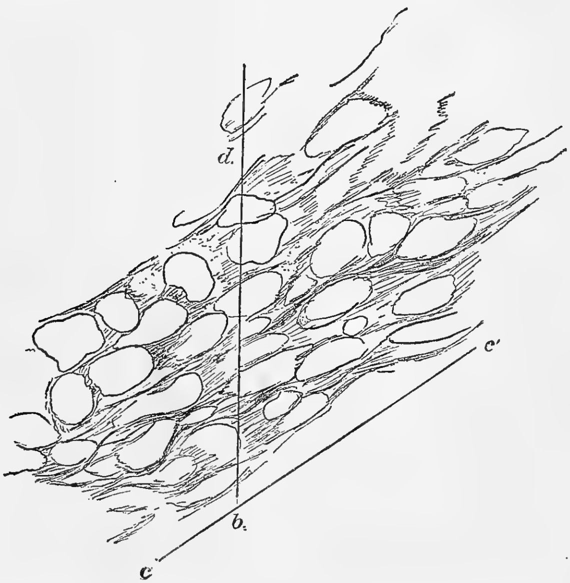

FIG. 6.—Magnified section through quartzite of Loughereen Hill: *d.b.* direction of dirt band; *c.c.'* direction of incipient cleavage within the dirt band.

by some of the quartzite masses of Howth, *e. g.* in Loughereen Hill, from which I obtained specimens for slicing. Under the microscope the difference in the composition of the bands which was naturally to be expected is very clearly revealed; the bands are distinguished by the presence of a larger quantity of sericite and opaque earthy and ferruginous matter than the intervening rock.

All the bands are affected by incipient cleavage, the sericite and streaks of earthy matter lying with their long axes athwart the direction of the bands at an angle of about 40°, the long axes of the quartz grains sharing the same direction. It is possible to break a hand-specimen of the rock along the dirt bands, and the fractured face exhibits a striation indicating sliding. Joint planes, at right angles to the banding, are frequently undulated, showing that the movement has not proceeded far enough to impose a definite schistosity upon the rock.

Having now shown that the quartzites under discussion were originally good sandstones, and even more or less laminated sandstones, we may proceed to inquire into their abnormal and very remarkable stratigraphical relations.

Discordant stratigraphical position.—The curious isolation of the quartz knobs described by Professor Blake, in Anglesey, and the discordant strike of the quartzite of Brandy Hole, described by Mr. Kelly, might naturally be expected to find their explanation in movements subsequently produced to the deposition of the stratigraphical system in which they occur: and a prolonged examination of the behaviour of the rock in the field leaves little doubt on this point. The solution of the difficulty is to be found in the differential movement of rocks of different degrees of rigidity when subjected to powerful earth-pressures.

In tracing well-defined beds of quartzite obviously interbedded along the cliffs and coast of Howth, one is surprised to find them suddenly and abruptly terminating in a joint plane, the joint blocks which should have continued the direction of the bed having disappeared and their place having been taken by the slate of the district: or again, when examining the slate, one sometimes unexpectedly encounters a huge parallelepiped of quartzite, it may be six or seven feet in length and three or four feet square at the base, lying athwart the general lie of the country. This is evidently a joint block torn out from a bed of quartzite and carried by the general flow of the country into a novel position; it is in fact a foundling produced by internal earth drift. This movement of parts of beds out of their place makes the surveying of the district a peculiarly difficult task, the more especially in the northern part of the Hill of Howth, which consists of the squeezed basal conglomerates of the Cambrian (?) system, and where it frequently is a matter of doubt whether a series of boulders are ancient beach pebbles or merely squeezed out joint blocks of an adjoining bed.

At first acquaintance these dislocations are not a little astonishing, but on reflection one is rather inclined to wonder why they are not of more general occurrence. When a heterogeneous mass of soft shales and hardened sandstones or limestones of varying thickness is subjected to powerful earth-thrusts, one would scarcely expect it to behave precisely as shown by our neat little working models. One of the most general effects of such mountain pressure is the compression of the rock subjected to it in the direction of pressure and its extension in a plane at right angles to it. In a comparatively hard and rigid material the extension is frequently accomplished by fissures (as already shown by Heim and Daubrée). Such fissures are sufficiently common in the rocks of our district, both on the large and small scale. I have already described in another place the numerous fine parallel cracks which traverse the felspar of the foliated granite so common on the flanks of the Leinster hills. Exquisite examples of similar fractures are presented by the garnets so common in the mica-schists which result from contact alteration of the sandy slates of the district. The cracks run at right angles to the plane of foliation, and extend from the garnets into the surrounding grains of quartz as planes of vapour cavities (Pl. xv., fig. 3), which, therefore, are of secondary origin, as Julien has shown in other cases. A vast number of parallel planes of vapour cavities coexist with the preceding, traversing the quartz grains with wonderful continuity, a single vapour cavity plane crossing as many as fifteen to twenty individual quartz grains; in addition there is present a second system of similar planes, but situated in the plane of schistosity. These are not so readily accounted for; particularly since they neither shift nor are shifted by the preceding set which they intersect at right angles.

Passing from cracks of such minute dimensions, attention may next be directed to the specimen represented by the figure (Pl. xv., fig. 5) which represents a bed of quartzite an inch or two in thickness with some associated slate; the slate shows fairly good cleavage, but the quartzite is traversed by numerous open cracks. Similar cracks extend in great numbers side by side through quartzite beds several feet in thickness, and when filled up with white quartz, as is frequently the case, they give a very striking appearance to the rock (Pl. xv., fig. 4). This is probably the explanation of many "gash" veins.

In many cases such fissures have been injected under the mountain pressure by the material of the surrounding slate, and have frequently also been simultaneously very much increased in width, so that the originally continuous quartzose bed has become converted into a stream of joint blocks. Generally a bending and flowing of the sandstone has proceeded along with the other modes of deformation, but evidently the pressure has been far from uniform on each side of the moving stratum, so that great fragments have been pushed out from the general bedding plane and carried away by flowing argillaceous material, thus giving rise to those strangely isolated joint blocks and the curious sudden truncation of otherwise continuous quartzite beds. That scratches and slickensides should generally characterize the joint planes which bound the quarzite blocks is as naturally to be expected as it is universally apparent.

The apparently abnormal characters of the quartzite of our district thus find an explanation. So far from being difficulties, in the light of our present knowledge, they provide us with valuable indications of the manner in which the deformation of a country under earth pressures is accomplished; had our Cambrian deposits consisted wholly of plastic materials such as shales and slates, a monotonous cleavage would have been the chief result, but thanks to the presence of these less yielding quartz rocks we can study with an infinity of detail the foldings, crumplings, faultings, both horizontal and inclined, and the various other displacements which make the headland of Howth the glory and despair of the geological mapper.

P. S.—I reserve for a general account of the Hill of Howth the description of certain gray and greenish grits which are commonly interbedded with the slates, but as some of my friends have imagined that I included them in the general designation of Cambrian quartzite, I may take this opportunity to disclaim such an intention. These grits differ markedly from the quartzites, but might easily be confounded by a hasty observer with the green epidiorites (Lambay porphyry) which occur as such common intrusions in the headland; they are, however, truly clastic rocks, and in addition to the quartz grains of which they are chiefly composed contain a good deal of rounded and angular fragments of felspar, both orthoclase, microcline, and a triclinic felspar giving low extinction angles (12°), with occasional flakes of muscovite and a green chloritic mineral which resembles altered biotite. There are other quartzose rocks besides these, which will be referred to in my general account.

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EXPLANATION OF PLATE XV.

Figs. 1 and 2.—Micro-photograph from a thin slice of quartzite from Carrickgologan—fig. 2, as seen with ordinary light; fig. 1, between crossed Nicols. The black spot on the right of fig. 2 is a cavity where the quartzite has been torn away in grinding the slice; it can be identified on the left of fig. 1. By turning one of the figures through 180° in the plane of the paper, it will assume the position of the other, and the difference in appearance of the several constituent grains produced by crossing the Nicols can then be clearly traced.

Fig. 3.—Micro-photograph from a slice of garnet-bearing mica-schist from Glendalough. Near the centre of the field is a fragment of garnet which has been torn away from a crystal-aggregate on the left during post-Ordovician earth movements. It is traversed by fractures, seen as dark lines crossing it from side to side, and these are continued through the surrounding quartz as planes of vapour cavities.

Fig. 4.—Photograph of a bed of quartzite near "The Cave" on the Sutton side of Howth, showing numerous parallel quartz veins. The scale cannot be fairly judged by the figure sitting in the left hand upper corner, as the photograph was taken by a very short-focussed lens.

Fig. 5.—Photograph of a fragment of quartzite and slate, about one-third natural size. The quartzite at the top of the figure is traversed by numerous open cracks having their planes perpendicular to the cleavage planes of the slate seen below.

XXI.

LUNAR RADIANT HEAT, MEASURED AT BIRR CASTLE OBSERVATORY DURING THE TOTAL ECLIPSE OF JANUARY 28, 1888. By OTTO BOEDDICKER, Ph. D. With an Introduction by The Earl of Rosse, K.P., &c., President of the Royal Dublin Society.

(*Abstract of Paper read February* 18, 1891, *and published in the* Scientific Transactions, Royal Dublin Society, *Vol. IV., Part IX. page* 481, with Plates liii., liv., lv.)

Introduction.

The first measurements of Lunar Radiant Heat made at Birr Castle were obtained by means of Thermopiles of four couples, and were published in 1869. These piles were next replaced by single Thermo-couples of home manufacture, which led to the deduction of a curve, generally representing the variation of lunar heat with the phase. It was also proved—by the interposition of a sheet of glass—that the Moon's heat contains a much larger proportion of rays of low refrangibility than solar heat. At this stage the work was taken up by Dr. Copeland, who produced a reliable curve for the extinction of the heat in our atmosphere, as well as a more accordant phase-curve. The former results of heat-measurements through glass were confirmed, a fact which, together with the anomaly apparently brought out by the phase-curve, that the maximum of heat seems to fall before full Moon, rendered it very desirable to measure the lunar heat during an eclipse. After some unsuccessful attempts to do so, two very favourable opportunities occurred; one on the 4th October, 1884, the other on the 27th January, 1888. The observations made in 1884 were published in the Transactions R. D. S. for 1885; those obtained on the latter occasion form the subject of the present Paper.

1. The observations of 1888 and their reduction.

The apparatus consisted (as in 1884) of two Thermopiles, placed (with poles in reversed position) in the same circuit with the galvanometer, and alternately exposed to the lunar radiation, which, first collected by the speculum of three feet aperture, is concentrated on the piles by small condensing mirrors. The time of exposure was 30 seconds for each pile. Observing was carried on as far as possible uninterruptedly during the whole of the eclipse. Thus, the galvanometer was read off altogether 638 times, and 446 values for the lunar heat (each the mean of ten differences of eleven consecutive readings) became available for the construction of the final heat-curve. These values were corrected for altitude, for the varying distance of the Moon from Earth and Sun and finally for phase. The most probable curve was then constructed. (Plates liii. and liv., Scientific Trans. R. D. S., Vol. iv., Pt. ix.)

2. Construction of a curve representing the change of the Moon's light during the eclipse.

Assuming the Moon's and Sun's luminosities to be uniform, a light-curve was constructed on the supposition that the Moon's light at any given point of the Eclipse is proportional to the area of the Sun as seen from the Moon at the given instant. By dividing the penumbra into 80 zones, by computing the visible area of the Sun for each, and by multiplying these values with the area of the Moon as cut off by the corresponding penumbral zone—a curve of considerable accuracy was obtained. It is reproduced with the curve of the lunar heat in per cents. of Full Moon heat on Plate lv. The same Plate gives also the corresponding curves for 1884.

3. Discussion of the observations.

(*a*). The lunar heat seems to decrease a considerable time before the first contact with the penumbra. Making every allowance, it seems certain that the height at which our atmosphere begins to absorb solar heat cannot be less than 190 miles.

(*b*). During the progress of the penumbra the heat decreases more rapidly than the light.

(*c*). $26{\cdot}7^{m}$ before totality the emitted heat begins to preponderate over the reflected one.

(*d*). The minimum of heat falls (with 0·4 per cent.) about 45^m later than the minimum of light.

(*e*). About 7^m before the last contact with the penumbra the heat all but ceases to increase, and up to 1^h 30^m after the end of the eclipse it still amounts to only 81 per cent. of Full Moon heat. Two suggestions of a possible explanation of this anomaly are tentatively made.

CONCLUSION.

A series of observations necessary for a further elucidation of the subject concludes the Paper.

XXII.

THE SLUGS OF IRELAND. By R. F. SCHARFF, Ph. D., B. Sc.

(Plates LVI. and LVII.)

(*Abstract of Paper read February* 18, 1891, *and published in the* Scientific Transactions, Royal Dublin Society, *Vol. IV.*, *Part X.*, *page* 513, with Plates lvi. and lvii.)

A more minute description of the various species of slugs living in Ireland is not only of anatomical interest, but of much importance to those engaged in tracing the geographical distribution of animals.

Many problems with regard to the origin of our native Fauna have still to be solved. For instance, the question at what particular geological period Ireland was united with England and the Continent of Europe is one which can only be satisfactorily answered from a careful study and comparison of the respective Fauna and Flora of these countries.

Some of the Irish animals and plants may have been carried across the sea from England or France, by winds or marine currents, and have become established in time, and it is not therefore always safe to draw conclusions from all groups of the animal and vegetable kingdom. Slugs, however, are not likely to be carried about by aërial currents, and as they and their eggs are killed by immersion in sea-water, it seems only reasonable to conclude that any species now existing in Ireland, if it be proved to be identical in structure with a Continental form, has found its way across by means of a land passage.

There are thirteen species of slugs in Ireland, all of which, with one exception, are also found in Great Britain. This one species, viz. *Geomalacus maculosus*, is not only absent from Great Britain, but also from the whole of Central and Northern Europe. It appears again in Northern Spain, in the province of Asturias. In Ireland it has hitherto only been found in the counties of Kerry and Cork, which two counties have likewise yielded many interesting Southern plants.

Under the heading of each species mentioned in this Memoir, are paragraphs dealing with—1. External characters. 2. Anatomy. 3. Reproduction. 4. Habitat. 5. Food. 6. General Distribution. Neither the shell nor the radula (or tongue) are mentioned, as they do not afford such easy and reliable evidence in the identification of the species as the reproductive organs. Figures of the latter are given for every species.

The thirteen species of Irish slugs belong to five genera, viz. *Limax*, *Agriolimax*, *Amalia*, *Arion*, and *Geomalacus*. The species of the three first genera can be very readily discriminated from those of the genus *Arion*, by the absence of the caudal gland. This gland is present in *Geomalacus*, but it is not nearly so conspicuous as in *Arion*, in which its triangular opening at the end of the body is well seen.

Besides the characteristic just mentioned, the pulmonary opening in *Limax*, *Agriolimax*, and *Amalia* is situated behind the middle of the mantle. These three genera can again be separated into *Limax* and *Agriolimax*, both of which have a mantle with concentric wrinkles, and *Amalia*, in which the mantle is granulated instead of being wrinkled.

It is more difficult to find reliable external characters by which to separate the genera *Limax* and *Agriolimax*. However, in all cases, the young *Limax* possesses a dark band or row of spots along the side of its body, while in *Agriolimax* dark bands are quite absent, and when spots are present, they are scattered over the body, and not in regular rows.

In the slugs possessing a caudal gland, viz. *Arion* and *Geomalacus*, the pulmonary opening lies in front of the middle of the mantle, which distinguishes them easily from the preceding genera.

Three species of *Limax* are found in Ireland, and these are readily recognisable externally by the markings on the mantle. Thus the mantle (or shield covering the front portion of the slug's body) is either light with darker spots, or uniformly dark in *L. maximus* (L.). In the next species, viz. *L. flavus* (L.), there are lighter spots on the darker and generally yellow mantle. In *L. marginatus* (Müller), the third Irish species of *Limax*, the mantle, as in *L. maximus*, is light in colour, but instead of spots there is a very distinct dark band on each side of it.

There are two Irish species of *Agriolimax*. In *A. agrestis* the mantle is about one-third the length of the body, and the mucus, or slime, secreted by the slug is always milky. In *A. lævis* on the other hand, the mucus is colourless, and the mantle is about one half the length of the body.

Two species of Amalia occur in Ireland. This genus is characterized, besides the granulated mantle, by the possession of a horse-shoe shaped groove on the front portion of that part of the body. The two species *A. carinata* (Leach.) and *A. gagates* (Drap.) are not easily recognised, but the former secretes always a very viscid mucus, while that of the latter is watery. *A. carinata* is generally of a rich brown colour with a yellowish foot, while in *A. gagates* the foot is white and the general body colour is, as a rule, lead gray, but some times a very light drab.

Of the genus *Arion*, five species have been found in Ireland up to the present. Their external differences will be more easily represented in a tabular form, and the following may be considered a rough and ready synopsis of their external characteristics, but I must mention that in some cases only anatomical investigation will decide a doubtful point of identity.

(A.) Margin of foot with transverse striæ = *A. ater*, *A. subfuscus*.

I. Wrinkles keeled and elongated = *A. ater*.

II. Wrinkles flat and short = *A. subfuscus*.

(B.) Margin of foot without transverse striæ = *A. hortensis*, *A. Bourguignati*, *A. intermedius*.

I. Foot coloured = *A. hortensis*, *A. intermedius*.

a. Wrinkles flat = *A. hortensis*.

b. Wrinkles with conical spikes = *A. intermedius*.

II. Foot white = *A. Bourguignati*.

The last genus, *Geomalacus*, is the most interesting of all the Irish genera, as it combines in some respects the characters of the genera *Arion* and *Limax*. Moreover, as I have mentioned before, it is only found in the two most western points of Europe.

Only one species of *Geomalacus* is found in Ireland, *G. maculosus*. It is a dark gray slug, covered with white or yellowish spots. Like *Limax*, it has a hard internal shell, but, on the other hand, the pulmonary aperture is situated in the front portion of the mantle, as in *Arion*. Instead of the large triangular caudal gland which characterizes the species of *Arion*, it has only a transverse slit at the end of the body.

All the species of *Limax* and *Agriolimax* have a very wide distribution, ranging almost throughout Europe. The two species of *Amalia* have a less wide distribution, being more or less confined to Southern Europe. The exact range of the species of *Arion* is not so well known, but *Arion ater* seems to be spread over the greater part of Europe, and while *A. subfuscus* and *A. Bourguignati* are found in the north, *A. hortensis* is confined to Central and Southern Europe.

The colouring of slugs seems to be on the whole strictly protective, the most striking example of protective colouring among them being found in *Limax marginatus*, *Arion intermedius*, and *Geomalacus maculosus*. The first resembles the bark of the trees among which it lives; the second, a fungus-feeder, is just like a little mushroom emerging from the ground; while the last is so much like the lichens on which it lives, that it is very difficult to distinguish it from its surroundings.

XXIII.

ON SHUTTERS FOR USE IN STELLAR PHOTOGRAPHY. By J. JOLY, M.A., B.E., D.Sc., an Assistant to the Erasmus Smith Professor of Experimental Physics, Trinity College, Dublin.

[Read November 18, 1891.]

Mr. A. Rambaut having in the course of conversation mentioned to me certain difficulties attending the construction of shutters for stellar work with telescopes, I submitted to his judgment and experience some designs which received revision at his hands. These, as well as some yet untried notions of my own, are embodied in the following brief Paper.

The problem of constructing a shutter enabling one or more particular stars in the field of the telescope to be covered at will, or exposed for any fraction of the total exposure of the entire field, may be dealt with according as the conditions are such that:—

(*a*) One star only is to be eclipsed, which may be maintained in the centre of the field, or

(*b*) More stars than one are to be eclipsed. This condition including that in which one star only is to be eclipsed, but in a part of the field varying with the circumstances of each case.

The first conditions are, perhaps, on the whole best met in the following construction (see fig. 1) which is, in great part, due to Mr. Rambaut. Here the shutter is carried at the extremity of a fine steel needle projecting into the centre of the field. The needle carries at its other extremity a small permanent magnet, which is encircled by a coil of insulated wire. The needle being freely pivoted, a current in the coil will deflect the magnet, bringing it to point along the axis of the coil. The magnet, of course, rotates through 180° with a reversal of the current. Thus, it is evident, that by affixing the little shutter to the needle, so that its plane is at right angles to the length of the magnet, we may expose or cover, by switching a current, first in one and then in the other direction, through the coil. If not sufficiently dead beat, stops may be provided to bring up the magnet at the extremity of its swing. From the small mass of the moving parts there is not much apprehension of vibration in this form of shutter. It might be well to secure a dead beat arrangement, not by the use of stops, but by attaching a disc of thin paper or mica to the magnet. This disc might fill the space within the coil, and the air-friction of it would be considerable. Promptness, on the other hand, if a desideratum, would be sacrificed by this arrangement.

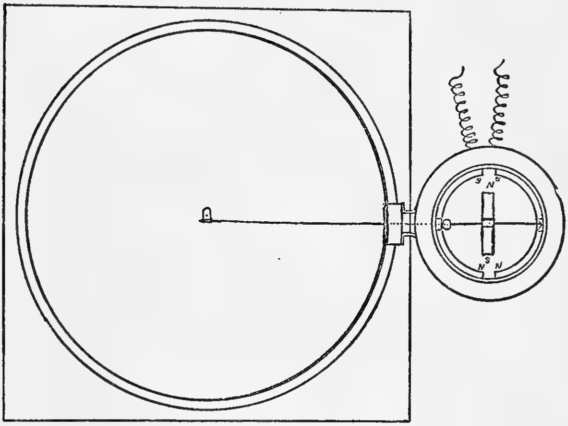

FIG. 1.

A variation of this arrangement is to place a curved permanent magnet (this is shown in fig. 1) within the coil, so that its poles normally control the position of the moving magnet till the attractive force is overcome by the superior magnetic force of a current traversing the coil. The plane of the shutter is here arranged in the plane of the moving magnet. In the first case a very brief reversal will not operate the shutter unless the moving magnet in its extreme position is inclined to the axis of the coil, the plane of the shutter not being arranged at right angles to the length of magnet. This will be readily understood on a little consideration. Hence to operate the first form of shutter reversals should be made at intervals say of one minute, and maintained for a second or two, an operation conveniently effected by clockwork, or even by hand. In the second case the moving magnet is deflected, not by a reversal of current, but by completing circuit. A very prompt deflection follows, as the needle is in a good position to feel the electro-magnetic effect. The permanent magnet may again be replaced by a small hair-spring controlling the position of the shutter when no current is passing. We may meet the conditions (*a*) by another method if through any reason the accommodation of the coil to one side be attended with inconvenience. But this will appear in treating of shutters to meet condition (*b*). In this case, by arranging the foregoing contrivance (fig. 1) so that the needle can be advanced more or less into the field by moving it through a hollow sprung spindle carrying the magnet, and by arranging either to rotate a ring encircling the field carrying with it the coil, or to clamp this at any point on the edge of a fixed ring, any part of the field can evidently be reached by the shutter; and so any one star in any part of the field eclipsed. Freedom to move the coil in a circular direction round the field is, probably, in any case advisable with this form of shutter in order that the needle may be brought along a radius in which it would not itself eclipse lesser stars.

It is, of course, possible to set the needle of the shutter, when thus provided with a circular motion round the field, so that by fixing a second shutter upon the needle two stars lying upon a radius, or nearly so, might be eclipsed. But the problem of dealing with more than one star, with this form of shutter, is best solved by providing more than one coil. Thus, by fitting two coils on the edge of the field, an easy adjustment of the needles in each enables any two stars to be eclipsed. The same current may operate each shutter, or the exposures of each may be regulated at will.

The next pattern of shutter depends on the same principles, but the coil, instead of being small and to one side of the field, surrounds the whole field of the photographic plate. The coil is wound of very fine wire, and is only some five millimetres in length (*i. e.* axially). Its width may be six or eight millimetres. A current through this coil produces a magnetic force all over the field, and suitably pivoted magnets anywhere in the field will set pointing along the axis of the coil in polar directions, depending upon the direction of the current. It is now only necessary to provide a simple and ready method of adjusting such magnets, each carrying its shutter, or itself serving as shutter, in any part of the field.

To meet conditions (*a*) with this form of shutter, we arrange a single projecting needle, fixed in position, and extending from the coil nearly into the centre of the field. At its extremity a small piece of magnetized watch-spring is carried pivoted in a little stirrup. The magnet carries a projecting shutter, balanced by a small bob. Its motion is through an arc of about 120°, in its extreme positions being brought up abruptly against a cross wire attached in the arch of the stirrup. (See fig. 2, which shows, to

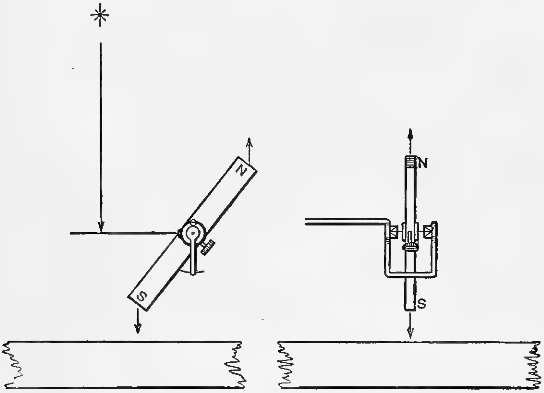

FIG. 2.

a large scale, two elevations parallel to the axis of the coil.) A brief reversal of the current will deflect this magnet, throwing it over in the stirrup, so that the star becomes uncovered. The extremely small mass of the moving parts, and the elasticity of the needle, secures almost complete absence of vibration.

To use this shutter we pass a current through the coil, so that the shutter is brought parallel to the sensitive plate. It is then some five or eight mms. from its surface. The telescope is now moved till the bright star is eclipsed by the shutter. Reversal of the current now secures exposure. All is ready then for putting in the plate. To meet conditions (*b*) with this form, the needle is arranged to move with sufficient stiffness through a small spring clip, sliding upon the ring of the coil. The clip may thus be adjusted to the most suitable point at the edge of the field, and the needle more or less advanced along the radius. If more than one star is to be covered, other clips and shutters are brought into use, as shown in fig. 3. The exposures—in the case of more than one shutter being used—are, of course, the same for all the shutters.

A variation of this form, in which the coil is separately brought up at the back of the plate suggests itself; the magnets and shutters being located as before.

Lastly, we may use permanent magnets in this pattern as in the other pattern. Of course we are then compelled to arrange all the magnets parallel to a common line joining the poles of the

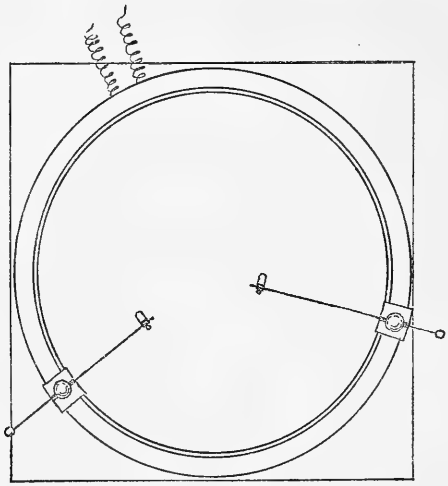

Fig. 3.

permanent field. The magnets themselves may then constitute the shutters, the star being covered by one of the poles when no current is passing in the coil. A square frame to the field is most convenient with this construction, enabling the supports of the magnets to be slid up and down in parallel directions. The pivoting of the magnets may be effected much as before.

In the discussion, Mr. Rambaut exhibited plates exemplifying the use of a shutter in securing greater definition of a bright star exposed for only a fraction of the total time of exposure. He considered the principal use of these shutters would be found in parallax work, when a bright star could be maintained in the centre of the field. He used, preferably, a coil and magnet placed to one side of the field, a projecting wire carrying the shutter, and found it well to use stops to check the oscillations of the needle. The action of this was very prompt. A pendulum made contact at the centre of its swing for a fractional part of the whole period of its oscillation.

XXIV.

ON THE CAUSE OF DOUBLE LINES AND OF EQUIDISTANT SATELLITES IN THE SPECTRA OF GASES. By G. JOHNSTONE STONEY, M.A., D.Sc., F.R.S.; Vice-President, Royal Dublin Society.

(*Abstract of a Paper read March* 26 *and May* 22, 1891, *and published in extenso in the* Scientific Transactions of the Royal Dublin Society, *Vol. IV.*, Part xi., *p.* 563).

The gaseous spectra of the light monad elements, Li, Na, K, Rb, Cs, are found to consist of three series of double lines. The spectrum of hydrogen consists of one such series, and the spectra of the heavy monads seem also to consist of double lines. Series of double lines also present themselves in the spectra of elements of higher atomicity, but are in them associated with more complex groups.

These double lines are due to events going on within the molecules of the vapour; and the aim of the communication of which this is an abstract is to ascertain what these events are. It is shown that each series of lines is due to the motion of an electron —a fixed electric charge—within each molecule, or, at all events, to some event which follows the same mathematical laws. The motion may be represented by the equations—

$$x = F_1(t),$$
$$y = F_2(t),$$
$$z = F_3(t),$$

which can be resolved by Fourier's Theorem into one definite series of elliptic partials in each of which the electron is to be conceived of as moving, the superposition of these motions being the actual motion of the electron. These partials may lie in the same or in different planes, and each of them has the form—

$$x = a \cos(\theta t),$$
$$y = b \cos(\theta t),$$

a, b, and θ being constants that vary from one partial to another.

Since every motion of electricity produces an electro-magnetic disturbance in the surrounding æther, the motion of the electron in any one of these partials would give rise to a line in the spectrum, and in this way the successive partials furnish a *definite* series of lines.

There is one case in which a further analysis is practicable, and the Paper deals especially with this case. It is where the forces that determine the path of the electron are some of them strong and some feeble. We may then regard these latter as perturbating forces; and, distinguishing the undisturbed orbit—that which the electron would have pursued if the strong forces alone had acted on it—from the actual orbit, we can represent the latter by applying perturbations to the undisturbed orbit. The character of the perturbations likely to occur, is known from the elaborate investigations which astronomers have made into the cause of the motions that go on within the solar system, and one of the most familiar of them is an apsidal motion affecting the elliptic partials into which the undisturbed orbit may be resolved. The undisturbed orbit will in general be such as would give rise to some definite series of single lines in the spectrum; and it is shown in the Paper that the consequence of some or all of its partials being exposed to the above-mentioned perturbation is to cause the corresponding lines of the series to become double.

In working out the details of the investigation it is shown that, from observations on the positions and intensities of the constituents of each pair of double lines, full information may be elicited about the *form* of the elliptic partial from which they arise, the *periodic time* of the motion of the electron in it, and the *direction* and *periodic time* of the apsidal perturbation affecting it. In this way it is ascertained from observations on the principal double line of sodium, that which gives rise to the D lines in the solar spectrum, that it is caused by (or, at all events, is due to an event which follows the same mathematical laws as) the motion of an electron within each molecule of the vapour, in an ellipse of which the axes have to one another a ratio lying somewhere between 11 to 1 and 13 to 1; round which ellipse the electron revolves 169·637 times in each jot[1] of time; the ellipse meanwhile being slowly

[1] The jot of time is the time that light takes to advance one tenth of a millimetre in vacuo. It is about the third of the millionth of the millionth of a second.

shifted round with an apsidal motion that carries it once round while the electron performs 1984 of its little elliptic revolutions. It further appears from the observations that in this case the direction of the apsidal shift is the same as the direction in which the electron revolves in the ellipse. These events occur with such extraordinary rapidity within the molecules of sodium, that slow as the apsidal circuits seem when compared with the much swifter revolutions of the electron, there is time for something like 36 of them to be completed within the average duration of the flights of a molecule between its encounters with other molecules, assuming (as is indicated by the kinetic theory of gases) that it is exposed to about 7000 millions of these encounters every second.

XXV.

ANALYSIS OF THE SPECTRUM OF SODIUM, INCLUDING AN INQUIRY INTO THE TRUE PLACE OF THE LINES THAT HAVE BEEN REGARDED AS SATELLITES. By G. JOHNSTONE STONEY, M.A., D.Sc., F.R.S.; Vice-President, Royal Dublin Society. (Plates XVI. and XVII.)

[Read November 18, 1891.]

Introduction.

In analyzing spectra, the following definitions and distinctions will be found of use:—

j, the *jot* of time, is the time that light takes to advance one-tenth of a millimetre in the open æther. In the open æther all rays[1] travel this distance in the same time, which is approximately one-third of the twelfthet (one-third of the millionth of the millionth) of a second of time.

The micro-jot is the millionth part of a jot.

j_1, the *air-jot* of time, is the time that *the ray of mean refrangibility* takes to advance one-tenth of a millimetre *in air*. Accordingly $j_1 = \mu_1 j$, where μ_1 is the refractive index of air for the ray of mean refrangibility. If we regard the ray whose wave-length is 5000 tenthet-metres as the mean ray, then μ_1 is very nearly 1·000280. (See British Association catalogue of oscillation-frequencies in the B. A. Report for 1878.)

λ is the *wave-length-in-air* of a ray, expressed in tenthet-metres, *as determined by Rowland.*[2]

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[1] By a ray of light is meant the light producing a line in the spectrum.

[2] λ is accordingly about 1/6000th more than the wave-length as determined by Ångström.

κ is the "*inverse-wave-length,*" i. e. $10^6/\lambda$. It is the number of wave-lengths-in-air which occupy one-tenth of a millimetre.

T is the *periodic time* of the waves of a ray of light, expressed in micro-jots. Hence $T = \mu\lambda$, in which μ is the refractive index of air for the ray of wave-length λ.

N is the *oscillation-frequency in each jot of time*, i. e. the number of the oscillations of the waves of a ray in each jot. It $= \kappa/\mu$.

Of these quantities N is obviously the one which is best adapted to theoretical investigation. It is, however, λ that is observed. From this κ can be accurately deduced, but $N = \kappa/\mu$ cannot be accurately obtained till we know the value of μ for different parts of the spectrum. We may, however, in a theoretical investigation, use, instead of N, any quantity proportional to it, *e. g.* $\mu_1 N$, where μ_1 has the value assigned to it above. We shall call this n. It is the oscillation-frequency in each "air-jot" of time. Accordingly

n is the *oscillation-frequency in each air-jot of time.* It $= \mu_1 N = \kappa.\mu_1/\mu$.

Now Ketteler's observations on the dispersion of air, though not sufficient for the general determination of μ, are enough to satisfy us that μ does not anywhere differ more than a *very* little from μ_1, its mean value. And accordingly, in comparing our results with observation, we shall regard μ_1/μ as unity, and treat κ (the quantity furnished by observation) as if it were identical with n (the quantity required by theory). With this we must be content until adequate determinations of μ for the various parts of the spectrum shall have been made.

METHOD OF ANALYSIS.

The spectrum of sodium, so far as it has been explored, consists of 14 pairs of lines, and of 8 others which have not yet been seen to be double. Professor Rydberg and Professors Kayser and Runge independently discovered that all the observed lines—with one remarkable exception—lie in three definite series, somewhat similar to that which Dr. Huggins had found in the Spectrum of Hydrogen; and they have worked out empirical formulæ which assign to the lines their places in these series. The kind of formula to be tried was suggested by Balmer's Law for the lines in hydrogen, viz.:

$$n = k\left(1 - \frac{4}{m^2}\right), \tag{1}$$

where k stands for the number 274·263. In this formula n becomes the oscillation-frequencies of the several hydrogen lines, when for m we write in succession the positive integers 3, 4, 5, &c. For the spectra of the other light monads, including sodium, Rydberg made use of the form

$$n = A + \frac{B}{(m + h)^2}, \tag{2}$$

in which the quantities A, B, and h have to be determined for each series. Kayser and Runge preferred the form

$$n = A + \frac{B}{m^2} + \frac{C}{m^4}, \tag{3}$$

in which the three constants to be determined for each series are A, B, and C. Either formula can be made to agree tolerably with the observations, and sometimes in more than one way.

In a Paper communicated last spring to the Royal Dublin Society,[1] the present author showed that each of the three series in the spectrum of sodium is due to the motion of an electron—a definite electric charge—within the molecules of sodium along an orbit; or at least to some event taking place within the molecules which follows the same mathematical laws as are furnished by such a motion of an electron. This motion may be resolved into its elliptic partials by Fourier's Theorem, and it is shown that each of these elliptic partials gives rise to a line in the spectrum, which will become a double line if the partial is exposed to an apsidal shift. It is also shown how the relative sizes, the forms, and other information about the partials may be obtained from the observations; and especially how the periodic time of each partial may be deduced from the positions of the two constituents of the double line to which it gives rise. It is found to be the periodic time

[1] Stoney on the cause of double lines in Spectra, Scientific Transactions of the Royal Dublin Society, Vol. IV., p. 563.

which corresponds to the position midway between the two constituents of the double line on a map of oscillation-frequencies.

Now the periodic times of these partials are not simply a fundamental period and its harmonics, as is the case with the vibrations that produce musical notes. Balmer's Law, however, and the empirical formulæ that Rydberg and Professors Kayser and Runge have found to be suitable, suggest that they in some way depend on an event of that simple character. In fact this state of things is represented mathematically by n (the position of the line on a map of oscillation-frequencies) being a function (probably some simple function) of $1/m$, which it is both in Balmer's Law and in the above-mentioned empirical formulæ.

In the case of the hydrogen spectrum this relation is conspicuously placed in evidence by a very simple diagram. For if we write y for $1/m$, and x for n, equation (1) becomes

$$y^2 = \frac{1}{4k} \cdot (k - x), \tag{4}$$

which, if we regard x and y as running co-ordinates, is the equation of a parabola. Hence the following rule—Draw the foregoing parabola and place its axis horizontal. Erect an ordinate at the distance k from the vertex. Double this out, and using its double length as unit, set off upon it the harmonics 1/2, 1/3, 1/4, &c. From the points so determined draw horizontal lines to the curve: these are the values of n for the successive lines of the hydrogen spectrum, on the same scale on which the distance of the ordinate from the vertex represents 274·263, which is the value of k. See Pl. XVI. fig. 1.

Now, having regard to the fact that the light monad elements, H, Li, Na, K, Rb, Cs, have all of them series of double lines which appear to belong to the same general type, we are justified in assuming that Balmer's Law is the simplest case of a general law which prevails throughout all the light monads. Hence, if the oscillation-frequencies be all plotted down as the horizontal lines of a diagram constructed as above with $x = n$ and $y = 1/m$, the curve passing through the ends of the horizontal lines in the other monads should be some curve of which the parabola is a particular case. This may happen in different ways, but the simplest hypothesis is that they are hyperbolas or ellipses. It appeared therefore to be worth ascertaining whether diagrams with hyperbolas or ellipses instead of the parabola would agree with the observed positions of the lines in one of the other monads. Sodium is the monad selected; chiefly because of the peculiar pair of lines that present themselves in the spectrum of this element—which Rydberg speaks of as satellites, and which Kayser and Runge regard as probably belonging to a fourth series of lines, of which they are the only term that has been found. There seemed some ground for hoping that the inquiry would reveal the true significance of these lines.

A curve of the second degree, with the axis of x as one of its principal axes, can be passed through any three assigned points. We have therefore to determine the ellipse or hyperbola that passes through three of the observed positions, and then to ascertain how far the other observed positions lie from that curve. The following lemma makes it easy to do this :—

Lemma.—When the y's of a number of points are given (in this case the successive values of $1/m$), so that the accurate values of y^2 for the successive points can be obtained, we may use, instead of the ellipse or hyperbola, the curve derived from it by making the new ordinates proportional to the squares of the old ones. Thus—the ellipse

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1,$$

and the hyberbola

$$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1,$$

furnish as their derived curves

$$\frac{x^2}{a^2} + \frac{z}{b^2} = 1, \quad \text{and} \quad \frac{x^2}{a^2} - \frac{z}{b^2} = 1,$$

in which z must be positive. In other words, the derived curve is the *portion* on the upper (*i. e.* positive) side of the axis of x, of a parabola with its axis vertical. This parabola passes through the ends of the axis major of the ellipse or hyperbola. When derived from an ellipse its vertex is above the axis of x, under it when derived from a hyperbola. The parabola degrades into a straight line, if the curve from which it is derived is a parabola instead of an ellipse or hyperbola. Thus, fig. 1 of Pl. XVI., when we substitute its derived curve, viz. $x = k\ (1 - 4z)$, simplifies into fig. 2, in which, as before, the horizontal lines represent the oscillation-frequencies of the successive hydrogen rays.

Hence the problem to be solved is reduced to the easier problem of passing a parabola with its axis vertical through three given points.

For m we are to put in succession the positive whole numbers 1, 2, 3, 4, &c.; that is for y we are to use the harmonic fractions 1, 1/2, 1/3, &c., and for z the squares of these, viz. 1, ·25, ·1′, ·0625, ·04, ·027′, ·02040816, ·015625, ·012345679, ·01, &c., or numbers proportional to them.

Some of these values may assign negative values to n (the oscillation-frequency). It has hitherto been assumed that it is only the positive values of n that need to be attended to; that in fact the negative values do not correspond to lines in the spectrum. This seems to be a mistake: for the elliptic partial from which a line arises being (see Stoney on double lines, Sc. Tr. R.D.S., Vol. IV., p. 570),

$$x = a \cos\left(\frac{2\ \pi\ n}{j_1}\ t\right),$$

$$y = b \sin\left(\frac{2\ \pi\ n}{j_1}\ t\right),$$

the effect of changing the sign of n is simply to reverse the direction in which the electron travels round the ellipse. If the ellipse maintains a fixed position, this partial produces a single line in the spectrum, the position of which is the same whether n is positive or negative. If the ellipse is subjected to an apsidal shift during the flight of the molecule, the partial produces a double line in the spectrum (*loc. cit.*), the constituents of which either occupy the same positions when $+ n$ is changed into $- n$, or each simply exchanges place with the other. Which of these will happen depends on the direction of the apsidal motion, and on this we shall have something more to say farther on (last paragraph on p. 216); but in either case the same two positions in the spectrum are occupied by the constituents of the double line. There is, however, one alteration the lines *must* undergo when n changes sign, viz. that what was before the more refrangible side of each line now becomes its less refrangible side. Now, this accords with what we find to be indicated in the case of that outlying pair of sodium lines that have been supposed to be satellites. While all other sodium lines are more nebulous on the less refrangible side, the constituents of this particular pair are nebulous on the more refrangible side. We should therefore be prepared for what we shall learn further on, viz. that this pair of lines is due to a negative value of n.

Before, however, we can draw the diagram for any of the series of lines, we are confronted at the outset with a difficulty. We have to settle what three points the curve is to pass through. This depends on what the number m is for the least refrangible line. It is 3 in the case of the hydrogen series, but there seems no reason to conclude with Kayser and Runge that it is 3 in other cases. A preliminary diagram was made on millimetric paper to help in determining this point. Each supposition as to the value of m in the least refrangible line furnishes a distinct set of points corresponding to the observed values of n for the terms of the series. It was easy to draw curves through the several sets plotted down in this way, and that set was preferred which most nearly agrees with the supposition that an ellipse or hyperbola takes the place of the parabola of the hydrogen series; or rather (since it was a diagram of the derived curves that was employed) that a parabola with its axis vertical takes the place of the straight line of the hydrogen series. This may be seen by inspection in some cases. In others it cannot be so determined, and it was necessary to have recourse to the calculation by which a parabola is passed through three of the points, and by which the deviations of the other points from the parabola are computed. The case in which these deviations proved to be smallest is the one finally selected.

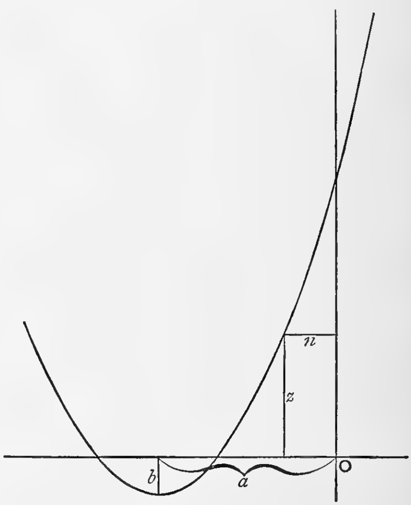

Fig. 3.

If the curve furnished by the relation between n and y is a hyperbola, the derived curve (representing the relation between n and z) is the part above the axis of n of a parabola such as that represented in fig. 3, its equation being

$$(a - n)^2 = P\,(b + z) \tag{5}$$

in which n and z are the running co-ordinates, P, a, and b being determined by the condition that the parabola shall pass through three given points, suppose $n_1 z_1,\ n_2 z_2,\ n_3 z_3.$

We easily find that this condition is fulfilled if

$$\left.\begin{aligned} P &= \frac{n_3 - n_1}{\dfrac{z_1 - z_2}{n_2 - n_1} - \dfrac{z_2 - z_3}{n_3 - n_2}} \\ 2a &= P\,\frac{z_1 - z_2}{n_2 - n_1} + n_1 + n_2 \\ b &= \frac{(a - n_1)^2}{P} - z_1 \end{aligned}\right\} \tag{6}$$

[Similarly, if the relation between n and y were such as to be represented by an ellipse, the derived curve would have the equation

$$(a + n)^2 = P\,(b - z), \tag{7}$$

in which, as before, P, a and b can be determined so as to make the curve pass through three given points].

The hyperbola of which equation (5) is the derived curve, is of course

$$(a - n)^2 = P.(b + y^2), \tag{5a}$$

and the ellipse corresponding to equation (7) is

$$(a + n)^2 = P\,(b - y^2) \tag{7a}$$

in which n and y are the running co-ordinates.

These are equivalent to

$$(a - n)^2 = P\left(b + \frac{1000}{m^2}\right), \tag{5b}$$

and

$$(a + n)^2 = P\left(b - \frac{1000}{m^2}\right) \tag{7b}$$

which give directly the relation between m and n, when for z we use 1000 times the values on page 209.

APPLICATION TO SERIES P.

Series P appears to be best represented by regarding the least refrangible pair of the series—the great D lines of the solar spectrum—as corresponding to $m = 2$. The values of m for the other lines will then be as in the following Table :—

m	$z = \frac{1000}{m_2}$	$x = \pm\kappa$ (which is nearly the same as n), by observation.
1	1000·0	Not yet observed
2	250·0	169·6878
3	111·1′	302·7762
4	62·5	350·5193
5	40·0	373·0703
6	27·7′	385·5080
7	20·40816	393·1049
8	15·625	398·0527

The Table also gives the values of x (by observation) and of z (by calculation) of the derived curve. If we pass a parabola with its axis vertical through three of these points, viz. through

$$z_2 = 250 \qquad z_3 = 111{\cdot}1' \qquad z_6 = 27{\cdot}7'$$
$$x_2 = 169{\cdot}6878 \qquad x_3 = 302{\cdot}7762 \qquad x_6 = 385{\cdot}5080,$$

we find, by the method of the last paragraph, that

$$\log P = 3{\cdot}774{,}0300$$
$$a = 3337{\cdot}4120$$
$$b = 1438{\cdot}35$$

Putting these values into equation (5) and computing the values of n (i. e. x) for the other terms of the series, we find

m	n calculated.	κ by observation (which is nearly the same as $\pm n$).	Difference.
1	− 469·4	Not yet observed.	Unknown.
2	Used for determining the constants.		0·00
3	Used for determining the constants.		0·00
4	+ 350·767	350·519	+ 0·25
5	+ 373·239	373·070	+ 0·17
6	Used for determining the constants.		0·00
7	+ 392·945	393·105	− 0·16
8	+ 397·776	398·053	− 0·28

Accordingly all the observed points lie nearly on this parabola. The parabola is in the position shown in fig. 3, from which it follows that the primary curve (which represents the relation between n and $1/m$) is a curve which is nearly a hyperbola. (See Pl. XVII., figs. 4 and 5.)

APPLICATION TO SERIES D.

Series D is best represented by a straight line for its derived curve, and accordingly by a parabola for its primary curve. Putting as before $x = n$ and $z = 1000/m^2$, and taking

$$x = a - \alpha z$$

as the equation of the derived curve, in which

$$a = 244{\cdot}93 \text{ and } \log \alpha = {\cdot}04357$$

and computing the successive terms, we find

m	n calculated.	$\pm\kappa$ by observation (which is nearly the same as n).	Difference.
1	− 860·6	Too far in ultra-violet for observation.	
2	− 31·17	Too far in ultra-red for observation.	
3	+ 122·093	+ 122·036	+ 0·057
4	+ 175·834	+ 175·884	− 0·050
5	+ 200·709	+ 200·746	− 0·037
6	+ 214·221	+ 214·256	− 0·035
7	+ 222·368	+ 222·363	+ 0·005
8	+ 227·656	+ 227·676	− 0·020

results which show that the primary curve of Series D approximates very closely indeed to a parabola. (See Pl. XVII., figs. 4 and 5.)

Application to Series S.

This is the most interesting of the series so far as the present inquiry is concerned, because it is the series to which belongs the outlying double line which has been supposed to be a satellite of one of the terms of Series D.

If we regard this particular line as the first term of the series, it will be found that the primary curve belonging to the series closely approximates to a hyperbola. If we regard that line as the second term, the curve approximates, but not so closely, to an ellipse. We shall, therefore, adopt here the former supposition. The values of m will then be as in the following Table:—

m	$z = \frac{1000}{m^2}$	$x = \pm\kappa$ (which is nearly the same as n), by observation.
1	1000·0	− 176·2686
2	250·0	+ 87·5500
3	111·1′	+ 162·3935
4	62·5	+ 194·1200
5	40·0	+ 210·5142
6	27·7′	+ 220·0515
7	20·40816	+ 226·1441
8	15·625	+ 230·2185

The co-ordinates in the Table are co-ordinates of the derived curve. It is approximately a parabola in the position of fig. 3. Taking equation (5) as its equation, the constants are to be determined by the condition that the parabola shall pass through three of the observed points, suppose through—

$$z_1 = 1000{\cdot}0 \qquad z_3 = 111{\cdot}1' \qquad z_6 = 27{\cdot}7'$$
$$x_1 = -176{\cdot}2686 \qquad x_3 = 162{\cdot}3935 \qquad x_6 = 220{\cdot}0515.$$

Using these values in equations (6), we find

$$\log P = 2{\cdot}526{,}3843$$
$$a = 434{\cdot}0587$$
$$b = 108{\cdot}514,$$

and computing the values of x, i. e. n, for the other terms, we get—

m	n calculated.	κ by observation (which is nearly the same as $\pm n$).	Difference.
1	Used for determining the constants.		0·00
2	+ 86·966	87·550	– 0·58
3	Used for determining the constants.		0·00
4	+ 194·337	194·120	+ 0·22
5	+ 210·662	210·514	+ 0·15
6	Used for determining the constants.		0·00
7	+ 225·919	226·144	– 0·22
8	+ 229·816	230·218	– 0·40

INFERENCES.

From the whole investigation we may draw the following inferences :—

1. That the outstanding differences are sufficiently large to warrant the conclusion that the primary curve is not an exact curve of the second degree, although in the case of Series P it approximates to a hyperbola ; in the case of Series S to a hyperbola or ellipse, probably to a hyperbola ; and to a parabola in the case of Series D.

2. That the approach to the parabola is very close in the case of Series D, but that, in the case of Series P and in the case of Series S, the actual curve, as indicated by the observations, is somewhat more curved in the vicinity of its vertex, than is the hyperbola which approximates to it.

3. That the double line which has been regarded by Rydberg as a satellite of one of the terms of Series D, and by Kayser and Runge as belonging to a fourth series, is in reality the first, or the second, term of Series S—the first, if the primary curve of Series S is of a hyperbolic form ; the second if it is elliptic.

4. That negative values of n furnish real lines in spectra, of which the double line spoken of above is an instance.

5. That in Series P the term corresponding to $m = 1$ has a negative value for its n, viz. 469·4, approximately corresponding to wave-length $\lambda = 2130$. This is perhaps not at too great a

distance in the ultra-violet to be observed, if the line have sufficient intrinsic brightness. Professor Hartley has succeeded in photographing as far as $\lambda = 1800$.

6. That in Series D there are two new terms corresponding to negative values of n, for one of which n is approximately $-860 \cdot 6$, and for the other $-31 \cdot 17$. These positions are the same as $\lambda = 1162$, and $\lambda = 32082$. The first of these is probably too far in the ultra-violet and the other much too far in the ultra-red, to be observed.

7. Similarly, in the hydrogen spectrum there seems to be a new line in the ultra-violet, viz. the line obtained by putting $m = 1$ into Balmer's formula. This makes $n = -822 \cdot 789$ which is the same as $\lambda = 1215$, a position, however, which is probably too far removed in the ultra-violet for observation.

8. Lines corresponding to negative values of n do not appear to have been observed in any of the monad elements except sodium, but examples of them are met with in some of the triple-line series of the dyads. Kayser and Runge record what is presumably one triple group of this kind in the spectra of zinc, cadmium, and mercury, and what is perhaps a second group in the spectra of zinc and cadmium (see the photographs they give of a part of each of these spectra, and the observations they make about them on p. 71 of their fourth Paper, "Über die Spectren der Elemente," in the Transactions of the Berlin Academy for 1891).

It is not yet known what kind of perturbation within the molecules would be competent to affect the partials of the undisturbed motion of an electron so as to resolve the resulting lines into triple lines. But it is, nevertheless, suggestive to find that in the spectra of Zn, Cd, and Hg, the constituents of the triple line corresponding to a negative value of n, are not reversed, but in the same relative positions to one another as are those furnished by positive values of n. If this non-reversal of position prevails among those double lines of sodium which are due to negative values of n, it will probably be indicated by the less refrangible constituent of the double line, No. 1 of Series S being the brighter, as is said to be the case with the double lines of the same series, which are due to positive values of n. This would imply a physical fact of importance, viz. that a change in the sign of n induces a change in the direction of the apsidal perturbation as well as in the direction of revolution in the elliptic partial. If, on the other hand, it is found that the more refrangible constituent of the double line is the stronger, this will go far to prove that the direction of the apsidal shift is independent of the sign of n. It is therefore desirable to ascertain by observation which constituent is the brighter.

9. Finally, our investigation makes it probable that there is some connexion between Series D and Series S in the spectrum of sodium, and that the same relation prevails between the two series of triple lines in the spectra of Zn, Cd, and Hg. This is suggested by the circumstance that the line which we now know to be the first term of Series S stands in a position in all these spectra which appears to be related in the same way to the positions in them of the lines of Series D. But what the connexion is we do not yet know.

Description of the Diagrams.

A sketch on a very small scale of the primary curves of the three sodium series is given in Pl. xvii., fig. 4, and a sketch of their derived curves is given in fig. 5. In both these figures, as in the diagrams of the corresponding hydrogen curves in Pl. xvi., the horizontal lines represent the oscillation-frequencies of the successive lines of each series, when measured from the vertical line to the curve belonging to that series. A small circle is placed round those dots that correspond to lines that have not yet been observed, and the cross on the upper line between – 500 and – 600 indicates the distance to which Professor Hartley has succeeded in photographing in the ultra-violet.

To judge what the approximation is that has been attained, imagine each of the diagrams enlarged, until the vertical line becomes ten metres long. Each of the diagrams would then occupy the side of a large house. Even on this immense scale the greatest deviation of the observed ends of the horizontal lines from the curve, would be less than six millimetres in the case of Series S, would be under three millimetres in Series P, and would be only a fraction of a millimetre in Series D. Although these deviations are very small, modern spectroscopic work is carried out with such accuracy that they may not be attributed to errors of observation, and, accordingly, we are justified in drawing the first and second of the inferences on p. 215.

XXVI.

SURVEY OF FISHING GROUNDS, WEST COAST OF IRELAND: PRELIMINARY NOTE ON THE FISH OBTAINED DURING THE CRUISE OF THE SS. "HARLEQUIN," 1891. BY ERNEST W. L. HOLT.

(COMMUNICATED BY PROFESSOR A. C. HADDON, M.A., F.Z.S.)

[Read NOVEMBER 18, 1891.]

THE more interesting among the forms mentioned in the following note will be described in detail in the Society's Scientific Transactions. References to others will be found in my reports "On the Result of Fishing Operations," and "On the Scientific Evidence on Economic Questions" (Scien. Proc. R.D.S., vol. vii., pt. 4).

SHORE FISHES.

Raia microcellata (Mont.). Blacksod Bay, Co. Mayo. Boylach and Loughrosmore Bays, Co. Donegal. *New to the Irish Fauna.*

Callionymus maculatus (Bonap.). 38 fathoms, Donegal Bay. *New to the Irish Fauna.*

Crystallogobius Nilssonii (Düb. and Kor.). Very common all along the coast, between 10 and 41 fathoms.

Rhombus norvegicus (Günther). 30 fathoms, Donegal Bay. *New to the Irish Fauna.*

Arnoglossus Grohmanni (Bonap.). Young specimens, from Killybegs Harbour.

Deep-sea Fishes.[1]

Pristiurus melanostoma (Raf.). 154 and 250 fathoms, Coast of Mayo.

**Scyllium canicula* (Cuv.). 154 fathoms, Coast of Mayo.

**Galeus vulgaris* (Flem.). 154 fathoms, Coast of Mayo.

**Acanthias vulgaris* (Risso.). 154 fathoms, Coast of Mayo.

Centrophorus squamosus (Gm. Linn.). 275 fathoms, Coast of Mayo. *New to the British Fauna.*

**Raia batis* (Linn.). 154 fathoms, Coast of Mayo.

**Raia oxyrhynchus* (Linn.). 500 to 375 fathoms, Coast of Mayo. *New to the Irish Fauna.*[2]

**Raia fullonica* (Linn.). 154 fathoms, Coast of Mayo.

**Raia circularis* (Couch). 115 fathoms, Coast of Kerry. 154 fathoms, Coast of Mayo.

Scorpæna dactyloptera (De la Roche). 220 fathoms, Coast of Kerry. 154 fathoms, Coast of Mayo.

**Trigla lyra* (Linn.). 115 fathoms, Coast of Kerry.

**Lophius piscatorius* (Linn.). 115 fathoms, Coast of Kerry.

**Gadus æglefinus* (Linn.). 154 fathoms, Coast of Mayo.

Gadus Esmarkii (Nilss.). Fairly common at about 30 to 40 fathoms, Coasts of Galway, Clare, and Kerry.

**Merluccius vulgaris* (Cuv.). 115 and 220 fathoms, Coast of Kerry. 154 fathoms, Coast of Mayo.

Phycis blennioides (Brünn.). 154 and 500 to 375 fathoms, Coast of Mayo.

**Molva vulgaris* (Flem.). 154 fathoms, Coast of Mayo.

Brosmius brosme (Müll.). 250 fathoms, Coast of Mayo.

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[1] The fish marked with an asterisk were also taken at depths of less than 100 fathoms.

[2] There is a doubtful record of this species from Belfast Lough, under the name of *R. mucronata*. (Birds, Fishes, and Cetacea of Belfast Lough. R. Lloyd Patterson: London, 1881, p. 228.) The *R. oxyrhynchus* referred to on the same page appears from the context to be the *R. oxyrhynchus* of Montagu and Thompson, considered by Day to be a synonym of *R. alba* (Lacép).

Macrurus lævis (Lowe). 220 fathoms, Coast of Kerry. 154 fathoms, Coast of Mayo.

**Arnoglossus megastoma* (Donov.). 115 and 220 fathoms, Coast of Kerry. 154 fathoms, Coast of Mayo.

Solea variegata (Donov.). 40 fathoms, Dingle Bay.

Argentina sphyræna (Linn.), 40 fathoms, Dingle Bay; and (?) 500 to 375 fathoms, Coast of Mayo, in stomach of Raia.

**Conger vulgaris* (Cuv.). 154 fathoms, Coast of Mayo.

I am not aware that the following forms have been previously recorded from depths exceeding 100 fathoms:

Scyllium canicula.
Galeus vulgaris.
Acanthias vulgaris.
Gadus æglefinus.

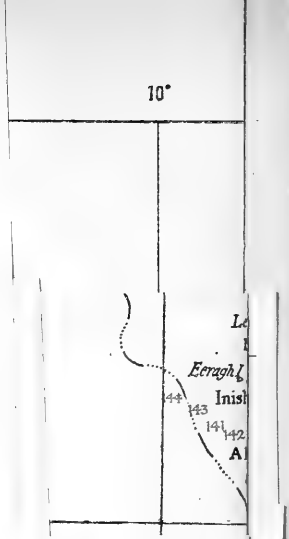
NOTE ADDED IN PRESS.

Cruise of the s.s. "Fingal," 1890.

Gobius Friesii (Malm.), 1 to 10 fathoms, Inver Bay and Killybegs Harbour, Co. Donegal, and Cleggan Bay, Co. Galway.

A series of specimens from these grounds appeared to bridge over the differences between *G. Friesii* and *G. macrolepis* (Scharff. Fishes of the "Lord Bandon" and "Flying Falcon." *Proc.*, R.I.A., vol. i., s. iii., 1891, p. 458). As some uncertainty remained, Dr. Scharff most generously agreed to submit the question to Professor Robert Collett, who, after comparison with the Norwegian example, writes me that he would not hesitate to identify all the Irish examples with *G. Friesii*.


ROYAL DUBLIN SOCIETY'S
Survey of Fishing Grounds, West Coast of Ireland,
1890 AND 1891.
S.S. FINGAL - MAY to AUGUST, 1890.
S.S. HARLEQUIN MARCH to JUNE, 1891.
REFERENCE:- RED FIGURES show STATIONS of S.S. FINGAL
BLUE " " " S.S. HARLEQUIN.
PLACES VISITED (not Stations) shown X for 1890
X for 1891.
RAILWAYS in course of Construction
100 FATHOM LINE
50 FATHOM LINE
COUNTY OF DONEGAL
DONEGAL BAY
SLIGO BAY
KILLALA BAY
COUNTY OF SLIGO
COUNTY OF MAYO
ACHILL
CLEW BAY
LOUGH MASK
COUNTY OF GALWAY
LOUGH CORRIB
CONNEMARA
IARCONNAUGHT
GALWAY
GALWAY BAY
ARRAN ISL.
COUNTY OF CLARE
ENNIS
LIMERICK
COUNTY OF LIMERICK
RIVER SHANNON
TRALEE BAY
TRALEE
COUNTY OF KERRY
DINGLE BAY
Killarney
COUNTY OF WATERFORD
YOUGHAL HARB.
CORK HARBOUR
KINSALE HARB.
COURTMACSHERRY BAY
CLONAKILTY BAY
GLANDORE BAY
KENMARE RIVER
BANTRY BAY
DUNMANUS BAY
LONG ISLAND BAY
VALENTIA I.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XXVII.

SURVEY OF FISHING GROUNDS, WEST COAST OF IRELAND, 1890–1891. INTRODUCTORY NOTE BY PROF. A. C. HADDON, M.A. (Cantab.), M.R.I.A.; Professor of Zoology, Royal College of Science, Dublin; Naturalist to the Survey.

It has long been felt that it was futile to discuss the problems of the development of the Irish Fisheries without possessing accurate information on the subject. No such knowledge was available. From time to time during this century the Royal Dublin Society has interested itself in Fishery matters, and during the last decade the Council have several times seriously considered whether renewed efforts should not be taken to attempt to treat the whole question from a scientific standpoint. The final result of this renewed interest is the Survey of the Fishery grounds on the West Coast of Ireland, which has been carried on for the last two years under the auspices of the Society. In Appendix E to the Report of the Council of the Royal Dublin Society for 1890 will be found a brief account of the history of the Survey, which has now drawn to a close.

Early in 1889 the Fishery Committee of the Royal Dublin Society intrusted to me the organization of the Natural History Department of the Survey, and after consultation with the Rev. W. S. Green and others, I drew up a plan of operations, including several books of schedules in which the scientific results were to be recorded. These latter were largely based upon those used by the Scotch Fishery Board. I also arranged for a complete equipment of apparatus, books, and other requisites for a long dredging cruise. In this matter the experience gained during over ten years' practical investigations in Marine Zoology, and from the organizing of several dredging cruises, served me in good stead.

Owing to my professional engagements I was unable to take a practical part during the first two months of the Survey of 1890. I therefore asked Professor E. E. Prince, of Glasgow, to act as my substitute, which he did with efficiency for five weeks. As Professor Prince could not spare any more time, I invited Mr. E. W. L. Holt, to take his place, and for a month and a-half Mr. Holt worked to my entire satisfaction. I joined the S.S. "Fingal" in June, and took charge of the Natural History Department until the end of the cruise, during which time I was greatly assisted by my friend Mr. A. F. Dixon, B.A., T.C.D. Dr. Scharff, Curator of the Natural History Museum, Science and Art Museum, Dublin; Mr. J. E. Duerden, of the Royal College of Science, Dublin, and others also rendered assistance for a short time.

The narrative of the Survey in 1890 has been published by Mr. Green. (Report of the Council of the Royal Dublin Society for 1890—Appendix E.) As the Survey was only half completed I forbore from publishing any of the results we had obtained until its completion. Mr. Holt has already published the two following papers, which have considerable biological interest. "Survey of Fishing Grounds, West Coast of Ireland, 1890, I., on the Eggs and Larvæ of Teleosteans," Trans. R. D. S., N.S. IV., pt. vii., 1890; "Survey of Fishing Grounds, West Coast of Ireland, Preliminary Note on the Fish obtained during the cruise of the S.S. 'Fingal,' 1890," Proc. R. D. S. VII., pt ii., 1891. Professor Prince has also completed a paper on the larval forms of Teleostei which came under his notice, which will very shortly be published in the Society's Transactions.

As Mr. Green decided to continue the Survey in 1891, during the spring months, I was again unable to undertake an active part in the work. With the sanction of the Fishery Committee I appointed Mr. Holt as my representative, and intrusted to him the whole of the Natural History Section of the Survey. The accompanying Reports "On the Results of the Fishery Operations," and "On the Scientific Evidence on the Economic Question of Fishes," will in some measure indicate the thorough and careful manner in which Mr. Holt fulfilled his trust. Mr. D. H. Lane, of Cork, volunteered to act as Mr. Holt's assistant, and his cheerful and untiring labours in the interest of the Survey deserve the warmest acknowledgment. I was able to be on board the S.S.

"Harlequin" only for a fortnight at Easter, and I was followed for another fortnight by my colleague, Professor T. Johnson, who studied the seaweeds brought up by the trawl.

Since the conclusion of the cruise Mr. Holt has remained in Dublin in order to work out the Zoological results of the Survey, and I placed my private room at the Royal College of Science at his disposal. During this time Mr. Holt has worked indefatigably, as the accompanying voluminous Reports will prove. In addition to these Mr. Holt has made some most important investigations on the larval and post-larval stages of fishes collected during the Survey, and some of his results are about to be published in the Society's Transactions. They will form a valuable and interesting addition to our knowledge of the life-history of British Fishes. There still remains a considerable amount of material of high scientific and practical interest which I hope Mr. Holt will find time to work up in the immediate future. The map accompanying the Reports was prepared by Mr. G. H. T. Beamish, C. E., to whom the naturalists of the Survey are indebted for every possible assistance.

In addition to the economic details here presented to the Society and the life-histories of numerous fish which the Society is publishing, there is a very large collection of Marine Invertebrates which it will take some time to classify. Some of the material is already in the hands of experts, and all of it will, I hope, be eventually worked over, and the reports published by the Society.

The time must now have passed when it can be asked What is the good of such knowledge? An acquaintance with the Marine Invertebrate fauna is as necessary to a right apprehension of fishery questions as is a knowledge of pasturage and root crops to the cattle-raiser. It is impossible to study the economics of animals without taking their food into consideration. The operations of the Survey were so arranged as to obtain the maximum amount of information on all the aspects of the fisheries that was possible with the time and resources at our disposal.

In the following Reports will be found that portion of the scientific results which have a more immediate economic aspect, and there, for the first time, we have accurate data which will assist towards the formation of a trustworthy knowledge of the state of the Fisheries of our Western sea-board. The narrative of the concluding cruise of the Survey in 1891, by the Rev. W. S. Green, will be found in the Report of the Council of the Royal Dublin Society for 1891, Appendix C. The following Reports by Mr. Holt were also included in the same Appendix.

It is hardly necessary to point out that, after all, the information obtained by the Survey is necessarily extremely incomplete. All we can claim for it is that it is accurate so far as it goes. Still it is a matter of congratulation for the Society that no similar work has yet been attempted in England. It is only in Scotland that the Fisheries have been systematically and scientifically treated, and there this has been accomplished by a State Department. The work of a Fishery Board has, in Ireland, been inaugurated by the Society, and it is to be hoped that the work thus commenced will not be allowed to drop.

Owing to the great length of coast which it was deemed advisable to cover, and to the comparatively short time for which a steamer could be chartered, the Survey could only be cursory. In but a few places it was thorough, and there only for a part of the year. Before it can be possible to gain a thorough knowledge of our Western Fisheries it will be necessary to have the undivided use of a steamer in which observations can be made from place to place during every month of the year. It will take many years of hard work before the Irish Fisheries can be adequately investigated. The Society may now hand over the responsibility of this undertaking to the Government—for it is clearly too heavy a responsibility for a local Society, and moreover is a matter of national importance.

XXVIII.

SURVEY OF FISHING GROUNDS, WEST COAST OF IRELAND, 1890–1891. REPORT ON THE RESULTS OF THE FISHING OPERATIONS. By ERNEST W. L. HOLT, Assistant Naturalist to the Survey.

(COMMUNICATED BY PROFESSOR A. C. HADDON, M.A., F.Z.S.)

[Read NOVEMBER 18, 1891.]

THIS Report consists (p. 227) of a list of the different kinds of fish captured during the Survey, with the scientific and vernacular names. In the case of each fish the vernacular name, which is first given, will be that used throughout this and other reports. The short list of alternative names has been mainly compiled from Day's "British Fishes," and the scientific nomenclature and classificatory order of that author has been followed throughout, on account of his work being the only reliable book of reference which is accessible to the public. The list of Irish names now in use by the fishermen of Connemara was kindly furnished by the Rev. Father Conway, P.P., of Carraroe. Other local names are inserted from our own observations.

A list follows (p 230) of the stations, with locality, date, soundings, &c., and nature of fishing implements, together with a list of the fishes, and a preliminary list of such invertebrates as have been identified. The number of mature and immature fish in each haul is shown, and a table, fully explained elsewhere, indicates the limits of size between the immature and mature forms of each species, upon which the distinction is based. Schedules follow (p. 293), showing the exact numbers, size, weight, condition of reproductive organs, and contents of stomach of all the more important kinds of fish, and the stations at which they were captured.

The Report concludes (p. 382) with a brief account of the effectiveness of different kinds of bait in line fishing.

The records from which this Report is derived consisted of the following:—

1. The Trawling Record.
2. The Long-line Fishing Record.
3. The Record of the condition of reproductive organs and stomach in fish caught.

The above were kept by the naturalists in charge from time to time.

From the commencement of the cruise of the "Fingal" until the 10th June, Professor E. E. Prince superintended the Naturalists' department. From that date until the 11th July the charge devolved upon me, and for a part of the time I was ably assisted by Mr. J. E. Duerden, of the Royal College of Science. Prof. Haddon took charge for the remainder of the cruise of the "Fingal."

For the records of the "Harlequin" I alone am responsible, and I have to acknowledge my great indebtedness to Mr. D. H. Lane, of Vernon Mount, Cork. This gentleman most kindly volunteered to act as my assistant, and performed his self-imposed duties with the greatest zeal and ability. Indeed the whole labour of keeping the records was thus taken off my hands, the details being written down in a rough form on deck at my dictation, and afterwards transferred to a fair copy. By this means we were able to get through a great deal more work than would otherwise have been possible.

Whilst the current business of the two cruises is thus accounted for, there remained at the close of the survey much necessary work, for the prosecution of which no accommodation was available, the premises of the Society being barely large enough for ordinary needs.

The collections had to be stored, and the specimens sorted and identified, whilst a ready access to the literature bearing on the subject was indispensable in drawing up the reports.

In this dilemma, Professor Haddon fortunately came to the rescue of the Society, by placing his private room at the Royal College of Science at my disposal, and thus, in the resources of literature and apparatus of the College, I have been placed in the most advantageous position for the prosecution of my inquiries. Indeed, there is no institution in the country so adequately fitted for carrying on investigations into the scientific aspects of economic questions, so far as they concern the fisheries.

LIST OF FISHES CAPTURED DURING THE SURVEY, WITH SCIENTIFIC AND VERNACULAR NAMES.

The fish marked † were taken for the first time in British waters. Those marked ‡ for the first time in Irish waters. Those marked § are confined to deep water. The fish marked * is new to science. The Irish names indicated ([a]) are taken from Hardiman's Edition of *H-Iar Connaught:* Dublin, 1846. The learned commentator is careful to give the scientific names of each fish, but omits to state from what part of the coast he derived the Irish names. He was unable to identify the "Hawke fish" of O'Flaherty with any species known to science, but translates it into Irish as Runnach Spaineach, which, I suppose, means Spanish Mackerel. The latter term, according to Nimmo, is applied at Roundstone to the Gar-pike, *Belone vulgaris*. A fisherman of Ballynakill rather puzzled us by identifying a fifteen-spined Stickleback as a young Spanish Mackerel; but the diagnosis is intelligible if he meant Belone.

†§*Pomatomus telescopium* (Risso.).

Pagellus centrodontus (De la Roche). Common Sea Bream. Gunner[1] (N.W. Ireland). Bien (W. of Ireland). Brame (Connemara). Murran roe (Antrim. Ball).

§*Scorpæna dactyloptera* (De la Roche).

Cottus scorpius (Linn.). Short-spined Bullhead. Sting Fish. Cobbler.

Cottus bubalis (Bl.). Long-spined Bullhead. Father Lasher. Cobbler.

Trigla cuculus[2] (Linn.). Red Gurnard. Cuckoo Gurnard. Pine-leaved Gurnard.

Trigla hirundo (Linn.). Sapphirine Gurnard. Grey Gurnard (Belfast). Tub, Latchet (S. and E. coast, England).

Trigla gurnardus (Linn.). Grey Gurnard. Knowd, or Nowd (Ireland). Cnudan (Irish).[a] Crudâne (Connemara).

Trigla lyra (Linn.). Piper.

Agonus cataphractus (Linn.). Armed Bullhead. Pogge.

Lophius piscatorius (Linn.). Angler. Mannafloyd (parts of Ireland).

Trachinus vipera (C. and V.). Lesser Weever. Stony Cobbler (Youghal).

Scomber scomber (Linn.). Mackerel. Runnach (Irish).[a] Runnagh (Connemara).

Echinus remora (Linn.). Remora.

Caranx trachurus (Linn.). Scad. Horse Mackerel.

Zeus faber (Linn.). John Dory.

Gobius ruthensparri (Euphr.). Spotted Goby. Double-spotted Goby.

Gobius niger (Linn.). Black Goby.

Gobius friesii (Malm.).

Gobius minutus (Gm. L.). Freckled Goby.

‡*Aphia pellucida* (Nard.). Nonnat.

‡*Crystallogobius nilssonii* (Düb. and Kor.). Crystal Goby.

Callionymus lyra (Linn.). Dragonet. Skulpin. Gowdie (Scotland).

Cyclopterus lumpus (Linn.). Lumpsucker. Cock and Hen Paidle (Scotland).

Liparis montagui Donov.). Montagu's Sucker.

Lepadogaster bimaculatus (Donov.). Double-spotted Sucker.

Blennius pholis (Linn.) Shanny. Shaw and Parrot-fish (Ireland).

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[1] The same names seem to be applied in parts of Ireland to this fish and the Ballan Wrasse.

[2] I have followed Day in considering *Trigla pini* (Bl.) as a synonym.

Centronotus gunnellus. Gunnel. Saw-eel and Butter-fish (Scotland). Nine Eyes.

Cepola rubescens (Linn.). Red Riband Fish. Pincher (Portrush). Portaferry Chicken (N. Ireland. Thompson).

Atherina presbyter (Jenyns). Sand Smelt.

Gasterosteus spinachia (Linn.). Sea Stickleback.

Labrus maculatus (Bl.). Ballan Wrasse. Rock Bream, Conner (W. coast of Ireland), Gunner (Mayo). Gregagh (N. Ireland). Bavin (N.E. Ireland). Morrian and Murran roe (Giant's Causeway). Bólögh (Connemara).

Labrus mixtus (Linn.). Cook Wrasse. Doctor (Killybegs). Livery Fish (N. Ireland).

Crenilabrus melops (Cuv.). Corkwing. Conner (W. coast of Ireland).

Ctenolabrus rupestris (Linn). Goldsinny. Pink, Two Spot, or Poisoned Brame (Dublin).

Gadus morrhua (Linn.). Cod. Tamlin Cod, when young (Cork Harbour). Trosg (Irish).[a] Thrusk (Connemara).

Gadus æglefinus (Linn.). Haddock. Cudog (Irish).[a] Caddóge (Connemara).

Gadus luscus (Willughby). Whiting Pout. Bib. Brassie (Scotland).

Gadus minutus (Linn.). Poor Cod.

Gadus merlangus (Linn.). Whiting. Mongach (Irish).[a] Fighteen (Connemara).

Gadus poutassou (Risso.). Poutassou. Couch's Whiting.

Gadus virens (Linn.). Coalfish. Black Pollack. Glasson, Glashan, Glassogue (W. of Ireland). Saithe, Podley, when young (Scotland). Mongach (Irish).[a]

‡*Gadus esmarkii* (Nilss.). Norway Pout.

Gadus pollachius (Linn.). Pollack. Whiting Pollack. Lythe (Scotland). Mongâh (Connemara).

§*Gadus argenteus* (Guichen.). Silvery Pout.

†§*Mora mediterranea* (Risso.). Moro.

Merluccius vulgaris (Cuv.). Hake. Herring Hake (Scotland).

Phycis blennioides (Brünn). Fork-beard. Forked Hake.

§*Haloporphyrus eques* (Gthr.).

Molva vulgaris (Flem.). Ling. Lunga (Irish).[a] Lónge (Connemara).

Motella mustela (Linn.). Five-bearded Rockling.

Motella tricirrata (Bl.). Lesser Three-bearded Rockling. Ronst dwrone (Irish) Slippery Jimmy (Dalkey).

Brosmius brosme (Müll.). Torsk. Tusk. Cat Ling (W. of Ireland).

Ammodytes lanceolatus (Lesauv.). Great Sandeel. Snedden (Co. Down).

Ammodytes tobianus (Linn.). Small Sandeel.

§*Macrurus coelorhynchus* (Risso.).

‡§*Macrurus rupestris* (Günner).

†§*Macrurus æqualis* (Gthr).

§*Macrurus lævis* (Lowe).

Hippoglossus vulgaris (Flem.). Halibut. Hali-but (Connemara).

Hippoglossoides limandoides (Bl.). Long Rough Dab. Smeareen (Dublin).

Rhombus maximus (Linn.). Turbot. Tairbert (Irish).[a] Thereberdh (Connemara).

Rhombus lævis (Rondel). Brill. Brit. Bret (Connemara).

‡*Rhombus norvegicus* (Gthr.). Norway Topknot.

Arnoglossus megastoma (Donov.). Witch. Whiff. Carter. Lantern. Sail Fluke (Scotland). White Sole, Ox- (? Rock) Sole, and Lemon Sole (Dublin). Megrim (Plymouth).

Arnoglossus laterna (Walb). Scaldfish. Scaldback (Plymouth). Megrim ? (Cornwall).

Arnoglossus grohmanni (Bonap.). Broad Scaldfish.

Pleuronectes platessa (Linn.). Plaice. Leathog garbh or Leathog breac (Irish).[a] Plâce (Connemara). Fluke.[1]

Pleuronectes microcephalus (Donov.). Lemon Dab. Smooth Dab. Lemon Sole Scotland). Merry Sole (Plymouth). Slippery Dab (Parts of Ireland).

Pleuronectes cynoglossus (Linn.). Pole Dab. Pole Flounder. Craig Fluke and Witch Sole (Scotland). White Sole (Dublin).

Pleuronectes limanda (Linn.). Common Dab. Sand Dab.

Pleuronectes flesus (Linn.). Flounder. Fresh water Fluke (Scotland).

Solea vulgaris. (Quensel). Common Sole. Black Sole. Sole (Connemara).

Solea lascaris (Risso). Lemon Sole. Sand Sole.

Solea variegata. (Donov.). Thickback.

Solea lutea. (Risso). Solanette. Little Sole.

Argentina sphyræna (Linn.).

Clupea harengus (Linn.). Herring. Sgadan (Irish).[a] Scudâne (Connemara).

Clupea sprattus (Linn.). Sprat.

Anguilla vulgaris (Turton). Common Eel. Asccann (Irish).[a] Os-kâne (Connemara).

Conger vulgaris (Cuv.). Conger.

*§*Nettophichthys retropinnatus* (Holt).

Siphonostoma typhle (Linn.). Broad-nosed Pipe-fish.

Syngnathus acus (Linn.). Great Pipe-fish. Earl[2] (S. of Ireld.). Sea Adder (Cornwall).

Nerophis æquoreus (Linn.). Snake Pipe-fish.

Nerophis lumbriciformis (Yarrell). Worm Pipe-fish.

Orthagoriscus mola (Linn.). Short Sun-fish.

§*Chimæra monstrosa* (Linn.). King of the Herrings. Rabbit-fish.

Galeus vulgaris (Flem.). Tope. Toper.

Mustelus vulgaris (Müll). Smooth Hound. Stinkard[3] (Ireland).

Selache maxima (Günn.). Basking Shark. Sun-fish (Ireland). Homer (Orkneys).

Scyllium canicula (Cuv.). Small-Spotted Dog. Rough Hound. Nurse.

Scyllium catulus (Turton). Nurse. Nurse Hound. Large-spotted Dog.

Pristiurus melanostomus (Bonap.) Black-mouthed Dog.

Acanthias vulgaris (Risso). Picked Dog. Piked Dog. Common Dog-fish. Feegágh (Connemara).[4]

†§*Centrophorus squamosus* (Gm. L.).

Echinorhinus spinosus (Cuv.) Spinous Shark.

Rhina squatina (Linn.) Angel Ray. Shark Ray. Angel Shark.

Torpedo nobiliana (Bonap.). Torpedo. Numb Ray, hence Mum Ray (Ireland).

Raia batis (Linn.). Grey Skate. Blue Skate (Scotland).

Raia macrorhynchus (Raf.). Flapper Skate.

‡*Raia oxyrhynchus* (Linn.). Sharp-nosed Skate.

Raia fullonica (Linn.). Shagreen Ray. Rough Flapper (Edinb.). Sand Ray (Ireld).

Raia clavata (Linn.). Thornback. Thorny back (Scotland). Maiden Ray (Ireland).

Raia maculata (Mont.). Spotted Ray. Homelyn. Maiden Ray (Ireland).

‡*Raia microcellata* (Mont.). Owl Ray. Painted Ray.

Raia circularis (Couch.). Sandy Ray. Cuckoo Ray. Sand Ray (Ireland).

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[1] Mr. Green tells me that Plaice are usually described on the W. and N.W. coast as Fluke, or Fluke with red spots; so that the term appears to have a generic meaning, as in Scotland.

[2] These names appear to apply to all Pipe-fish.

[3] This name seems more suited to the Tope.

[4] Apparently a generic name, also applied to "Maiden Rays."

LIST OF STATIONS, WITH NUMBER OF FISH CAUGHT AT EACH, AND PRELIMINARY LIST OF INVERTEBRATES.

Stations	1 to 121A,	SS. "Fingal, 1890.
Do.	122 to 240,	SS. "Harlequin," 1891.

It will be noticed that the nature of the fishing implement and the duration of fishing operations are given in every case—facts which must be taken into consideration when comparing the catches at different stations. The size of the beam chiefly used on board the "Fingal" was 25 feet; but the trawl nets used were of different kinds. When the kind of net is not specified, it is to be understood that a net of ordinary construction and mesh was used. The net indicated as "Patent" was a "Comyn's Patent discriminating trawl" net, supplied for a 25-foot beam, but towards the end of the cruise fitted on one somewhat larger. An endeavour will be made in Part XXIX. to compare the results obtained with this trawl with those obtained by the use of an ordinary net. On board the "Harlequin" a beam of 48 feet, with a net of ordinary construction and mesh, was almost invariably used, except in deep-sea fishing. As regards the Long lines full explanation as to the number of hooks and kind of bait employed will be found in the last section of this Report.

In discriminating between mature and immature fish, the following limits of size (in inches) have been used. The limit is intended to represent the minimum size of mature fish, and is explained in Part XXIX. (p. 418):—

Round Fish.

Common Sea Bream,	14
Red Gurnard,	10
Sapphirine Gurnard,	14
Grey Gurnard,	9
Angler,	25
Lesser Weever,	4
John Dory,	14
Sand Smelt,	5
Ballan Wrasse,	12
Corkwing,	4½
Cod,	20
Haddock,	10
Whiting,	8
Coalfish	20
Norway Pout,	4
Pollack,	18
Silvery Pout,	4
Ling,	24

Flat Fish.

Halibut,	23
Long Rough Dab,	6
Turbot,	18
Brill,	15
Witch,	9
Scaldfish,	4
Plaice,	15
Lemon Dab,	8
Pole Dab,	12
Common Dab,	7
Flounder,	7
Common Sole,	10
Lemon Sole,	3½
Solanette,	4

Skates and Rays.

Grey Skate,	26
Shagreen Ray,	35
Thornback,	19
Spotted Ray,	24
Owl Ray,	24
Sandy Ray,	24

May 8, 1890.

Station **1.**—KENMARE RIVER. 7 fathoms. Mud. ½ hour. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	1	1	0
Cod,	6	..	most
Plaice,	33	..	some
Common Dab,	16	..	some
Common Sole,	3	3	0
Thornback,	4	4	0

Invertebrates.—*Virgularia*. Shore Crabs. Ascidians.

May 8, 1890.

Station **2.**—KENMARE RIVER. 7 fathoms. Mud. 1 hour. 25 foot Beam Patent Net.

	Gross No.	No. Mature.	No. Immature.
Plaice,	13	..	some (3 very small).
Common Sole,	1	1	0
Thornback,	2	..	..

May 9, 1890.

Station **3.**—KENMARE RIVER. 10 fathoms. Mud. 1½ hour. 25 foot Beam. Patent Net.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	1	1	0
Brill,	1	1	0
Plaice,	5	0	5
Dab,	1	1	0
Common Sole,	7	7	0
Thornback,	2	2	0

Invertebrates.—*Luidia*. *Palmipes membranaceus*. Many weeds.

May 9, 1890.

Station **4.**—KENMARE RIVER. 20 fathoms. Mud and sand. 2 hours. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Red Gurnard,	1	0	0
Grey Gurnard,	6	6	0
Brill,	1	1	0
Witch,	1	..	..
Plaice,	3	..	some.
Common Dab,	4	4	0
Common Sole,	1	1	0
Thornback,	1	..	..
Grey Skate,	1	1	0

No weeds.

May 10.

Station 5.—BALLINSKELLIGS BAY. 6 fathoms. Sand. 1 hour 15 minutes. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	2	2	0
Plaice,	19	..	some.
Common Dab,	16	16	0
Common Sole,	1	1	0
Thornback,	2	2	0

May 10.

Station 6.—BALLINSKELLIGS BAY. 5 fathoms. Sand. 1 hour 5 minutes. Otter Trawl.

	Gross No.	No. Mature.	No. Immature.
Plaice,	3	..	some
Common Sole,	1	1	0

May 12, 1890.

Station 7.—DINGLE BAY. 22 fathoms. Sand. 4 hours. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	2	2	0
Ballan Wrasse,	1	..	..
Cod,	1	1	0
Whiting Pout,	2	..	..
Poor Cod,	1	..	..
Turbot,	1	1	0
Witch,	4	4	0
Plaice,	7	..	most
Lemon Dab,	5	5	0
Common Dab,	7	7	0
Common Sole,	8	..	some
Small spotted Dog,	1	..	..
Grey Skate,	2	2	0

Invertebrates.—Sand Urchins. Dead men's fingers (*Alcyonium*).

May 16.

Station 8.—OFF THE SKELLIGS. 74 to 80 fathoms. Sand and mud. 1 hour 20 minutes. Long Lines.

	Gross No.	No. Mature.	No. Immature.
Gurnard,	2	1	..
Cod,	1	1	0
Haddock,	4	4	0
Ling,	5	5	0
Conger,	5	..	..
Picked Dogs,	60–70	..	..
Small Spotted Dog,	1	..	..
Tope,	12	..	..
Skate,	No. uncertain	all	0
Thornback,	5	5	0

MAY 19, 1890.

Station **9**.—OFF VALENTIA. 40 fathoms. Long Lines.

	Gross No.	No. Mature.	No. Immature.
Cod,	3	3	0
Haddock,	3	3	0
Pollack,	3	3	0
Ling,	12	..	some.
Conger,	38	..	..
Small spotted Dogs,	2	..	..

MAY 19, 1890.

Station **10**.—OFF PORT MAGEE. 43 fathoms. Long Lines.

	Gross No.
Bream,	2
Red Gurnard,	1
Picked Dogs,	many

MAY 19, 1890.

Station **11**.—OFF VALENTIA. 40 fathoms. Long Lines.

Cod, 1. Haddock, 1. Pollack, 1. Ling, 6. Conger, 24.

MAY 20.

Station **12**.—OFF DINGLE BAY. 53 fathoms. Dark-grey sand. 3 hours. 25 foot Beam.

	Gross No.	No. Mature.	No Immature.
Grey Gurnard,	10	10	0
Hake,	2	0	2 (very small).
Witch,	34	34	0
Common Dab,	1	1	0
Common Sole,	6	6	0
Argentina sphyræna,	1	..	..
Grey Skate,	1	1	0
Thornback,	5	4	1

Invertebrates.—Common Starfish. *Epizoanthus*. Hermits. Spider Crabs (*Stenorhynchus*).

MAY 20.

Station **13**.—OFF DINGLE BAY. 50 fathoms. Dark-grey sand. 1 hour, 45 minutes 25 foot Beam.

	Gross No.
Witch,	18
Common Sole,	1
Torpedo,	1
Thornback,	2

May 21.

Station **14.**—OFF COOSHCROON. 30 fathoms. Long Lines.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	3	3	0
Cod,	1	..	..
Ling,	5	..	some
Conger,	12	..	..
Tope,	2	..	..
Picked Dog,	over 20	..	..
Small-spotted Dog,	over 12	..	..
Grey Skate,	5	5	0
Thornback,	4	4	0

One large Turbot came to the side, but dropped off out of reach of the gaff.

May 22.

Station **15.**—OFF DINGLE BAY. 74 to 80 fathoms. 1 hour, 15 minutes Long Lines.

	Gross No.	No. Mature.	No. Immature.
Haddock,	4	4	0
Hake,	4	4	0
Ling,	16	16	0
Conger,	7	..	..
Tope, &c.,	Great numbers	..	..
Thornback,	35	35	0

Several Hake and Ling were eaten off the hooks, the heads and portions of the bodies alone remaining.

May 23.

Station **16.**—OFF DINGLE BAY. 74 to 80 fathoms. Fine sand. 2 hours. 18 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	2	1	1
Witch,	7	7	0
Thornback,	2	..	..
Grey Skate,	1	..	..

May 27.

Station **17.**—SMERWICK. 6 to 15 fathoms. Sand. 1 hour, 5 minutes. 18 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Plaice,	5	..	some.
Common Dab,	5	1	4

Invertebrates.—Sand stars. Annelids. Hermits. Common Shrimps. Edible crabs.

MAY 27.

Station **18**.—BRANDON BAY. 9 to 16 fathoms. Red sand. 1 hour. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	1	1	0
Brill,	3	One fine	some.
Common Sole,	10	..	some.
Small spotted Dog,	1	..	..
Grey Skate,	12	..	..

Invertebrates.—Sandstars. Crabs, &c.

MAY 27.

Station **19**.—TURBOT BANK OFF KILCLOGHER HEAD. 10 fathoms. Fine sand. 1 hour. 25 foot Beam.

	Gross No.
Grey Skate,	1
Small spotted Dog,	2

MAY 28, 1890.

Station **20**.—BETWEEN ARAN AND MOGHER. Dredge.

JUNE 2.

Station **21**.—GALWAY BAY. 16 fathoms. Sand. $3\frac{1}{2}$ hours. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Sapphirine Gurnard,	1	1	0
Grey Gurnard,	11	..	some.
Anglers,	2	..	..
Gunnel,	1	..	..
Turbot,	1	1	0
Plaice,	3	0	0
Lemon Dab,	3	3	0
Common Dab,	19	..	some.
Common Sole,	6	6	0
Solanette,	3	..	..
Thornback,	3	..	..
Small spotted Dog,	5	..	..

Invertebrates.—Starfish (*A. glacialis*). Norway lobsters (*Nephrops*). Spider-crabs (*Stenorhynchus*), Scallops (*Pecten*).

JUNE 4, 1890.

Station **22**.—KILLEANY BAY. Shrimp Trawl from Gig.

	Gross No.
Plaice,	1 very small.
Eel,	1 very small.

Station **23**.—ROCK POOLS, W. SHORE OF KILLEANY BAY. Corkwing.

Black Goby,
Double-spotted Goby,
Shanny,
Gunnel,
Pipe-fish,
Long-spined Bull-head,
Young Pollack,
5-bearded Rockling,

Invertebrates.—*Asterina gibbosa.* Urchins (*E. miliaris and S. lividus*). *Lineus marinus.* Scale-back (*Halocydna gelatinosa*). Prawns (*Palaemon*). *Galathæa nexa.* Dog whelks (*Nassa reticulata*). Eggs of Dog whelk. Ascidians, *Botryllus, Clavellina, &c.*

JUNE 5.

Station **24**.—INSIDE ARAN ISLANDS. 13 to 20 fathoms. Fine sand. 1 hour. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Witch, . . .	1	1	0
Plaice, . . .	2	0	2
Common Dab, . .	3	3	0
Common Sole, . .	6	6	0
Conger, . . .	3	..	..
Grey Skate, . . .	1	0	1

Invertebrates.—Jellyfish (*Cyanæa*). Anemones (*Anthea*). Lingthorns (*L. savignii*). Edible Crabs. Swimming Crabs (*P. holsatus*). Spider Crabs (*Stenorhynchus*). Eggs of Squid. Scallops (Pecten). About 2 tons of seaweed, mostly *Laminaria digitata.*

JUNE 5.

Station **25**.—OFF GREATMAN'S BAY. 20 fathoms. Fine sand. 2 hours. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . .	7	..	some.
John Dory, . . .	1	0	1
Common Dab, . .	4	4	0
Common Sole, . .	2	2	0
Grey Skate, . . .	5	0	5

JUNE 6.

Station **26**.—KILKIERAN BAY. 4 to 8 fathoms. Coral. Sand and mud. 18 foot Beam. (Shot from a "Glothogue").

Ballan Wrasse, . .	1 mature.
Thornback, . . .	3

Invertebrates.—Sponges (*Grantia*). Star fish (*A. rubens and A. glacialis*). Brittle stars (*O. nigra, O. pentaphyllum, Ophioglypha*), *Antedon rosaceus.* Heart urchins. *Terebella and Spirorbis.* Swimming Crabs (*P. corrugatus*) *Hippolyte varians. Trochus, &c.*

JUNE 7.

Station **27.**—BIRTURBUY BAY. 7 fathoms. Soft mud, coral, and weeds. 10 minutes. 25 foot Beam.

Small-spotted Dog, . . .	1
Herring, post-larval, . . .	1

Trawl choked by weeds.

Invertebrates.—Sponges (*Rhaphyras*). Common Star-fish. *Henricia sanguinolenta.* Swimming crabs (*P. corrugatus*). Hermits (with Turritella shells, and one with *Adamsia palliata*). Spider crabs (*Stenorhynchus*). *Lyonsia norvegica* (dead shells). *Tapes vulgaris* and *Pecten pusio.* Periwinkle shells. Ascidians.

JUNE 9.

Station **28.**—ROUNDSTONE BAY. 5 fathoms coral and mud.

Invertebrates.—*Henricia sanguinolenta. Ophioglypha albida. Synapta. Terebella. Eusyllis. Nereis. Psammobia ferroensis. Tapes virginia. Nucula nucleus. Pecten tigrina. Turritella terebra.* Dog whelks (*Nassa*). *Philina aperta. Bulla hydatis. Cynthia?*

JUNE 9.

Station **29.**—GORTEEN BAY. 4 to 12 fathoms. Sand. ¾ hour. Otter Trawl.

	Gross No.	No. Mature.	No. Immature.
Plaice, . . .	6	0	6
Common Sole, . .	1	1	0
Spotted Ray, . .	1	1	0
Thornback, . . .	1	1	0

Invertebrates.—Sponges (*Rhaphyras*).

JUNE 9.

Station **30.**—GORTEEN BAY. 4 to 12 fathoms. Sand. ¾ hour. Otter Trawl.

	Gross No.
Angler, . . .	1
Plaice, . . .	4 mostly immature.

JUNE 9.

Station **31.**—BIRTURBUY BAY. 7 to 13 fathoms. Mud and rock. 35 min. 25 feet Beam.

	Gross No.	No. Mature.	No. Immature.
Ballan Wrasse, . .	1	..	..
Plaice, . . .	3	..	some.
Common Sole, . .	1	1	0
Lemon Dab, . .	1	1	0

Invertebrates.—Sponges (*Rhaphyras*). Anenomes (*Actinoloba, Anthea,* and *Adamsia*). Hydroids (*A. ramosa*). Deadmen's fingers (*Alcyonium*). Starfish (*A. rubens, A. glacialis,* and *H. sanguinolenta*). Brittle stars (*O. albida, O. pentaphyllum,* and *O. nigra*). Urchins (*E. esculentus*), *Lineus marinus, Serpula, Spirorbis, Chætopterus, Arcturus longicornis.* Gammarids (in bulbs of *Laminaria bulbosa*), *Galathæa nexa.* Hermits (*P. bernhardus,* with *Adamsia,* and others). Spider Crabs (*Maia* and *Stenorhynchus*). Swimming Crabs (*P. holsatus* and *P. corrugatus*). Scallops (*P. maximus* and *P. opercularis*), *Ciona intestinalis,* &c. Many weeds.

JUNE 10.

Station **32**.—BIRTURBUY BAY.

DREDGE. **Invertebrates.**—Same as last Station, also *Dog-whelks*, &c. *Psamathe. Pontobdella muricata* with eggs on shell. Priapulus. *Lyonsia norvegica* (dead shells). *Bulla hydatis. Scaphander lignarius*, &c.

JUNE 11.

Station **33**.—CLIFDEN HARBOUR. 6 fathoms. Mud, sand, stones. 2 hours. Shrimp trawl from whaleboat.

	Gross No.	No. Mature.	No. Immature.
Corkwing, . . .	6	6	0
Broad Scald-fish (*Arnoglossus grohmanni*), . .	1	..	..
Thornback, . . .	1	1	0
Freckled Gobies, . .	..	..	..
Spotted Gobies. . .	..	..	..
Sea Sticklebacks. . .	..	..	..
Snake Pipe-fish, . .	..	..	..

Invertebrates.—Anemones (*Anthea*). Hydroids (*A. antennina*). Star fish (*A. rubens*, *A. glacialis*, and *H. sanguinolenta*). Common Shrimps, Prawns (*P. serratus*) *Galathœa nexa*, *G. squamifera*. Swimming Crabs (*P. holsatus* and *P. corrugatus*), Shore Crabs, Spider Crabs (*Stenorhynchus*). Hermits with Sponges, *Lineus marinus*, *Spirorbis*, *Serpula*, *Chœtopterus* (tubes only), *Nucula nucleus*, *Turritella terebra*, *Trochus*. Ascidians.

JUNE 12.

Station **34**.—CLIFDEN HARBOUR. 7 fathoms. Mud and sand. 20 min. 18 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Plaice, . . .	2	2	0
Lemon Dab, . .	2	2	0
Thornback, . . .	1	0	1

Sucker (*L. bimaculatus*) with eggs in a Whelk shell.

JUNE 12.

Station **35**.—INISHBOFFIN HARBOUR. 1 to 5 fathoms. Sand and weeds. Shrimp trawl (from gig).

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . .	1	0	1
Long-spined Bullhead, .	3	..	..
Black Goby, . .	1	..	..
Spotted Goby, . .	many.	..	..
Gunnel, . . .	several.	..	..
Dragonet, . . .	,,	0	all.
Sea Stickleback, . .	,,	many.	many.
Cod, . . .	2	0	2 (very small).
Coalfish, . . .	many.	0	all very small.
Pollack, . . .	few.	0	all very small.
Snake Pipe-fish, . .	1	1	0

JUNE 12.

Station **36.**—INISHBOFFIN HARBOUR. 1 to 5 fathoms. Sand[1] and weeds. Muslin trawl.

	Gross No.	No. Mature.	No. Immature.
Lump-fish,	1	0	1 (post-larval).
Freckled Goby,	many.	some.	some.
Spotted Goby,	many.	some.	some.
Sea Stickleback,	many.	0	all.
Corkwing,	1	0	1 (very young).
Coal-fish,	many.	0	all very young.
Pollack,	few.	0	
Great Pipe-fish,	many.	..	

Invertebrates.—Anemones (*Anthea*). Common Shrimps. *Hippolyte varians.* Spider Crabs (*Hyas*).

JUNE 13.

Station **37.**—OFF CLEGGAN BAY. 25 min. 25 foot Beam. 18 fathoms. Shells, stones, and rocks.

	Gross No.	No. Mature.	No. Immature.
Plaice,	2	0	2 (small).
Small-spotted Dog,	1	..	..
Spotted Ray,	2	2	0

Invertebrates.—Sponges. Urchins (*E. esculentus*). Sun-star (*S. papposa*) Trawl hitched twice.

JUNE 13.

37A.—Tow Nets. OFF THE BILLS.

JUNE 13.

37B.—OFF ACHILL HEAD.

A Short Sun-fish shot by Mr. Green. Length, $77\frac{1}{2}$ inches. Circumference in front of fins 99 inches. From tip of dorsal to tip of ventral fin, 99 inches.

JUNE 13.

Station **38.**—BLACKSOD BAY. Fine sand. $1\frac{1}{2}$ hour. 25 foot Beam.

	Gross No.	No. Mature.	No Immature.
Plaice,	28	0	28
Lemon Dab,	4	4	0
Dab,	4	4	0
Common Sole,	9	9	0
Worm Pipe-fish,	2	0	2 (small).
Small spotted Dog,	5	..	..
Thornback,	2	2	0

Invertebrates.—Sponges. *Suberites domunculus* with Hermits. Deadmen's fingers. (*Alcyonium*, deep orange variety). Common Starfish. Lingthorns (*Luidia*). *Henricia sanguinolenta.* Brittle stars (*O. albida and O. pentaphyllum*). Urchins (*E. miliaris*). *Nereis. Psamathe. Galathœa nexa.* Hermits (in *Turritella*, *Nassa*, and *Natica* shells). Spider crabs (*H. coarctatus and S. rostratus*). Edible crabs. Oyster shells. Horse mussels (*M. modiola*). *Venus.* Scallops (*P. opercularis*). Razor shells (*Solen ensis, &c.*). *Philine aperta. Velutina lœvigata.* Eggs of Squid. *Ciona intestinalis, &c. Botryllus.*

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[1] Hard, white sand, interrupted by tracts of weeds.

JUNE 15.

Station **39.**—UPPER END OF BLACKSOD BAY. Dredge. Bottom very stony.

Great Pipe-fish,	several.

Invertebrates.—Urchins (*E. esculentus*). *Venus gallina*, var. *gibba*. *Tapes*. *Chiton*.

JUNE 16.

Station **40.**—BLACKSOD BAY. 4 to 10 fathoms. Mud. 3 hours. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Sapphirine Gurnard,	1	1	0
Grey Gurnard,	2	2	0
Freckled Goby,	..	..	..
Gunnel,	..	..	..
John Dory,	1	1	0
Turbot,	2	0	2
Brill,	2	0	2
Plaice,	29	..	29
Common Dab,	25	22	3
Common Sole,	3	..	..
Solanette,	several.	..	..
Spotted Ray,	20	..	..
Thornback,	20	..	..

Invertebrates.—As in St. 38. Also Anemones (*A. dianthus*, orange variety). *Harmathoe imbricans*. Swimming crabs (*P. holsatus*). *Mactra subtruncata*. *Thracia*. *Natica montacuti*, var. *conica*. Common whelks. Periwinkles, &c.

JUNE 16.

Statton **41.**—BLACKSOD BAY. 9 fathoms. Soft mud. 2 hours. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
John Dory,	1	1	0
Brill,	3	3	0
Plaice,	59	some.	..
Common Dab,	15	15	0
Common Sole,	10	..	..
Thornback,	12	..	..

JUNE 16.

Station **42.**—BLACKSOD BAY. 9 fathoms. Soft mud. 2 hours. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	6	..	..
Turbot,	1	0	1
Brill,	2	0	2
Plaice,	72	some.	..
Common Dab,	35	..	..
Common Sole,	24	..	..
Thornback,	2	..	..

JUNE 16.

Station **43.**—BLACKSOD BAY. 9 fathoms. Soft mud. 2 hours. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	2	..	..
Brill,	2	2	0
Plaice,	35	some.	0
Lemon Dab,	2	2	0
Common Dab,	12	..	..
Common Sole,	17	..	..
Spotted Ray,	4	4	0

JUNE 17.

Station **44.**—BLACKSOD BAY. 9 fathoms. Soft mud. 1½ hour. 25 foot Beam. Patent Trawl.

	Gross No.	No. Mature.	No. Immature.
Brill,	1	0	1
Plaice,	21	0	21
Common Dab,	4	4	0
Common Sole,	3	3	0
Thornback,	8	..	..

JUNE 17.

Station **45.**—BLACKSOD BAY. 6 fathoms. Soft mud. ½ hour. 25 foot Beam. Patent Net.

	Gross No.	No. Mature.	No. Immature.
Gunnel,	3	..	..
Brill,	2	0	2
Plaice,	20	..	some.
Common Dab,	5	..	..
Common Sole,	10	10	0
Thornback,	3	..	..

Invertebrates.—As in other Stations in this Bay. Also, Hydroids (*A. antennina. C. johnstoni. Hydractinia and Sertularia*). Anemones. (*Anthea*). *Choetopterus*. Sea-mice (*Aphrodite*). Edible crabs. Swimming crabs (*P. corrugatus*). *Porcellana longicornis*. *Pinnotheres* (on Ascidians). Razor shells (*Solen ensis*). *Tellina pellucida*. Sea hares (*Aplysia*).

JUNE 18.

Station **46.**—OFF ERRIS HEAD. 30 fathoms. Rock. 1½ hour. Long Lines.

	Gross No.	No. Mature.	No. Immature.
Sapphirine Gurnard,	1	1	0
Grey Gurnard,	4	4	0
Cod,	4	4	0
Ling,	7	7	0
Conger,	18	..	..

Many small-spotted Dogs, Picked Dogs and Tope.

JUNE 18.

Station **47**.—OFF BROADHAVEN. 25 fathoms. Sand. $1\frac{1}{4}$ hours. 25 foot Beam. Patent Net.

	Gross No.	No. Mature.	No. Immature.
Plaice,	1	..	..
Common Sole,	1	1	0

No Invertebrates or weeds.

JUNE 20.

Station **48**.—INVER BAY, OUTSIDE LIMITS. 25 fathoms. Soft mud. 2 hours. 25 foot Beam. Patent Net.

	Gross No.	No. Mature.	No. Immature.
Brill,	1	1	0
Dab,	2	2	0

JUNE 20.

Station **49**.—INVER BAY, INSIDE LIMITS. 1 hour. 25 foot Beam. Patent Net.

	Gross No.	No. Mature.	No. Immature.
Gurnard,	1	1	0
Turbot,	1	1	0
Plaice,	7	0	7
Lemon Dab,	1	1	0
Common Dab,	14	14	0
Common Sole,	1	1	0
Small Pipe-fish,	1	..	..
Conger,	1	..	..
Thornback,	3	..	..

Invertebrates.—Norway lobsters (*Nephrops*). Swimming crabs (*P. holsatus*). Squid (*L. media*).

JUNE 20.

Station **50**.—INVER BAY. Inside limits. 10 to 6 fathoms. Dredge.

	Gross No.
Gobins friesii,	2

Invertebrates.—*Caryophyllia.* Common Star-fish. Brittle Stars (*O. albida* and *O. pentaphyllum*). Heart Urchins (*Echinocardium*). Sea Cucumbers (*C. pentactes*). Scale-backs (*Harmothoe imbricans*). *Lanice conchilegia. Lagis korani. Serpula. Spirobis. Sipunculus.* Gapers (*L. elliptica* and *M. truncata*). *Pecten pusio.* Cockles. (*C. edule*, *C. echinatum*, *C. norvegicum*, and *C. minimum*). *Tellina tenuis* and *T. pellucida. Nucula nucleus. Venus. Lima. Anomia.* Common Whelks. Dog Whelks. *Trochus cinerarius. Turritella terebra. Natica mentacuti.*

JUNE 23.

Station **51**.—KILLYBEGS. Shrimp Trawl.

	Gross No.
Gobius friesii,	1
Goldsinny,	1
Common Dab,	1 mature.

Invertebrates.—*Synapta. Astropecten. O. pentaphyllum. Eurylepta. Sipunculus. Munida. Galathœa nexa. Velutina lævigata. Marginella lævis.* Ascidians, &c.

JUNE 24.

Station **52**.—KILLYBEGS. Shrimp Trawl.

	Gross No.
Aphia pellucida,	4
Spotted Goby,	many.
Gobius friesii ?,	several.
Freckled Goby,	many.
Dragonet,	several.

JUNE 25.

Station **53**.—INVER BAY. Outside Limit. 25 fathoms. Soft mud. 2 hours. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	12	12	0
Angler,	2	..	..
Cod,	1	1	0
Haddock,	1	1	0
Whiting,	1	1	0
Hake,	3	3	0
Long Rough Dab,	3	3	0
Brill,	2	2	0
Witch,	2	2	0
Plaice,	23	..	some.
Lemon Dab,	6	6	0
Pole Dab,	125	125	0
Dab,	28	28	0
Sole,	2	2	0
Worm Pipe-fish,	1	..	..
Conger,	2	..	..
Thornback,	1	1	0
Sharp-nosed Skate,	1	1	0
Small-spotted Dog,	2	..	..

Invertebrates.—Star-fish (*A. rubens* and *A. glacialis*). Norway Lobsters (*Nephrops*).

JUNE 25.

Station **54**.—INVER BAY. Inside Limits. 8 to 13 fathoms. Sand. 2 hours. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	18	18	0
Brill,	1	1	0
Plaice,	12	0	12
Lemon Dab,	8	8	0
Common Dab,	67	67	0
Common Sole,	3	3	0
Thornback,	2	2	0

JUNE 26.

Station **55**.—DONEGAL BAY. 32 fathoms. Grey sand. 2 hours. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	10	10	0
Angler,	1	1	0
Haddock,	4	4	0
Ling,	1	1	0
Turbot,	1	1	0
Brill,	1	1	0
Witch,	3	3	0
Plaice,	28	most.	..
Lemon Dab,	2	2	0
Pole Dab,	11	11	0
Common Dab.	96	0	some.
Common Sole,	9	9	0
Conger,	1	..	..
Tope,	1	..	..
Small-spotted Dog,	1	..	..

JUNE 26.

Station **56**.—DORAN HEAD, DONEGAL BAY. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	7	7	0
Turbot,	1	1	0
Plaice,	1	1	0
Lemon Dab,	1	1	0
Dab,	18 mostly small.		..
Sole,	1	1	0
Conger,	3	..	..
Small-spotted Dog,	1	..	..

Invertebrates.—Star-fish (*A. rubens* and *A. glacialis*). *Astropecten irregularis.* Brittle stars (*O. pentaphyllum*). Edible Crabs. Scallops (*P. opercularis*). Much *Laminaria* in the net.

JUNE 28.

Station **57**.—INNISHLYRE. 4 fathoms. Mud. Dredge from Gig.

Young Cod,
Freckled Goby,
Great Pipe-fish.

Invertebrates.—*Sagartia. Sertularians. Sabella pavonia. Nereis*, &c. *Nebalia. Amphipods.* Gammarids. Common Shrimps. Prawns (*P. serratus*). *Hippolyte varians.* Hermits. *Galathœa nexa.* Spider Crabs (*Hyas* and *Stenorhynchus*). Shore Crabs (with *Sacculina*). Scallops (*P. opercularis, P. pusio*, and *P. varius*). *Ostrea. Anomia. Nucula. Venus.* Cockles. *Saxicava. Tellina. Chiton. Turritella terebra.* Eggs of same. Whelks. Dog Whelks. *Trochus.* Ascidians.

JUNE 30.

Station **58**.—CLEW BAY. 22 to 18 fathoms. Fine sand. $2\frac{1}{2}$ hours. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard. . .	14	14	0
Turbot, . . .	1	1	0
Brill, . . .	4	4	0
Plaice, . . .	1	0	1
Lemon Dab, . . .	1	1	0
Common Dab, . .	26	26	0
Grey Skate, . . .	1	1	0
Spotted Ray, . .	1	1	0
Thornback, . . .	3	3	0
Picked Dog, . . .	2	..	..
Small-spotted Dog, . .	3	..	..

Much Oar weed in the net.

JUNE 30.

Station **59**.—CLEW BAY. 11 to 16 fathoms. Sand first, then rock. 65 min. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . .	3	3	0
Brill, . . .	1	1	0
Common Dab, . .	2	2	0
Common Sole, . .	2	2	0
Thornback, . . .	1	1	0
Spotted Ray, . .	2	2	0

A good deal of sea-weed in the net.

JULY 1.

Station **60**.—CLEW BAY. 18 to 17 fathoms. Fine sand. 2 hours 5 minutes 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . .	10	10	0
Brill, . . .	4	4	0
Witch, . . .	1	1	0
Plaice, . . .	1	0	1
Common Dab, . .	24	24	0
Common Sole, . .	4	4	0
Thornback, . . .	3	..	..
Picked Dogs, . .	6	..	..
Small-spotted Dogs, . .	2	..	..

Invertebrates.—Common Star-fish. Sun-stars (*S. papposa*). Brittle Stars (*O. lacertosa* and *O. pentaphyllum*). Urchins (*E. esculentus* and *E. miliaris*). Spider Crabs (*Hyas* and *Stenorhynchus*). Swimming Crabs (*P. holsatus*). Edible Crabs. Turritella. Dog Whelks. Spawn of Squid (*Loligo*). *Venus*. *Tellina*.

Some Oar weed in the net.

July 1.

Station **61**.—CLEW BAY. 15 fathoms. Fine sand and rock. 45 minutes. 25 oot Beam.

	Gross No.	No. Mature.	No. Immature.
Common Dab . .	3	3	0
Thornback. . . .	1	0	1
Picked Dog, . . .	1	..	..

The net burst.

Invertebrates.—Sun Stars (*S. papposa* and *S. endeca*). Brittle Stars (*O. pentaphyllum*). Hermits. Edible Crabs. Eggs of Squid (*Loligo*).

July 2.

Station **57a**.—INNISHLYRE ROADS. 1 to 4 fathoms. Mud and zostera. Shrimp Trawl.

Many immature and small Cod, Coalfish, &c. Armed Bull-head, Dragonets, 1 immature Common Sole.

July 1.

Station **62**.—CLEW BAY. 16 fathoms (?) Dredge.

Not much taken.

July 4.

Station **63**.—40 miles off ACHILL HEAD. 220 fathoms. Fine sand. 2 hours 40 minutes. 18 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Silvery Pout (*G. argenteus*),	several.	all.	..
Fork Beard, . .	5	0	all.
Macrurus cœlorhyncus, .	9	..	..
Macrurus lævis, . .	16	..	..
Pole Dab, . . .	several.	..	..
King of the Herrings, .	1	0	1
Grey Skate, . .	1	0	1

Invertebrates.—Urchins (*Cidaris papillata*). Brittle Stars (*O. pentaphyllum*). Sea Cucumbers (*H. tremula*). Prawns (*Pandalus annulicornis* ?). *Anamathia*. Hermits (in *Cassidaria* shells, one with *Sagartia*). Arcturus. *Cassidaria tyrrhenia* (living). Octopus (*O. vulgaris*), &c.

JULY 4.

Station **64**.—30 miles OFF ACHILL HEAD. 144 fathoms. Fine sand. $2\frac{1}{2}$ hours. 18 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Pomatomus telescopium .	2	0	2
Piper, ...	2	2	0
Norway Pout (*Gadus esmarkii*),	1	1	0
Silvery Pout (*Gadus argenteus*),	50	50	0
Macrurus cœlorhynchus,	..	..	several.
Macrurus lævis, . . .	..	..	several.
Witch, ...	7	..	..
Pole Dab, . . .	3	..	..
Nettophichthys retropinnatus,	1	..	..
King of the Herrings, .	2	..	..
Black-mouthed Dog, .	1	0	1

Invertebrates.—Urchins (*S. raschii* and *C. papillata*). *Henricia rosea.* Sea Cucumbers (*H. tremula*). Skate Leech (*P. muricata*). Anemones (*Actinauge richardi* and *Sagartia*). *Fusus.* Squids (*Rossia*). *Pycnogonum littorale*, &c.

JULY 5.

Station **65**.—BLACKSOD BAY. 5 fathoms. Fine sand and mud. 1 hour. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . .	5	..	some.
Brill, . . .	1	1	0
Plaice, . . .	13	0	13
Lemon Dab, . .	2	2	0
Common Dab, . .	7	..	some.
Common Sole, . .	6	..	some.
Thornback, . .	13	..	..
Small-spotted Dog, about	24	..	..

Invertebrates.—Oysters and Scallops (*Pecten*). Much weed in the net.

JULY 7.

Station **66**.—BLACKSOD BAY. Otter Trawl, from a Hooker.

	Gross No.
Brill, . . .	1
Plaice, . . about	40
Common Dab, . about	40
Common Sole, . .	3

JULY 5.

Station **67**.—BLACKSOD BAY. $4\frac{1}{2}$ fathoms. Coarse sand. 1 hour 50 minutes. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . .	1	..	..
Turbot, . . .	2	0	2
Brill, . . .	3	3	0
Plaice, . . .	14	0	14
Common Dab, . .	12	12	0
Thornback, . . .	21	..	..
Spotted Ray, . .	12	..	..

JULY 7.

Station **67A**.—BLACKSOD BAY. 1 to 3 fathoms. Mud and zostera. Shrimp Trawl.

Corkwing, mature and immature.
Young Cod, Whiting, Coal-fish, &c.

JULY 9.

Station **68**.—BLACKSOD BAY. 14 to 12 fathoms. Fine sand to rough sand. 2 hours. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	1	1	0
Common Dab,	7	7	0
Spotted Ray,	5	5	0
Thornback,	4	1	3

Trawl torn, and came up reversed.

JULY 8.

Station **69**.—BLACKSOD BAY. 9 fathoms. Sand. $1\frac{1}{4}$ hour. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Turbot,	1	0	1
Brill,	2	2	0
Plaice,	15	0	15
Lemon Dab,	1	1	0
Common Dab,	12	12	0
Common Sole,	13	13	0
Thornback,	2	1	1
Small-spotted Dog,	3	..	..

JULY 10.

Station **70**.—54 miles off ACHILL HEAD. 500 fathoms. Grey sand. 1 hour. 18 foot Beam. Rocky ground; brought up in trawl a piece of soft sandstone, 30 × 12 × 8 inches, weighing 280 lbs.

	Gross No.	No. Mature.	No. Immature.
Scorpæna dactyloptera,	1	..	..
Moro (*Moro mediterranea*),	3	1	2
Forkbeard,	several	..	..
Haloporphyrus eques,	5	some mature	..
Macrurus rupestris,	4	4	0
Macrurus æqualis,	7	1	6
Grey Skate,	2	2	0

Invertebrates.—*Astropecten sphenoplax* (Bell).[1] *Phormosoma placenta*. Urchins (*Echinus*. *Cidaris papillata*. *Spatangus raschii*). *Psolus*. *Epizoanthus*. Anemones. *Terebratula cranium*. *Fusus*, &c.

Rorquals (*Balænoptera* sp.), were seen during the day.

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[1] To be published in the *Proceedings*, Royal Dublin Society, vol. VII., (N.S.), (Part 5).

JULY 10, 1890.

Station **71**.—34 miles OFF ACHILL HEAD. 175 fathoms. Fine sand. $1\frac{1}{2}$ hour. 18 foot Beam.

	Gross No.	No. Mature.	No. Immature.
King of the Herrings, .	2	0	0

Invertebrates.—Brittle Star (*Ophiothrix*). Urchins (*Cidaris papillata*). *Galathæa. Shrimp. Scaphander. Cardium?* &c.

A shoal of young Poutassou (*Gadus poutassou*) observed at the surface. Some were caught in a tow-net.

JULY 10, 1890.

Station **72**.—20 miles OFF ACHILL HEAD. 127 fathoms. Sharp sand. $1\frac{3}{4}$ hour. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Ling, . . .	1	1	0
Witch, . . .	10	..	some.

Trawl burst.

Invertebrates.—Urchins (*C. papillata, S. raschii*, and *Echinus*). Sea Cucumbers (*H. tremula*). *Ophiothrix. Zoanthus.* Sponges, &c.

JULY 12, 1890.

Station **73**.—KILLARY BAY. 15 to 9 fathoms. Mud. 1 hour. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . .	1	1	0
Brill, . . .	1	1	0
Plaice, . . .	5	..	some.
Common Dab, . .	16	16	0
Common Sole, . .	5	5	0
Thornback, . . .	10	10	0
Small-spotted Dog, . .	1	..	..

Invertebrates.—*Sagartia miniata.* Hydroids (*A. antennina* and *A. ramosa*). Jellyfish (*Chrysaora*). Common Starfish (*Henricia*). Brittle Stars (*O. fragilis* and *A. filiformis*). Sun Stars (*S. papposa*). Urchins (*E. miliaris*). Norway Lobsters (*Nephrops*). Hermits (some with sponges).

JULY 15, 1890.

Station **74**.—OFF KILLARY. 12 fathoms. Sand and rock. 55 minutes. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Brill, . . .	4	4	0
Lemon Dab, . .	2	2	0
Common Dab, . .	6	..	some.
Small-spotted Dog, . .	1	..	..
Thornback, . .	2	..	..
Spotted Ray, . .	1	1	0

Invertebrates.—Starfish (*A. rubens* and *A. glacialis*). Brittle Stars (*O. fragilis*). Urchins (*E. esculentes*). Hydroids (*A. ramosa*). Deadmen's fingers (*Alcyonium*). Scallops (*Pecten*). Eggs of Dog Whelk (*Nassa*). Edible Crabs. Ascidians (*Botryllus*, &c.)

July 15, 1890.

Station **75**.—CLEGGAN BAY. 5 fathoms. Sand and stones. 10 minutes. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Gobius friesii,	1	..	..
Plaice,	4	..	some.
Common Sole,	1	1	0
Smooth Hound,	1	..	..

Invertebrates.—Spider Crabs (*Stenorhynchus*). Much sea-weed in net.

July 15, 1890.

Station **76**.—CLEGGAN BAY. 7 to 12 fathoms. Sand. 25 minutes. 25 foot Beam.

	Gross No.
Plaice,	26, some immature.

A great number were lost by the propellor cutting the trawl net.

Invertebrates.—*Polycera quadrilineata. P. ocellata.*

July 15.

Station **77**.—CLEGGAN BAY. 7 to 12 fathoms. Sand. 45 minutes. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Plaice,	55	..	a few.
Common Dab,	15	15	0
Common Sole,	4	4	0
Small-spotted Dog,	1	..	..
Spotted Ray,	2	..	..

July 16.

Station **78**.—OFF THE BILLS. 35 fathoms. Long Lines.

	Gross No.	No. Mature.	No. Immature.
Red Gurnard,	1	1	0
Cod,	1	1	0
Ling,	13	13	0
Torsk,	2	2	0
Halibut,	1	1	0
Turbot,	1	1	0
Conger,	17	..	..
Nurse Hound,	7	..	..
Picked Dog,	6	..	..
Tope,	1	..	..

July 16.

Station **79**.—DAVALAUN. 13 fathoms. Sand. 30 minutes. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Red Gurnard,	1	1	0
John Dory,	1	1	0
Brill,	8	..	some.
Plaice,	1	1	0
Nurse Hound,	3	..	..
Spotted Ray,	14	14	0

JULY 18, 1890.

Station **80**.—OFF SLYNE HEAD. 55 fathoms. Long Lines.

	Gross No.	No. Mature.	No. Immature.
Red Gurnard, . .	1	1	0
Cod, ...	3	3	0
Haddock, . . .	1	1	0
Coal-fish, . . .	3	..	..
Ling, . . .	23	13	1*
Picked Dogs, . .	7	..	..
Nurse Hound, . .	2	..	..
Tope, . . .	4	..	..
Grey Skate, . . .	2	..	..

JULY 19, 1890.

Station **81**.—CASHEEN BAY. fathoms. Otter Trawl from a Hooker. 3 hauls of ½ hour each.

	Gross No.
John Dory, . . .	1
Plaice, . . .	8
Common Sole, . .	6
Thornback, . . .	4
Grey Skate, . . .	1 (weighing 150 lbs.)

JULY 25, 1890.

Station **82**.—6 MILES OFF GREGORY SOUND. 48 fathoms. Mud and sand. 1½ hour. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . .	2	2	0
Haddock, . . .	5	5	0
Witch, . . .	19	..	most.
Grey Skate, . . .	5	..	..
Thornback, . . .	5	..	..

Invertebrates.—Common starfish. Lingthorns (*Luidia*). *Astropecten irregularis.*

JULY 25.

Station **83**.—GALWAY BAY. 20 fathoms. Mud and sand. 35 minutes. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Red Gurnard, . .	1	1	0
Piper, . . .	1	1	0
Angler, . . .	1	0	1
Common Dab, . .	1	1	0

Invertebrates.—Brittle Stars. (*O. aculeata*). Urchins (*E. esculentus*). Hydroid- (*A. ramosa and S. polyzonias*), *Corynactis. Caryophillia. Pycnogonum* on *Sertularia polyzonias.* Dead men's fingers (*A. digitatum*). *Doto fragilis.* Scallops (*Pecten*). Net burst.

* 9 Ling not measured.

July 25.

Station **84**.—GALWAY BAY. 24 fathoms. Sand. 2 hours 15 minutes. 32 foot Beam. Patent Net.

	Gross No.	No. Mature.	No. Immature.
Piper, . . .	1	1	0
Haddock, . . .	1	1 fine.	0
Pollack, . . .	1	1	0
Common Dab, . .	3	3	0
Conger, . . .	2 large.	..	..
Smooth Hound, . .	1	..	..

Invertebrates.—Starfish (*A. glacialis*). Lingthorn (*L. savignii*). Urchins *E. esculentus*). *Gorgonia verrucosa*. *Tritonia*. No weeds in trawl.

July 28.

Station **85**.—GALWAY BAY. 19 to 15 fathoms. Sand. 2 hours. 32 foot Beam. Patent Net.

	Gross No.	No. Mature.	No. Immature.
Brill, . . .	1	1	0
Plaice, . . .	12	0	12
Common Dab, . .	8	8	0

Invertebrates.—Only 1 common starfish. No weeds in trawl. A few dabs escaped.

July 29.

Station **86**.—OFF INISHMAAN. 20 to 7 fathoms. Sand, shells and coral. 32 foot Beam.

	Gross No.	No. Mature.	No. Immature.
John Dory, . . .	1	0	1
Brill, . . .	1	1	0
Plaice, . . .	2	0	2
Spotted Ray, . .	6	6	0

Many seaweeds and nullipores in net.

Invertebrates.—Sponges *Pachymatisma johnstoni* (?), &c. Hydroids (*A. antennina*). Anemone (*Sagartia miniata*). *Epizoanthus*. Deadmen's fingers (*A. digitatum*). *Gorgonia verrucosa*. Urchins (*E. esculentus and E. flemingi*). Starfish (*A. rubens and A. glacialis*). Lingthorns (*L. savignii and L. sarsii*). *Astropecten irregularis*. Brittle Stars (*Ophioglypha lacertosa and Ophiothrix aculeata*). Edible crabs. Spider crabs (*Stenorhyncus and Hyas*). Scallops (*Pecten*). Razor shells (*S. cardita*). Cockles (*cardium*). Gaper (*Mya*). *Lamellaria*. Whelks. *Aporrhais, &c.* Ascidians *Botryllus*).

July 30.

Station **87**.—OFF THE ARAN ISLANDS.

	Gross No.	No. Mature.	No. Immature.
John Dory, . . .	5	5	0
Angler, . . .	1	0	1
Lemon Dab, . . .	1	1	0
Conger, . . .	1 large.	..	..
Thornback, . . .	1	..	..
Spotted Ray, . .	1	..	..

Invertebrates.—Sponge (*Pachymatisma johnstoni?*). Urchins (*E. esculentus*). Spider Crabs (*Stenorhynchus*). Scallops (*Pecten*). Gapers (*Mya*). Torbay Bonnet. No weeds.

JULY 30.

Station **88**.—OFF THE ARAN ISLANDS. 32 foot Beam. Patent Net.

	Gross No.	No. Mature.	No. Immature.
John Dory,	1	0	1
Turbot,	1	0	1
Plaice,	5	0	5
Small-spotted Dog,	1	..	0
Angel Ray,	2	2	..
Thornback,	5	5	0
Common Sole,	11	11	0

Invertebrates.—Scallops (*Pecten*). No weeds.

JULY 30.

Station **89**.—OFF THE ARAN ISLANDS. Mackerel Nets.

	Gross No.	No. Mature.	No. Immature.
Mackerel,	2	2	0
Scad,	2	2	0

JULY 31.

Station **90**.—GALWAY BAY. 15 fathoms. Soft mud. 50 minutes. 32 foot. Beam. Patent Net.

	Gross No.
Sapphirine Gurnard,	1
Red Gurnard,	2
Plaice,	1 small.
Ray,	5

AUGUST 7.

Station **91**.—GALWAY BAY. 14 fathoms. Sand and shells. 30 minutes. Shrimp Trawl.

Grey Gurnard,	1	very small.
Dragonet,	6	
Scaldfish,	5	small.
Common Dab,	1	very small.
Solanette,	63	mature.

Invetebrates.—*Podocoryne* on shells. *Paraphellia expansa.* Brittle Stars (*O. lacertosa* and *O. albida*). *Astropecten. Terebella.* Hermits. Spider Crabs (*Stenorhnchus*). *Ebalia.* Swimming Crabs. Scallops (*Pecten*). *Arca. Venus.* Cockles (*Cardium*). *Eolis. Natica. Aporrhais.* Dog Whelks (*Nassa*). Elephant's Tooth Shells (*Dentalium*). Ascidians (*Molgula*).

AUGUST 7.

Station **92**.—GALWAY BAY. 20 fathoms. Soft mud. 1 hour, 10 minutes. 32 foot Beam. Patent Net.

No entry.

AUGUST 8.

Station **93**.—CASHEEN BAY. Mud and rock. 32 foot Beam. Patent Net.

John Dory,	1	mature.
Thornback,	1	mature.

Trawl hitched. Much sea-weed. **Invertebrates.**—Ascidians.

AUGUST 8.

Station **94**.—CASHEEN BAY. 9 fathoms. Mud and rock. 32 foot Beam. Patent Net.

Plaice,	1	immature.
Dab,	1	mature.
Sole,	4	mature.

Trawl hitched, and beam broken. Much seaweed.

Invertebrates,—Anemones (*A. dianthus*), large white variety. Starfish (*A. rubens* and *A. glacialis*). Brittle Stars (*Ophiothrix*). Spider Crabs (*Stenorhynchus*). Lobster (*Homarus*). Scallops (*Pecten*). *Terebra*. *Ascidians.*

AUGUST 9.

Station **85**.—SOUTH SOUND, ARAN. 24 fathoms. Fine sand. 1 hour, 30 minutes. 28 foot Beam. Patent Net.

Piper,	2	mature.
Ray,	1	mature.

AUGUST 11.

Station **96**.—CASHLA, OR COSTELLO BAY. 18 foot Beam.

Goldsinny,	1	mature.
Pollack,	1	mature.

Trawl hitched. **Invertebrates.**—Sponges.

AUGUST 11.

Station **97**.—KILLEANY BAY. 2 to 7 fathoms. Sand. Shrimp Trawl.

Short-spined Bullhead,	10	
Spotted Goby,	30	
Freckled Goby,	3	
Dragonet,	3	
Sea Stickleback,	12	
Wrasse,	14	very small.
Pollack,	2	very small.
Lemon Dab,	1	mature; very fine.
Great Pipefish,	1	
Snake Pipefish.	1	
Worm Pipefish,	1	

A very large quantity of sea-weed in the net.

Invertebrates.—Common Shrimps. *Hippolyte varians*. Hermits. Spider Crabs (*Stenorhynchus*). Swimming Crabs (*P. arcuatus* and *P. corrugatus*). Scallops (*P. opercularis*, and a few *P. maximus*). Sea Hares (*Aplysia*). Squids (*Sepiola*).

August 11.

Station **98.**—OFF INISHMAAN. 16 to 18 fathoms. Grey sand. 50 minutes. 28 foot Beam. Patent Net.

	Gross No.	No. Mature.	No. Immature.
John Dory,	3	0	3
Brill,	1	1	0
Plaice,	1	0	1
Common Dab,	2	2	0
Common Sole,	3	3	0
Small-spotted Dog,	2	..	..
Thornback,	3	3	0
Spotted Ray,	35	35	0

1 Sole escaped.

August 12.

Station **99.**—KILLEANY BAY. 7? fathoms. Sand. 15 minutes. Otter Trawl.

	Gross No.	No. Mature.	No. Immature.
Ballan Wrasse,	3	3	0
Plaice,	13	13 2 fine.	0
Lemon Dab,	2	2	0
Thornback,	3 rather small	..	..
Spotted Ray,	3 rather small	..	..

August 13.

Station **100.**—VENTRY HARBOUR. 4 fathoms. Sand. 40 minutes. Otter Trawl.

Spotted Gobies,	
Pollack,	1 very small.
Plaice,	4 immature.

Much seaweed.

Invertebrates.—Anemones (*Anthea*). Spider Crabs (*Stenorhynchus*).

August 13.

Station **101.**—OFF VENTRY. 20 fathoms. Grey sand. Shrimp Trawl.

Common Dab, . . 2 very small.

August 12.

Station **102.**—DINGLE BAY. 9 to 7 fathoms. Mud, coral, and fine sand. 1 hour, 30 minutes. 28 foot Beam. Patent Trawl.

Small-spotted Dog, . . 1

August 13.

Station **103.**—DINGLE BAY. 9 to 7 fathoms. Mud and fine sand. Shrimp Trawl.

Black Goby,	3	
Armed Bullhead,	3	
Common Dab,	53	small.

Invertebrates.—Common Starfish. Brittle Stars (*O. lacertosa*). Swimming Crabs (*Portunus*). Scallops (*Pecten*). *Mactra stultorum* (dead shells). *Aporrhais. Natica. Eledone cirrhosa.*

August 14.

Station **104.**—OFF VALENTIA. 41 fathoms. Fine mud and sand. Shrimp Trawl.

Grey Gurnard,	3	very small.
Dragonet,	2	very small.
Gobies,		small.
Witch,	1	very small.

Invertebrates.—Common Starfish. Lingthorns (*L. savignii* and *L. sarsii*). *Astropecten.* Brittle Stars (*O. lacertosa*). Common Shrimps, &c.

August 14.

Station **105.**— Shrimp Trawl.

Bullheads,		
Spotted Gobies,		
Montagu's Sucker,	2	
Gunnell,	1	
Sea Stickleback,	2	
Pollack,	11	very small.

Much weeds.

Invertebrates.—Brittle Stars (*O. aculeata*). Prawns (*Palæmon*). Shrimps (*Crangon*). Scallops (*Pecten*). *Chiton.* Sea Hares (*Aplysia*). *Eolis coronata.*

August 16.

Station **106.**—KENMARE RIVER. 26 to 23 fathoms. Sand, shells, and soft mud. 2 hours. 28 foot Beam. Patent Net.

	Gross No.	No. Mature.	No. Immature.
Piper,	6	6	0
Haddock,	1	1	0
Hake,	5	5	0
Witch,	32	32	0
Plaice,	6	6	0
Common Dab,	8	8	0
Common Sole,	2	2	0
Conger,	2 very large	..	..
Grey Skate,	1	1	0
Thornback,	1	1	0

Net torn. 1 Piper, 1 Plaice, 3 Common Dabs, *at least*, escaped.

Invertebrates.—Urchins (*E. esculentus*).

AUGUST 16.

Station **107.**—KENMARE RIVER. 8 to 5 fathoms. Mud. 50 minutes. 28 foot Beam. Patent Net.

Plaice, . . .	2	mature.
Common Sole, . .	1	mature.

Invertebrate.—Common Starfish (violet variety). Sponges.

AUGUST 16.

Station **108.**—KILMAKALOGUE BAY. Shrimp Trawl.

Black Goby, . . .	3	
Freckled Goby, . .		numerous.
Dragonet, . . .	3	young.
Whiting, . . .	3	small.
Dab, . . .	3	small.

Invertebrates.—Common Starfish. Brittle Stars (*O. lacertosa*). Shrimps (*Crangon*). Prawns (*Palæmon*). Hermits. Swimming Crabs (*P. arcuatus*). *Philine aperta Bulla.* Scallops (*Pecten*). Razor Shells (*Solen*).

AUGUST 18.

Station **109.**—KENMARE RIVER. $2\frac{1}{2}$ fathoms. Mud. Shrimp Trawl.

Grey Gurnard, . .	1	
Black Goby . . .	29	
Pollack, . . .	5	
Plaice, . . .	5	very small.
Common Dab, . .	58	
Sole, . . .	1	immature; small.

Invertebrates.—Sponges. *Virgularia. Podocoryne* (with Hermits). Common Starfish. Common Shrimps. Swimming Crabs. Cockles. Mussels. *Mactra. Corbula. Nucula. Philine.* Whelks. Dog Whelks. Ascidians.

AUGUST 18.

Station **110.**—KENMARE RIVER, off Blackwater. 10 to 13 fathoms. Mud. 1 hour. 28 foot Beam. Patent Net.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . . .	1	1	0
Plaice, . . .	4	2	2
Common Dab, . . .	1	1	0
Common Sole, . . .	6	6	0
Conger, . . .	2 large.	0	0
Small-spotted Dog, . .	1	..	..
Thornback . . .	2	..	..

Invertebrates.—Sea Cucumbers (*C. pentactes*). Urchins (*E. miliaris*. Squids (*Loligo*).

AUGUST 18.

Station **111.**—KENMARE RIVER, off Blackwater. 13 fathoms. Mud. Shrimp Trawl.

Common Dab, . . 8 small.

Invertebrates.—Brittle Stars (*O. lacertosa*). Common Shrimps. Hermits. Cockles. *Mactra solida.* *Nucula.* *Terebra.* *Venus.* *Philine.*

AUGUST 28.

Station **112.**—KENMARE RIVER. 25 to 23 fathoms. Mud and sand. 75 minutes. 28 feet Beam. Patent Net.

	Gross No.	No. Mature.	No. Immature.
Piper, . . .	8	8	0
Hake, . . .	1	1	0
Brill, . . .	1	1	0
Witch, . . .	55	45	10
Plaice, . . .	8	0	8
Common Dab, . .	2	2	0
Common Sole, . .	5	5	0
Thornback, . .	2	2	0

AUGUST 19.

Station **113.**—OFF THE SKELLIGS. 80 fathoms. Mud and sand. Long Lines.

	Gross No.	No. Mature.	No. Immature.
Haddock, . . .	1	1 fine.	0
Ling, . . .	3	3	0
Picked Dog, . .	24	..	..
Spinous Shark, . .	1 (96 in. in length).		0
Grey Skate, . .	5	5	0
Shagreen Ray, . .	2	2	0

AUGUST 19.

Station **114.**—OFF THE SKELLIGS. 80 fathoms. Sand and mud. 45 minutes. Shrimp Trawl.

Gobies, many, ...	small.
Dragonet, ...	1 very small.
Silvery Pout, many, ...	all small.
Hake, ...	3 very small.
Long Rough Dab, ...	20 very small.
Witch, ...	4 small.
Lemon Dab, ...	2 very small.
Pole Dab, ...	5 very small.

Invertebrates.—Foraminifera (*Astrorhysa*). Sponges and *Podocoryne* (with Hermits). Anemones (*Peachia, Actinauge, Bunodes coronata*). Lingthorns (*L. savignii* and *L. sarsii*, Heart Urchins (*Amphidotus roseus*). *Neomenia.* Common Shrimps. Prawns. *Pycnogonum littorale.* *Lyonsia.* *Isocardia cor* (young). Squids (*Sepiola* and *Loligo*).

AUGUST 20.

Station **115**.—OFF THE SKELLIGS. 62 to 52 fathoms. Mud and sand. 1 hour. 48 foot Beam. Patent Net, with large muslin net inside.

	Gross No.	No. Mature.	No. Immature.
Piper, . . .	4	4	0
Dragonet, . . .	1	0	0
Silvery Pout, (*G. argenteus*),	many,		all.
Hake, . . .	3	1	2 small.
Long Rough Dab, . .	16	0	16 very small.
Witch, . . .	12	11	1 small.
Scaldfish, . . .	2	2	
Common Sole, . .	1	0	

Invertebrates.—Sponges, *Phakellia ventrilabrum*. Common Starfish. Common Shrimps. Small Macrourous Decapod Crustaceans. *Isocardia cor* (1 valve).

AUGUST 21.

Station **116**.—BALLINSKELLIGS BAY. 5 to 8 fathoms. Sand. 1 hour. 28 foot Beam. Patent Net.

	Gross No.	No. Mature.	No. Immature.
Sapphirine Gurnard, . .	1	1	0
John Dory, . . .	1	1	0
Turbot, . . .	1	0	1
Plaice, . . .	5	0	5
Common Dab, . .	1	..	..
Common Sole, . .	2	2	0

AUGUST 21.

Station **117**.—BALLINSKELLIGS BAY. 6 fathoms. Sand. 10 minutes. Otter Trawl.

	Gross No.	No. Mature.	No. Immature.
Turbot, . . .	1	0	1
Plaice, . . .	35	14	21
Common Dab, . .	4	4	0

The Net was inside out, so that the pockets were outside. This may account for the absence of soles.

AUGUST 21.

Station **118**.—BALLINSKELLIGS BAY. 32 to 28 fathoms. Soft mud. 1 hour. 28 foot Beam. Patent Net, with large muslin net inside.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . .	1	1	0
Dragonet, . . .	1	..	..
Crystallogobius, . .	very many,	..	..
Witch, . . .	9	2	7 some very small.
Common Dab, . .	10	most.	..
Common Sole, . .	1	1	0
Thornback, . . .	2	2	0

Other small fish. Gobies, &c.

Invertebrates.—*Halcampa arenaria*. *Caryophillia*. Common Starfish. Brittle Stars (*O. lacertosa*).

AUGUST 23.

Station **119.**—BALLINSKELLIGS BAY. 1 to 2 fathoms. 15 minutes. Clean sand. Shrimp Trawl.

Dragonet,	2 immature.
Sea Sticklebacks,	5
Wrasse,	5 very small.
Pollack,	6 very small.
Plaice,	21 small.
Common Dab,	3 very small.

Invertebrates.—Anemones (*A. cereus*). Shrimps (*Crangon and Hippolyte*).

AUGUST.

Station **120.**—NEAR HORSE ISLAND, BALLINSKELLIGS BAY. 1 to 4 fathoms. Sand with zostera. Shrimp Trawl.

Black Goby,	many.
Freckled Goby,	many.
Dragonet,	4 small.
Sea Stickleback,	3
Wrasse,	11 very small.
Cod,	1 very small.
Pollack,	5 very small.

Invertebrates.—*Hippolyte varians. Trochus zizyphinus.*

AUGUST.

Station **121.**—NEAR HORSE ISLAND, BALLINSKELLIGS BAY. 3 to 5 fathoms. 15 minutes. Sand with zostera. Shrimp Trawl.

Gobies,
Dragonet,
Sticklebacks,
Snake Pipe-fish,
Worm Pipe-fish.

Station **121** A.—INSIDE THE NYMPH BANK, OFF BALLYCOTTIN. 41 fathoms. Sand. 25 foot Beam. Patent Net, with large muslin net inside.

Scaldfish. Some mature. Some very small.

Many other fish. No record was kept, as this Station is not included in the West Coast district.

MARCH 21, 1891.

Station **122.**—OFF BULL ROCK. 55 fathoms. 3 hours. Trawl capsized.

Dragonet, ... 1 small.

Invertebrates.—Hydroids. Brittle Stars (*O. lacertosa* and *Amphiura*). Fragments of Urchins. Nemerteans (*Carinella annulata*, and others). *Polyopthalmus. Lagis korani*, &c. *Neomenia? Nebalia.* Amphipods. Shrimps (*C. vulgaris, C. spinosus* and *C. fasciatus?*). *Galathœa nexa.* Hermits. Swimming Crabs (*Portunus*). *Ebalia. Tellina. Pinna* (fragments). *Scaphander. Bulla. Natica catena. Scalaria. Fusus.*

MARCH 21, 1891.

Station **123.**—BALLINSKELLIGS BAY. 35 to 27 fathoms. Sand. 1 hour. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	8	6	2
Whiting,	1	1	0
Brill,	2	2	0
Turbot,	1	1	0
Plaice,	8	7	1
Lemon Dab,	1	..	..
Common Sole,	56	48	8
Small-spotted Dog,	1	..	..
Grey Skate,	2	2	0
Spotted Ray,	4	4	0
Thornback,	1	0	1

Invertebrates.—Common Starfish. Common Squids (*L. forbesii*).

MARCH 23.

Station **124.**—50 MILES W. OF BOLUS HEAD. 220 fathoms. White Coral. 25 foot Beam. 2 hours.

	Gross No.	No. Mature.	No. Immature.
Scorpæna dactyloptera,	3	0	3
Hake,	1	1	0
Witch,	7	7	0
Macrurus lævis,	1	0	0

Invertebrates.—White Coral (*Lophohelia prolifera*[1]), with associated Hydroids, Annelids, and Polyzoans (*Retipora*). Brittle Stars (*O. lütkeni*). Urchins (*Echinus*, *Spatangus raschii*, and *Cidaris papillata*). Sea Cucumbers (*H. tremula*).

MARCH 23.

Station **125.**—40 MILES W. of BOLUS HEAD. 115 fathoms. 1 hour. 18 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Angler,	1	1	0
Piper,	1	0	1
Hake,	3	2	1
Witch,	1	0	1
Sandy Ray,	1	0	1

A large stone came up nearly to the surface, and then broke through the net. No fish were seen to escape.

Invertebrates.—Common Starfish (one). *Ophiothrix lütkeni*. *Astropecten ?* Urchins (*S. raschii* and *C. papillata*). Hydroid (*Eudendrium ?*)

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[1] This coral appears to be new to the Irish Fauna.

MARCH 28.

Station **126.**—KENMARE RIVER. 26 fathoms. Mud. $1\frac{3}{4}$ hours. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	2	1	1
Cod,	2	2	0
Haddock,	2	1	1
Whiting,	5	5	0
Ling,	1	1	0
Plaice,	7	3	4
Lemon Dab,	2	2	0
Common Dab,	2	2	0
Common Sole,	22	22	0
Small-spotted dog,	1	..	..
Thornback,	7	1	6

MARCH 28.

Station **127.**—KENMARE RIVER. 21 fathoms. Mud. 1 hour. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	2	1	1
Haddock,	1	1	0
Whiting,	4	2	2
Plaice,	5	3	2
Lemon Dab,	1	1	0
Common Dab,	39	35	4
Flounder,	2	2	0
Common Sole,	12	12	0
Grey Skate,	3	3	0
Spotted Ray,	1	1	0
Thornback,	3	2	1

Invertebrates.—Starfish (*A. rubens* and *A. glacialis*). Lingthorns (*L. savignii*). Brittle Stars (*Amphiura* and *O. lacertosa*). *Astropecten irregularis*. Urchins (*E. esculentus* and *Spatangus purpureus*, dead). Sea Cucumbers (*C. pentactes* and *C. sp. ?*). Sea Mice (*Aphrodite aculeata*). Eggs of Skate Leech (*Pontobdella*). *Galathœa nexa*. Norway lobsters (*Nephrops*). Hermits. Spider crabs. (*I. dorsettiensis*). *Gonoplax* Squids (*L. media*).

Much weed (*L. saccharina* and *L. digitata*) in trawl.

MARCH 28.

Station **128.**—KENMARE RIVER, near Blackwater. 10 fathoms. Mud. 1 hour 20 minutes. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Brill,	2	2	0
Plaice,	6	2	4
Common Dab,	13	10	3
Flounder,	1	1	0
Spotted Ray,	1	1	0
Thornbacks,	4	4	0

Net choked with mud and weeds. Invertebrates as in last Station.

MARCH 30.

Station **129.**—DUNKERRON, KENMARE RIVER. 4 to 5 fathoms. Mud. Thrimp Trawl.

	Gross No.	No. Mature.	No. Immature.
Spotted Goby, . .	8	..	..
Whiting, . . .	1	0	1
Common Dab, . .	5	0	5

Invertebrates.—*Alcyonidium gelatinosum*, Common Shrimps. Hermits (*P. bernhardus*). *Porcellana longicornis*. Spider Crabs (*H. araneus* and *I. dorsettiensis*). Shore Crabs. Common Mussels. Scallops (*P. opercularis*). *Astarte*. *Mactra subtruncata*. Common Whelks. Dog Whelks (*Nassa*). *Philine*. Ascidians.

MARCH 30.

Station **130.**—KENMARE RIVER, off Sneem. 24 fathoms. Mud. 2 hours. Patent Trawl. 25 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Pole Dab, . . .	1	1	0
Common Dab, . .	1	1	0
Thornback, . .	1	1	0

Freckled Goby. *Crystallogobius nilssonii*. Scaldfish, small (In muslin bag).

MARCH 30.

Station **131.**—KENMARE RIVER (mouth). 45 to 48 fathoms. Sand. hours. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . .	20	18	2
Piper, . . .	4	4	0
Angler, . . .	1	1	0
Long Rough Dab, . .	1	1	0
Plaice, . . .	1	0	1
Common Sole, . .	4	4	0
Conger, . . .	1 large.	..	..
Picked Dog, . . .	1	..	..
Grey Skate, . .	4	4	0
Spotted Ray, . .	5	5	0
Thornback, . . .	4	4	0

Invertebrates.—Common Starfish. *Astropecten*. *Cymothoa*. *Atelecyclus heterodon*. *Gonoplax*. Sea Mice (*Aphrodite*). *Turritella*. *Aporrhais*.

March 31.

Station **132.**—BALLINSKELLIGS BAY. 23 to 29 fathoms. Sand and rock. 1 hour 50 minutes. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	3	1	2
Cod,	1	1	0
Turbot,	1	1	0
Plaice,	1	0	1
Lemon Dab,	1	1	0
Common Sole,	31	30	1
Small-spotted Dog,	1	..	..
Grey Skate,	1	0	1
Spotted Ray,	2	2	0
Thornback,	1	1	0

Crystallogobius (in muslin bag).

Invertebrates.—Brittle Stars (*O. lacertosa*). Sea Mice (*Aphrodite*). Lugworms. Gammarids. *Atelecyclus. Tellina.*

March 31.

Station **133.**—DINGLE BAY. 40 fathoms. Sand and rock. 1 hour 50 minutes. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	23	22	1
Poor Cod,	1	1	0
Pollock,	1	1	0
Hake,	1	0	1
Lemon Dab,	2	2	0
Common Sole,	2	2	0
Thickback,	1	..	..
Picked Dog,	1	..	..
Grey Skate,	2	2	0
Spotted Ray,	1	0	1
Thornback,	4	4	0

Invertebrates.—Deadmen's fingers (*Alcyonium*). Common Starfish. Lingthorns (*L. savignii*). *Astropecten. Henricia.* Cushion Star (*Goniaster*). Prawns (*P. serratus*). Squids (*L. media* and *Sepiola*). *Tritonia hombergii.*

April 1.

Station **134.**—S. W. CORNER OF SMERWICK HARBOUR. Seine on sandy margin.

	Gross No.	No. Mature.	No. Immature.
Sand Smelt,	6	5	1
Sandeels,	many.	..	all small.
Plaice,	4	0	4
Herring,	6	0	6 post-larval.

APRIL 2.

Station **135**.—SMERWICK HARBOUR. 6 to 8 fathoms. Sand. Shrimp Trawl. 20 minutes.

	Gross No.	No. Mature.	No. Immature.
Common Dab,	3	2	1
Flounder,	1	1	0

APRIL 2.

Station **136**.—OFF LOOP HEAD. 70 fathoms. Sand. Long Lines. 1 hour 10 minutes.

	Gross No.	No. Mature.	No. Immature.
Cod,	5	5	0
Haddock,	1	1	0
Coalfish,	43	43	0
Ling,	3	3	0
Conger,	5 large.	..	..
Small-spotted Dog,	6	..	..
Tope,	3	..	..
Picked Dogfish,	1	..	..
Grey Skate,	1	1	0
Shagreen Ray,	2	2	0
Thornback,	12	12	0

APRIL 3.

Station **137**.—CASHEEN BAY. 7 fathoms. Mud. ½ hour. Otter Trawl from Hooker.

	Gross No.	No. Mature.	No. Immature.
Plaice,	2	2	0
Common Sole,	1	1	0
Thornback,	1	1	0

Invertebrates.—Cotton Spinner (*Holothuria nigra*).

APRIL 3.

Station **138**.—KILKIERAN BAY. 5 fathoms. Mud and coral. Shrimp Trawl.

Short-spined Bullhead,
Long-spined Bullhead,
Speckled Goby,
Freckled Goby,
Corkwing;
Broad-nosed Pipefish,
Thornback, 3 (2 immature),
15-spined Stickleback, 1,
Pollack, 1 immature.

Invertebrates.—Brittle Stars (*O. nigra* and *O. pentaphyllum*). *Antedon rosacea.* Urchins (*E. esculentus*). *Phyllodoce viridis.* Planarians. Common Shrimps. Prawns (*Pandalus*). *Hippolyte varians.* Hermits. Spider Crabs (*S. rostratus. I. dorsettiensis. H. araneus* and *H. coarctatus*). Swimming Crabs (*P. arcuatus* and *P. corrugatus*). Gammarids. *Caprella.* Scallops (*P. opercularis* and *P. maximus*). *Anomia.* Common Whelks. Dog Whelks (*Nassa*). *Turritella terebra.* Ascidians. *Clavellina*, &c.

APRIL 6.

Station **139.** MASON ISLAND, ROUNDSTONE. Seine net.

Sandeels, . . . a few.

APRIL 6.

Station **140.**—ROUNDSTONE. Two hauls of Shrimp Trawl. 1st. Coral bottom. 2nd. Mud and weeds.

Gunnel,
Freckled Goby.

Invertebrates.—1st haul: *Antedon. Glycera,* &c.

,, 2nd haul: Common Starfish (violet variety). Brittle Stars (*O. lacertosa* and *O. albida*). *Glycera. Polyopthalmus.* Spider Crabs (*Maia squinado. S. rostratus* and *I. dorsettiensis*). *Philine. Scaphander lignarius,* &c. Ascidians.

APRIL 7.

Station **141.**—WEST OF INISHMORE (Aran Island). 52 to 56 fathoms. Mud and sand. $4\frac{1}{4}$ hours. Long Lines.

	Gross No.	No. Mature.	No. Immature.
Cod, . . .	2	2	0
Coalfish, . . .	4	4	0
Ling, . . .	2	2	0
Small-spotted Dog, . .	4	..	..
Tope, . . .	1	..	..
Shagreen Ray, . .	1	1	0
Thornback, . . .	6	5	1

APRIL 7.

Station **142.**—WEST OF INISHMORE (Aran Island). 50 fathoms. 48 foot Beam.

Trawl shot upside down.

Invertebrates.—*Epizoanthus incrustans* (with Hermits). Lingthorns (*L. sarsii*). *Synapta. Carinella annulata.* Spider Crabs (*Stenorhynchus*). *Ebalia. Scaphander lignarius.* Spawn of ditto? *Philine. Natica. Turritella.*

APRIL 7.

Station **143.** WEST OF INISHMORE (Aran Island). 46 to 44 fathoms. 50 min. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Gurnard, . . .	8	4	4
Haddock, . . .	3	3	0
Ling, . . .	1	0	1
Long Rough Dab, . .	1	1	0
Witch, . .	1	1	0
Pole Dab, . .	1	0	1
Thornback, . .	2	2	0
Skate, . .	3	..	..

APRIL 7.

Station **144.**—WEST OF INISHMORE (Aran Island). 4½ hours.

12 mackerel caught by Glothogues off Aran Island.

APRIL 8.

Station **145.** KILLEANY BAY. Naturalist Trawl.

APRIL 8.

Station **146.**—6 MILES S.W. OF GREGORY SOUND. 38 fathoms. Soft mud. 1 hour 17 minutes. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Red Gurnard,	1	1	0
Sapphirine,	1	1	0
Grey Gurnard,	14	12	0
John Dory,	7	..	some.
Cod,	3	3	2
Haddock,	12	12	0
Poor Cod,	1	1	0
Whiting,	11	11	0
Norway Pout,	1	1	0
Pollack,	6	6	0
Hake,	4	4	0
Ling,	1	1	0
Long Rough Dab,	1	0	1
Turbot,	3	3	0
Brill,	1	1	0
Pole Dab,	4	..	some.
Dab,	1	1	0
Solanette,	1	1	0
Conger,	9	..	..
Small-spotted Dog,	6	..	..
Sandy Ray,	1	1	0
Thornback,	6	6	0
Sharpnosed Skate,	1	..	..

APRIL 8.

Station **147.**—SOUTH SOUND, ARAN ISLANDS. 25 to 20 fathoms. Sand. 1½ hour.

	Gross No.	No. Mature.	No. Immature.
Gurnard,	300	3	297
John Dory,	1	0	1
Dragonet,	5	5	0
Poor Cod,	1	..	..
Whiting,	5	5	0
Turbot,	1	0	1
Scald Fish,	1	0	0
Dab,	29	15	14
Sole,	7	4	3
Solanette,	7	2	5
Spotted Ray,	3	..	..
Thornback,	5	2	3

April 9.

Station **148.**—7 MILES S.S.W. OF GREGORY SOUND. 38 fathoms. Sand. 1½ hour. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Gurnard,	11	8	3
Angler,	2	..	..
John Dory,	1	0	1
Cod,	2	2	0
Haddock,	2	2	0
Whiting,	4	4	0
Pollack,	2	2	0
Ling,	1	1	0
Long Rough Dab,	5	5	0
Turbot,	1	1	0
Brill,	1	1	0
Witch,	1	1	0
Lemon Dab,	1	1	0
Dab,	4	2	2
Skate,	2	2	0
Shagreen Ray,	1	1	0
Thornback,	1	1	0
Small-spotted Dog,	5	..	..
Picked Dog,	2	..	..
Conger,	6 large.	..	..

Invertebrates.—Hydroids. Common Starfish. Lingthorn (*Luidia*). Astropecten. Shrimps. *Mysis*. Edible crabs. Ascidians.

April 9.

Station **149.**—5 MILES W.S.W. OF GREGORY SOUND. 39 to 36 fathoms. Sand. 48 foot beam. 1 hour.

	Gross No.	No. Mature.	No. Immature.
Sapphirine Gurnard,	1	1	0
Gurnard,	17	13	4
Cod,	1	1	0
Haddock,	1	1	0
Whiting,	2	2	0
Pollack,	2	2	0
Long Rough Dab,	3	..	..
Brill,	1	1	0
Pole Dab,	1	0	1
Common Dab,	2	2	0
Conger,	1 large.	..	..
Small-spotted Dog,	3	..	..
Picked Dog,	6	..	..
Shagreen Ray,	1	..	..
Thornback,	2	1	1
Spotted Ray,	1	1	0

APRIL 14.

Station **151.**—LOUGH ATALIA, GALWAY. Shore collecting at low tide.

Freckled Gobies. Young Freshwater Eels. Gunnels.	Very common in pools.

Prawns. Very numerous in Zostera Beds.[1]
Beds of young mussels around piers of bridge.

APRIL 15.

Station **152.**—GALWAY BAY. 15 fathoms. Sand. Shrimp Trawl. 20 minutes.

	Gross No.	No. Mature.	No. Immature.
Armed Bullhead,	..	..	..
Freckled Goby,	..	..	..
Dragonet,	..	..	..
Scaldfish,[2]	26	0	all small
Common Dab,	4	0	4
Solanette,	17	5	12

Invertebrates.—Hydroids. Common Starfish (violet variety). Brittle stars (*O. lacertosa*). *Astropecten irregularis.* Zoeœ. Spider Crabs (*Stenorhynchus*). Mask Crabs (*Corystes*). Hermits (in *Natica* shells). Scallops (*P. opercularis*). Dog Whelks. Periwinkles (*S. littoralis*). *Scaphander lignarius.* Squids (*Sepiola*).

APRIL 15.

Station **153.**—GALWAY BAY. 17 to 19 fathoms. Soft mud. 2 hours. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	6	1	5
John Dory,	3	1	2
Dragonet,	1	..	..
Cod,	1	1	0
Haddock,	5	5	0
Whiting,	1	1	0
Pollock,	1	1	0
Halibut,	1	1	0
Plaice,	5	2	3
Lemon Dab,	13	13	0
Common Dab,	36	11	25
Common Sole,	3	2	1
Solanette,	3	0	3
Small spotted Dog,	1	..	..
Thornback,	4	4	0
Smooth Hound,	1	..	..

Invertebrates.—Hydroids (*Antennularia antennina*). Deadmen's fingers (*Alcyonium*). Starfish (*A. rubens*, violet, and *A. glacialis*). Brittle Stars (*O. lacertosa*). *Astropecten irregularis.* Mask Crabs (*Corystes*). Swimming Crabs. Spider Crabs (*Maia squinado*, *S. rostratus*, and *Inachus dorsettiensis*). Scallops (*P. opercularis*). Whelks. Eggs of Whelk. Ascidians.

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[1] These beds seem to furnish the supply of prawns for the Corrib river anglers.

[2] We were informed by the Galway fishermen that we should catch great numbers of very young turbot and brill here. Perhaps they so designate small scaldfish.

April 15.

Station **154**.—WEST OF FOUL SOUND, Aran Island. 33 fathoms. Sand. 40 minutes. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	1	0	1
Angler,	2	2	0
Poor Cod,	1	1	0
Whiting,	1	1	0
Plaice,	1	1	0
Pole Dab,	1	1	0
Common Dab,	2	2	0
Sole,	1	1	0
Small-spotted Dog,	1	..	..
Thornback,	1	0	1
Spotted Ray,	1	0	1

Invertebrates.—Common Starfish (*violet*). Edible Crabs. Two Killers (*Orca gladiator*) and a Basking Shark were seen at the surface.

April 15.

Station **156**.—MOUTH OF KILLEANY BAY, INISHMORE. Mackerel Nets. Set all night.

	Gross No.	No. Mature.	No. Immature.
Ballan Wrasse,	1	1	0
Corkwing,	2	2	0
Coal-fish,	2	0	2
Pollack,	34	4	30

April 16.

Station **157**.—GREATMAN'S BAY. 3 to 4 fathoms. Coral (*nullipores*). Shrimp Trawl.

Freckled Goby.	1
Dragonet,	1
Double-spotted Sucker,	1

Invertebrates.—Anemones (*A. cereus*). Common Starfish (violet). Lingthorn (*L. savignii*). Brittle Stars (*O. lacertosa*). Urchins (*E. miliaris*). Sea Cucumber (white). Spider Crabs (*H. araneus* and *S. rostratus*). Swimming Crabs. Hermits. Shrimps (*C. vulgaris* and *C. fasciatus*?). Sea Hare (*Aplysia*). *Turritella terebra*, *Venus gallina*, &c.

April 16.

Station **158**.—Shore collecting at low tide in GREATMAN'S BAY. A few Shannies in the pools. Prawns very numerous. Urchins (*Strongylocentrotus lividus*) very numerous. The rocks are granite. The Urchin does not make holes, but seeks shelter under or between large stones. Periwinkles and *Trochus* very numerous. The Periwinkles are here collected for sale.

APRIL 17.

Station **159.**—CLEGGAN BAY. 4 to 9 fathoms. Sand. 1 hour. 48 foot Beam. Net choked with weeds or mud.

	Gross No.	No. Mature.	No. Immature.
Gurnard, . . .	2	1	1
Ballan Wrasse, . .	5	5	0
Plaice, . . .	60	13	47
Lemon Dab, . . .	3	3	0
Common Sole, . .	4	4	0
Small-spotted Dog, . .	2	..	..
Thornback, . . .	6	4	2
Spotted Ray, . .	1	1	0

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APRIL 17.

Station **160.**—BOFFIN HARBOUR. 1 to 2 fathoms. Sand and weeds. Shrimp Trawl.

Long-spined Bullheads.
Spotted Gobies.
Goby.
Dragonet. Several. All immature.
Corkwings. Several. All immature.
Plaice. 1. Immature.
Sea Sticklebacks.
Worm Pipe-fish.
Great Pipe-fish.

Invertebrates.—Anemones (*Anthea*). Lingthorn (*L. savignii*). Scalebacks (*Harmothoe*). *Idotea*, Shrimps, Prawns. Hermits, in *Turritella* and *Natica* shells, with *Podocoryne carnea* on latter. Spider Crabs (*H. araneus*, *S. rostratus*, and *I. dorsettiensis*). Swimming Crabs (several species). Shore Crabs. Sea Hares. Common Limpets. Squid *Sepiola*).

Numbers of young sandeels were seen at the sandy margins.

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APRIL 18.

Station **161.**—Long lines off BOFFIN. 5 to 10 fathoms. Sand and rocks. Down all night.

	Gross No.	No. Mature.	No. inmature.
Pollack, . . .	1	1	0
Congers, . . .	4 large.	..	..
Picked Dogs, . .	2	..	..
Grey Skate, . . .	1	1	0
Thornback, . . .	1	1	0

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APRIL 18.

Station **162.**—Mackerel nets outside FORT ISLAND all night. No fish caught. Nets slimy and offensive, with dark-green vegetable matter.

APRIL 18.

Station **163.**—CLEW BAY. 13 to 15 fathoms. $2\frac{1}{2}$ hours. **48** foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	9	9	0
Plaice,	9	1	8
Lemon Dab,	1	1	0
Common Dab,	37	31	6
Common Sole,	32	30	2
Small-spotted Dog,	1	..	..
Thornback,	22	18	4
Spotted Ray,	1	1	0

APRIL 20.

Station **164.**—CLEW BAY. 18 fathoms. Sand. 48 foot Beam. $1\frac{1}{2}$ hours.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	8	8	0
Whiting,	4	4	0
Coal-fish,	1	1	0
Pollack,	1	1	0
Brill,	1	1	0
Plaice,	15	2	13
Common Dab,	5	5	0
Common Sole,	4	4	0
Small-spotted Dog,	1	..	..
Thornback,	6	6	0

Net choked with large Jelly-fish. *Aurelia* and *Cyanœa.*

Invertebrates.—Common Starfish.

APRIL 20.

Station **165.**—28 miles N.W. OF ACHILL HEAD. 154 fathoms. Sand. Long lines. Down 2 hours 45 minutes.

	Gross No.	No. Mature.	No. Immature.
Haddock,	2	2	0
Ling,	5	5	0
Small-spotted Dog,	1	..	..
Picked Dog,	23	..	..
Tope,	8	..	..
Black-mouthed Dog,	3	3	0
Grey Skate,	1	1	0
Shagreen Ray,	1	..	..
Sandy Ray,	1	1	0

Invertebrates.—*Cidaris papillata.* Great numbers of *Cymothoa,* and various Amphipods came up on the lines. Many of the fish were almost entirely devoured by them.

April 20.

Station **166**.—28 miles off ACHIL HEAD. 154 fathoms. Sand. 2 hours 45 minutes. 18 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Scorpœna dactyloptera,	1	0	1
Haddock,	3	3	0
Ling,	2	2	0
Macrurus lævis,	8	..	..
Witch,	47	44	3
Conger,	1 large.	..	..
Sandy Ray,	1	1	0

Invertebrates.—Urchins (*Cidaris papillata* and *Spatangus raschii*) very abundant. A few sea-cucumbers (*H. tremula*).

April 21.

Station **167**.—BLACKSOD BAY. 3 to 4 fathoms. Sand. Naturalist's and Shrimp Trawls.

Armed Bull Head, Plaice, Common Dab,	All small.
Freckled Goby, &c.	

Invertebrates.—Sponges (*G. compressa*). Common Starfish (red and violet varieties). Brittle Stars (*O. lacertosa*). Idotea. Shrimps (*C. vulgaris* and *C. fasciatus*). Hermits in shells of periwinkles (*L. littorea* and *L. littoralis*). *Philine aperta*. *Eggs of Natica*. Squid (*Sepiola*).

April 21.

Station **168**.—BLACKSOD BAY. 5 to 7 fathoms. Sand. 1 hour 35 minutes. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Turbot,	1	0	1
Brill,	1	1	0
Plaice,	18	3	15
Common dab,	17	16	1
Common sole,	18	17	1
Thornback,	40	23	17
Spotted ray,	2	1	1
[1]Owl ray,	1	1	0

Invertebrates.—Hydroids (*A. antennina*, *Sertularia*, and *Sertularella*). Common Starfish. Lingthorn. *Henricia sanguinolenta*. Brittle Stars (*Ophiothrix*). Urchins (*E. miliaris*). Worms (*Chœtopterus*, *Spirorbis*, *Terebella*, etc.). Gammarids, Hermits in *Turritella* and other shells with sponge (*Suberites domunculus*). Shrimps. Spider Crabs (*H. araneus* and *H. coarctatus*). Edible Crabs. Razor Shells (*S. ensis*). Horse Mussels. Scallops (*P. opercularis*). Oysters (very large). *Philine aperta*. Ascidians (*C. intestinalis*, etc., and *Botrylloides*).

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[1] *Raia microcellata* (Mont).

April 21.

Station **169.**—BLACKSOD BAY. 5 to 7 fathoms. Sand. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Plaice, . . .	46	5	41
Lemon Dab, . . .	3	3	0
Common Dab, . .	8	5	3
Common Sole, . .	5	5	0
Small-spotted Dog, . .	4	..	..
Grey Skate, . . .	4	..	..

April 23.

Station **170.**—OFF DUGORT BAY. 4 to 5 fathoms. Sand. Mackerel nets down all night.

One very small Lumpsucker.

April 23.

Station **171.**—OFF DUGORT BAY. 5 fathoms. Sand. Long lines down all night.

Conger, . . .	1	large
Small-spotted Dog, . .	6	
Picked Dog, . . .	1	
Flapper Skate, . .	2	large

April 23.

Station **172.**—DUGORT BAY. Seine net on sandy margin.

Sandeels, very many.
Plaice, 2 } Immature.
Flounder, 6 }
Lemon Sole, 1

April 23.

Station **173.**—FRENCH PORT. 1 to 3 fathoms. Sand. Shrimp Trawl.

	Gross No.
Freckled Goby, . .	1
Pollack, . . .	3 very small.
Plaice, . . .	36 very small.

Invertebrates.—Anemones (*Anthea cereus*). Common Starfish. Common Shrimps. Hermits. Shore Crabs. Razor Shells (*S. siliqua*).

April 23.

Station **174.**—FRENCH PORT. Seine, with sprat mesh bunt, on sandy margin, at high tide.

Nothing caught. Shells of Cockles and Gapers (*Mya*) on beach.

APRIL 24.

Station **175**.—BROADHAVEN, opposite Barrett's Point. Seine on sandy margin.

Brill, 1, very small.
Plaice, 1, very small.

APRIL 25.

Station **176**.—BROADHAVEN BAY. 25 to 19 fathoms. Fine sand. 1 hour, 20 minutes. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	21	5	16, nearly mature.
Crystallogobius,	3 (in tow-net on beam).		..
Turbot,	2	1	1
Plaice,	3	0	3
Common Dab,	31	19	12
Common Sole,	14	14	0
Small-spotted Dog,	1	..	..
Thornback,	5	5	0

Invertebrates.—Hydroids. *Astropecten irregularis.* Annelids. Nemertean (*Carinella annulata*). Swimming Crabs. Edible Crabs. *Flustra.*

APRIL 25.

Station **177**.—OFF DOWNPATRICK HEAD. 20 to 18 fathoms. Mud and sand. 1 hour. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	6	3	3
Haddock,	1	1	0
Brill,	1	1	0
Plaice,	1	0	1
Common Dab,	18	18	0
Thornback,	1	1	0
Spotted Ray,	4	4	0

Invertebrates.—Hydroids (*A. antennina*). Common Starfish (violet). *Astropecten irregularis. Carinella annulata.* Annelids.

APRIL 28.

Station **178**.—BLACKSOD BAY. 9 to $5\frac{1}{2}$ fathoms. Sand. 2 hours. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	2	2	0
Cod,	2	2	0
Pollack,	1	1	0
Turbot,	3	1	2
Brill,	9	9	0
Plaice,	39	25	14
Common Dab,	23	15	8
Common Sole,	23	23	0
Lemon Sole,	2	0	0
Thornback,	8	4	4
Spotted Ray,	16	15	1
Owl Ray,	1	1	0

APRIL 28.

Station **179.**—BLACKSOD BAY. 5 fathoms. Sand. 30 minutes. Shrimp Trawl.

Freckled Goby,	1	
Scaldfish,	2	small.
Common Dab,	9	small.
Solanette.	2	1 mature, 1 immature.

Invertebrates (including Station **178**) —Hydroids (*Obelia geniculata* and *Sertularians*). Brittle Stars (*O. lacertosa* and *O. pentaphyllum*). Urchins (*E. miliaris*). Common Starfish (red and violet varieties). *Henricia sanguinolenta.* Annelids. Common Shrimps. Gammarids. Hermits (*P. bernhardus*). Hermits in *Turritella* and other shells with sponge (*Suberites domunculus*). Spider Crabs (*M. squinado, S. rostratus,* and *H. coarctatus*). *Porcellana longicornis. Psammobia ferroensis. Pectunculus glycimeris* (very large). Razor Shells (*S. ensis*). Horse Mussels. Whelks. *Natica montacuti. Aporrhais pespelicani. Turritella terebra* (very large). Periwinkles (*L. littoralis*). *Philine aperta.* Ascidians (*C. intestinalis,* &c.).

APRIL 29.

Station **180.**—OFF BALLYNAKILL. 14 fathoms. Sand and gravel. 1 hour. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	1	1	0
Crystallogobius,	1 (in tow-net on beam).		
Cod,	1	1	0
Pollack,	1	1	0
Turbot,	1	0	1
Plaice,	14	4	10
Lemon Dab,	2	2	0
Common Dab,	8	6	2
Common sole,	6	6	0

Invertebrates.—Starfish (*A. rubens* and *A. glacialis*). Lingthorn (*L. savignii*). *Astropecten irregularis.* Edible Crabs. Spider Crabs (*S. rostratus*).

April 30.

Station **181.**—OFF DAVALAUN. 30 fathoms. Sand and rock. 38 minutes. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	3	1	2
Crystallogobius (in small nets),	..	..	..
Ling,	1	0	1
Common Dab,	2	2	0
Common Sole,	1	1	0

Invertebrates.—Sun-stars (*S. papposa*). Cushion Stars (*Goniaster*). Urchins *E. esculentus*). Common Starfish. Polyzoans (*Porella*).

April 30.

Station **182.**—CLEGGAN BAY. 8 to 11 fathoms. Soft mud. 1 hour. 48 foot beam.

	Gross No.	No. Mature.	No. Immature.
John Dory,	1	1	0
Sucker (*Lepadogaster bimaculatus*),	1	0	0
Ballan Wrasse,	7	7	0
Plaice,	20	11	9
Common Dab,	1	1	0
Small-spotted Dog,	1	..	..
Thornback,	1	..	..

Net choked with Oar weed and Tangles.

Invertebrates.—Brittle Stars (*O. lacertosa*, and *A. filiformis*). *Antedon rosaceus*. Hermits. *Trochus cinerarius*. Polyzoans. Sponges (*G. ciliata*). Ascidians.

May 1.

Station **183.**—Fine Mesh Crabpot in BALLYNAKILL HARBOUR.

Shore Crabs. Swimming Crabs (*P. corrugatus*). Spider Crabs (*H. araneus*).

Station **184.**—BALLYNAKILL HARBOUR. Tow-net two fathoms below surface. Jelly Fish *Sarsia tubulosa*, *Hybocodon*, and *Cydippe*). Copepods. Small Annelids. One egg of Lemon Dab.

May 2.

Station **185.**—BALLYNAKILL HARBOUR. ½ to 2 fathoms. Sand. Shrimp Trawl.

Short-spined Bullhead,	1
Long-spined Bullhead,	Many.
Freckled Goby,	4
Spotted Goby,	Many.
Lump-fish,	1 very small.
Gunnel,	1 very small.
Cod,	Several very small.
Coalfish,	12 very small.
Corkwing,	Many small.
Ballan Wrasse,	Many small.
Dragonet,	1 small.
Plaice,	11 very small.
Sea Stickleback,	
Broad-nosed Pipefish,	
Great Pipefish,	
Snake Pipefish,	
Worm Pipefish,	
Thornback,	Many very small.

Invertebrates.—Worms (*Polyopthalmus*, *Terebella*, and Nereids). Shore Crabs (many with *Sacculina*). Swimming Crabs (*P. puber*, and *P. corrugatus*). *Scrobicularia*. Scallops (*P. opercularis*).

May 4.

Station **186**.—BOFFIN HARBOUR. 5 fathoms. Sand. Shrimp Trawl.

	Gross No.
Gunnel,	5 very small.
Short-spined Bullhead,	1
Spotted Gobies,	..
Montagu's Sucker,	1
Sea Sticklebacks,	..

A great number of weeds, Tangle and Oar weed. Anemones (*Anthea cereus*).

May 4.

Station **187**.—CLEGGAN BAY. 4 to 5 fathoms. Sand. Shrimp Trawl. A short haul. No fish caught.

May 5.

Station **188**.—BLACKSOD BAY. 9 to 7 fathoms. Sand. 1 hour 15 minutes. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	1	1	0
Cod,	1	1	0
Turbot,	2	1	1
Plaice,	15	5	0
Common Dabs,	18	5	13
Sole,	13	11	2
Thornback,	7	0	7
Spotted Ray,	1	1	0

April 5.

Station **189**.—BLACKSOD BAY. 8 to 6 fathoms. Sand. 30 minutes. Shrimp Trawl.

Dragonets. Echinoderms and Molluscs.

May 5.

Station **190**.—BLACKSOD BAY. 4 fathoms. Mud and sand. 1 hour 20 minutes. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	4	4	0
Turbot,	1	0	1
Brill,	1	0	1
Plaice,	41	15	26
Common Dab,	12	12	0
Common Sole,	4	3	1
Thornback,	20	..	..
Spotted Rays,	11	..	..

MAY 5.

Station **191**.—NORTH OF CLEGGAN, BLACKSOD BAY. Long lines. Down all night.

	Gross No.
Conger,	4 large.
Small-spotted Dog,	9
Nurse Hound,	3
Tope,	1
Thornback,	1

MAY 6.

Station **192**.—BELLACRAGHER BAY. 19 fathoms. Soft black mud. Shrimp Trawl.

Armed Bullhead, Gobies, Gunnell, Common Starfish (violet). Annelids (*Glycera ?*). *Nucula nucleus.*

MAY 7.

Station **193**.—NORTH OF ACHILL ISLAND. 20 fathoms. Sand and rocks. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Dab,	3	1	2
Spotted Ray,	2	2	0

Trawl hitched.

Invertebrates.—Many Urchins (*E. esculentus*).

MAY 8.

Surface Net off BOFFIN.

MAY 8.

Station **195**.—OFF BOFFIN. Grey sand. Long lines, down all night.

	Gross No.	No. Mature.	No. Immature.
Cod,	1	1	0
Ling,	1	0	1
Conger,	5 large.	..	..
Picked Dog,	1	..	..

MAY 8.

Station **196**.—DAVALAUN SOUND. 16 to 13 fathoms. Sand and rock. 15 minutes. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Red Gurnard, . . .	1	1	0
John Dory, . . .	1	1	0
Cod, ...	1	1	0
Pollack, . . .	11	8	3
Turbot, . . .	1	1	0
Brill, . . .	1	1	0
Plaice, . . .	36	36	0
Thornback, . . .	1	1	0
Spotted Ray, . .	1	1	0

Invertebrates.—Great masses of sponge[1] (*Rhaphyras griffithsii*). Deadmen's Fingers (*A. digitatum*). Common Starfish. Urchins (*E. esculentus*). *Antedon rosaceus.* Cotton Spinners (*H. nigra*).

MAY 8.

Station **197**.—OFF INISHTURK. 24 fathoms. Sand and rock. 15 minutes. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Cod, ...	1	1	0
Whiting, . . .	1	1	0

Trawl hitched.

Invertebrates.—Star Fish (*A. glacialis*). Urchins (*E. esculentus*).

Station **198**.—Surface Net off CLARE ISLAND.

Station **199**.—SHIP SOUND, BOFFIN. 5 to 7 fathoms. Long lines, down all night.

	Gross No.	No. Mature.	No. Immature.
Ling, . . .	3	3	0
Conger, . . .	3 large.	..	..
Tope, . . .	1	..	..

Station **200**.—15 MILES W. OF CLARE ISLAND. 45 to 60 fathoms. Gravel. Long lines.

	Gross No.	No. Mature.	No. Immature.
Cod, ...	2	2	0
Ling, . . .	13	13	0
Conger, . . .	1 large.	..	..
Small-spotted Dog, . .	1	..	..
Picked Dog, . . .	25	..	..
Tope, . . .	8	..	..
Grey Skate, . . .	13	13	0
Thornback, . . .	7	7	0

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[1] A broken piece measured 20 inches × 17 × 8.

Station **201**.—45 MILES N. N. W. OF BLACK ROCK.[1] 500 to 375 fathoms. Sand and fine gravel. 3 hours 5 minutes. 18 foot Beam.

	Gross No.
Sharp-nosed Skate,	1 mature
Fork Beard,	1 rather large.

Invertebrates.—*Astropecten.* Urchins (*Cidaris papillata. Spatangus raschii, Echinus,* sp. Red). *Phormosoma placenta. Phormosoma?* sp. (Red). Sea Cucumber. (*H. tremula*). Crabs (*Anamathia*). Hermit with associated anemone. Lamp Shell (*Terebratula cranium*). Large Polynoids.

The Trawl was reversed during the course of the haul.

Station **202**.—45 MILES N.N.W. of BLACK ROCK. 275 fathoms. Sand and rock. 1 hour 20 minutes. 18 feet Beam.

Trawl carried away. No fish. A few Urchins (*C. papillata*) and *Galathœa nexa.*

Station **203**.—45 MILES N.N.W. of BLACK ROCK. 250 fathoms. 1 hour. Long Lines.

Torsk,	2
Black-mouthed Dog,	1
Shark (*Centrophorus squamosus*),	1

Invertebrates.—*Cidaris papillata.* Amphipods, &c.

MAY 14.

Station **204**.—DONEGAL BAY. 32 fathoms. Sand. 2 hours. 48 feet Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	14	14	0
Red Gurnard,	1	1	0
Cod,	1	1	0
Haddock,	25	25	0
Whiting,	9	9	0
Pollack,	1	1	0
Long Rough Dab,	8	8	0
Plaice,	7	5	2
Lemon Dab,	4	4	0
Pole Dab,	39	24	15
Common Dab,	140	140	0
Picked Dog,	10	..	..
Shagreen Ray,	1	..	..
Thornback,	4	0	4

Invertebrates.—Common Starfish. Lingthorn (*L. savignii*). *Astropecten irregularis.* Brittle Stars (*O. albida*). Annelids. Edible Crabs. Swimming Crabss Norway Lobsters (*Nephrops*). Squid (*L. media*).

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[1] An Island off the mouth of Blacksod Bay.

MAY 14.

Station **205**.—DONEGAL BAY. 30 to 19 fathoms. Mud and sand. 2 hours. 48 feet Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	16	16	0
Cod,	1	1	0
Haddock,	21	21	0
Whiting,	11	11	0
Pollock,	1	1	0
Ling,	1	1	0
Turbot,	1	1	0
Brill,	1	1	0
Plaice,	9	7	2
Lemon Dab,	5	5	0
Pole Dab,	16	16	0
Common Dab,	90	90	0
Common Sole,	2	2	0
Picked Dog,	48	..	..
Thornback,	1	..	..

Invertebrates.—Common Starfish. Norway Lobsters (*Nephrops*). Squids (*L. media*). Many Jellyfish (*Aurelia aurita*), in the trawl.

MAY 15.

Station **206**.—OUTER HARBOUR, KILLYBEGS. 14 to 16 fathoms. Stones and mud. 45 minutes. 18 foot Beam.

Common Dab,	1
Shagreen Ray,	1

Trawl torn. Many Jellyfish (*A. aurita*) in net.

Invertebrates.—Urchins (*E. esculentus*).

Station **207**.—OUTER HARBOUR, KILLYBEGS. 16 to 14 fathoms. Sand and mud. 1 hour. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	8	6	2
Plaice,	1	0	1
Lemon Dab,	4	4	0
Common Dab,	8	6 ?	2 ?
Common Sole,	3	3	0
Small-spotted Dog,	1	..	..
Thornback,	1	1	0
Spotted Ray,	3	2	1

Crystallogobius in bottom tow-net.

Invertebrates.—Cushion Stars (*Goniaster*). Urchins (*E. esculentus*). Cotton Spinners (*H. Nigra*). Norway Lobsters (*Nephrops*). Anemones (*Anthea*) and larval *Peachia ?* Jellyfish (*aurelia*). *Cydippe, Sarsia, Thaumantias*, &c., in bottom tow-net.

MAY 16.

Station **208**.—INNER HARBOUR, KILLYBEGS. 4 fathoms. Very dee black mud. Shrimp Trawl.

Shore Crabs and Ascidians.

MAY 16.

Station **209.** — INNER HARBOUR, KILLYBEGS, S. E. Corner $5\frac{1}{2}$ to 4 fathoms. Gravel and stones. Shrimp Trawl.

Freckled Gobies.
Young Coalfish.
Broad Scaldfish (*A. grohmanni*). 3 very small.

Much Tangle weed.

Invertebrates.—Starfish (*A. rubens* and *A. glacialis*). Brittle Stars (*O. pentaphyllum*). *Astropecten irregularis.* Annelids. Common Shrimps. Prawns (*Palæmon*). Hermits, with Sponge (*S. domunculus*). *Galathæa nexa.* Spider Crabs (*S. rostratus*). Shore Crabs. Swimming Crabs (*P. arcuatus*). *Porcellana longicornis. Aporrhais pesplicani. Lamellaria perspicua. Philine aperta.*

MAY 18.

Station **210.**—MOUTH OF KILLYBEGS HARBOUR. 5 to 7 fathoms. Mud Shrimp Trawl.

Nothing but Jelly-fish caught. *Aurelia*, *Cyanœa*, and *Cydippe.*

Station **211.**—Same place and date. Triangular midwater net at surface. A few young Gadoids, probably under umbrella of *Cyanœa.* Numerous Jellyfish, mostly *Cyanœa*, *Aurelia*, and *Cydippe.* A few Sarsia. Shoals of Herrings round the ship.

MAY 18.

Station **212.**—WEST OF ST. JOHN'S POINT, DONEGAL BAY. 30 to 31 fathoms. Sand, gravel, fine sand, and rock. 45 minutes. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . .	15	14	1
Cook Wrasse, . .	1	1	0
Haddock, . . .	3	3	0
Pollack, . . .	1	1	0
Brill, . . .	1	1	0
Norway Topknot (*Rhombus norvegicus*), . .	1	..	..
Plaice, . . .	2	0	2
Lemon Dab, . .	1	1	0
Common Dab, . .	25	20	5
Common Sole, . .	5	5	0
Spotted Ray, . .	1	1	0

Very young Gadoids, Flatfish, and Dragonet in bottom tow-net.

Invertebrates.—Larval Actinians (*Peachia*, &c.). *Corymorpha. Steenstrupia. Actinula.* Small Siphonophore. Ctenophores. Hydromedusæ (*Thaumantias*, *Oceania*, &c.). *Tomopteris scolopendra. Sagitta.* Young Ophiurids. *Astropecten irregularis.* Urchins (*E. esculentus*). Cotton Spinner (*H. nigra*). Edible Crabs. Larval Norway Lobsters (*Nephrops*). Zoeæ of *Porcellana*, &c. Copepods. *Nebalia.* Nudibranchs (*Eolis*). Pteropods (*Spirialis retroversus*).

May 19.

Station **213**.—TEELIN HARBOUR. 3 fathoms. Sand and peat. Shrimp Trawl.

Small Scaldfish; very small Flatfish; young Dabs and Plaice; very small Cod and Coalfish; Great Pipe-fish; a great quantity of small woolly weeds.

Invertebrates.—Common Starfish (violet). Brittle Stars (*Ophiura albida*). Urchins (*Amphidotus*). Common Shrimps. Swimming Crabs. Shore Crabs and Hermits. Ctenophores (*Cydippe*) and Hydromedusæ (*Sarsia*).

May 19.

Station **214**.—OFF TEELIN. 33 to 37 fathoms. Mud and sand. 2 hours. 48 foot Beam.

Dab, . . . 1 mature.

The trawl-net was fouled by a large tow-net, so did not fish.

In bottom tow-net—Foraminifera (*Astrorhysa*). *Corymorpha*. Hydromedusæ *Oceania*. *Sarsia*. *Thaumantias*). Ctenophores (*Cydippe*). Larval Actinians (including *Peachia* (?) on *Thaumantias* and free). *Epizoanthus*, with Hermits. Small Annelids. Small Crabs (*Ebalia*). Copepods. *Philine*.

May 19.

Station **215**.—OFF TEELIN. 25 to 28 fathoms. Sand. 1 hour, 35 minutes. 47 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . .	39	14	25
Whiting, . . .	4	4	0
Ling, . . .	1	1	0
Plaice, . . .	1	0	1
Lemon Dab, . .	2	2	0
Common Dab, . .	28	18	10
Common Sole, . .	1	1	0
Small-spotted Dog, .	2	..	..

Station **216**.—INVER BAY, inside Trawling Limits. 8 to 13 fathoms. Mud and sand. 1 hour, 15 minutes. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . .	21	9	12
Cod, . . .	2	2	0
Coalfish, . . .	3	3	0
Pollack, . . .	1	1	0
Plaice, . . .	14	10	4
Common Dab, . .	23	23	0
Common Sole, . .	4	4	0
Small-spotted Dog, . .	2	..	..
Thornback, . . .	4	4	0

MAY 20.

Station **217**.—OFF DORAN HEAD. 13 to 10 fathoms. Mud and sand. 2 hours. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Red Gurnard,	1	1	0
Grey Gurnard,	8	8	0
Sapphirine Gurnard,	3	3	0
Haddock,	2	2	0
Brill,	1	0	1
Plaice,	19	6	13
Common Dab,	66	42	24
Common Sole,	12	12	0
Small-spotted Dog,	2	..	..
Leptocephalus,	2 (in bottom tow-net).		

Invertebrates.—Starfish (*A. rubens* and *A. glacialis*). *Astropecten irregularis.* Mask Crabs (*Corystes*). *Galathœa nexa. Philine.*

MAY 20.

Station **218**.—OFF ROSSNOLEAGH POINT. Mud and sand. Shrimp Trawl.

Freckled Gobies.
Solanette.
Scaldfish.

MAY 20.

Station **219**.—OFF TEELIN. 22 to 26 fathoms. Fine sand. 1 hour. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	1	0	1
Haddock,	4	4	0
Plaice,	22	8	14
Lemon Dab,	2	1	1
Pole Dab,	2	2	1
Common Dab,	22	22	0
Common Sole,	6	6	0
Small-spotted Dog,	1	..	..

MAY 20.

Station **220**.—DAWROS BAY. Long lines down all night. Nothing caught.

May 21.

Station **221**.—LOUGHROSMORE BAY. 19 to 5 fathoms. Sand. 2 hours 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	1	1	0
Whiting,	1	1	0
Turbot,	2	1	1
Plaice,	19	0	19
Lemon Dab,	1	1	0
Common Dab,	18	18	0
Small-spotted Dog,	6	..	0
Thornback,	6	..	..
Spotted Ray,	10	nearly all	..
Owl Ray,	2	2	..

Invertebrates.—Edible Crabs. Sandeels in bottom tow-net.

May 21.

Station **222**.—BOYLACH BAY. 22 to 20 fathoms. Sand. 1 hour 30 minutes. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	4	4	0
Whiting,	1	1	0
Turbot,	2	2	0
Lemon Dab,	1	1	0
Common Dab,	38	28	10
Small-spotted Dog,	2	..	..
Thornback,	1	1	0

May 21.

Station **223**.—LOUGHROSMORE BAY. 9 to 4 fathoms. Sand. 1 hour, 45 minutes. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Turbot,	3	2	1
Brill,	2	0	2
Witch,	1	1	0
Plaice,	75	0	75 (mostly small)
Lemon Dab,	1	1	0
Common Sole,	4	3	1 (small)
Small-spotted Dog,	2	..	..
Smooth Hound,	2	..	..
Thornback,	6	5	1
Owl Ray,	2	2	0

Invertebrates.—Edible Crabs. Urchins (*E. esculentus*).

MAY 22.

Station **224**.—BOYLACH BAY. 9 to $4\frac{1}{2}$ fathoms. Sand. 1 hour, 30 minutes. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . . .	2	2	0
John Dory, . . .	1	0	1 (very small)
Turbot, . . .	1	0	1 (small)
Brill, . . .	5	0	5 (2 small)
Plaice, . . .	21	0	21 (mostly small)
Common Dab, . . .	3	3	0
Common Sole, . . .	12	10	2
Angel Ray, . . .	1	1	0
Thornback, . . .	23	23	0
Owl Ray, . . .	9	9	0

Invertebrates.—*Astropecten irregularis*. Common Shrimps. Edible Crabs. Squids (*L. media*).

MAY 22.

Station **225**.—ROSSES BAY. 32 to 25 fathoms. Sand, rock. 1 hour. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . .	12	10	2
Common Dab, . .	5	5	0
Sandy Ray, . .	3	3	0

Trawl hitched, and net torn.

Invertebrates.—Lingthorns (*Luidia*). *Astropecten irregularis*. Urchins (*E. esculentus*). Edible Crabs. Polyzoans (*Porella*). Sponges (*Phakellia*).

MAY 22.

Station **226**.—BURTON PORT. Rocks. Long lines down 24 hours.

Conger, 14. Lines fouled by strong tide.

MAY 26.

Station **227**.—GOLA ROADS. Sand. Long lines.

Plaice, 4 mature

MAY 26.

Station **228**.—GOLA ROADS. Sand. Long lines.

Common Dab, 1 mature.

MAY 27.

Station **229**.—N.E. of STAGS OF ARANMORE. 35 fathoms. Gravel and rock Long lines, down $1\frac{1}{2}$ hour.

	Gross No.	No. Mature.	No. Immature.
Cod, . . .	3	3	0
Ling, . . .	3	3	0

Invertebrates.—Sun Stars (*S. papposa*). Cushion Stars (*Goniaster*). Edible Crabs. Polyzoans (*Porella*).

May 27.

Station **230.**—EAST OF TORY ISLAND. 29 fathoms. Sand and gravel. 1 hour. 48-foot Beam.

Red Gurnard, 1. Trawl hitched.

Invertebrates.—Brittle Stars (*O. pentaphyllum*). Larval Actinians. Jellyfish in bottom tow net.

May 27.

Station **231.**—NORTH OF TORY ISLAND. Long lines. Down all night.

	Gross No.	No. Mature.	No. Immature.
Cod,	1	1	0
Coal-fish,	1	1	0
Ling,	31	31 fine.	0
Halibut,	1	1 fine.	0
Skate,	1	1 fine.	0

Bottom Fauna.—Small Urchins.

May 28.

Station **232.**—WEST OF HORN HEAD. 9 to 10 fathoms. Sand, rock. $1\frac{1}{2}$ hour. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Cod,	6	2	4
Turbot,	1	0	1
Plaice,	22	6	16
Common Dab,	2	1	1
Thornback,	2	2	0
Spotted Ray,	1	1	0

Trawl hitched.

Invertebrates.—Urchins (*E. esculentus*). Edible Crabs. Polyzoans and Ascidians on Weeds.

May 28.

Station **233.**—SHEEPHAVEN (outer part). 22 to 18 fathoms. Sand. 1 hour. 48 foot beam.

	Gross No.	No. Mature.	No. Immature.
Sapphirine Gurnard,	1	1	0
Grey Gurnard,	7	7	0
Turbot,	2	1	1
Brill,	1	0	1
Plaice,	7	3	4
Common Dab,	9	9	0
Common Sole,	2	2 fine	0
Thornback,	2	2	0

MAY 28.

Station **234.**—SHEEPHAVEN (N.W. part). Long lines, down all night.

	Gross No.	No. Mature.	No. Immature.
Cod, . . .	2	2 fine	0
Ling, . . .	2	2 fine	0
Tope, . . .	1	..	..
Small-spotted Dog, .	2	..	..
Thornback, . .	1	..	..

MAY 29.

Station **235.**—DOWNIES BAY. 13 fathoms. Sand. 1 hour. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . .	1	1	0
Turbot, . . .	3	3	0
Plaice, . . .	46	37 (some fine)	9
Common Dab, . .	16	16	0
Common Sole, . .	3	3	0
Thornback, . .	2	2	0
Sandy Ray, . .	1	1	0

Invertebrates.—Edible Crabs.

MAY 29.

Station **236.**—DOWNIES BAY. $10\frac{1}{2}$ to 4 fathoms. Sand. 1 hour. 48-foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . .	13	13	0
Cod, . . .	1	1	3
Coal-fish, . . .	1	1	0
Turbot, . . .	2	0	2
Brill, . . .	1	1	0
Plaice, . . .	84	25 (some fine)	59 (mostly small).
Common Dab, . .	17	17	0
Flounder, . . .	11	11	0
Common Sole, . .	23	23	0
Small-spotted Dog, .	4	..	..

Invertebrates.—Spider Crabs (*H. coarctatus*). Squids (*L. media*). Polyzoans (*Alcyonidium*).

MAY 29.

Station **237.**—LOUGH SWILLY. Long lines, down all night.

Conger, 5; large. Invertebrates. Common Star-fish.

May 30.

Station **238.**—LOUGH SWILLY. 8 to 12 fathoms. Sand. 2 hours. 48 ft. Beam.

	Gross No.	No. Mature.	No. Immature.
Sapphirine Gurnard, . .	1	1 fine.	0
Grey Gurnard, . .	10	10	0
Turbot, . . .	4	2	2 none small.
Brill, . . .	2	1	1 small.
Plaice, . . .	1	0	1 small.
Common Dab, . .	36	28	8
Smooth Hound, . .	1	..	..
Thornback, . . .	16	some.	..
Spotted Ray, . .	2	2	0

Invertebrates.—Sponges (*G. ciliata*). Hydroids. Brittle Stars (*Ophiothrix*). Isopods (*Idotea linearis* and sp.) Shrimps (*C. spinosus*). Polyzoans (*Alcyonidium* and Flustra). Dog Whelks (*Mactra truncata*). Squids (*L. media*).

May 30.

Station **239.**—LOUGH SWILLY. $7\frac{1}{2}$ to $5\frac{1}{2}$ fathoms. Sand. 1 hour. 48 ft. Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . .	1	1	0
Turbot, . . .	1	0	1
Brill, . . .	1	0	1
Plaice, . .	14	7	7
Common Dab, . .	12	10	2
Common Sole, . .	1	1	0
Small-spotted Dog, . .	1	..	..
Thornback, . . .	25	21	4
Spotted Ray, . .	1	..	..

Station **240.**—LOUGH SWILLY. 6 to $8\frac{1}{2}$ fathoms. Sand. 1 hour 15 minutes. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard, . .	3	2	1
Turbot, . . .	1	1 fine	0
Plaice, . . .	8	0	8 small.
Common Dab, . .	18	14	4 (1 very small
Smooth Hound, . .	1	..	.. in bottom
Small-spotted Dog, . .	6	..	.. tow-net).
Thornback, . . .	17	17	0

Very small Herrings or Sprats in bottom tow-net.

Invertebrates.—Hydroids (*Sertularia*, &c.). Common Star-fish. Brittle Stars (*O. albida*). Annelids (*Nereis*, *Lanice conchilegia*. Sea Mice *Aprodite*). *Idotea linearis*, *Caprella*. Gammarids. Common Shrimps. Hermits (*P. bernhardus*). Spider Crabs (*H. araneus*, and *S. rostratus*). Swimming Crabs. *Psammobia ferroensis*. *Mactra*. *Thracia*. Gaper (*Mya truncata*). Scallops (*P. opercularis*). *Eolis rufibranchialis*. *Helcion*. Whelks. Squids (*L. media*). Ascidians. Jelly-fish (*Aurelia* and *Cyanæa*) in the trawl.

JUNE 2.

Station **241**.—OFF MALIN HEAD. Long lines, down all night.

	Gross No.	No. Mature.	No. Immature.
Cod,	3	3	0
Ling,	18	18	0
Conger,	1 large	..	..
Tope,	8	..	..
Small-spotted Dog,	4	..	..
Grey Skate,	3	3	0

Invertebrates.—Hydroids. Sun Stars (*S. papposa*). Brittle Stars (*O. nigra*). Whelks.

JUNE 2.

Station **242**.—OFF PORTSTEWART. 48 foot Beam.

	Gross No.	No. Mature.	No. Immature.
Grey Gurnard,	102	some.	many.
John Dory,	1	0	1 very small.
Turbot,	2	0	2
Brill,	1	1	0
Plaice,	10	0	10
Common Dab,	26	17	9
Common Sole,	12	9	3
Thornback,	26	26	0
Spotted Ray,	4	2	2

LIST OF ABBREVIATIONS DENOTING THE NATURE OF THE FISHING IMPLEMENTS USED.

18 = 18 feet Beam Trawl. Ordinary mesh.
18 l. = ,, ,, ,, ,, ,, lined at Cod end with Sprat mesh.
25 = 25 feet ,, ,, ,, ,,
25 P. = ,, ,, ,, Comyn's Patent Discriminating Trawl Net.
28 P. = 28 feet ,, ,, ,, ,, ,, ,, ,,
32 P. = 32 feet ,, ,, ,, ,, ,, ,, ,,
48 = 48 feet ,, ,, Ordinary mesh.
O. = Otter Trawl. Ordinary mesh. (Usually from Fishing Boats).
Sh. = 8 feet Beam Shrimp Trawl. (Usually from Boats).
N. = ,, ,, Muslin or Calico Naturalists' Trawl. (Usually from Boats).
$\triangle$ = Triangular Sprat-mesh and Muslin Tow-net, Sides 10 feet. [lining.
R. = Ring Tow-nets. (Besides special stations, always used when trawling or
M. = Mackerel Nets.
S. = Seine. Wings Herring mesh. Bunt Calico. (From Shore and Boats).
L. = Long lines.
D. = Dredge. Various patterns and sizes.

EXPLANATIONS OF SOUNDINGS.

c. = Coarse.
cl. = Clean.
crl. = "Coral" (usually nullipores).
d. = Dark.
f. = Fine.
g. = Grey.
gr. = Gravel.
m. = Mud.
m. s. = Mud and Sand.

r. = Rock.
rd. = Red.
rh. = Rough.
s. = Sand.
s. m. = Soft mud.
sh. = Shells.
shp. = Sharp.
st. = Stones.
z. = Zostera (Sea-grass).

SCHEDULES SHOWING THE NUMBERS OF EACH OF THE MORE IMPORTANT KINDS OF FISH, WHERE AND WHEN CAUGHT, WITH CONDITIONS OF REPRODUCTIVE ORGANS AND CONTENTS OF STOMACH. COMPILED FROM THE VARIOUS RECORDS KEPT ON BOARD THE "FINGAL" AND "HARLEQUIN." BY ERNEST W. L. HOLT, Assistant Naturalist to the Survey.

Fishing Implement and Station No.		Date.	Depth in fathoms.	Nature of bottom.	Hours down.	LOCALITY.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined.		Condition of Reproductive Organs.					Nature of Food and Remarks.		
										Males.	Females.	†Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	0.	?	
						RED GURNARD—*Trigla cuculus* (Linn.).													
25.	**4**	1890. May 9	20	m.s.	2	Kenmare River, .	1	21	..	..	1	..	..	..	..	1 ♀	..	..	Crabs.
L.	**78**	July 16	35	..	..	Off the Bills, .	1	17½	..	..	1	..	..	..	1 ♀	..	..	..	Crab and Crangon.
25.	**79**	16	13	s.	½	Davalaun, . .	1	15	..	..	..	..	..	..	..	..	..	..	
25.	**83**	25	20	m.s.	½	Galway Bay, .	1	14	..	..	1	..	..	..	1 ♀	..	..	..	Crab. Crangon.
L.	**80**	18	55	..	..	Off Slyne Head, .	1	16½	..	1	..	..	..	1 ♂	..	..	..	..	Galathæa.
32P.	**90**	31	15	s.m.	1	Galway Bay, .	2	..	..	..	..	..	..	..	..	..	..	..	
48.	**146**	1891. April 8	38	s.m.	¾	Off Gregory Sound,	1	13	..	1	..	..	1 ♂	..	..	..	1	..	
48.	**196**	May 8	16/13	s.r.	¼	Davalaun Sound, .	1	15½	..	..	1	..	..	..	1 ♀	..	..	..	Sandeels.
48.	**204**	14	32	s.	2	Donegal Bay, .	1	13	..	..	1	..	..	..	1 ♀	..	1	..	
48.	**217**	20	13/10	m.s.	2	Off Doran Head, .	1	13	¾	1	..	..	..	..	1 ♂	..	..	..	Fish.
48.	**230**	27	29	s.gr.	6	E. of Tory Island,	1	13 ?	..	..	..	..	..	..	..	..	..	..	

† Immature fish as here described are such as have never become sexually adult.

‡ This sign throughout the Schedules means "at night."

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Females.	Condition of Reproductive Organs. Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					SAPPHIRINE GURNARD—*Trigla hirundo* (Linn).													
	1890.																	
25. **21**	June 2	16	s.	$3\frac{1}{2}$	Galway Bay,	1	14	..	1	..	..	..	..	1 ♂	..	..	..	
25. **40**	16	4/10	s.m.	3	Blacksod Bay,	1	22	..	1	..	..	..	..	1 ♂	..	..	..	Portunus holsatus. Crangon. Solen. Sandeels.
L. **46**	18	30	r.	..	Off Erris Head,	1	25	..	..	1	..	..	..	..	1 ♀	1	..	
32P. **90**	July 31	15	s.m.	1	Galway Bay,	1	..	..	..	..	..	..	..	..	..	..	..	
28P. **116**	Aug. 21	5/8	s.	1	Ballinskelligs Bay,	1	16	..	..	1	..	..	..	..	1 ♀	..	..	Sandeels.
	1891.																	
48. **146**	April 8	38	s.m.	$1\frac{1}{4}$	Off Gregory Sound,	1	19	3	1	..	..	1 ♂	..	..	..	1	..	
48. **149**	9	39/36	s.	1	. . . .	1	21	$3\frac{1}{2}$	..	1	..	1 ♀	..	..	..	1	..	
48. **217**	May 5	13/10	m.s.	2	Off Doran Head,	1	20	3	..	1	..	1 ♀	..	..	..	..	..	1 Corystes.
						2	12	..	1	1	1 ♀	1 ♂	..	..	..	1	..	1 Annelids and Crabs.
48. **233**	28	22/13	s.	1	Sheephaven,	1	13	..	1	..	..	..	..	1 ♂	..	..	..	
48. **238**	30	8/12	s.	2	Lough Swilly,	1	23	$3\frac{3}{4}$	..	1	..	..	1 ♀	..	..	..	..	1 Weever and other fish.
					GREY GURNARD—*Trigla gurnardus* (Linn.).													
	1890.																	
25. **1**	May 8	7	m.	$\frac{1}{2}$	Kenmare River,	1	16	$1\frac{1}{2}$	1	..	..	1 ♂	..	..	..	..	..	1 Dabs.
25. **3**	9	10	m.	$1\frac{1}{2}$	. . . .	1	17	$1\frac{1}{2}$	..	1	..	..	..	1 ♀	..	1	..	
						2	10/11	..	2	..	..	2 ♂	..	..	..	..	..	2 Shrimps and sprats.
25. **4**	9	20	m.s.	2	. . . .	4	12/16	..	..	4	..	..	1 ♀	3 ♀	..	..	..	4 Shrimps and sprats.

25.	**5**	10	6	s.	$1\frac{1}{4}$	Ballinskelligs Bay,	2	13/14	$\frac{3}{4}$/1	..	2	..	1 ♀	1 ♀	..	..	..	..	2 Sandeels.
25.	**7**	12	22	s.	4	Dingle Bay, . .	2	13/14	$\frac{3}{4}$/1	..	2	..	..	2 ♀	..	..	..	..	2? Zoëœ and Cuttle.
L.	**8**	16	74/80	s.m.	..	Off Skelligs, . .	2	16	$1\frac{1}{2}$	..	2	..	..	2 ♀	..	..	..	2	
25.	**12**	20	53	d.s.	3	Off Dingle Bay, .	10	15	1	1	2	..	..	..	1 ♂ 2 ♀	..	..	3	
L.	**14**	21	30	s.r.	..	Off Cooshcroon, .	3	16	..	..	3	..	..	1 ♀	2 ♀	..	..	..	
18.	**16**	23	74/80	f.s.	..	Off Dingle Bay, .	2	6/15	..	2	..	..	2 ♂	..	..	..	..	..	
25.	**18**	27	9/16	rd.s.	1	Brandon Bay, .	1	11	$\frac{1}{2}$	..	1	..	..	..	..	1 ♂	..	..	1 Sandeels.
25.	**21**	June 2	16	s.	$3\frac{1}{2}$	Galway Bay, .	11	7/14	$\frac{1}{4}$/1	..	11	3 ♀	..	..	4 ♀	4 ♀	..	..	Annelids, zoëœ and crabs.
							6	5	..	6	..	6 ♂	..	..	..	..	..	..	
25.	**25**	5	20	f.s.	2	Off Greatman's Bay,	1	$12\frac{1}{2}$	$\frac{3}{4}$	..	1	..	..	1 ♀	..	..	..	..	
25.	**40**	16	4/10	s.m.	3	Blacksod Bay, .	2	11/15	$\frac{1}{4}$/1	..	..	..	..	..	1 ♀	1 ♀	..	..	2 Sandeels.
25.	**42**	16	9	s.m.	2	. . . .	6	..	..	..	..	..	..	..	..	..	..	..	
25.	**43**	16	9	s.m.	2	. . . .	2	17	1	..	1	..	..	..	..	1 ♀	1	..	
							1	$1\frac{1}{4}$	..	..	..	..	..	..	..	..	..	..	
L.	**46**	18	30	n.	..	Off Erris Head	4	17	$1\frac{1}{2}$	..	2	..	..	..	1 ♀	1 ♀	2	..	
25.	**49**	20	8/13	m.s.	1	Inver Bay, inside limits.	1	17	$1\frac{1}{2}$	..	**1***	..	..	..	1 ♀	..	..	..	*Nearly spent.
25.	**53**	25	25	s.m.	2	Inver Bay, outside limits.	12	$11\frac{1}{2}$/$17\frac{1}{2}$	$\frac{1}{2}$/$1\frac{1}{4}$	..	10	..	..	..	5 ♀	5 ♀ 1 ♂	..	..	10 Crustaceans and Sandeels.
25.	**54**	25	8/13	..	2	Inver Bay, inside limits.	18	10/15	$\frac{1}{2}$/1	1*	7	..	..	..	4 ♀ 2 ♂	3 ♀	..	..	* (♂ 10 in.). The smallest not examined.
25.	**55**	26	32	g.s.	2	Donegal Bay, .	10	9/14	$\frac{1}{2}$/1	2	4	..	..	..	2 ♀ 2 ♂	2 ♀ 2 ♂	..	..	
25.	**56**	26	13/10	g.s.	..	Doran Head, .	7	13	$\frac{3}{4}$	4	2	..	..	..	1 ♀	1 ♀ 2 ♂	5	..	1 Callionymus.
25.	**58**	30	20	f.s.	$2\frac{1}{2}$	Clew Bay, . .	14	14	1	2	7	..	..	..	1 ♀	6 ♀ 1 ♂	..	..	9 Gammarus, Mysis, Crystallogobius and Sandeels.
25.	**59**	30	14	s.r.	1	. . . .	3	13	$\frac{3}{4}$	1	2	..	..	..	..	2 ♀ 2 ♂	..	..	

Fishing Implement and Station No.		Depth in fathoms.	Nature of bottom.	Hours down.	LOCALITY.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined.		Condition of Reproductive Organs.					Nature of Food and Remarks.		
									Males.	Females.	Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	0.	?	
					GREY GURNARD—*continued.*													
25. **60**	July 1	18	f.s.	2	. . . .	10	12/17	½/¾	2	8	..	..	..	1 ♀	7 ♀ 2 ♂	..	..	1 Crab. 9 Sandeels.
25. **65**	5	5	f.s.m.	1	Blacksod Bay, .	5	8/13	..	2	1	..	..	..	..	1 ♀	..	..	1 Crab. 1 Shrimp. 1 Sandeels.
25. **67**	5	4½	cr.s.	2	. . . .	1	..	..	..	..	..	..	..	..	..	..	..	
25. **68**	9	13	f.s.rh.s.	2	. . . .	1	9	..	..	..	..	..	..	..	..	..	..	
25. **73**	12	13	m.	1	Killary Bay, .	1	10½	½	1	..	1 ♂	..	..	..	..	..	..	1 Crangon.
25. **82**	25	48	m.s.	..	Off Gregory Sound,	2	11/13	½/¾	1	1	..	..	1 ♂ ?	..	1 ♂ ? 1 ♀	..	..	2 Amphipods.
Sh. **104**	Aug. 14	41	f.m.s.	..	Off Valentia, .	3	1¼	..	..	..	..	..	..	..	..	..	..	
Sh. **109**	18	2½	m.	..	Kenmare River, .	1	..	..	..	..	..	..	..	..	..	..	..	
28P. **110**	18	12	m.	1	. . . .	1	16	1½	..	..	..	..	..	..	..	..	..	
28P. **118**	21	30	s.m.	1	Ballinskelligs Bay,	4	1	..	..	..	..	..	..	..	..	..	..	
,,						1	12	¾	..	..	..	..	..	..	..	..	..	
48. **123**	1891. Mar. 21	27	f.s.	1	Ballinskelligs Bay,	2	13	½	..	2	..	2 ♀	..		..	1	..	1 Shrimps, prawns and sandeels.
						4	11½	½	3	1	..	3 ♂	..	1 ♀	..	..	..	4 Shrimps.
						2	6½	..	2	..	2 ♂	..	..	..	..	..	..	2 Shrimps.
48. **126**	28	26	m.	1/¾	Kenmare River, .	1	11	½	..	1	..	..	..	..	1 ♀	..	..	1 Pandalus and Portunus.
						1	8	..	1	..	1 ♀	..	..	..	..	..	..	1 Young Pleuronectid.
48. **127**	28	21	m.	1	. . . .	1	16	1½	..	1	..	1 ♀	..	..	..	1	..	

							1	8½	..	..	1	1 ♀	..	..	..	..	..	..	
48.	**131**	30	45/48	s.	2	. . . .	8	14	½	1	7	..	..	..	1 ♂ 4 ♀	3 ♀	2	..	4 Shrimps. 2 Gadus esmarkii.
							8	12	..	4	4	1 ♀	..	..	3 ♂	1 ♂ 3 ♀	1	..	7 Shrimps.
							2	9½	..	1	1	1 ♂ 1 ♀	..	..	..	..	..	..	2 Shrimps.
							1	8½	..	..	..	..	..	..	..	..	..	..	
							1	8	..	..	..	..	..	..	..	..	..	..	
48.	**132**	31	23/29	s.sh.	1/¾	Ballinskelligs Bay,	1	18½	2	..	1	..	..	..	1 ♀	..	..	..	1 Fish.
							2	8½	..	..	..	..	..	..	..	..	..	..	
48.	**133**	31	40	s.st.r.	1/¾	Dingle Bay, .	15	12½	¾	5	3	..	1 ♂	1 ♂	3 ♂ 3 ♀	..	..	..	
							7	11	½	3	1	..	1 ♂	..	2 ♂ 1 ♀	..	..	..	
							1	7	..	..	..	..	..	..	..	..	..	..	
48.	**143**	April 4	46/44	..	3/4	Off Inishmore, Aran Islands. .	2	11	½	..	..	..	..	..	..	..	..	..	
							2	10	½	..	..	..	..	..	..	..	..	..	
							3	6	..	..	..	..	..	..	..	..	..	..	
							1	5	..	..	..	..	..	..	..	..	..	..	
48.	**146**	8	38	s.m.	1¼	Off Gregory Sound,	5	13	¾	1	3	..	1 ♂	..	3 ♀	..	2	..	2 Mysis.
							5	12	¾	3	1	..	..	..	1 ♀	3 ♂	2	..	1 Mysis.
							2	11	..	1	..	..	..	..	..	1 ♂	1	..	
							2	7	..	..	..	..	..	..	..	..	..	..	
48.	**147**	8	25/20	s.	1½	South Sound, .	1	15	1¼	..	..	..	..	..	..	..	..	..	
							2	11	½	..	..	..	..	..	..	..	..	..	
							1	8½	..	..	..	..	..	..	..	..	..	..	

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Females.	Condition of Reproductive Organs. Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	Nature of Food and Remarks. 0.	?	
					Grey Gurnard—*continued.*													
48. **147**	April 8	25/20	s.	1½	South Sound, .	32	7½	..	..	..	..	..	..	..	..	..	..	
						28	6½	..	..	..	..	..	..	..	..	..	..	
						110	5	..	..	..	..	..	..	..	..	..	..	
						116	4¾	..	..	..	..	..	..	..	..	..	..	
						7	3¼	..	..	..	..	..	..	..	..	..	..	
						7	3	..	..	..	..	..	..	..	..	..	..	
48. **148**	9	38	s.	1½	Off Gregory Sound,	4	14	1	..	4	..	1 ♀	..	3 ♀	..	1	..	2 Mysis. 1 Fish.
						3	11½	¾	2	1	..	1 ♀	..	..	2 ♂	3	..	
						1	10	½	..	1	..	..	..	..	1 ♀	1	..	
						2	8½	..	2	..	2 ♂	..	..	..	..	2	..	
						1	5	..	..	..	..	..	..	..	..	..	..	
48. **149**	9	39/36	s.	1	Off Gregory Sound,	13	11/13	½/¾	..	..	..	..	..	..	..	..	..	
						4	7	..	..	..	..	..	..	..	..	..	..	
48. **153**	15	17/19	s.m.	2	Galway Bay, .	1	11	½	..	1	..	1 ♀	..	..	..	..	..	
						4	7½	..	?	..	4 ♂ ?	..	..	..	..	..	..	
						1	6	..	?	..	1 ♂ ?	..	..	..	..	..	..	
48. **154**	15	33	s.	¾	Off Foul Sound, .	1	7	..	..	..	..	..	..	..	..	..	..	
48. **159**	17	4/9	m.	1	Cleggan Bay, .	1	17½	1¼	..	1	..	1 ♀	..	..	..	..	..	Sandeels.

						1	5½	..	..	..	..	..	..	..	..	..	..	
48. **163**	18	13/15	s.	2½	Clew Bay, . .	1	13½	¾	..	..	..	..	..	..	..	..	..	
						3	11	½	..	..	..	..	..	..	..	..	..	
						5	10	½	..	..	..	..	..	..	..	..	..	
48. **164**	20	18	s.	1½	. . .	4	14	1	..	2	..	1 ♀	..	..	1 ♀	..	..	2 Mysis and fish.
						4	11	½	..	..	..	..	..	..	..	..	..	
48. **176**	25	25/19	f.s.	1¼	Broadhaven Bay, .	1	14	1	..	1	..	..	..	1 ♀	..	..	..	1 Mysis.
						4	9½	..	..	..	..	..	..	..	..	..	..	
						16	8	..	..	..	..	..	..	..	..	..	..	
48. **177**	25	20/18	m.s.	1	Off Downpatrick Hd.	3	10	½	..	..	..	..	..	..	..	..	..	
						1	8½	..	..	..	..	..	..	..	..	..	..	
						2	6½	..	..	..	..	..	..	..	..	..	..	
48. **178**	28	9/5	s.	2	Blacksod Bay, .	1	17	1½	..	1	..	..	..	1 ♀	..	1	..	
						1	14	¾	1	..	..	..	..	..	1 ♂	1	..	
48. **180**	29	14	s.gr.	1	Ballynakill, . .	1	18	2	..	..	..	..	..	..	..	..	..	
48. **181**	30	30	s.st.r.	½	Off Davalaun, .	2	6	..	..	..	..	..	..	..	..	..	..	
48. **188**	May 5	9/7	s.	1¼	Blacksod Bay, .	1	10	..	..	..	..	..	..	..	..	..	..	
48. **190**	5	4	m.s.	1¾	Blacksod Bay, .	1	18½	1¾	..	1	..	..	..	1 ♀	..	..	..	1 Sandeels.
						3	15	1¼	..	..	..	..	..	..	..	..	..	
48. **204**	14	32	s.	2	Donegal Bay, .	1	15	1¼	..	1	..	1 ♀	..	..	..	..	..	1 Fish.
						5	12	¾	2	1	..	1 ♀	..	1 ♂	1 ♂	..	2	1 Fish.
						8	10	½	..	..	..	..	..	..	..	..	..	

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	LOCALITY.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined.		Condition of Reproductive Organs.					Nature of Food and Remarks.		
									Males.	Females.	Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	0.	?	
					GREY GURNARD—*continued.*													
48. **205**	May 14	30/19	m.s.	2	Donegal Bay, .	7	14	1	..	..	..	..	..	..	..	..	..	
						4	11	$\frac{1}{2}$	..	..	..	..	..	..	..	..	..	
						5	10	..	..	..	..	..	..	..	..	..	..	
						5	14	1	..	5	..	4 ♀	1 ♀	..	..	1	..	3 Crystallogobius. 1 Fish.
48. **207**	15	16/14	s.m.	1	Killybegs Harbour,	3	7/10	..	..	..	..	..	..	..	..	..	..	
48. **212**	18	31/30	s.gr. f.s.st.r.	..	Off St. John's Point,	5	13	$\frac{3}{4}$	1	2	..	1 ♀	1 ♂	1 ♀	..	1	..	1 Crustaceans. 2 Fish.
						5	12	$\frac{3}{4}$	..	..	..	..	..	..	..	..	..	
						4	10	$\frac{1}{2}$	..	..	..	..	..	..	..	..	..	
						1	8	..	..	..	..	..	..	..	..	..	..	
48. **215**	19	35/28	s.	$1\frac{1}{4}$	Off Teelin, . .	11	11	$\frac{1}{2}$	4	1	3 ♂ 1 ♀	..	1 ♂	..	..	1	..	1 Annelids. 3 Crustaceans.
						3	$9\frac{1}{2}$	..	..	1	..	..	..	1 ♀	..	1	..	
						6	8	..	..	..	..	..	..	..	..	..	..	
						11	7	..	..	..	..	..	..	..	..	..	..	
						8	4/6	..	..	..	..	..	..	..	..	..	..	
48. **216**	20	8/13	m.s.	$1\frac{1}{4}$	Inver Bay, inside limits,	6	14	1	..	..	..	..	..	..	..	..	..	
						15	7/10	..	..	..	..	..	..	..	..	..	..	
48. **217**	20	13/10	m.s.	2		1	17	$1\frac{1}{2}$	..	1	..	..	..	1 ♀	..	..	..	1 Zoëæ and Fish.
						7	$13\frac{1}{2}$	1	..	2	..	2 ♀	..	..	..	..	..	1 Loligo media. 1 Fish.

48.	**219**	20	22/26	f.s.	1	Off Teelin, . .	1	7	..	..	..	..	..	..	..	..	..	..	
48.	**221**	21	19/5	s.	2	Loughrosmore Bay,	1	13½	1	..	..	..	..	..	..	..	..	..	
48.	**222**	21	22/20	s.	1½	Boylach Bay, .	1	13	¾	..	1	..	1 ♀	..	..	..	..	..	1 Mysis.
,,							3	11	..	..	..	..	..	..	..	..	..	..	
48.	**223**	21	2/4	s.	..	Donegal Bay, .	2	½	..	..	..	..	..	..	..	..	..	..	
							2	¾	..	..	..	..	..	..	..	..	..	..	
48.	**224**	22	9/4	s.	1½	Boylach Bay, .	2	15	1¼	..	2	..	1 ♀	..	1 ♀	..	..	..	1 Portunus and Sandeels. 1 Shrimps.
48.	**225**	22	32/25	s.r.	1		2	12½	¾	..	1	..	..	..	..	1 ♀	1	..	
							10	9½	..	..	..	..	..	..	..	..	..	..	
							2	6½	..	..	..	..	..	..	..	..	..	..	
48.	**233**	28	22/13	s.	1	Sheephaven, . .	1	16	1½	..	1	..	..	..	..	1 ♀	1	..	
							2	14	1	..	2	..	1 ♀	..	1 ♀	..	2	..	
							4	13	¾	..	4	..	..	..	..	4 ♀	1	..	3 Sandeels.
48.	**235**	29	13	s.	1	Downies Bay, .	1	14	1	..	1	..	..	..	..	1 ♀	..	..	1 Siphons of Lamellibranchs.
48.	**236**	29	10½/4	s.	1	. . . .	7	16½	1½	..	5	..	2 ♀	..	2 ♀	1 ♀	..	..	5 Sandeels.
							5	12½	¾	..	..	..	..	..	..	..	..	..	
48.	**238**	30	8/12	s.	2	Lough Swilly, .	4	18	2	..	4	..	..	..	2 ♀	2 ♀	1	..	1 Mysis. 2 Sandeels.
							1	16	1½	..	1	..	1 ♀	..	..	..	..	..	1 Sandeel.
							2	13	¾	1	1	..	..	..	1 ♂	1 ♀	..	..	2 Sandeels.
							1	10	½	..	..	..	..	..	..	..	..	..	
48.	**239**	30	7½/5½	s.	1	Lough Swilly, .	1	17	1½	..	1	..	..	..	..	1 ♀	..	..	1 Fish.
48.	**240**	June 1	6/8½	s.	..	Lough Swilly, .	2	12	¾	..	2	..	..	..	1 ♀	1 ♀	..	..	1 Shrimps. 2 Sandcels.
							1	5½	..	..	1	1 ♀	..	..	..	..	..	..	1 Shrimps and Sandeels.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Number Examined. Females.	Condition of Reproductive Organs. Immature.	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					PIPER—*Trigla lyra* (Linn.).													
18 l. **64**	1890. July 4	144	f.s.	..	30 m. off Achill Hd.	2	12 (abt.)	..	..	..	..	..	..	..	..	..	..	
32P. **84**	28	24	s.	$2\frac{1}{2}$	Galway Bay,	1	18	$2\frac{1}{2}$	..	1	..	..	..	..	1 ♀	..	..	1 Ophioglypha lacertosa and Crab.
28P. **95**	Aug. 9	24	f.s.	..	South Sound,	1	15	$1\frac{1}{4}$	..	1	..	..	..	..	1 ♀	..	..	2 O. albida, O. lacertosa, Pagurus and Crustacean.
,,						1	$18\frac{1}{2}$	$2\frac{1}{4}$	1	..	..	..	1 ♂	..	..	..	..	
28P. **106**	16	26/23	s.sh. s.m.	2	Kenmare River,	1	13	1	1	..	..	..	1 ♂	..	..	..	..	4 O. lacertosa. 2 Pagurus.
,,						1	15	$1\frac{3}{4}$	1	..	..	..	..	1 ♂	..	..	..	
,,						2	$16/16\frac{1}{2}$	2	1	1	..	..	..	..	1 ♂ 1 ♀	..	..	
,,						2	$17/19\frac{1}{2}$	$2\frac{1}{4}/3\frac{1}{4}$	..	2	..	..	..	..	2 ♀	..	..	
28P. **112**	18	25/23	m.s.	$1\frac{1}{4}$	Kenmare River,	2	13/18	$1/2\frac{1}{4}$	2	..	..	..	..	2 ♂	..	..	..	2 Amphiura. 6 O. lacertosa. 6 Pagurus (with Natica shells).
,,						2	$15\frac{1}{2}/16$	$1\frac{1}{2}/2$	..	2	..	..	..	..	2 ♀	..	..	
,,						4	$18\frac{1}{2}/21\frac{1}{2}$	$2\frac{1}{2}/4\frac{1}{2}$	..	4	..	..	..	..	4 ♀	..	..	1 O. albida. 1 Aphrodite. 1 Annelid. 3 Crangon. 1 Pagurus. 2 Young Flatfish.
28P. **115**	20	62/52	m.s.	1	Off the Skelligs,	4	$15\frac{1}{2}/18$	$2/2\frac{1}{2}$	..	4	..	..	..	..	4 ♀	..	..	
25. **125**	1891 Mar. 23	115	r.	1	40 m. off Bolus Hd.	1	Young	..	..	..	..	..	..	..	..	..	..	
48. **131**	30	45/48	s.	2	Kenmare River,	4	$18\frac{1}{2}$	$2\frac{3}{4}$	..	4	..	4 ♀	..	..	..	..	..	2 Gonoplax. 1 Portunus. 2 Pagurus. 1 Crangon. 1 Aporrhais, 1 Turritella (with Pagurus).
					JOHN DORY—*Zeus faber* (Linn.).													
25. **25**	1890. June 5	20	f.s.	2	Off Greatman's Bay,	1	13	$1\frac{3}{4}$	1	..	..	..	1 ♂	..	..	..	..	1 Fish.
25. **40**	16	4/10	f.s.	3	Blacksod Bay,	1	15	2	..	1	..	1 ♀	..	..	..	..	..	1 Sandeels.

25.	**41**	16	9	s.m.	2	Blacksod Bay, .	1	14	1½	..	1	..	..	..	..	1 ♀	..	..	1 Sandeels.
25.	**79**	July 16	13	s.	½	Davalaun, . .	1	14	1½	..	..	..	..	..	..	..	..	..	
O.	**81**	19	8	..	1½	Casheen Bay, .	1	..	..	..	..	..	..	..	..	..	..	..	
O.	**86**	29	20/7	s.sh. crl.	1	Off Inishmaan, .	1	12½	1½	1	..	..	..	1 ♂	..	..	1	..	
32P.	**87**	30	..	..	..	Aran Isles, . .	2	14/14½	1¾/2	..	2	..	..	..	*1 ♀	1 ♀	..	..	2 Fish (* Ripe ♀ 14 inches).
	,,						3	19/21	5/6½	..	3	..	..	..	3 ♀	..	..	..	1 Herring. 2 Fish.
32P.	**88**	30	..	..	..	Aran Isles, . .	1	12	1¼	..	1	..	..	..	..	1 ♀	..	..	1 Fish.
32P.	**93**	Aug. 8	..	m.r.	..	Casheen Bay, .	1	13	1½	1	..	..	..	..	1 ♂	..	..	..	1 Fish.
28P.	**98**	11	16/18	gr.s.	1	Off Inishmaan, .	3	12½/14	1½/1¾	2	1	..	..	..	2 ♂	*1 ♀	2	..	1 Fish (* ♀ 14 inches. Just spent).
28P.	**116**	21	5/8	s.	1	Ballinskellig's Bay,	1	17	3½	..	1	..	..	..	1 ♀	..	..	..	1 Herring.
48.	**146**	1891. April 8	38	s.m.	1¼	Off Gregory Sound,	1	11	1	1	..	..	1 ♂	..	..	..	1	..	
	,,						3	15/16	2½	3	..	..	3 ♂	..	..	..	3	..	
	,,						3	16/19	2½/4½	..	3	..	3 ♀	..	..	..	2	..	1 Fish.
48.	**147**	8	25/20	s.	1½	South Sound, .	1	4½	..	1?	..	1 ♂	..	..	..	..	..	..	
48.	**148**	9	38	s.	1½	Off Gregory Sound,	1	12½	1	1	..	..	1 ♂	..	..	..	..	..	
48.	**153**	15	17/19	s.m.	2	Galway Bay, .	1	4	..	1	..	1 ♂	..	..	..	..	..	..	
	,,						1	4½	..	1	..	1 ♂	..	..	..	..	..	..	
	,,						1	18	4	..	1	..	1 ♀	..	..	..	1	..	
48.	**182**	30	8/11	..	1	Cleggan Bay, .	1	20	6	..	1	..	1 ♀	..	..	..	..	..	1 Sandeels.
48.	**196**	May 8	16/13	s.r.	¼	Davalaun Sound, .	1	18	3½	..	1	..	1 ♀	..	..	..	..	..	1 Sandeels.
48.	**224**	22	9/4½	s.	1½	Boylach Bay, .	1	5½	..	..	1	1 ♀	..	..	..	..	..	..	
48.	**242**	June 2	8	s.	1	Off Port Stewart, .	1	5	..	..	1	1 ♀	..	..	..	..	..	..	

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Females.	Condition of Reproductive Organs. Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					COD—*Gadus morrhua* (Linn).													
25. **1**	1890. May 8	7	m.	$\frac{1}{2}$	Kenmare River. .	6	9/21	..	4	2	4 ♂ 2 ♀	..	..	..	..	..	..	Crangon. Portunus. Buccinum. Fish.
25. **7**	12	22	..	4	Dingle Bay, . .	1	32	14	1	..	..	..	..	..	1 ♂	..	..	1 Fish.
L. **8**	16	74/80	s.m.	..	Off Skelligs, .	1	35	15	..	1	..	..	..	..	1 ♀	1	..	
						1	35	12	1	..	1 ♂ ?	..	..	..	..	..	..	
L. **9**	19	40	..	..	Off Benacry Head,	2	32/36	12/16	..	2	..	..	..	..	2 ♀	..	..	Portunus. Carcinas. Eledone.
L. **14**	21	30	s.r.	..	Off Cooshcroon, .	1	30	11	..	..	..	..	..	..	..	..	..	
Sh. **35**	June 12	1/5	s.	..	Boffin Harbour, .	1	$1\frac{3}{4}$	..	..	..	..	..	..	..	..	..	..	
						1	$2\frac{1}{4}$	..	..	..	..	..	..	..	..	..	..	
L. **46**	18	30	r.	..	Off Erris Head, .	4	31/40	10/18	2	2	..	..	..	..	2 ♂ 2 ♀	..	..	Pagurus. Portunus. Eledone. Dabs. Sandeels.
25. **53**	25	25	s.m.	..	Inver Bay (outside),	1	23	..	..	..	..	..	..	..	..	..	..	
Sh **57A**	July 2	4/1	m.z.	..	Innishlyre Roads,	2	$1\frac{1}{2}/1\frac{3}{4}$	..	..	..	..	..	..	..	..	..	..	
,,						14	$2/2\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						4	$3/3\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
Sh. **67A**	7	3/1	m.z.	..	Blacksod Bay, .	2	$3\frac{3}{4}/4$	..	..	..	..	..	..	..	..	..	..	
L. **78**	July 16	35	..	..	Off The Bills, .	1	36	14	..	1	..	..	..	..	1 ♀	..	..	1 Annelids.
L. **80**	18	55	..	..	Off Slyne Head, .	3	32	14	1	3	..	..	..	..	1 ♂ 3 ♀	..	..	Galatha. Eledone. Gadus.
Sh. **105**	Aug. 14	4?	m.	..	Valentia Harbour,	1	3	..	..	..	..	..	..	..	..	..	..	

48.	**126**	Mar. 28	26	m.	$1\frac{3}{4}$	Kenmare River, .	2	33/33$\frac{1}{2}$	13/14	2	..	..	..	..	..	2 ♂	..	..	..	garis. 1 Nephrops norvegicus.
48.	**132**	31	23/29	s.shl.	$1\frac{3}{4}$	Ballinskelligs Bay,	1	25	18	1	..	..	..	..	..	1 ♂	..	..	..	1 Sandeel.
L.	**136**	April 2	70	..	..	Off Loop Head, .	4	30	10	2	2	..	..	..	..	2 ♂ 1 ♀	1 ♀	..	..	2 Ophiothrix fragilis. 1 Xantho. 1 Nephrops. 3 Munida.
							1	37	16	..	1	..	..	..	..	1 ♀	..	..	..	1 Xantho and Munida.
L.	**141**	7	52/50	m.s.	$4\frac{1}{4}$	Off Inishmore, .	1	29	9	..	1	..	..	..	..	..	1 ♀	..	..	1 O. fragilis.
							1	37	20	..	1	..	..	..	..	..	1 ♀	..	..	1 Munida and Fish.
48.	**146**	8	38	s.m.	$1\frac{1}{4}$	Off Gregory Sound,	1	33	12	1	..	..	..	..	..	1 ♂	..	..	..	1 Sternum of duck?
							2	34/38	15/16	..	2	..	..	..	..	1 ♀	1 ♀	..	..	2 Corystes and Munida. 1 Eledone. 1 Gadus esmarkii.
48.	**148**	9	38	s.	$1\frac{1}{2}$	Off Gregory Sound,	2	36	19	1	1	..	..	..	..	1 ♂	1 ♀	1	..	1 Fish.
48.	**149**	9	39/36	s.	1	Off Gregory Sound,	1	36	13	..	1	..	..	..	..	..	1 ♀	..	..	1 Munida.
L.	**150**	9	34/31	s.r.	3	Off Gregory Sound,	2	32	12	2	..	..	..	..	..	1 ♂	1 ♂	..	..	2 Munida.
48.	**153**	15	17/19	s.m.	2	Galway Bay, .	1	36	16	1	..	..	..	..	..	..	1 ♂	..	..	1 Palæmon, Corystes, Nephrops, Dab and Crystallogobius.
L.	**155**	15	27/30	s.	$2\frac{1}{4}$	Off Foul Sound, .	1	36	12	..	1	..	..	..	..	..	1 ♀	1	..	
48.	**178**	28	9/5$\frac{1}{2}$	s.	2	Blacksod Bay, .	1	30	9	1	..	..	..	..	..	..	1 ♂	..	..	1 Portunus puber and Xantho florida.
							1	34$\frac{1}{2}$	12$\frac{1}{2}$	1	..	..	..	..	..	1 ♂	..	..	..	1 Cancer pagurus and Sandeels.
48.	**180**	29	14	s.gr.	1	Ballynakill, .	1	36	16	..	1	..	..	..	..	1 ♀	..	..	..	1 Lamellibranchs.
Sh.	**185**	May 2	$\frac{1}{2}$/2	s.	..	Ballynakill Harb.,	6	$1\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	..	
48.	**188**	5	9/7	s.	$1\frac{1}{4}$	Blacksod Bay, .	1	25$\frac{1}{2}$	6$\frac{1}{2}$	..	1	1 ♀	..	..	..	..	..	..	..	1 Dab and Sandeels.
L.	**195**	8	25/16	g.s.	$10\frac{1}{4}$	Off Boffin, . .	1	35	12	..	1	..	1 ♀	..	..	..	..	1	..	
48.	**197**	8	24	s.r.	$\frac{1}{4}$	Off Inishturk, .	1	30	10	..	1	..	..	..	..	..	1 ♀	..	..	1 Sandeels and stones.
L.	**200**	9	45/60	gr.	..	Off Clare, . .	1	25	7	..	1	1 ♀	..	..	..	..	..	..	..	1 Ophiothrix, Munida, Aporrhais and Sandeels.
							2	35	12	..	2	..	..	..	..	..	2 ♀	1	..	1 Callionymus and Gadus esmarkii.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined: Males.	Number Examined: Females.	Condition of Reproductive Organs: Immature	⅓ Ripe.	¾ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					COD—*Gadus morrhua* (Linn).													
	1890.																	
25. 1	May 8	7	m.	½	Kenmare River.	6	9/21	..	4	2	4 ♂ 2 ♀	..	..	..	..	..	..	Crangon. Portunus. Buccinum. Fish.
25. 7	12	22	..	4	Dingle Bay,	1	32	14	1	..	..	..	..	..	1 ♂	..	..	1 Fish.
L. 8	16	74/80	s.m.	..	Off Skelligs,	1	35	15	..	1	..	..	..	..	1 ♀	1	..	
						1	35	12	1	..	1 ♂ ?	..	..	..	..	..	..	
L. 9	19	40	..	..	Off Benaery Head,	2	32/36	12/16	..	2	..	..	..	..	2 ♀	..	..	Portunus. Carcinas. Eledone.
L. 14	21	30	s.r.	..	Off Coosheroon,	1	30	11	..	..	..	..	..	..	..	..	..	
Sh. 35	June 12	1/5	s.	..	Boffin Harbour,	1	1¾	..	..	..	..	..	..	..	..	..	..	
						1	2¼	..	..	..	..	..	..	..	..	..	..	
L. 46	18	30	r.	..	Off Erris Head,	4	31/40	10/18	2	2	..	..	..	..	2 ♂ 2 ♀	..	..	Pagurus. Portunus. Eledone. Dabs. Sandeels.
25. 53	25	25	s.m.	..	Inver Bay (outside),	1	23	..	..	..	..	..	..	..	..	..	..	
Sh 57A	July 2	4/1	m.z.	..	Innishlyre Roads,	2	1½/1¾	..	..	..	..	..	..	..	..	..	..	
,,						14	2/2½	..	..	..	..	..	..	..	..	..	..	
,,						4	3/3½	..	..	..	..	..	..	..	..	..	..	
Sh. 67A	7	3/1	m.z.	..	Blacksod Bay,	2	3¾/4	..	..	..	..	..	..	..	..	..	..	
L. 78	July 16	35	..	..	Off The Bills,	1	36	14	..	1	..	..	..	..	1 ♀	..	..	1 Annelids.
L. 80	18	55	..	..	Off Slyne Head,	3	32	14	1	3	..	..	..	..	1 ♂ 3 ♀	..	..	Galatha. Eledone. Gadus.
Sh. 105	Aug. 14	4?	m.	..	Valentia Harbour,	1	3	..	..	..	..	..	..	..	..	..	..	
	1891.																	
48. 126	Mar. 28	26	m.	1¾	Kenmare River,	2	33/33½	13/14	2	..	..	..	..	2 ♂	..	..	..	1 Terebella. 1 Crangon vulgaris. 1 Nephrops norvegicus.
48. 132	31	23/29	s.shl.	1¾	Ballinskelligs Bay,	1	25	18	1	..	..	..	..	1 ♂	..	..	..	1 Sandeel.
L. 136	April 2	70	..	..	Off Loop Head,	4	30	10	2	2	..	..	..	2 ♂ 1 ♀	1 ♀	..	..	2 Ophiothrix fragilis. 1 Xantho. 1 Nephrops. 3 Munida.
						1	37	16	..	1	..	..	..	1 ♀	..	..	..	1 Xantho and Munida.
L. 141	7	52/50	m.s.	4¼	Off Inishmore,	1	29	9	..	1	..	..	..	..	1 ♀	..	..	1 O. fragilis.
						1	37	20	..	1	..	..	..	..	1 ♀	..	..	1 Munida and Fish.
48. 146	8	38	s.m.	1¼	Off Gregory Sound,	1	33	12	1	..	..	..	..	1 ♂	..	..	..	1 Sternum of duck?
						2	34/38	15/16	..	2	..	..	..	1 ♀	1 ♀	..	..	2 Corystes and Munida. 1 Eledone. 1 Gadus esmarkii.
48. 148	9	38	s.	1½	Off Gregory Sound,	2	36	19	1	1	..	..	..	1 ♂	1 ♀	1	..	1 Fish.
48. 149	9	39/36	s.	1	Off Gregory Sound,	1	36	13	..	1	..	..	..	..	1 ♀	..	..	1 Munida.
L. 150	9	34/31	s.r.	3	Off Gregory Sound,	2	32	12	2	..	..	..	..	1 ♂	1 ♂	..	..	2 Munida.
48. 153	15	17/19	s.m.	2	Galway Bay,	1	36	16	1	..	..	..	..	..	1 ♂	..	..	1 Palæmon, Corystes, Nephrops, Dab and Crystallogobius.
L. 155	15	27/30	s.	2¼	Off Foul Sound,	1	36	12	..	1	..	..	..	..	1 ♀	1	..	
48. 178	28	9/5⅓	s.	2	Blacksod Bay,	1	30	9	1	..	..	..	..	..	1 ♂	..	..	1 Portunus puber and Xantho florida.
						1	34½	12½	1	..	..	..	..	1 ♂	..	..	..	1 Cancer pagurus and Sandeels.
48. 180	29	14	s.gr.	1	Ballynakill,	1	36	16	..	1	..	..	..	1 ♀	..	..	..	1 Lamellibranchs.
Sh. 185	May 2	½/2	s.	..	Ballynakill Harb.,	6	1½	..	..	..	..	..	..	..	..	..	..	
48. 188	5	9/7	s.	1¼	Blacksod Bay,	1	25½	6½	..	1	1 ♀	..	..	..	..	..	..	1 Dab and Sandeels.
L. 195	8	25/16	g.s.	10¼	Off Boffin,	1	35	12	..	1	..	1 ♀	..	..	..	1	..	
48. 197	8	24	s.r.	¼	Off Inishturk,	1	30	10	..	1	..	..	..	..	1 ♀	..	..	1 Sandeels and stones.
L. 200	9	45/60	gr.	..	Off Clare,	1	25	7	..	1	1 ♀	..	..	..	..	..	..	1 Ophiothrix, Munida, Aporrhais and Sandeels.
						2	35	12	..	2	..	..	..	..	2 ♀	1	..	1 Callionymus and Gadus esmarkii.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Number Examined. Females.	Condition of Reproductive Organs. Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					Cod—*continued.*													
48. **204**	May 14	32	s.	2	Donegal Bay,	1	34½	12	1	..	..	..	..	..	1 ♂	..	..	1 Corystes.
48. **205**	14	30/19	m.s.	2	Donegal Bay,	1	36½	14	..	1	..	..	..	..	1 ♀	..	..	1 Loligo media, and Haddock.
Sh. **213**	19	3	m.s.	..	Teelin Harbour,	60	1/1¾	..	..	..	..	..	..	..	..	..	..	
48. **216**	20	8/13	m.s.	1¼	Inver Bay (inside),	1	24	5½	..	1	1 ♀	..	..	..	..	..	..	1 Sole, Wrasse, and Sprat.
,,						1	25	6¼	1	..	..	..	..	..	1 ♂	..	..	1 Portunus arcuatus, Gonoplax and Nullipore.
L. **229**	27	35	gr.r.	1½	Off Stags of N. Aran,	2	32	12	..	2	..	..	..	..	2 ♀	..	..	1 Munida. 1 Galathæa. 1 Xantho. 1 Fish.
,,						1	37	14	..	1	..	..	..	..	1 ♀	..	..	1 Nereis, Portunus, Xantho and Atelecyclus.
L. **231**	27	14	r.	11‡	Off Tory Island,	1	33½	11	1	..	..	..	..	..	1 ♂	..	..	1 Echinus, Galathæa and Anomia.
232	28	9/10	s.r.	1½	Off Horn Head,	2	15½	..	2	..	2 ♂ ? 1 ♂ ?	..	..	..	..	..	..	1 Amphiura. 1 Gammarid and Pagurus.
,,						2	16½	..	1	1	1 ♀	..	..	..	..	1	..	1 Amphiura.
,,						1	23½	..	..	1	1 ♀	..	..	..	..	..	..	1 Stenorhynchus, Portunus corrugatus, Xantho and Hyas.
,,						1	28	..	1	..	..	..	..	..	1 ♂	..	..	1 Xantho, Hyas, Gunnel and Fish.
L. **234**	28	12/14	..	12‡	Sheephaven,	1	38	16	1	..	..	..	..	..	1 ♂	..	..	1 Lutraria.
						1	41	19	..	1	..	..	..	..	1 ♀	..	..	1 Corystes, Lutraria and Fish.
48. **236**	29	10/4½	s.	1	Downies Bay,	1	28	..	..	1	..	..	..	..	1 ♀	1	..	
L. **241**	June 2	22/23	..	11‡	Off Malin Head,	3	35	15	..	..	..	..	..	..	..	..	..	

HADDOCK—*Gadus æglefinus* (Linn.).

L.	**8**	1890. May 16	74/80	s.m.	$1\frac{1}{4}$	Off the Skelligs, .	4	18/23	$2\frac{1}{4}/4\frac{1}{2}$	..	4	..	..	..	2 ♀	2 ♀	..	..	4 Echinoderms.
L.	**9**	19	40	..	..	Off Benacry Head,	3	18 ?	$2\frac{1}{4}$	3	..	..	..	..	..	..	..	..	
L.	**15**	22	74/80	s.m.	$1\frac{1}{4}$	Off Dingle Bay, .	4	15/21	..	4	..	..	..	..	..	4 ♂	..	..	2 Echinoderms. 2 Gastero-pods.
25.	**53**	June 25	25	s.m.	2	Inver Bay (outside),	1	$12\frac{1}{2}$	$\frac{1}{2}$	1	..	1 ♂	..	..	..	..	1	..	
25.	**55**	26	32	g.s.	2	Donegal Bay, .	4	13/19	$\frac{3}{4}/2\frac{1}{2}$	..	..	..	..	..	..	..	..	..	
L.	**80**	July 18	55	..	..	Off Slyne Head, .	1	23	$4\frac{1}{2}$	..	..	..	..	..	..	..	..	..	
25.	**82**	25	48	m.s.	$1\frac{1}{2}$	Off Gregory Sound,	2	12	$\frac{3}{4}$	2	..	..	2 ♂	..	..	..	..	..	1 Amphiura.
	,,						3	$13\frac{1}{2}$	1	1	2	..	1 ♂	..	..	2 ♀	..	..	3 Pagurus.
32P.	**84**	28	24	s.	$2\frac{1}{4}$	Galway Bay, .	1	$15\frac{1}{2}$	$1\frac{3}{4}$	..	1	..	..	..	..	1 ♀	..	..	1 Ophioglypha and Corbula.
28P.	**106**	Aug. 16	26/23	s.sh. s.m.	2	Kenmare River, .	1	13	$1\frac{1}{2}$	..	1	..	..	..	..	1 ♀	1	..	
L.	**113**	19	80	m.s.	..	Off the Skelligs, .	1	25	$4\frac{3}{4}$	..	..	..	..	..	..	..	..	..	Viscera eaten out on line.
48.	**126**	1891. Mar. 28	26	m.	$1\frac{3}{4}$	Kenmare River, .	1	$6\frac{1}{2}$	..	1	..	1 ♂	..	..	..	..	..	..	Amphipods.
	,,						1	14	1	..	1	..	..	..	..	..	..	..	
48.	**127**	28	21	m.	1	Kenmare River, .	1	$16\frac{1}{2}$	$1\frac{1}{2}$	..	1	..	..	.	..	1 ♀	..	..	1 Amphiura.
L.	**136**	April 2	70	..	$1\frac{1}{4}$	Off Loop Head, .	1	28	9	..	1	..	..	..	1 ♀	..	1	..	
48.	**143**	7	46/44	..	$\frac{3}{4}$	Off Inishmore, .	2	12	..	..	2	..	..	1 ♀	..	1 ♀	..	..	1 Amphiura. 1 Ophioglypha.
	,,						1	18	..	..	1	..	..	..	1 ♀	..	1	..	
48.	**146**	8	38	s.m.	$1\frac{1}{4}$	Off Gregory Sound,	4	12	$\frac{1}{2}$	..	..	..	..	..	..	..	..	..	
	,,						5	13	$\frac{3}{4}$	3	2	..	..	..	2 ♀	3 ♂	..	..	4 Amphiura. 1 Arenicola.
	,,						3	14	1	..	..	..	..	..	..	..	..	..	
48.	**148**	9	38	s.	$1\frac{1}{2}$	Off Gregory Sound,	2	$14\frac{1}{2}$	..	1	1	..	..	..	..	1 ♂ 1 ♀	..	..	2 Amphiura.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Females.	Condition of Reproductive Organs. Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					Cod—*continued.*													
48. 204	May 14	32	s.	2	Donegal Bay,	1	34½	12	1	..	..	..	..	..	1 ♂	..	..	1 Corystes.
48. 205	14	30/19	m.s.	2	Donegal Bay,	1	36½	14	..	1	..	..	..	..	1 ♀	..	..	1 Loligo media, and Haddock.
Sh. 213	19	3	m.s.	..	Teelin Harbour,	60	1/1¾	..	..	..	..	..	..	..	..	..	..	
48. 216	20	8/13	m.s.	1¼	Inver Bay (inside),	1	24	5½	..	1	1 ♀	..	..	..	..	..	..	1 Sole, Wrasse, and Sprat.
,,						1	25	6¼	1	..	..	..	..	..	1 ♂	..	..	1 Portunus arcuatus, Gonoplax and Nullipore.
L. 229	27	35	gr.r.	1½	Off Stags of N. Aran,	2	32	12	..	2	..	..	..	..	2 ♀	..	..	1 Munida. 1 Galathæa. 1 Xantho. 1 Fish.
,,						1	37	14	..	1	..	..	..	..	1 ♀	..	..	1 Nereis, Portunus, Xantho and Atelecyclus.
L. 231	27	14	r.	11‡	Off Tory Island,	1	33½	11	1	..	..	..	..	..	1 ♂	..	..	1 Echinus, Galathæa and Anomia.
232	28	9/10	s.r.	1½	Off Horn Head,	2	15½	..	2	..	2 ♂ ?	..	..	..	..	..	..	1 Amphiura. 1 Gammarid and Pagurus.
,,						2	16½	..	1	1	1 ♂ ? 1 ♀	..	..	..	..	1	..	1 Amphiura.
,,						1	23½	..	..	1	1 ♀	..	..	..	..	..	..	1 Stenorhynchus, Portunus corrugatus, Xantho and Hyas.
,,						1	28	..	1	..	..	..	..	..	1 ♂	..	..	1 Xantho, Hyas, Gunnel and Fish.
L. 234	28	12/14	..	12‡	Sheephaven,	1	38	16	1	..	..	..	..	..	1 ♂	..	..	1 Lutraria.
						1	41	19	..	1	..	..	..	..	1 ♀	..	..	1 Corystes, Lutraria and Fish.
48. 236	29	10/4½	s.	1	Downies Bay,	1	28	..	..	1	..	..	..	..	1 ♀	1	..	
L. 241	June 2	22/23	..	11‡	Off Malin Head,	3	35	15	..	..	..	..	..	..	..	..	..	
					HADDOCK—*Gadus æglefinus* (Linn.).													
L. 8	1890. May 16	74/80	s.m.	1¼	Off the Skelligs,	4	18/23	2¼/4½	..	4	..	..	..	2 ♀	2 ♀	..	..	4 Echinoderms.
L. 9	19	40	..	..	Off Benacry Head,	3	18 ?	2¼	3	..	..	..	..	..	..	..	..	
L. 15	22	74/80	s.m.	1¼	Off Dingle Bay,	4	15/21	..	4	..	..	..	..	..	4 ♂	..	..	2 Echinoderms. 2 Gasteropods.
25. 53	June 25	25	s.m.	2	Inver Bay (outside),	1	12½	½	1	..	1 ♂	..	..	..	..	1	..	
25. 55	26	32	g.s.	2	Donegal Bay,	4	13/19	¾/2½	..	..	..	..	..	..	..	..	..	
L. 80	July 18	55	..	..	Off Slyne Head,	1	23	4½	..	..	..	..	..	..	..	..	..	
25. 82	25	48	m.s.	1½	Off Gregory Sound,	2	12	¾	2	..	..	2 ♂	..	..	..	..	..	1 Amphiura.
,,						3	13½	1	1	2	..	1 ♂	..	..	2 ♀	..	..	3 Pagurus.
32P. 84	28	24	s.	2¼	Galway Bay,	1	15½	1¾	..	1	..	..	..	..	1 ♀	..	..	1 Ophioglypha and Corbula.
28P. 106	Aug. 16	26/23	s.sh. s.m.	2	Kenmare River,	1	13	1½	..	1	..	..	..	..	1 ♀	1	..	
L. 113	19	80	m.s.	..	Off the Skelligs,	1	25	4¾	..	..	..	..	..	..	..	..	..	Viscera eaten out on line.
48. 126	1891. Mar. 28	26	m.	1¾	Kenmare River,	1	6½	..	1	..	1 ♂	..	..	..	..	..	..	Amphipods.
,,						1	14	1	..	1	..	..	..	..	..	..	..	
48. 127	28	21	m.	1	Kenmare River,	1	16½	1½	..	1	..	..	.	..	1 ♀	..	..	1 Amphiura.
L. 136	April 2	70	..	1¼	Off Loop Head,	1	28	9	..	1	..	..	..	1 ♀	..	1	..	
48. 143	7	46/44	..	¾	Off Inishmore,	2	12	..	..	2	..	..	1 ♀	..	1 ♀	..	..	1 Amphiura. 1 Ophioglypha.
,,						1	18	..	..	1	..	..	..	1 ♀	..	1	..	
48. 146	8	38	s.m.	1¼	Off Gregory Sound,	4	12	½	..	..	..	..	..	..	..	..	..	
,,						5	13	¾	3	2	..	..	..	2 ♀	3 ♂	..	..	4 Amphiura. 1 Arenicola.
,,						3	14	1	..	..	..	..	..	..	..	..	..	
48. 148	9	38	s.	1½	Off Gregory Sound,	2	14½	..	1	1	..	..	..	..	1 ♂ 1 ♀	..	..	2 Amphiura.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	LOCALITY.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Females.	Condition of Reproductive Organs. Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					HADDOCK—*continued.*													
48. **149**	April 9	39/36	s.	1	Off Gregory Sound,	1	12	$\frac{1}{2}$	1	..	..	..	..	..	1 ♂	..	..	1 Amphiura.
48. **153**	15	17/19	s.m.	2	Galway Bay,	2	16	$1\frac{1}{4}$	..	2	..	..	..	..	2 ♀	..	..	1 Amphiura. 1 Gebia.
,,						3	18	2	..	2	..	..	..	..	2 ♀	..	..	1 Corystes. 1 Crustacean.
L. **165**	20	154	s.	$2\frac{3}{4}$	Off Achill Head,	1	26	6	..	1	..	..	..	1 ♀	..	1	..	
18. **166**	20	154	s.	$2\frac{3}{4}$	Off Achill Head,	1	15	1	..	1	..	..	..	1 ♀	..	1	..	
,,						1	16	$1\frac{1}{2}$	..	1	..	..	..	1 ♀	..	..	..	1 Annelid.
,,						1	20	$2\frac{1}{2}$	..	1	..	..	..	1 ♀	..	1	..	
48. **177**	25	20/18	m.s.	1	Off Downpatrick Hd.	1	17	$1\frac{1}{2}$	1	..	..	..	..	..	1 ♂	..	..	1 Annelid.
48. **204**	May 14	32	s.	2	Donegal Bay,	13	$13\frac{1}{2}$	..	2	1	1 ♀	..	..	..	2 ♂	..	..	2 Annelids. 1 Portunus. 1 Cymothoa. 1 Tellina.
,,						11	$15\frac{1}{2}$	$1\frac{1}{4}$	1	4	1 ♀ ?	..	..	..	1 ♂ 3 ♀	..	..	2 Amphiura. 2 Annelids. 1 Cymothoa. 1 Portunus. 2 Aplysia.
						1	$18\frac{1}{2}$	2	..	1	..	..	..	..	1 ♀	..	..	1 Annelids and Aplysia.
48. **205**	14	30/19	m.s.	2	Donegal Bay,	10	14	..	..	..	..	..	..	..	..	..	..	
,,						8	15	..	..	..	..	..	..	..	..	..	..	
,,						2	19	$2\frac{1}{2}$	1	1	..	..	..	..	1 ♂ 1 ♀	2	..	
,,						1	$20\frac{1}{2}$	3	..	1	..	..	..	..	1 ♀	1	..	
48. **212**	18	31/30	s.gr. f.s.r.	$\frac{3}{4}$	Donegal Bay,	1	$13\frac{1}{2}$	..	..	1	..	..	..	..	1 ♀	1	..	
,,						2	$15\frac{1}{2}$	..	..	2	..	..	..	..	2 ♀	..	..	1 Echinoderms. 2 Annelids. 1 Lamellibranchs.

48.	**217**	May 20	13/10	m.s.	2	Off Doran Head, .	2	13	..	..	1	1 ♀	..	..	..	..	..	..	1 Crystallogobius.
48.	**219**	20	22/26	f.s.	1	Off Teelin, . .	4	15	..	..	3	..	..	..	..	3 ♀	1	..	2 Annelids. 1 Crustaceans.
						WHITING—*Gadus merlangus* (Linn.).													
25.	**53**	1890. June 25	25	s.m.	2	Inver Bay (outside),	1	18	2	..	1	..	..	..	..	1 ♀	1	..	
Sh.	**57A.**	July 2	4/1	m.z.	2	Inishlyre Roads, .	1	$3\frac{1}{4}$	..	..	..	..	..	..	..	..	..	..	
Sh.	**67A.**	7	3/4	m.z.	..	Blacksod Bay, .	1	$1\frac{3}{4}$	..	..	..	..	..	..	..	..	..	..	
	,,						4	$2\frac{1}{4}$	..	..	..	..	..	..	..	..	..	..	
	,,						5	$2\frac{1}{2}/2\frac{3}{4}$	..	..	..	..	..	..	..	..	..	..	
Sh.	**108**	Aug. 16	..	..	..	Kilmakalogue, .	3	Small	..	..	..	..	..	..	..	..	..	..	
48.	**123**	1891. Mar. 21	27	f.s.	1	Ballinskellig's Bay,	1	$13\frac{1}{2}$	$\frac{1}{2}$	..	1	..	..	..	1 ♀	..	1	..	
48.	**126**	28	26	m.	$1\frac{3}{4}$	Kenmare River, .	1	$11\frac{1}{2}$	$\frac{1}{4}$	..	1	..	..	..	1 ♀	..	..	..	
	,,						4	$12\frac{1}{2}$	$\frac{1}{2}$	..	4	..	..	1 ♀	3 ♀	..	3	1	
	,,						1	$15\frac{1}{2}$	1	..	1	..	1 ♀	..	..	..	..	..	1 Mysis.
48.	**127**	28	21	m.	1	Kenmare River, .	2	$6\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
							2	$11\frac{1}{2}$	$\frac{1}{4}$	..	2	..	1 ♀	..	..	1 ♀	2	..	
Sh.	**129**	30	4/5	m.	..	Kenmare River, .	1	6	..	..	..	..	..	..	..	..	..	..	
48.	**146**	April 8	38	s.m.	$1\frac{1}{4}$	Off Gregory Sound,	1	12	$\frac{1}{2}$	1	..	..	..	..	1 ♂	..	..	..	1 Fish.
	,,						1	14	$\frac{1}{2}$	..	1	..	1 ♀	..	..	..	..	..	
	,,						6	$15\frac{1}{2}$	1	..	..	..	..	..	..	..	..	..	
	,,						2	16	..	..	2	..	1 ♀	..	1 ♀	..	2	..	
	,,						1	17	..	..	1	..	..	..	1 ♀	..	..	..	1 Herring & Gadus esmarkii.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined: Males.	Number Examined: Females.	Condition of Reproductive Organs: Immature.	½ Ripe.	¾ Ripe.	Ripe.	Spent.	Nature of Food and Remarks: 0.	?	
					Haddock—*continued.*													
48. 149	April 9	39/36	s.	1	Off Gregory Sound,	1	12	½	1	..	..	..	..	..	1 ♂	.	..	1 Amphiura.
48. 153	15	17/19	s.m.	2	Galway Bay, .	2	16	1¼	..	2	..	..	..	..	2 ♀	..	..	1 Amphiura. 1 Gebia.
,,						3	18	2	..	2	..	..	..	..	2 ♀	..	..	1 Corystes. 1 Crustacean.
L. 165	20	154	s.	2¾	Off Achill Head, .	1	26	6	..	1	..	..	..	1 ♀	..	1	..	
18. 166	20	154	s.	2¾	Off Achill Head, .	1	15	1	..	1	..	..	..	1 ♀	..	1	..	
,,						1	16	1½	..	1	..	..	..	1 ♀	..	..	..	1 Annelid.
,,						1	20	2½	..	1	..	..	..	1 ♀	..	1	..	
48. 177	25	20/18	m.s.	1	Off Downpatrick Hd.	1	17	1½	1	..	..	..	..	..	1 ♂	..	..	1 Annelid.
48. 204	May 14	32	s.	2	Donegal Bay, .	13	13½	..	2	1	1 ♀	..	..	..	2 ♂ 1 ♂	..	..	2 Annelids. 1 Portunus. 1 Cymothoa. 1 Tellina.
,,						11	15½	1¼	1	4	1 ♀?	..	..	..	3 ♀	..	..	2 Amphiura. 2 Annelids. 1 Cymothoa. 1 Portunus. 2 Aplysia.
						1	18½	2	..	1	..	..	..	..	1 ♀	..	..	1 Annelids and Aplysia.
48. 205	14	30/19	m.s.	2	Donegal Bay, .	10	14	..	..	..	..	..	..	..	..	..	..	
,,						8	15	..	..	..	..	..	..	..	..	..	..	
,,						2	19	2½	1	1	..	..	..	..	1 ♂ 1 ♀	2	..	
,,						1	20½	3	..	1	..	..	..	..	1 ♀	1	..	
48. 212	18	31/30	s.gr. f.s.r.	¾	Donegal Bay, .	1	13½	..	..	1	..	..	..	..	1 ♀	1	..	
,,						2	15½	..	..	2	..	..	..	..	2 ♀	..	..	1 Echinoderms. 2 Annelids. 1 Lamellibranchs. 1 Crystallogobius.
48. [illegible]	20	22/26	f.s.	1	Off Teelin, .	4	15	..	..	3	..	..	..	..	3 ♀	1	..	2 Annelids. 1 Crustaceans.
					WHITING—*Gadus merlangus* (Linn.).													
25. 53	1890. June 25	25	s.m.	2	Inver Bay (outside),	1	18	2	..	1	..	..	..	..	1 ♀	1	..	
Sh. 57A.	July 2	4/1	m.z.	2	Inishlyre Roads, .	1	3¼	..	..	..	..	..	..	..	..	..	..	
Sh. 67A.	7	3/4	m.z.	..	Blacksod Bay, .	1	1¾	..	..	..	..	..	..	..	..	..	..	
,,						4	2¼	..	..	..	..	..	..	..	..	..	..	
,,						5	2½/2¾	..	..	..	..	..	..	..	..	..	..	
Sh. 108	Aug. 16	..	..	..	Kilmakalogue, .	3	Small	..	..	..	..	..	..	..	..	..	..	
48. 123	1891. Mar. 21	27	f.s.	1	Ballinskellig's Bay,	1	13½	½	..	1	..	..	..	1 ♀	..	1	..	
48. 126	28	26	m.	1¾	Kenmare River, .	1	11½	¼	..	1	..	..	..	1 ♀	..	..	..	
,,						4	12½	½	..	4	..	..	1 ♀	3 ♀	..	3	1	
,,						1	15½	1	..	1	..	1 ♀	..	..	..	..	..	1 Mysis.
48. 127	28	21	m.	1	Kenmare River, .	2	6½	..	..	..	..	..	..	..	..	..	..	
						2	11½	¼	..	2	..	1 ♀	..	..	1 ♀	2	..	
Sh. 129	30	4/5	m.	..	Kenmare River, .	1	6	..	..	..	..	..	..	..	..	..	..	
48. 146	April 8	38	s.m.	1⅓	Off Gregory Sound,	1	12	½	1	..	..	..	..	1 ♂	..	..	..	1 Fish.
,,						1	14	½	..	1	..	1 ♀	..	..	..	..	..	
,,						6	15½	1	..	..	..	..	..	..	..	..	..	
,,						2	16	..	..	2	..	1 ♀	..	1 ♀	..	2	..	
,,						1	17	..	..	1	..	..	..	1 ♀	..	..	..	1 Herring & Gadus esmarkii.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Females.	Condition of Reproductive Organs. Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	Nature of Food and Remarks. 0.	?	
					Whiting—*continued*.													
48. **147**	May 8	25/10	s.	$1\frac{1}{2}$	South Sound, .	3	11	$\frac{1}{4}$	..	3	..	..	..	..	3 ♀	3	..	
,,						1	$12\frac{1}{2}$	$\frac{1}{2}$	..	1	..	..	..	1 ♀	..	1	..	
,,						1	14	$\frac{3}{4}$	..	1	..	..	..	1 ♀	..	..	..	1 Sprat.
48. **148**	9	38	s.	$1\frac{1}{2}$	Off Gregory Sound,	3	14	1	1	2	..	1 ♀	..	..	1 ♀ 1 ♂	2	..	1 Fish.
						1	16	$1\frac{1}{4}$	..	..	..	..	..	1 ♀	..	1	..	
48. **149**	9	39/36	s.	1	Off Gregory Sound,	2	16	1	..	2	..	2 ♀	..	..	..	..	..	2 Fish.
48. **153**	15	17/19	s.m.	2	Galway Bay, .	1	10	..	1	..	..	..	..	1 ♂	..	1	..	
48. **154**	15	33	s.	$\frac{3}{4}$	Off Foul Sound, .	1	14	..	..	..	..	..	..	..	..	..	..	
48. **164**	20	18	s.	$1\frac{1}{2}$	Clew Bay, . .	3	18	1	..	2	..	..	..	..	..	1	..	1 Stones.
,,						1	21	2	..	1	..	..	..	..	1 ♀	1	..	
48. **197**	May 8	24	s.r.	$\frac{1}{4}$	Inishturk, . .	1	12	..	1	..	..	..	..	..	1 ♂	..	..	1 Sandeels.
48. **204**	14	32	s.	2	Donegal Bay, .	2	12	..	1	1	..	..	..	..	1 ♂ 1 ♀	2	..	
,,						3	14	1	1	2	..	..	..	..	1 ♂ 2 ♀	1	..	2 Sprats.
,,						3	17	$1\frac{1}{4}$	..	2	..	..	..	..	2 ♀	1	..	1 Crangon.
48. **205**	14	30/19	m.s.	2	. . . .	2	10	..	..	..	..	..	..	..	..	..	..	
,,						4	12	..	..	..	..	..	..	..	..	..	..	
,,						5	14	..	..	..	..	..	..	..	..	..	..	
48. **215**	19	35/28	s.	$1\frac{1}{4}$	Off Teelin, . .	1	11	..	..	..	..	..	..	..	..	..	..	
,,						3	13	$\frac{3}{4}$	1	2	..	1 ♀	..	..	1 ♂ 1 ♀	1	..	1 Sprat. 1 Crystallogobius.

48. **221**	21	19/5	s.	2	Loughrosmore Bay,	1	$16\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
48. **222**	21	22/20	s.	$1\frac{1}{2}$	Boylach Bay, .	1	$15\frac{1}{2}$	..	..	1	..	..	..	..	1 ♀	..	..	1 Amphiura.
					COALFISH—*Gadus vireus* (Linn.).													
Sh. **35, 36**	1890. June 12	1/5	s.	..	Boffin Harbour, .	77	1/3	..	..	..	..	..	..	..	..	..	..	
R. **51, 52**	22	5	m.	..	Killybegs H. (inner)	10*	2/3	..	..	..	..	..	..	..	..	..	..	* (At the surface).
Sh. **57**A.	July 2	4/1	m.	..	Innishlyre Roads,	2	2	..	..	..	..	..	..	..	..	..	..	
Sh. **67**A.	7	3/1	m.	..	Blacksod Bay, .	5	2/3	..	..	..	..	..	..	..	..	..	..	
L. **80**	18	55	..	..	Off Slyne Head, .	3	..	..	..	..	..	..	..	..	..	..	..	
L. **136**	1891. April 2	70	..	$1\frac{1}{4}$	Off Loop Head, .	1	39	14	1	..	..	..	..	1 ♂	..	..	..	
,,						42	36	12	5	6	..	..	..	..	5 ♂ 6 ♀	5	..	3 Mysis. 5 Crustaceans. 3 Stones.
L. **141**	7	52/50	m.s.	$4\frac{1}{4}$	Off Inishmore, .	4	35	$11\frac{1}{2}$	2	2	..	..	..	..	2 ♂ 2 ♀	1	..	3 Mysis.
L. **150**	9	34/31	s.r.	3	Off Gregory Sound,	2	$36\frac{1}{2}$	14	2	..	..	..	..	..	2 ♂	..	..	2 Mysis. 1 Fish.
M. **156**	15	5/7	crl.	10‡	Killeany Bay, .	2	15	..	..	..	..	..	..	..	..	..	..	
48. **164**	20	18	s.	$1\frac{1}{2}$	Clew Bay, . .	1	27	5	..	1	..	..	..	..	1 ♀	..	..	1 Crystallogobius.
Sh. **185**	May 2	$\frac{1}{2}$/2	s.	..	Ballynakill Harb.,	41	1	..	..	..	..	..	..	..	..	..	..	
Sh. **213**	19	3	m.s.	..	Teelin Harbour, .	40	1	..	..	..	..	..	..	..	..	..	..	
48. **216**	5	8/13	m.s.	$1\frac{1}{4}$	Inver Bay (inside),	1	28	7	..	1	..	..	..	..	1 ♀	..	..	1 Sprats.
,,						1	32	10	..	1	..	..	..	..	1 ♀	..	..	1 Sprats.
,,						1	33	12	1	..	..	..	..	..	1 ♂	..	..	1 Sprats.
L. **231**	27	21/29	s.	11‡	Off Tory Island, .	1	33	10	1	..	..	..	..	..	1 ♂	1	..	
48. **236**	29	$10/4\frac{1}{2}$	s.	1	Downies Bay, .	1	35	12	..	1	..	..	..	..	1 ♀	..	..	1 Sandeels.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Number Examined. Females.	Condition of Reproductive Organs. Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	Nature of Food and Remarks. 0.	?	
					POLLACK—*Gadus pollachius* (Linn.).													
L. **9**	1890. May 19	40	..	..	Off Benacry Head,	1	22	..	1	..	1 ♂	..	..	..	..	1	..	
,,						1	24	..	..	1	..	1 ♀	..	..	..	1	..	
,,						1	36	..	1	..	..	1 ♂	..	..	..	1	..	
Sh. **35,36**	June 12	1/5	s.	..	Boffin Harbour, .	2	$1\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
Sh. **57A.**	July 2	4/1	m.z.	..	Innishlyre Roads, .	5	$1\frac{3}{4}$	..	..	..	..	..	..	..	..	..	..	
,,						7	$2\frac{1}{4}$	..	..	..	..	..	..	..	..	..	..	
,,						1	10	..	..	..	..	..	..	..	..	..	..	
Sh. **67A.**	7	3/1	z.m.	..	Blacksod Bay, .	1	$1\frac{3}{4}$	..	..	..	..	..	..	..	..	..	..	
,,						4	$2\frac{1}{4}/2\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
32P. **84**	July 28	24	s.	$2\frac{1}{4}$	Galway Bay, .	1	24	$6\frac{1}{2}$	..	1	..	..	..	..	1 ♀	..	..	1 Fish.
18. **96**	Aug. 11	..	..	..	Cashla Bay, .	1	22	9	..	1	..	..	..	..	1 ♀	..	..	1 Fish.
Sh. **97**	Aug. 11	2/7	s.	..	Killeany Bay, .	1	$\frac{3}{4}$	..	..	..	..	..	..	..	..	..	..	
,,						1	$1\frac{3}{4}$	..	..	..	..	..	..	..	..	..	..	
,,						1	3	..	..	..	..	..	..	..	..	..	..	
Sh. **100**	13	4	s.	$\frac{3}{4}$	Ventry Harbour, .	1	$3\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
Sh. **105**	14	4?	m.	..	Valentia Harbour,	4	$2\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						3	$3\frac{3}{4}$	..	..	..	..	..	..	..	..	..	..	

	,,						4	$4\frac{1}{4}$	..	..	..	..	..	..	..	..	..	..	
Sh.	**109**	18	$2\frac{1}{2}$	m.	..	Kenmare River, .	5	small	..	..	..	..	..	..	..	..	..	..	
Sh.	**119**	23	1/2	s.	..	Ballinskelligs Bay,	2	$2\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
	,,						4	$3/3\frac{3}{4}$	..	..	..	..	..	..	..	..	..	..	
Sh.	**120**		3/4	s.z.	..	Ballinskelligs Bay,	5	$2/3\frac{1}{4}$	..	..	..	..	..	..	..	..	..	..	
48.	**133**	1891. Mar. 31	40	s.r.	$1\frac{3}{4}$	Dingle Bay, .	1	29	9	1	..	..	..	..	1 ♂	..	..	..	1 Fish.
Sh.	**138**	April 3	5	m.crl.	..	Kilkieran Bay, .	1	$6\frac{1}{2}$	..	1	..	1 ♂	..	..	..	..	..	..	
48.	**146**	8	38	s.m.	$1\frac{1}{4}$	Off Gregory Sound,	2	31	9	1	1	..	..	1 ♀	1 ♂	..	..	..	2 Fish.
	,,						4	33	12	1	2	..	..	..	1 ♂	2 ♀	..	..	3 Fish.
48.	**148**	9	38	s.	$1\frac{1}{2}$	Off Gregory Sound,	2	33	$13\frac{1}{2}$	..	2	..	1 ♀	..	1 ♀	.. 1 ♂	1	..	1 Scaldfish and Gadus esmarkii.
48.	**149**	9	39/36	..	1	Off Gregory Sound,	2	$33\frac{1}{2}$	11	1	1	..	..	..	..	1 ♀	..	..	1 Argentina.
48.	**153**	15	17/19	s.m.	2	Galway Bay, .	1	31	$6\frac{1}{2}$	1	..	..	..	..	..	1 ♂	..	..	1 Crystallogobius.
M.	**156**	15	5/7	crl.	10‡	Killeany Bay, .	14	13/14	..	3	..	3 ♂ 1 ♂	..	..	..	..	..	..	1 Zoëæ. 2 Mysis. 1 Palæmon.
	,,						7	15	..	1	2	2 ♀ 2 ♂	..	..	..	..	..	..	2 Mysis. 1 Zoëæ. 1 Gammarids.
	,,						7	16	..	2	1	1 ♀	..	..	..	..	..	..	1 Mysis. 3 Gammarids. 1 Sandeels.
	,,						4	17/18	..	..	3	2 ♀	..	..	..	1 ♀	..	..	1 Mysis. 2 Gammarids. 1 Zoëæ. 1 Sepiola.
	,,						1	22	..	..	1	..	1 ♀	..	..	..	..	..	1 Annelids and Seaweed.
	,,						1	24	..	..	1	..	1 ♀	..	..	..	..	..	1 Pandalus and Fish.
L.	**161**	18	5/10	s.r.	10‡	Off Boffin, . .	1	$22\frac{1}{2}$	3	..	1	..	..	..	1 ♀	..	1	..	
48.	**164**	20	18	s.	$1\frac{1}{2}$	Clew Bay, . .	1	28	$5\frac{1}{4}$	..	1	..	..	..	..	1 ♀	..	..	1 Fish.
48.	**178**	28	$9/5\frac{1}{2}$	s.	2	Blacksod Bay, .	1	34	$11\frac{1}{2}$	..	1	..	..	..	..	1 ♀	..	..	1 Sandeels.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Females.	Condition of Reproductive Organs. Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					Pollack—*continued.*													
48. **180**	April 29	14	s.gr.	1	Ballynakill, .	1	28	6	..	..	..	..	..	..	..	..	..	
48. **196**	May 5	16/13	s.r.	¼	Davalaun Sound, .	3	17	1½	1	..	1 ♂	..	..	..	..	1	..	
,,						2	21	3½	..	1	..	1 ♀	..	..	..	1	..	
,,						4	24	5	2	..	..	..	..	..	2 ♂	1	..	1 Sandeels.
,,						2	29	7	..	2	..	..	..	..	2 ♀	1	..	1 Sandeels.
48. **204**	14	32	s.	2	Donegal Bay, .	1	33½	10	1	..	..	..	..	..	1 ♂	..	..	1 Crystallogobius.
48. **205**	14	30/19	m.s.	2	Donegal Bay, .	1	28	8	1	..	..	..	..	1 ♂	..	..	..	1 Sprats.
48. **212**	18	31/30	s.gr. f.s.r.	¾	Donegal Bay, .	1	33½	10	..	1	..	..	..	..	1 ♀	..	..	1 Clupeoids and Gurnard.
48. **216**	20	8/13	m.s.	1¼	Inver Bay (inside),	1	29	8½	..	1	..	..	..	..	1 ♀	..	..	1 Sprats.
					HAKE—*Merluccius vulgaris* (Cuv.).													
25. **12**	1890. May 20	53	d.g.s.	3	Off Dingle Bay, .	2	8	..	..	..	..	..	..	..	..	..	..	
L. **15**	22	74/80	s.m.	1¼	Off Dingle Bay, .	4	30/40	17	..	4	..	..	2 ♀	..	2 ♀	4	..	
25. **53**	June 25	25	s.m. s.sh.	2	Inver Bay (outside),	3	39/43	14/17	..	3	..	1 ♀	..	1 ♀	1 ♀	3	..	
28P. **106**	Aug. 16	26	s.m.	2	Kenmare River, .	5	30/31	7½/10	4	1	..	..	..	..	4 ♂ 1 ♀	2	..	3 Herrings.
28P. **112**	18	25	m.s.	1¼	Kenmare River, .	1	28½	6½	1	..	..	..	..	1 ♂	..	1	..	
Sh. **114**	19	80	s.	..	Off the Skelligs, .	3	1¼/1½	..	..	..	..	..	..	..	..	..	..	
28P. **115**	20	62	m.s.	1	Ballinskelligs Bay,	1	29	7	..	1	..	..	..	..	1 ♀	..	..	1 Fish.

48.	**123**	Mar. 21	27	f.s.	1	Ballinskelligs Bay,	1	30 ?e	scaped	..	..	..	..	..	..	..	..	..	
25.	**124**	23	220	..	2	Off Bolus Head, .	1	30	7½	..	1	..	..	..	..	1 ♀	1	..	
25.	**125**	23	115	..	1	Off Bolus Head, .	1	6	..	..	..	..	..	..	..	..	..	..	
	,,						2	28	..	2	..	..	1 ♂	1 ♂	..	..	2	..	
48.	**126**	28	26	m.	1¾	Kenmare River, .	1	29½	..	1	..	..	..	..	..	1 ♂	..	..	1 Ophioglypha albida and Whiting.
48.	**133**	31	40	s.r.	2	Dingle Bay, .	1	7½	..	..	..	♂ ?	..	..	..	..	..	..	
48.	**146**	April 8	38	s.m.	1¼	Off Gregory Sound,	1	34	8	1	..	..	..	..	..	1 ♂	1	..	
	,,						3	39	20	..	2	..	1 ♀	..	..	1 ♀	1	..	
L	**165**	20	154	s.	2¾	Off Black rock, .	1	39	17	..	1	..	1 ♀	..	..	..	1	..	
						LING—*Molva vulgaris* (Flem.).													
L.	**8**	1890. May 16	74/80	s.m.	1¼	Off The Skelligs, .	6	37/50	25	..	6	..	..	6 ♀	..	..	6	..	
L.	**9**	19	40	..	..	Off Benacry Head,	12	20/50	8/12	6*	6	..	..	..	..	..	6	..	* (♂ 35 to 42 in.).
L.	**14**	21	30	s.r.	..	Off Cooshcroon, .	5	17/54	2/18	2	3*	1 ♂	..	..	1 ♂	3 ♀	..	..	5 Fish. * (♀ 30 to 34 in.).
L.	**15**	22	74/80	s.m.	1¼	Off Dingle Bay, .	16	31/53	5/32	9*	7*	..	..	4 ♂	5 ♂	7 ♀	16	..	* (♂ 29 to 41, ♀ 31 to 53 in.).
L.	**46**	June 18	30	r.	1½	Off Erris Head, .	1	24	2	..	1	..	1 ♀	..	..	..	1	..	
	,,						3	28/39	4/10	3	..	..	..	..	2 ♂	1 ♂	3	..	
	,,						3	50	..	..	..	..	..	..	..	..	..	..	
25.	**55**	26	32	g.s.	2	Donegal Bay, .	1	42	16	..	1	..	..	..	..	1 ♀	..	..	1 Haddock (12 inches long).
25 l.	**72**	July 10	127	sh.s.	..	Off Achill Head, .	1	53	21	1	..	..	..	..	..	1 ♂	1	..	
L.	**78**	16	35	..	..	Off The Bills, .	13	25/53	3½/26	3*	2*	..	..	1 ♂	2 ♂	2 ♀	5	..	* (♂ 46 in., ♀ 25 and 53 in.).

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Number Examined. Females.	Condition of Reproductive Organs. Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	Nature of Food and Remarks. 0.	?	
					Ling—*continued.*													
L. **80**	Ma 18	55	..	..	Off Slyne Head, .	1	21	2	1	..	..	..	..	..	1 ♂	1	..	
,,						2	26½/27	4½/10	..	2	..	..	..	..	2 ♀	2	..	
,,						2	29/31	5½/12	2	..	..	..	..	..	2 ♂	2	..	
,,						2	34/35	18/13	..	2	..	..	..	..	2 ♀	2	..	
,,						1	37	11	..	1	..	..	..	..	1 ♀	1	..	
,,						2	37/38	15/14	..	2	..	..	..	..	2 ♀	2	..	
,,						1	41	13	1	..	..	..	1 ♂	..	..	1	..	
,,						2	46/47	17/22	1	1*	..	..	..	..	1 ♂ 1 ♀	2	..	* (♀ 47 in.).
,,						10	48	25	1	9	..	..	..	..	1 ♂ 9 ♀	7	..	3 Eledone.
L. **113**	Aug. 19	80	m.s.	..	Off The Skelligs, .	1	44	14½	1	..	..	..	..	..	1 ♂	1	..	
,,						1	49	24	1	..	..	..	..	..	1 ♂	1	..	
,,						1	50	28	..	1	..	..	..	..	1 ♀	..	..	1 Scad.
48. **126**	1891. Mar. 28	26	m.	1¾	Kenmare River, .	1	51	30	..	1	..	1 ♀	..	..	..	..	..	1 Fish.
L. **136**	April 2	70	..	1¼	Off Loop Head, .	1	33	8	..	1	..	1 ♀	..	..	..	..	..	1 Eledone.
						2	49	25/32	..	2	..	..	1 ♀	..	1 ♀	2	..	
L. **141**	7	52/50	m.s.	4½	Off Inishmore, .	2	42	12/15	..	2	..	1 ♀	..	..	1 ♀	1	..	1 Nephrops.
48. **143**	7	46/44	..	1	Off Inishmore, .	1	22	..	..	..	..	..	..	..	..	..	..	

48. **146**	8	38	s.m.	$1\frac{1}{4}$	Off Gregory Sound,	1	40	18	1	..	..	..	..	1 ♂	..	1	..	
48. **148**	9	38	s.	$1\frac{1}{2}$	Off Gregory Sound,	1	$36\frac{1}{2}$	15	..	1	..	..	..	1 ♀	..	..	..	1 Gadus esmarkii.
L. **150**	9	34/31	s.m.	3	Off Gregory Sound,	5	33	15	2	..	..	..	..	1 ♂	1 ♂	..	..	2 Fish.
,,						2	39	20	1	..	..	..	..	..	1 ♂	1	..	
,,						2	42	20	1	1	..	..	1 ♀	..	1 ♂	2	..	
,,						6	45	23	1	..	..	..	..	1 ♂	..	1	..	
,,						1	48	25	..	1	..	..	..	1 ♀	..	1	..	
,,						1	52	31	..	..	..	..	..	..	..	..	..	
L. **155**	15	27/30	s.	$2\frac{1}{4}$	Off Foul Sound, .	3	32	15	3	..	..	..	..	3 ♂	..	3	..	
,,						4	40	18	2	1	..	..	..	2 ♂	1 ♀	3	..	
,,						4	43	20	2	..	..	..	..	2 ♂	..	2	..	
,,						2	47	25	2	..	..	..	..	2 ♂	..	2	..	
,,						1	48	29	1	..	..	..	..	1 ♂	..	1	..	
L. **165**	20	154	s.	$2\frac{3}{4}$	Off Achill Head, .	1	39	15	1	..	..	..	..	1 ♂	..	1	..	
,,						2	42	17	..	1	..	1 ♀	..	..	..	1	..	
,,						1	49	25	..	1	..	1 ♀	..	..	..	1	..	
,,						1	54	..	..	.	..	..	..	..	..	..	..	
18. **166**	20	154	s.	$2\frac{3}{4}$	Off Achill Head, .	1	41	..	1	..	..	..	..	1 ♂	..	1	..	
,,						1	47	..	..	1	..	..	1 ♀	..	..	..	..	1 Witch.
48. **181**	30	30	s.r.	$\frac{1}{2}$	Off Davalaun, .	1	21	$1\frac{1}{2}$	..	1	1 ♀	..	..	..	..	1	..	
L. **195**	May 8	25/16	g.s.	$10\frac{1}{4}$	Off Boffin, . .	1	23	..	..	1	1 ♀	..	..	..	..	..	..	1 Loligo forbesii.
L. **199**	9	5/7	..	$10\frac{1}{4}$	Ship Sound, .	3	25/40	..	..	..	..	..	..	..	..	..	..	

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined.		Condition of Reproductive Organs.					Nature of Food and Remarks.		
									Males.	Females.	Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	0.	?	
					Ling—*continued.*													
L. **200**	May 9	45/60	g.	..	Off Clare Island, .	2	35	12	1	..	..	..	..	1 ♂	..	1	..	
,,						4	39	18	2	..	..	..	..	2 ♂	..	2	..	
,,						1	44	20	..	..	..	..	..	..	..	..	..	
,,						6	47	26	2	1	..	..	..	2 ♂	1 ♀	2	..	1 Fish.
48. **205**	14	30/19	m.s.	2	Donegal Bay, .	1	47	18	1	..	..	..	..	1 ♂	..	..	..	1 Gurnard and Haddock.
48. **215**	19	35/28	s.	1¼	Off Teelin, . .	1	42	..	..	1	..	..	..	1 ♀	..	1	..	
L. **229**	27	35	gr.r.	1½	Off N. Aran Stags,	1	23½	3	..	1	1 ♀	..	..	..	..	1	..	
,,						1	30	7	..	1	..	..	..	1 ♀	..	..	..	1 Cephalopods.
,,						1	39	12	1	..	..	..	..	1 ♂	..	..	..	1 Cephalopods.
L. **231**	27	21/29	s.	10‡	Off Tory Island, .	1	37	..	..	1	..	..	..	..	1 ♀	..	1	1 Eledone. 1 Gurnard and Haddock. 2 Fish.
,,						8	40/44	..	..	7	..	..	..	1 ♀* 3 ♂	6 ♀ 2 ♂	4	..	* (Ripe ♀, 41 in. with diseased ovaries).
,,						12	45/49	..	5	6	..	..	..	.. 1 ♂	6 ♀ 1 ♂	4	..	2 Eledone. 6 Fish (1 Pleuronectid).
,,						9	50/54	..	2*	5	..	..	..	..	5 ♀	3	..	4 Fish. (1 Dab 15½ inches). * (♂ 51 and 52 in).
,,						1	58	..	..	1	..	..	..	..	1 ♀	1	..	
L. **234**	28	12/14	s.	12‡	Sheephaven, .	2	40/48	..	1	1*	..	..	..	1 ♂	1 ♀	2	..	* (40 in.).
L. **241**	June 2	22/23	st.gr.	12	Off Malin Head, .	2	26/32	..	..	..	..	..	..	..	..	..	..	
						11	46/53	..	..	..	..	..	..	..	..	..	..	

TORSK—*Brosmius brosme* (Müll.).

L.	**78**	1890. July 16	35	..	..	Off the Bills, .	1	16	$1\frac{3}{4}$	..	1	..	..	..	..	1 ♀	..	..	1 Crustacean.
	,,						1	26	6	1	..	..	..	..	..	1 ♂	1	..	
L.	**203**	1891. May 12	250	..	1	. . . . .	1	27	7	1	1 ♂ ?	..	..	..	..	..	1	..	
	,,						1	$27\frac{1}{2}$	8	1	1 ♂ ?	..	..	..	..	..	1	..	

HALIBUT—*Hippoglossus vulgaris* (Flem.).

L.	**78**	1890. July 16	35	..	..	Off the Bills, .	1	60	95	..	1	..	..	..	..	1 ♀	1	..	
48.	**153**	1891. April 15	17/19	s.m.	2	Galway Bay, .	1	29	10	..	1	..	1 ♀	..	..	..	..	..	1 Corystes.
L.	**231**	May 27	..	..	11‡	Off Tory Island, .	1	53	68	..	1	..	*1 ♀	..	..	..	..	..	1 Red Gurnard. *(Nearly $\frac{3}{4}$ ripe.)

LONG ROUGH DAB—*Hippoglossoides limandoides* (Bl.).

25.	**53**	1890. June 25	25	s.m.	2	Inver Bay (outside)	3	$8\frac{1}{2}/10\frac{1}{2}$	$\frac{1}{4}/\frac{1}{2}$	..	..	..	..	..	..	..	..	..	
Sh.	**114**	Aug. 19	80	m.s.	$\frac{3}{4}$	Off the Skelligs, .	5	$1/1\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
	,,						3	$3\frac{3}{4}$	..	..	..	..	..	..	..	..	..	..	
	,,						7?	small	..	..	..	..	..	..	..	..	..	..	
28P.	**115**	Aug. 20	62/52	m.s.	1	. . . . .	3	$1\frac{1}{4}$	..	..	..	..	..	..	..	..	..	..	
	,,						6	$1\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
	,,						4	$1\frac{3}{4}$	..	..	..	..	..	..	..	..	..	..	
	,,						3	small	..	..	..	..	..	..	..	..	..	..	

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Number Examined. Females.	Condition of Reproductive Organs. Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					Long Rough Dab—*continued.*													
48. **131**	1891. Mar. 30	45/48	s.	2	Kenmare River, .	1	$10\frac{1}{2}$	..	..	1	..	..	..	..	1 ♀	..	..	1 Echinoderms and Annelids.
48. **143**	April 7	46/44	s.	1	Off Inishmore, .	1	8	..	..	1	..	..	..	..	1 ♀	..	..	1 Amphiura.
48. **146**	8	38	s.m.	$1\frac{1}{4}$	Off Gregory Sound,	1	$3\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
48. **148**	9	38	s.	$1\frac{1}{2}$	Off Gregory Sound,	1	5	..	1	..	1 ♂	..	..	..	..	..	..	
,,						2	6	..	1	1	..	..	..	1 ♂ 1 ♀	..	..	..	
,,						2	7	..	..	2	..	..	..	*2 ♀	..	..	..	*(1 nearly spent).
48. **149**	9	39/36	s.	1	Off Gregory Sound,	2	7	..	..	2	..	..	..	2 ♀	..	..	..	2 Amphiura.
,,						1	8	..	..	1	..	..	..	..	1 ♀	..	..	1 Amphiura.
48. **204**	May 14	32	s.	2	Donegal Bay, .	8	9	..	1	1	..	..	..	1 ♂	1 ♀	..	..	
					TURBOT—*Rhombus maximus* (Linn.).													
25. **7**	1890. May 12	22	s.	4	Dingle Bay, .	1	22	10	1	..	..	..	..	1 ♂	..	..	..	1 Sandeels.
25. **21**	June 2	16	s.	$3\frac{1}{2}$	Galway Bay, .	1	18	6	1	..	..	..	..	1 ♂	..	..	..	1 Lamellibranchs.
25. **40**	16	4/10	s.m.	3	Blacksod Bay, .	2	13	2	..	2	2 ♀	..	..	..	..	1	..	1 Annelids.
25. **42**	16	9	s.m.	2	Blacksod Bay, .	1	14	$1\frac{1}{2}$	..	1	1 ♀	..	..	..	..	..	..	1 Sandeels.
25P. **49**	20	8/13	..	1	Inver Bay (inside),	1	24	$11\frac{1}{2}$	..	1	..	..	1 ♀	..	..	1	..	
25. **55**	26	32	g.s.	..	Donegal Bay, .	1	23	10	1	..	..	..	..	1 ♂	..	1	..	(Tapeworms).

25.	**56**	26	10/13	..	..	Off Doran Head, .	1	20	..	1	..	..	..	..	..	..	..	..	[illegible]
25.	**58**	30	22/18	f.s.	..	Clew Bay, .	1	25	12	1	..	..	..	..	1 ♂	..	1	..	
25.	**67**	July 5	4½	c.s.	..	Blacksod Bay, .	2	14/15	2/2½	..	2	2 ♀	..	..	..	..	2	..	
25.	**69**	9	9	s.	1¼	Blacksod Bay, .	1	12½	1½	..	1	1 ♀	..	..	..	..	..	..	1 Sprats and Sandeels.
32P.	**88**	30	..	..	..	Off the Aran Islands,	1	15	2½	1	..	..	..	..	..	1 ♂ ?	1	..	
28P.	**116**	Aug. 21	5/8	s.	1	Ballinskelligs Bay,	1	13	2¼	1	..	..	..	..	..	1 ♂ ?	..	..	1 Sandeels.
O.	**117**	21	..	..	..	Ballinskelligs Bay,	1	13	2	..	1	1 ♀ ?	..	..	..	..	1	..	
48.	**123**	1891. Mar. 21	27	f.s.	1	Ballinskelligs Bay,	1	25	12	1	..	..	1 ♂	..	..	..	..	..	1 Herrings.
48.	**132**	31	23/29	s.sh.	2	Ballinskelligs Bay,	1	24	10	1	..	..	..	..	1 ♂	..	..	..	1 Sandeels.
48.	**146**	April 8	38	s.m.	1¼	Off Gregory Sound,	3	23	9/11	3	..	..	..	..	3 ♂	..	..	..	3 Fish. 1 Gadus esmarkii.
48.	**147**	8	25/20	s.	1½	South Sound, .	1	15½	2½	1	..	..	1 ♂	..	..	..	..	..	1 Sprats.
48.	**148**	9	38	s.	1½	Off Gregory Sound,	1	23	10	1	..	..	..	..	1 ♂	..	..	..	1 Gadus esmarkii.
48.	**168**	21	5/7	s.	1½	Blacksod Bay, .	1	12½	1¾	..	1	1 ♀	..	..	..	..	1	..	(Tapeworms).
48.	**176**	25	25/19	f.s.	1¼	Broadhaven, .	2	17 /25	3½/10½	..	2	..	..	..	..	2 ♀	2	..	
48.	**178**	28	9/5½	s.	2	Blacksod Bay, .	1	14	2	1	..	1 ♂	..	..	..	..	..	..	
	,,						1	16	3	1	..	..	..	1 ♂	..	..	..	..	
	,,						1	28½	19	..	1	..	1 ♀	..	..	..	..	..	2 Sandeels.
48.	**180**	29	14	s.gr.	1	Ballynakill, . .	1	14	2	1	..	1 ♂	..	..	..	..	1	..	
48.	**188**	May 5	9/7	s.	1¼	Blacksod Bay, .	2	14/19	2/5	..	2	1 ♀	..	..	..	*1 ♀	..	..	1 Dabs. 1 Sandeels. *(Spent ♀ 19 inches).
48.	**190**	5	4	m.s.	1¾	Blacksod Bay, .	1	14	2	1	..	1 ♂	..	..	..	..	..	..	1 Solea.
48.	**196**	8	16/13	s.r.	¼	Davalaun Sound, .	1	22	8	1	..	..	1 ♂	..	..	..	..	..	1 Sandeels.
48.	**205**	14	30/19	m.s.	2	Donegal Bay, .	1	26	14	1	..	..	..	..	1 ♂	..	..	..	1 Cepola and Callionymus.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Females.	Condition of Reproductive Organs. Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	Nature of Food and Remarks. 0.	?	
					Turbot—*continued.*													
48. **221**	May 21	19/5	s.	2	Loughrosmore Bay,	1	17½	4½	..	1	..	..	..	..	1 ♀	..	..	1 Sandeels (more than 60).
,,						1	19	5½	..	1	..	..	..	..	1 ♀	..	..	1 Sandeels.
48. **222**	21	22/20	s.	1½	Boylach Bay, .	1	19½	5½	..	1	..	..	..	..	1 ♀	1	..	
,,						1	22½	8¼	..	1	..	..	1 ♀	..	..	..	..	1 Loligo.
48. **223**	21	9/4	s.	1¾	Loughrosmore Bay,	1	15½	3	..	1	1 ♀	..	..	..	..	..	..	1 Sandeels.
,,						1	20	6½	..	1	..	..	..	..	1 ♀	..	..	1 Sandeels.
,,						1	24½	14	..	1	..	..	1 ♀	..	..	..	..	1 Sandeels.
48. **224**	22	9/4½	s.	1½	Boylach Bay, .	1	11½	1¼	..	1	1 ♀	..	..	..	..	..	..	1 Sandeels.
48. **232**	28	9/10	s.r.	1½	Off Horn Head, .	1	17	..	1	..	..	..	..	..	1 ♂	..	..	
48. **233**	28	22/13	s.	1	Sheephaven, .	2	15/19	..	2	..	1 ♂	..	..	..	*1 ♂	2	..	*(Spent ♂ 19 inches).
48. **235**	29	13	s.	1	Downies Bay, .	3	18	6	2	1	..	..	1 ♂	..	1 ♂ 1 ♀	3	..	
48. **236**	29	10½/4	s.	1	Downies Bay, .	2	13	..	1	1	1 ♀	..	1 ♂	..	..	1	..	1 Sandeels.
48. **238**	30	8/12	s.	2	Lough Swilly, .	1	30	20	..	1	..	..	1 ♀	..	..	..	..	1 Sprats and Sandeels.
,,						3	17/18	..	1	1	*1 ♀	..	..	..	1 ♂	..	..	2 Sandeels. * (female 17½ inches).
48. **239**	30	7½/5½	s.	1	Lough Swilly, .	1	15	..	..	1	1 ♀	..	..	..	..	..	..	1 Sandeels.
48. **240**	June 1	6/8½	s.	1¼	Lough Swilly, .	1	27	18½	..	1	..	..	1 ♀	..	..	..	..	1 Sprat and Callionymus.
48. **242**	2	8	s.	..	Ardmalin Bay, .	2	16	..	..	..	..	..	..	..	..	..	..	

BRILL—*Rhombus lævis* (Rondel).

25P.	**3**	1890. May 9	10	m.	1½	Kenmare River, .	1	21	5¼	1	..	..	..	..	1 ♂	..	..	..	1 Herrings.
25.	**4**	9	20	m.s.	2	Kenmare River, .	1	22	6	..	1	..	..	..	1 ♀	..	..	..	
25.	**18**	27	9/16	rd.s.	1	Brandon Bay, .	1	14	1½	1	..	..	1 ♂	..	..	..	1	..	
	,,						2	24	8	..	2	..	..	2 ♀	..	..	1	..	1 Sandeels.
25.	**40**	June 16	4/10	s.m.	3	Blacksod Bay, .	1	8	¼	..	1	1 ♀	..	..	..	..	..	..	
	,,						1	18	3	..	1	..	..	..	1 ♀	..	..	..	1 Solanette.
25.	**41**	16	9	s.m.	2	Blacksod Bay, .	1	13	1½	1	..	..	1 ♂ ?	..	..	..	..	..	1 Sandeels.
	,,						2	17	2½	1	1	..	..	..	..	1 ♂ ? 1 ♀	..	..	2 Sandeels.
25.	**42**	16	9	s.m.	2	Blacksod Bay, .	2	14/15	1½/2	1	1*	..	1 ♂	..	1 ♀	..	..	..	2 Sandeels. *(♀ 15 inches).
25.	**43**	16	9	s.m.	2	Blacksod Bay, .	2	15½	2	1	..	..	1 ♂	..	..	..	..	..	1 Sandeels.
25P.	**44**	17	9	s.m.	1½	Blacksod Bay, .	1	13	1½	..	..	..	..	..	..	..	..	..	
25P.	**45**	17	6	s.m.	½	Blacksod Bay, .	2	13	2	..	..	..	..	..	..	..	..	..	
25P.	**48**	20	25	s.m.	2	Inver Bay (outside)	1	19?	3½	1	..	..	..	1 ♂	..	..	1	..	
25.	**53**	25	25	s.m.	2	Inver Bay (outside)	2	24/25	6/8	..	2	..	..	..	1 ♀	1 ♀	2	..	
25.	**54**	25	8/13	m.s.	2	Inver Bay (inside),	1	26	8	..	1	..	..	..	..	1 ♀	1	..	
25.	**55**	26	32	g.s.	2	Donegal Bay, .	1	21	4½	1	..	..	..	..	..	1 ♂	1	..	
25.	**58**	30	22/18	f.s.	2½	Clew Bay, . .	4	15/19	2/3	4	..	..	..	..	..	4 ♂	3	..	1 Loligo.
25.	**59**	30	11/16	s.r.	1	Clew Bay, . .	1	18	3½	1	..	..	..	..	..	1 ♂	..	..	1 Fish.
25.	**60**	July 1	18/17	f.s.	2	Clew Bay, . .	1	17	2½	1	..	..	..	..	1 ♂	..	..	..	1 Sandeels.
	,,						3	23	6/6¾	..	3	..	..	..	..	3 ♀	..	..	3 Sandeels.
25.	**65**	5	5	m.f.s.	1	Blacksod Bay, .	1	17	2½	..	1	..	..	..	1 ♀	..	..	..	1 Sprats and Sandeels.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Number Examined. Females.	Condition of Reproductive Organs. Immature.	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	Nature of Food and Remarks. O.	?	
					Brill—*continued.*													
O. **66**	July 5	$4\frac{1}{2}$	c.s.	..	Blacksod Bay, .	3	17	3	..	3	..	..	..	..	3 ♀	..	..	1 Crangon. 1 Loligo. 1 Sprats and Sandeels.
25. **69**	9	9	s.	$1\frac{1}{4}$	Blacksod Bay, .	2	16/17	$2\frac{1}{2}$/3	1	1	..	..	..	1 ♂	1 ♀	..	..	2 Sprats and Sandeels.
25. **73**	12	15/9	m.	1	Killary Bay, .	1	21	$4\frac{3}{4}$	..	1	..	..	..	..	1 ♀	..	..	1 Sprats.
25. **74**	15	12	.r	1	Off Killary Bay, .	1	19	$4\frac{1}{2}$	..	1	..	..	..	..	1 ♀	..	..	1 Sandeels.
,,						3	$15\frac{1}{2}$	2	3	..	..	..	..	..	3 ♂	3	..	
25. **79**	16	13	s.	$\frac{1}{2}$	Davalaun, . .	8	13/23	..	..	..	..	..	..	..	..	..	..	
32P. **85**	28	19/15	s.	2	Galway Bay, .	1	$18\frac{1}{2}$	$3\frac{1}{2}$	1	..	..	..	..	..	1 ♂	..	..	1 Sprats.
O. **86**	29	20/7	s.shl. crl.	..	Off Inishmaan, .	1	18	3	1	..	..	..	..	..	1 ♂	1	..	
28P. **98**	Aug. 11	16/18	g.s.	$\frac{3}{4}$	Off Inishmaan, .	1	18	$3\frac{1}{2}$	..	1	..	..	..	..	1 ♀	..	..	1 Fish.
28P. **112**	18	20/23	m.s.	$1\frac{1}{4}$	Kenmare River, .	1	20	6	1	..	..	..	..	..	1 ♂	..	..	1 Young Clupeoids (Sprats?).
48. **123**	1891. Mar. 21	27	f.s.	1	Ballinskelligs Bay,	2	$22\frac{1}{2}$	6	2	..	..	2 ♂	..	..	..	2	..	
48. **128**	28	10	m.	$1\frac{1}{4}$	Kenmare River, .	2	15	$1\frac{3}{4}$	1	1	..	..	..	1 ♂	1 ♀	..	..	
48. **146**	April 8	38	s.m.	$1\frac{1}{4}$	Off Gregory Sound,	1	24	8	1	..	..	..	1 ♂	..	..	1	..	
48. **148**	9	38	s.	$1\frac{1}{2}$	Off Gregory Sound,	1	19	4	1	..	..	1 ♂	..	..	..	1	..	
,,						1	21	$5\frac{1}{4}$	..	1	..	1 ♀	..	..	..	1	..	
48. **149**	9	39/36	s.	1	Off Gregory Sound,	1	20	4	1	..	..	1 ♂	..	..	..	1	..	
48. **164**	20	18	s.	$1\frac{1}{2}$	Clew Bay, . .	1	20	4	1	..	..	..	1 ♂	..	..	..	..	

48.	**168**	21	5/7	s.	$1\frac{1}{2}$	Blacksod Bay, .	1	23	$6\frac{1}{2}$	..	1	..	..	..	1 ♀	..	1	..	
S.	**175**	23	0/1	s.	..	Broadhaven, .	1	$2\frac{1}{4}$	..	..	..	..	..	..	..	..	..	..	
48.	**177**	25	20/18	m.s.	1	Off Downpatrick H.	1	$18\frac{1}{2}$	$3\frac{3}{4}$	1	..	..	..	1 ♂	..	..	1	..	
48.	**178**	28	$9/5\frac{1}{2}$	s.	2	Blacksod Bay, .	1	16	$2\frac{1}{2}$	1	..	..	1 ♂	..	..	..	..	..	1 Sandeels.
	,,						3	$18\frac{1}{2}$	$3\frac{1}{2}$	2	1	..	1 ♂	..	1 ♀	1 ♂	1	..	2 Sandeels.
	,,						1	20	$4\frac{1}{2}$	1	..	..	..	..	1 ♂	..	..	..	1 Sandeels and Fish.
	,,						4	23	$6\frac{1}{2}$	..	4	..	1 ♀	..	3 ♀	..	..	..	4 Sandeels.
48.	**190**	May 5	4	m.s.	$1\frac{3}{4}$	Blacksod Bay, .	1	14	$1\frac{1}{2}$	1	..	..	..	..	..	1 ♂	..	..	1 Sandeels.
48.	**196**	8	16/13	s.r.	$\frac{1}{4}$	Davalaun Sound, .	1	20	$4\frac{1}{2}$	..	1	..	1 ♀	..	..	..	..	..	1 Sandeels.
48.	**205**	14	30/19	m.s.	2	Donegal Bay, .	1	25	8	1	..	..	..	..	..	1 ♂	1	..	
48.	**212**	18	31/30	s.gr. f.s.r.	$\frac{3}{4}$	Donegal Bay, .	1	24	8	..	1	..	..	..	1 ♀	..	..	..	1 Small Clupeoids.
48.	**217**	20	13/10	m.s.	2	Off Doran Head, .	1	$10\frac{1}{2}$	..	1	..	..	1 ♂	..	..	..	..	..	
48.	**223**	21	9/4	s.	$1\frac{3}{4}$	Loughrosmore Bay,	2	12	..	1	1	1 ♂ 1 ♀	..	..	..	..	..	..	2 Sandeels.
	,,						1	13	$1\frac{1}{4}$	..	1	1 ♀	..	..	..	..	..	..	1 Sandeels.
48.	**224**	22	$9/4\frac{1}{2}$	s.	$1\frac{1}{2}$	Boylach Bay, .	2	$10\frac{1}{2}$	..	..	2	2 ♀	..	..	..	..	..	..	2 Sandeels.
	,,						3	$12\frac{1}{2}$	1	1	2	1 ♂ 2 ♀	..	..	..	..	..	..	3 Sandeels.
48.	**233**	28	22/13	s.	1	Sheephaven, .	1	12	..	1	..	..	..	..	..	1 ♂	1	..	
48.	**236**	29	$10\frac{1}{2}/4$	s.	1	Downies Bay, .	1	$15\frac{1}{2}$	2	..	1	..	..	..	..	1 ♀	..	..	1 Sandeels.
48.	**238**	30	8/12	s.	2	Lough Swilly, .	1	$11\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
	,,						1	24	8	..	1	..	..	..	1 ♀	..	..	..	1 Sandeels.
48.	**239**	30	$7\frac{1}{2}/5\frac{1}{2}$	s.	1	Lough Swilly, .	1	14	$1\frac{1}{2}$	..	1	1 ♀ ?	..	..	..	..	..	..	1 Sandeels.
48.	**242**	June 2	8	s.	..	Off Port Stewart, .	1	17	3	..	..	..	..	..	..	..	..	..	

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Females.	Condition of Reproductive Organs. Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	Nature of Food and Remarks. 0.	?	
					WITCH (SAIL FLUKE)—*Arnoglossus megastoma* (Donov.).													
25. **4**	1890. May 9	20	m.s.	2	Kenmare River, .	1	..	..	..	..	1 ♂ or ♀	..	..	..	..	..	..	1 Sprats.
25. **7**	12	22	s.	4	Dingle Bay, .	4	12/16	..	..	4	..	..	4 ♀	..	..	..	..	4 Loligo.
25. **12**	20	53	d.g.s.	3	Off Dingle Bay, .	34	$9\frac{1}{2}$/18	$\frac{1}{2}$/$\frac{3}{4}$	*25	*9	..	..	..	some ♂ ♀	♂ ♀	..	..	34 Sandeels. *(♂ $9\frac{1}{2}$/17. ♀ 10/18).
25. **13**	20	50	d.g.s.	$1\frac{3}{4}$	Off Dingle Bay, .	18	..	..	..	..	..	..	..	..	..	..	..	
18. **16**	23	74/80	f.s.	2	Off Dingle Bay, .	7	14/18	..	..	7	..	..	..	..	7 ♀	..	..	7 Fish.
25. **24**	June 5	13/20	f.s.	1	Inside Aran Islands,	1	10	$\frac{1}{2}$	1	..	..	..	1 ♂	..	..	..	..	
25. **53**	25	25	s.m.	2	Inver Bay (outside),	2	14/17	1/$1\frac{1}{2}$	..	2	..	..	..	..	2 ♀	..	..	1 Crustaceans. 1 Fish.
25. **55**	26	32	g.s.	2	Donegal Bay, .	3	15	$1\frac{1}{4}$	1	1	..	..	..	..	1 ♂ 1 ♀	..	..	2 Crystallogobius.
25. **60**	July 1	18/17	f.s.	2	Clew Bay, . .	1	17	$1\frac{1}{2}$	..	1	..	..	..	..	1 ♀	..	..	1 Sandeels.
251. **72**	10	127	shp.s.	$1\frac{3}{4}$	Off Achill Head, .	10	$8\frac{1}{2}$/16	0/$1\frac{1}{4}$	*6	*4	..	..	..	..	6 ♂ 4 ♀	9	..	1 Fish. *(♂ $8\frac{1}{2}$. ♀ 16).
25. **82**	25	48	m.s.	$1\frac{1}{2}$	Off Gregory Sound,	2	..	..	..	..	..	..	..	..	..	..	..	
,,						7	10	..	..	..	..	..	..	..	..	..	..	
,,						5	$10\frac{1}{2}$	$\frac{1}{2}$	1	4	..	..	..	..	..	..	..	5 Crangon, Sprats & Sandeels.
,,						5	11/$12\frac{1}{2}$	$\frac{1}{2}$/$\frac{3}{4}$	..	5	..	..	..	..	..	..	..	5 Crustaceans and Fish.
Sh. **104**	Aug. 14	41	f.m.s. s.sh.	..	Off Valentia, .	1	$2\frac{1}{4}$	..	..	..	..	..	..	..	..	..	..	
28P. **106**	16	26/23	s.m.	2	Kenmare River, .	13	13/14	1/$1\frac{1}{4}$	2	11	..	..	..	..	2 ♂ 11 ♀	2	..	10 Whiting. 2 Gobies.

,,						10	15/16	$1\frac{1}{2}$	..	10	..	..	..	..	10 ♀	2	..	10 Fish.
,,						8	16/17	$1\frac{3}{4}$	..	8	..	..	..	..	8 ♀	..	..	8 Fish.
,,						1	18	2	..	1	..	..	..	..	1 ♀	..	..	1 Sprats.
28P. **112**	18	25/23	m.s.	$1\frac{1}{4}$	Kenmare River, .	10	$12\frac{1}{4}$	1	..	10	..	..	..	..	10 ♀	..	..	
,,						33	$15\frac{1}{2}$	$1\frac{1}{2}$	..	33	..	..	..	..	33 ♀	..	..	
,,						12	$16/17\frac{1}{2}$	$1\frac{1}{2}/2$	..	12	..	..	..	..	12 ♀	8	..	1 Crangon. 3 Sprats.
Sh. **114**	19	80	m.s.	$\frac{3}{4}$	Off the Skelligs, .	15	$\frac{3}{4}/2\frac{1}{4}$	..	..	..	..	..	..	..	..	..	..	
,,						2	4	..	..	..	..	..	..	..	..	..	..	
,,						1	7	..	..	..	..	..	..	..	..	..	..	
,,						1	10	..	..	..	..	..	..	..	..	..	..	
28P. **115**	20	62/52	m.s.	1	. . . . .	1	$5\frac{1}{4}$	..	..	..	..	..	..	..	..	..	..	
,,						1	12	$\frac{3}{4}$	..	..	..	..	..	..	..	..	..	
,,						7	$14/14\frac{1}{2}$	$1/1\frac{1}{4}$	..	7	..	..	..	..	7 ♀	..	4	1 Crangon (?). 2 Sprats (? Argentina).
,,						3	17	$1\frac{1}{2}/1\frac{3}{4}$	..	3	..	..	..	..	3 ♀	1	..	1 Annelids. 1 Whiting Pout (? Gadus argenteus).
28P. **118**	21	32/28	s.m.	1	. . . . .	1	$1\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						1	3	..	..	..	..	..	..	..	..	..	..	
,,						4	4	..	..	..	..	..	..	..	..	..	..	
,,						1	12	$\frac{3}{4}$	..	1	..	..	..	..	..	..	..	
,,						1	14	1	..	1	..	..	..	..	..	..	..	1 Crangon (?) and Fish.
,,						1	16	$1\frac{1}{4}$	..	1	..	..	..	..	1 ♀	..	..	1 Fish.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Females.	Condition of Reproductive Organs. Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					WITCH (SAIL FLUKE)—*continued.*													
25. **124**	1891. Mar. 23	220	..	2	Off Bolus Head,	1	11	..	..	1	..	..	..	..	1 ♀	1	..	
,,						3	12	$\frac{3}{4}$	2	1	..	..	..	2 ♂ 1 ♀	..	3	..	
,,						2	13/14	..	..	1	..	..	..	1 ♀	..	1	..	
,,						2	15/17	..	..	2	..	..	..	..	2 ♀	2	..	
25. **125**	23	115	..	1	Off Bolus Head,	1	4	..	..	..	..	..	..	..	..	..	..	
48. **143**	April 7	46/44	..	1	Off Inishmore,	1	17	..	..	1	..	..	..	..	1 ♀	..	..	1 Gadus esmarkii.
48. **148**	9	38	s.	$1\frac{1}{2}$	Off Gregory Sound,	1	12	..	1	..	..	..	..	1 ♂	..	..	..	1 Fish.
18. **166**	20	154	s.	$2\frac{3}{4}$	Off Achill Head,	3	$10\frac{1}{2}$	..	2	..	..	..	..	1 ♂	1 ♂	2	..	
,,						8	12	$\frac{1}{2}$	2	1	..	..	..	2 ♂	1 ♀	3	..	
,,						7	$13\frac{1}{2}$	$\frac{3}{4}$	1	5	..	..	..	1 ♂	5 ♀	6	..	
,,						29	16	$1\frac{1}{4}$	..	23	..	..	..	1 ♀	22 ♀	18	..	1 Munida. 1 Gadus esmarkii. 1 Phycis blennioides. 2 Fish.
48. **223**	May 21	9/4	s.	$1\frac{3}{4}$	Loughrosmore Bay,	1	13	..	..	1	..	..	..	..	1 ♀	..	..	1 Sandeels.
					PLAICE—*Pleuronectes platessa* (Linn.).													
25. **1**	1890. May 8	7	m.	$\frac{1}{2}$	Kenmare River,	33	9/22	..	6	6	..	..	..	..	6 ♂ 6 ♀	12	..	
25P. **2**	8	7	m.	1	Kenmare River,	10	10/20	..	3	7	..	..	..	..	3 ♂ 7 ♀	..	2	Priapulus. Carcinas.
25P. **3**	9	10	m.	$1\frac{1}{2}$	Kenmare River,	5	12/14	..	4	1*	..	..	..	..	4 ♂ 1 ♀	..	..	5 Brittle stars. * (Female 14 inches).

25.	**4**	9	20	m.s.	2	Kenmare River, .	2	14	..	1	..	..	..	1 ♂	..	..	..	..	1 Brittle stars.
	,,						1	17	..	..	1	..	..	..	..	1 ♀	..	..	1 Brittle stars.
25.	**5**	10	6	s.	$1\frac{1}{4}$	Ballinskelligs Bay,	19	10/17	..	9	10	..	..	..	9 ♂	10 ♀	..	..	Nereis. Donax anatinus. Sandeels.
O.	**6**	10	5	s.	1	Ballinskelligs Bay,	3	$14/15\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	3 Donax anatinus.
25.	**7**	12	22	s.	4	Dingle Bay, . .	7	11/15	$\frac{1}{2}/1\frac{1}{2}$	4	3	..	..	..	4 ♂	3 ♀	..	..	7 Arenicola.
18.	**17**	27	6/15	s.	1	Smerwick Harbour,	5	12/15	..	1	4*	..	..	..	..	1 ♂ 4 ♀	..	..	Ophiurians. Nereis. Crangon. Schizopods. Sandeels. * (Females 15 inches).
25.	**21**	June 2	16	s.	$3\frac{1}{2}$	Galway Bay, .	3	11/12	$\frac{1}{2}$	1	2	..	..	..	..	..	..	..	3 Annelids.
Sh.	**22**	4	3	s.	..	Killeany Bay, .	1	3	..	..	..	..	..	..	..	..	..	..	
25.	**24**	5	13/20	f.s.	1	Inside Aran Islands,	2	$12\frac{1}{2}/14$	1	..	2	..	..	..	..	2 ♀	..	..	2 Annelids.
O.	**29**	9	4/12	s.	$\frac{3}{4}$	Gorteen Bay, .	6	12/14	..	3	3	..	..	..	3 ♂	3 ♀	..	..	2 Echinoderms. 2 Annelids. 2 Sandeels.
O.	**30**	9	4/12	s.	$\frac{3}{4}$	Gorteen Bay, .	4	10/16	..	4	..	..	..	..	2 ♂	2 ♂	..	..	2 Annelids. 2 Lamellibranchs.
25.	**31**	9	7/13	m.r.	$\frac{1}{2}$	Birturbuy Bay .	3	11/16	..	3	..	..	..	..	1 ♂	2 ♂	..	..	3 Annelids and Lamellibranchs.
18.	**34**	12	7	m.s.	$\frac{1}{4}$	Clifden Harbour, .	2	$15\frac{1}{2}$	$1\frac{1}{4}$	1	1	..	..	..	..	1 ♂ 1 ♀	..	..	2 Annelids.
Sh.	**35**	12	2	s.	..	Boffin Harbour, .	2	1/4	..	..	..	..	..	..	..	..	..	..	
25.	**37**	13	18	sh.st.r.	$\frac{1}{2}$	Off Cleggan Bay, .	2	small	..	..	..	..	..	..	..	..	..	..	
25.	**38**	13	7	f.s.	$1\frac{1}{2}$	Blacksod Bay, .	28	11/17	$\frac{1}{2}/2\frac{1}{4}$	9	19	..	..	..	..	9 ♂ 19 ♀	..	..	Nephthys. Crustaceans. Solen. Tapes.
25.	**40**	16	4/10	s.m.	3	Blacksod Bay, .	29	$9\frac{1}{2}/13$	$\frac{1}{4}/1$	16	13	..	..	..	..	16 ♂ 13 ♀	5?	..	Nephthys. Venus gallina. Solen ensis. Tapes. Tellina. Nucula.
25.	**41, 42, 43**	16	9	s.m.	6	Blacksod Bay, .	150	13/17	$\frac{3}{4}/1\frac{1}{2}$	1	4	..	..	..	..	1 ♂ 4 ♀	..	..	Annelids. Crustaceans. Venus. Tapes. Thracia. Solen-ensis.
25P.	**44**	17	9	s.m.	$1\frac{1}{2}$	Blacksod Bay, .	21	10/14	..	..	..	..	..	..	..	..	..	..	
25P.	**45**	17	6	s.m.	$\frac{1}{2}$	Blacksod Bay, .	20	10/16	..	..	..	..	..	..	..	..	..	..	

Fishing Implement and Station No.		Date.	Depth in fathoms.	Nature of bottom	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined.		Condition of Reproductive Organs.					Nature of Food and Remarks.		
										Males.	Females.	Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	0.	?	
						Plaice—*continued*.													
25P.	**47**	June 18	25	s.	$1\frac{1}{4}$	Off Broadhaven .	1	..	..	..	..	..	..	..	..	..	..	..	
25P.	**49**	20	8/13	s.	1	Inver Bay (inside),	6	11/12	$\frac{1}{2}$/1	6	..	..	..	..	1 ♂	5 ♀	..	..	Harmothoe. Stenorhynchus.
,,							1	17	2	..	1	..	..	..	..	1 ♀	..	..	Harmothoe. Stenorhynchus.
25.	**53**	25	25	s.m.	2	Inver Bay (outside),	1	9	..	..	..	..	..	..	..	..	..	..	
,,							7	10/11	..	..	..	..	..	..	..	..	..	..	
,,							15	12/17	$\frac{1}{2}/1\frac{3}{4}$	10	5	..	..	..	5 ♂ ?	5 ♂ ? 5 ♀	..	..	Annelids and Crustaceans.
25.	**54**	25	8/13	m.s.	2	Inver Bay (inside),	1	9	..	..	..	..	..	..	..	..	..	..	
,,							11	10/13	$\frac{1}{4}$/1	4	5	..	1 ♂	..	..	3 ♂ 5 ♀	..	..	Annelids and Lamellibranchs.
25.	**55**	26	32	g.s.	2	Donegal Bay, .	28	14/16	..	7	3	..	1 ♂	..	..	6 ♂ 3 ♀	..	..	Spatangus. Nereis. Aphrodite.
25.	**56**	26	13/10	m.s.	..	Off Doran Head, .	1	..	..	..	..	..	..	..	..	..	..	..	
25.	**58**	30	22/18	f.s.	$2\frac{1}{2}$	Clew Bay, . .	1	13	1	..	..	..	..	..	..	1 ♂	..	..	1 Sandeels.
25.	**60**	July 1	18/17	f.s.	2	Clew Bay, . .	1	9	..	1	..	..	..	..	..	1 ♂	..	..	1 Ophioglypha.
25.	**65**	5	5	f.s.m.	1	Blacksod Bay, .	13	$9\frac{1}{2}$/12	$\frac{1}{2}$/1	5	3	..	..	..	1 ♀ ?	4 ♀ ? 3 ♀	..	..	Nephthys. Pagurus. Stenorhynchus and Lamellibranchs.
O.	**66**	7	..	..	..	Blacksod Bay, .	20(a	bout	..	..	..	..	..	..	..	..	..	..	
25	**67**	5	$4\frac{1}{2}$	c.s.	2	Blacksod Bay, .	14	6/11	0/$\frac{1}{2}$	..	..	..	..	..	..	..	..	..	
25.	**69**	9	9	s.	$1\frac{1}{4}$	Blacksod Bay, .	15	11/15	$\frac{1}{2}/1\frac{1}{2}$	6	4	..	..	..	..	6 ♂ 4 ♀	..	..	Lanice. Lagis. Solen ensis. Venus gallina.
25.	**73**	12	15/9	m.	1	Killary Bay, .	5	12/16	$\frac{3}{4}$/2	4*	1	3 ♂	..	..	..	1 ♂ 1 ♀	3	..	2 Amphiura. * (Males 12 inches. Female 16 inches)

25.	**75**	15	5	s.st.	¼	Cleggan Bay, .	2	12	¾	2	..	2 ♂	..	..	..	..	..	..	
	,,						2	17½	2¼	..	2	..	..	..	..	2 ♀	..	..	O. lacerta. Synapta. Venus. Nucula. Solen. Molgula.
25.	**76**	15	15	s.	25	Cleggan Bay, .	7	14½	1	7	..	..	..	..	..	7 ♂	..	..	
	,,						5	15	1¼	..	5	..	..	..	..	5 ♀	..	..	Lagis. Nucula. Solen.
	,,						14	11½/16¼	¾/2	..	..	..	..	..	..	..	..	..	
25.	**77**	15	7/12	s.	¾	Cleggan Bay, .	55	10½/21	½/3¾	6	6	..	3 ♂	..	..	3 ♂ 6 ♀	..	..	A. filiformis. Synapta. Tellina. Mactra. Solen. Nucula. Trochus.
25.	**79**	16	13	s.	½	Davalaun, . .	1	16	1½	..	..	..	..	..	..	..	..	..	
O.	**81**	19	8		1½	Casheen Bay, .	8	..	..	..	..	..	..	..	..	..	..	..	
32P.	**85**	28	19/15	s.	2	Galway Bay, .	6	10½/11½	½	5	1	..	..	..	..	5 ♂ 1 ♀	2	..	Annelids.
	,,						6	12/14	¾/1	5	1	..	..	..	..	5 ♂ 1 ♀	6	..	
O.	**86**	29	20/7	s.sh. crl.	1	Off Inishmaan, .	1	13	1	..	1	..	..	..	..	1 ♀	1	..	
	,,						1	16	2	1	..	..	..	..	..	1 ♂	1	..	
32P.	**88**	30	..	..	..	Aran Islands, .	5	12/13	..	4	..	..	..	..	1 ♂	3 ♂	..	..	Membranipora. Psammobia. Edwardsia.
32P.	**90**	31	15	s.m.	1	Galway Bay, .	1	small	..	..	..	..	..	..	..	..	..	..	
32P.	**94**	Aug. 8	9	m.r.	½	Casheen Bay, .	1	11	½	1	..	..	..	..	..	1 ♂	..	..	1 Nephthys and Lamellibranchs.
28P.	**98**	11	16/18	g.s.	1	Off Inishmaan, .	1	11	½	1	..	..	..	..	..	1 ♂	..	..	1 Shrimp.
O.	**99**	12	..	s.	¼	Killeany Bay, .	10	15½/18½	1¾/3	4	6	..	..	..	..	4 ♂ 6 ♀	2	..	3 Amphiura. 1 Lagis. 5 Lamellibranchs.
	,,						2	26/27	8/9	..	2	..	..	..	1 ♀	1 ♀	..	..	2 Solen.
O.	**100**	13	4	s.	¾	Ventry Harbour, .	1	11	¾	1	..	..	..	..	..	1 ♂	..	..	1 Annelids.
	,,						2	14	1½	..	2	..	..	..	..	2 ♀	..	..	2 Nucula, Corbula, Venus and Solen.
	,,						1	18	3	1	..	..	..	..	..	1 ♂	..	..	1 Amphiura and O. albida.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Number Examined. Females.	Condition of Reproductive Organs. Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					Plaice—*continued.*													
28P. **106**	Aug. 16	26/23	s.sh.	2	Kenmare River, .	6	$14\frac{1}{2}/17\frac{1}{2}$	$1\frac{1}{2}/2\frac{1}{2}$	4	2	..	..	1 ♂	2 ♂	1 ♂ 2 ♀	3	..	2 Amphiura. 2 Annelids. 1 Solen.
28P. **107**	16	8/5	s.m. m.	1	Kenmare River, .	2	15/16	$2/2\frac{3}{4}$	..	2	..	..	..	..	2 ♀	..	..	2 Annelids.
Sh. **109**	18	$2\frac{1}{2}$	m.	..	Kenmare River, .	5	$2\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
28P. **110**	18	10/13	m.	1	Kenmare River, .	2	12/14	$1/1\frac{1}{4}$	1	1	..	..	..	..	1 ♂ 1 ♀	1	..	1 Amphiura.
,,						2	$16\frac{1}{2}/18$	$2\frac{1}{4}/2\frac{3}{4}$	..	2	..	..	..	..	2 ♀	..	..	2 Amphiura and Annelids.
28P. **112**	18	25/23	m.s.	$1\frac{1}{4}$	Kenmare River, .	6	$12\frac{1}{2}/14\frac{1}{2}$	$1/1\frac{3}{4}$	5	1	..	..	1 ♂	..	4 ♂ 1 ♀	..	..	Amphiura. Nephthys. Annelids. Crustaceans. Solen, etc.
,,						2	16/18	2/3	1	1	..	..	1 ♂	..	1 ♀	..	..	Cerianthus. Aphrodite. Nephthys. Annelids. Solen. Nucula.
28P. **116**	21	5/8	s.	1	Ballinskelligs Bay,	2	12/13	$1\frac{1}{4}/1\frac{1}{2}$	1	1	..	..	..	..	1 ♂ 1 ♀	..	..	2 Annelids and Lamellibranchs.
,,						2	14	$1\frac{1}{2}$	1	1	..	..	..	..	1 ♂ 1 ♀	..	..	2 Amphiura and Lamellibranchs (Siphons).
,,						1	16	2	..	1	..	..	..	1 ♀	..	..	..	1 Lamellibranchs.
O. **117**	21	6	s.	..	Ballinskelligs Bay	17	$13/13\frac{1}{2}$	$1\frac{1}{4}/1\frac{3}{4}$	12	5	..	..	..	1 ♂	11 ♂ 5 ♀	..	..	
,,						4	$14\frac{1}{2}$	$1\frac{3}{4}$	3	1	..	..	4 ♂	..	1 ♀	..	..	Amphiura. Annelids. Tellina.
,,						6	15	2	2	4	..	..	1 ♂	2 ♀	1 ♂ 2 ♀	..	..	1 Idotea. 1 Venus. 1 Donax. 2 Lamellibranchs.
,,						6	16	$2\frac{1}{4}$	2	4	..	..	..	..	2 ♂ 4 ♀*	..	..	1 Amphiura. 1 Venus. 1 Donax. 1 Tellina. 2 Lamellibranchs. * (All just spent).
,,						2	18	$3\frac{1}{2}$	..	2	..	..	..	1 ♀	1 ♀*	2	..	

Sh. **119**	23	1/2	d.s.	$\frac{1}{4}$	Ballinskelligs Bay,	19	$1\frac{1}{2}/2\frac{3}{4}$	..	..	..	..	..	..	..	..	..	..	* (Just spent).
,,						1	$7\frac{1}{4}$	..	..	..	..	..	..	..	..	..	..	
48. **123**	1891. Mar. 21	27	f.s.	1	Ballinskelligs Bay,	1	2	..	..	1	1 ♀	..	..	..	..	..	..	1 Amphiura, Annelids, and Sandeels.
,,						5	$15/17\frac{1}{2}$	$1\frac{1}{2}/2$	3	2*	..	..	..	3 ♂ 1 ♀	1 ♀	1	..	2 Lamellibranchs. 1 Natica. 1 Molgula. * (♀ 16 and $17\frac{1}{2}$ inches).
,,						2	$19\frac{1}{2}/21\frac{1}{2}$	3/4	1*	1	..	..	..	1 ♂ 1 ♀	..	..	..	1 Annelids. 1 Venus gallina. 1 Molgula. *(♂ $21\frac{1}{2}$ in.).
148. **126**	28	26	m.	$1\frac{3}{4}$	Kenmare River, .	1	$11\frac{1}{2}$		..	..	..	..	..	..	..	..	..	
						5	13/15	$\frac{3}{4}/1\frac{1}{4}$	4	1	..	..	..	4 ♂	1 ♀	1	..	3 Annelids. 1 Lamellibranchs.
						1	20	$3\frac{1}{4}$	..	1	..	..	..	1 ♀	..	1	..	
48. **127**	28	21	m.	1	Kenmare River, .	2	12	$\frac{3}{4}$	2	..	..	..	..	1 ♂	1 ♂	..	..	2 Amphiura.
,,						3	16	$1\frac{1}{2}$	3	..	..	2 ♂	..	1 ♂	..	..	..	3 Amphiura.
48. **128**	28	10	m.	$1\frac{1}{4}$	Kenmare River, .	1	..	..	..	..	..	..	..	..	..	..	..	
,,						3	13	..	..	..	..	..	..	..	..	..	..	
,,						2	18	..	..	..	..	..	..	..	..	..	..	
48. **131**	30	45/48	s.	2	Kenmare River, .	1	$14\frac{1}{2}$	..	..	1	..	..	..	..	1 ♀	..	..	1 Amphiura.
48. **132**	31	23/29	s.sh.	2	Ballinskelligs Bay,	1	13	$\frac{3}{4}$	1	..	..	..	..	1 ♂	..	..	..	1 Annelids.
O. **137**	April 3	7	m.	$\frac{1}{2}$	Casheen Bay, .	2	17	$1\frac{3}{4}$	..	..	..	..	..	..	..	..	..	
48. **153**	15	17/19	s.r.	2	Galway Bay, .	1	12	..	..	..	..	..	..	..	..	..	..	
,,						4	15/17	1/2	..	4	..	..	..	..	4 ♀	1	..	2 Annelids. 2 Portunus. 2 Lamellibranchs.
48. **154**	15	33	s.	$\frac{3}{4}$	Off Foul Sound, .	1	22	$5\frac{1}{2}$	..	1	..	..	..	..	1 ♀	..	..	1 Annelids.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined.		Condition of Reproductive Organs.					Nature of Food and Remarks.		
									Males.	Females.	Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	0.	?	
					Plaice—*continued.*													
48. **159**	April 17	4/9	m.	1	Cleggan Bay, .	7	11	$\frac{1}{2}$	3	..	..	..	..	..	3 ♂	..	..	2 Amphiura. 1 Lamellibranchs.
,,						40	14	1	3	1	..	..	..	..	3 ♂ 1 ♀	..	..	1 Ophioglypha. 2 Amphiura. 1 Solen. 3 Lamellibranchs.
,,						11	$16\frac{1}{2}$	$1\frac{1}{2}$	1	4	..	..	..	..	1 ♂ 4 ♀	..	..	3 Amphiura. 1 Gammarids. 3 Lamellibranchs.
,,						2	18/19	2/3	..	2	..	..	..	..	2 ♀	..	..	2 Portunus.
48. **163**	18	13/15	s.	$2\frac{1}{2}$	Clew Bay, . .	8	$13\frac{1}{2}$	1	2	2	..	..	..	..	2 ♂ ? 2 ♀ ?	..	..	2 Annelids. 2 Lamellibranch shells (tube of Lanice ?).
,,						1	17	2	..	1	..	..	..	..	1 ♀	..	..	1 Echinoderms.
48. **164**	20	18	s.	$1\frac{1}{2}$	Clew Bay, . .	2	12	$\frac{1}{2}$	1	1	1 ♀	..	..	..	1 ♂	..	..	1 Lamellibranch. 1 Molgula.
,,						8	$13\frac{1}{2}$	$\frac{3}{4}$	4	..	..	..	..	..	4 ♂	1	..	1 Annelids. 1 Lamellibranchs. 1 Molgula.
,,						3	$14\frac{1}{2}$	1	..	3	..	..	..	..	3 ♀	..	..	1 Annelids. 3 Lamellibranchs.
,,						2	$15\frac{1}{2}$	$1\frac{1}{4}$	..	2	..	..	..	..	2 ♀	..	..	1 Annelids. 2 Lamellibranchs.
48. **167**	21	3/4	s.	..	Blacksod Bay, .	1	10	..	..	..	..	..	..	..	..	..	..	
48. **168**	21	5/7	s.	$1\frac{1}{2}$	Blacksod Bay, .	3	12	$\frac{3}{4}$	1	1	..	..	..	..	..	..	..	2 Annelids. 1 Solen.
,,						12	$13\frac{1}{2}$	1	2	4	..	..	..	1 ♂	1 ♂ 4 ♀	..	..	1 Amphiura. 1 Annelids. 1 Gammarid. 3 Solen.
,,						3	$17\frac{1}{2}$	$2\frac{1}{2}$	..	3	..	..	..	3 ♀	..	..	..	3 Solen.
48. **169**	21	5/7	s.	..	Blacksod Bay, .	41	$13\frac{1}{2}$	$1\frac{3}{4}$	..	..	..	..	..	..	..	..	..	
,,						5	17	1	..	..	..	..	..	..	..	..	..	

S.	**172**	23	$1\frac{1}{2}/0$	s.	..	Dugort Bay, .	2	$2\frac{1}{2}/4$	..	..	..	..	..	..	..	..	..	..	
Sh.	**173**	23	1/3	s.	..	French Port, .	16	3/4	..	..	..	..	..	..	..	..	..	..	
	,,						16	6	..	..	..	..	..	..	..	..	..	..	
	,,						4	9	..	..	..	..	..	..	..	..	..	..	
S.	**175**	24	0/1	s.	..	Broadhaven, .	1	3	..	..	..	..	..	..	..	..	..	..	
48.	**176**	25	25/19	f.s.	$1\frac{1}{4}$	Broadhaven Bay, .	3	12/13	$\frac{3}{4}/1$	..	3	3 ♀	..	..	..	..	..	..	3 Echinoderms. 1 Serpula. 2 Lamellibranchs. 1 Natica. 1 Molgula.
48.	**177**	25	20/18	m.s.	1	Off Downpatrick H[d].	1	12	$\frac{1}{2}$	1	..	..	..	..	1 ♂	..	..	1	
48.	**178**	28	$9/5\frac{1}{2}$	s.	2	Blacksod Bay, .	14	13	1	4	..	1 ♂	..	..	1 ♂	2 ♂	..	..	
	,,						25	16/18	..	3	5	..	..	..	1 ♂	2 ♂ 5 ♀	..	..	3 Annelids. 2 Solen ensis. 4 Lamellibranchs.
48.	**180**	29	14	s.gr.	1	Ballynakill, . .	10	14	1	5	..	..	..	..	..	5 ♂	..	..	5 Lamellibranchs.
	,,						4	16	$1\frac{1}{2}$	..	3	..	..	..	..	3 ♀	1	..	1 Crustaceans. 1 Molgula (?).
48.	**182**	30	8/11	s.m.	1	Cleggan Bay, .	2	$11\frac{1}{4}$	$\frac{3}{4}$	1	1	1 ♂ 1 ♀	..	..	..	..	..	..	1 Echinoderms. 1 Annelids. 2 Lamellibranchs.
	,,						7	13	1	2	..	..	..	..	..	2 ♂	..	..	2 Annelids.
	,,						9	15	$1\frac{1}{4}$	3	1	..	..	..	..	3 ♂ 1 ♀	..	..	1 O. lacertosa. 1 Nereis. 3 Nucula.
	,,						1	17	2	..	1	..	..	..	..	1 ♀	..	..	1 Amphiura.
	,,						1	20	3	..	1	..	..	..	..	1 ♀	..	..	1 Portunus and Lamellibranchs.
48.	**188**	May 5	9/7	s.	$1\frac{1}{4}$	Blacksod Bay, .	1	14	1	..	..	..	..	..	..	..	..	..	
	,,						7	$15\frac{1}{2}$	$1\frac{1}{2}$	..	..	..	..	..	..	..	..	..	
	,,						6	$17\frac{1}{2}$	$2\frac{1}{2}$	..	6	..	..	..	..	6 ♀	1	..	5 Solen ensis.
	,,						1	$20\frac{1}{2}$	$3\frac{1}{2}$	..	1	..	..	..	..	1 ♀	..	..	1 Gammarids and Lamellibranchs.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Number Examined. Females.	Condition of Reproductive Organs. Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					Plaice—*continued.*													
48. **190**	May 5	4	m.s.	$1\frac{3}{4}$	. . . .	1	10	..	..	..	..	..	..	..	..	..		
”						5	$11\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
”						20	13	..	1	2	..	..	..	..	1 ♂ 2 ♀	..	..	2 Annelids. 2 Solen ensis.
”						14	15	$1\frac{1}{4}$	..	5	1 ♀	..	..	..	4 ♀	..	..	1 Amphiura. 3 Annelids. 4 Solen ensis. 2 Lamellibranchs.
”						1	17	2	..	1	..	..	..	..	1 ♀	..	..	1 Solen ensis and Zostera.
48. **196**	8	16/13	s.r.	$\frac{1}{4}$	Davalaun Sound, .	20	16	..	..	..	..	..	..	..	..	..	..	
”						8	18	$2\frac{1}{2}$	..	1	..	..	..	..	1 ♀	..	..	1 Lamellibranchs.
”						5	19	4	..	2	..	..	..	..	2 ♀	1	..	1 Lamellibranchs.
”						3	20/21	$4\frac{1}{2}$	..	3	..	..	..	..	..	..	..	1 O. albida. 1 Annelids. 1 Crustaceans. 1 Pecten. 1 Lamellibranchs.
48. **204**	14	32	s.	2	Donegal Bay, .	2	13	..	..	..	..	..	..	..	..	..	..	
”						3	16	$1\frac{3}{4}$	1	..	..	..	..	..	1 ♂	..	..	1 Lamellibranchs.
”						2	18	$2\frac{1}{4}$	1	1	..	..	..	..	1 ♂ 1 ♀	..	1	1 Crustaceans.
48. **205**	14	30/19	m.s.	2	Donegal Bay, .	2	14	1	1	1	..	..	..	..	1 ♂ 1 ♀	1	..	1 Annelids.
”						4	16	$1\frac{1}{2}$	2	..	..	..	..	..	2 ♂	..	..	2 Amphidotus. 1 Gammarids.
”						2	18	$2\frac{1}{2}$	1	1	..	..	..	..	1 ♂ 1 ♀	..	..	1 Amphidotus. 1 Lagis. 1 Annelids. 1 Gammarids.
”						1	22	$4\frac{3}{4}$	..	1	..	..	..	..	1 ♀	..	..	1 Amphidotus.

48.	**207**	15	16/14	s.m.	1	Killybegs Harbour (outer).	1	$14\frac{1}{2}$	$1\frac{1}{4}$	..	1	..	..	..	..	1 ♀ 1 ♂	..	..	1 Annelids and Lamellibranchs.
48.	**212**	18	31/30	s.gr. f.s.r.	$\frac{3}{4}$	Donegal Bay, .	2	$13\frac{1}{2}$	1	1	1	..	..	..	..	1 ♀	1	..	1 Ebalia and Lamellibranchs.
48.	**215**	19	35/28	s.	$1\frac{1}{4}$	Off Teelin, . .	1	14	..	1	..	..	..	..	..	1 ♂	1	..	
48.	**216**	20	8/13	m.s.	$1\frac{1}{4}$	Inver Bay (inside),	4	13	..	..	..	..	..	..	..	..	..	..	
	,,						6	15/16	..	..	..	..	..	..	..	..	..	..	
	,,						2	$17\frac{1}{2}$	..	1	1	..	..	..	..	1 ♂ 1 ♀	..	..	2 Annelids. 1 Munida. 1 Crangon.
	,,						2	$19\frac{1}{2}$	3	..	2	..	..	..	..	2 ♀	..	..	2 Annelids.
48.	**217**	20	13/10	m.s.	2	Off Doran Head, .	3	12	..	1	1	1 ♀	..	..	..	1 ♂	..	..	2 Annelids.
	,,						10	13	..	1	1	1 ♀	..	..	..	1 ♂	1	..	1 Corystes.
	,,						6	15	$1\frac{1}{2}$	1	1	..	..	..	..	1 ♂ 1 ♀	..	..	2 Annelids.
48.	**219**	20	22/26	f.s.	1	Off Teelin, . .	14	13	..	2	1	1 ♀	..	..	..	2 ♂	1	..	2 Annelids.
	,,						5	16	..	2	1	..	..	..	..	2 ♂ 1 ♀	..	..	1 Amphidotus. 1 Annelids. 1 Crustaceans.
	,,						1	18	$2\frac{1}{2}$	..	..	..	..	..	..	..	..	..	
	,,						2	$22\frac{1}{2}$/23	$5\frac{1}{4}/5\frac{1}{2}$	..	2	..	..	..	..	2 ♀	..	..	2 Amphidotus.
48.	**221**	21	19/5	s.	2	Loughrosmore Bay,	10	$6/9\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
	,,						5	11	..	..	..	..	..	..	..	..	..	..	
	,,						4	14	$1\frac{1}{2}$	..	1	..	..	..	..	1 ♀	..	..	1 Annelids.
48.	**223**	21	9/4	s.	$1\frac{3}{4}$	Loughrosmore Bay,	20	3/4	..	..	..	..	..	..	..	..	..	..	
	,,						40	6/8	..	..	..	..	..	..	..	..	..	..	
	,,						7	9/10	..	..	..	..	..	..	..	..	..	..	
	,,						3	11	..	..	..	..	..	..	..	..	..	..	
	,,						5	$12\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Number Examined. Females.	Condition of Reproductive Organs. Immature	Condition of Reproductive Organs. $\frac{1}{2}$ Ripe.	Condition of Reproductive Organs. $\frac{3}{4}$ Ripe.	Condition of Reproductive Organs. Ripe.	Condition of Reproductive Organs. Spent.	0.	?	Nature of Food and Remarks.
					Plaice—*continued.*													
48. **224**	May 22	9/4$\frac{1}{2}$	s.	1$\frac{1}{2}$	Boylach Bay, .	8	6$\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						7	7	..	..	..	..	..	..	..	..	..	..	
,,						2	8$\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						2	10$\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						2	12	..	..	..	..	..	..	..	..	..	..	
L. **227**	26	..	..	..	Gola Roads, .	4	..	..	..	..	..	..	..	..	..	..	..	
48. **232**	28	9/10	s.r.	1$\frac{1}{2}$	Off Horn Head, .	2	13	..	1	..	..	..	..	..	1 ♂	..	1	
,,						14	14$\frac{1}{2}$	..	3	1	..	..	..	..	3 ♂ 1 ♀	..	1	1 Amphiura. 1 Echinoderms. 3 Lamellibranchs. 1 Gastropod.
,,						3	17	..	1	2	..	..	..	..	1 ♂ 2 ♀	..	..	1 O. albida. 3 Lamellibranchs. 1 Gammarid. 1 Pagurus. 3 Lamellibranchs.
,,						3	18/20	..	..	3	..	1 ♀	? ..	..	2 ♀	..	..	1 Amphiura. 3 Lamellibranchs.
48. **233**	28	22/13	s.	1	Sheephaven, .	4	13/14	..	..	..	..	..	..	..	..	..	..	
,,						3	16	..	1	1	..	..	..	..	1 ♂ 1 ♀	..	..	2 Amphiura.
48. **235**	29	13	s.	1	Downies Bay, .	1	8	..	..	..	..	..	..	..	..	..	..	
,,						8	12/14$\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						13	16/17	..	2	3	..	..	..	..	2 ♂ 3 ♀	..	..	2 Amphiura. 3 Lamellibranchs (Siphons).

,,						23	18/21	..	..	7	..	..	..	..	7 ♀	2	..	5 Lamellibranchs (Siphons).
,,						1	$23\frac{1}{4}$	..	..	1	..	..	..	..	1 ♀	..	..	1 Lamellibranchs (Siphons).
48. **236**	29	$10\frac{1}{2}/4$	s.	1	Downies Bay, .	1	$5\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						38	6/8	..	..	..	..	..	..	..	..	..	..	
,,						5	9	..	..	..	..	..	..	..	..	..	..	
,,						15	10/12	..	..	..	..	..	..	..	..	..	..	
,,						14	15	..	3	3	..	..	..	..	3 ♂ 3 ♀	2	..	2 Annelids. 2 Lamellibranchs.
,,						9	$16\frac{1}{2}$	..	2	2	..	..	..	..	2 ♂ 2 ♀	..	..	1 Amphiura. 3 Lamellibranchs.
,,						1	$18\frac{1}{2}$	..	1	..	..	..	..	..	1 ♂	..	..	1 Amphidotus.
,,						1	$24\frac{3}{4}$	7	..	1	..	..	..	..	1 ♀	..	..	1 Terebella. 1 Idotea. 1 Lamellibranchs.
48. **238**	30	8/12	s.	2	Lough Swilly, .	1	$9\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
48. **239**	30	$7\frac{1}{2}/5\frac{1}{2}$	s.	1	Lough Swilly, .	7	$12\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						6	16	..	1	1	..	..	..	..	1 ♂ 1 ♀	..	..	1 Venus Gallina. 1 Nucula. 1 Lamellibranchs.
,,						1	18	..	..	1	..	..	..	..	1 ♀	..	..	1 O. lacertosa.
48. **240**	June 1	$6/8\frac{1}{2}$	s.	$1\frac{1}{4}$	Lough Swilly, .	5	6/7	..	..	1	1 ♀	..	..	..	..	..	..	1 Lamellibranchs.
,,						2	$8\frac{1}{2}/9$	..	..	2	2 ♀	..	..	..	..	..	..	2 Lamellibranchs.
,,						1	11	..	..	1	1 ♀	..	..	..	..	..	..	1 Annelids and Lamellibranchs.
48. **242**	2	8	5	..	Off Portstewart, .	6	5/8	..	..	..	..	..	..	..	..	..	..	
,,						4	9/12	..	..	..	..	..	..	..	..	..	..	

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Number Examined. Females.	Condition of Reproductive Organs. Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					LEMON DAB ("LEMON SOLE")—*Pleuronectes microcephalus* (Donov.).													
	1890.																	
25. **7**	May 12	22	s.	..	Dingle Bay,	4	9/11	..	4	..	..	..	..	4 ♂	..	..	4	
,,						1	12	..	..	1	..	..	..	1 ♀	..	..	1	
25. **21**	June 2	16	s.	..	Galway Bay,	3	8/10	..	..	3	..	..	..	3 ♀	..	..	..	3 Annelids.
25. **31**	9	7/13	m.s.r.	..	Birturbuy Bay,	1	8	..	..	1	..	..	..	..	1 ♀	..	..	1 Annelids and Lamellibranchs.
18. **34**	12	7	m.s.	..	Clifden Harbour,	2	14/15	1/1$\frac{1}{2}$	..	2	..	..	..	2 ♀	..	..	..	2 Annelids and Crustaceans.
25. **38**	13	7	f.s.	..	Blacksod Bay,	3	8	$\frac{1}{4}$	3	..	..	..	..	2 ♂	1 ♂	..	..	3 Annelids and Philine aperta.
,,						1	12$\frac{1}{2}$	$\frac{1}{2}$	..	1	..	..	..	..	1 ♀	..	..	1 Annelids and Philine aperta.
25. **43**	16	9	s.m.	..	Blacksod Bay,	2	12	..	..	2	..	..	..	..	2 ♀	..	..	2 Nereis, Crustaceans and Lamellibranchs.
25P. **49**	20	8/13	s.	..	Inver Bay (inside),	1	11	$\frac{1}{2}$	..	1	..	..	..	..	1 ♀	..	1	1 Stenorhynchus and Goby.
25. **53**	25	25	s.m.	..	Inver Bay (outside),	2	8$\frac{1}{2}$/9$\frac{1}{2}$	$\frac{1}{4}$	..	..	..	..	..	..	..	..	..	
,,						4	10/10$\frac{1}{2}$	$\frac{1}{2}$	..	..	..	..	..	..	..	..	..	
25. **54**	25	8/13	s.	..	Inver Bay (inside),	6	8/9	$\frac{1}{4}$	1	..	..	..	..	1 ♂	..	..	..	
,,						3	10/12	$\frac{1}{2}$	1	2	..	..	..	1 ♂ 1 ♀	1 ♀	..	..	
25. **55**	26	32	g s.	..	Donegal Bay,	2	9/11	..	..	..	..	..	..	..	..	..	..	
25. **56**	26	32	g.s.	..	Off Doran Head,	1	10	$\frac{1}{2}$	..	1	..	..	..	1 ♀	..	..	..	1 Ophioglypha albida.
25. **58**	30	22/18	f.s.	..	Clew Bay,	1	11	..	1	..	..	..	..	1 ♂	..	..	..	1 Crustaceans.
25. **65**	July 5	5	m.f.s.	..	Blacksod Bay,	2	9	$\frac{1}{2}$	1	1	..	..	..	1 ♂	1 ♀	..	..	2 Annelids.

25.	**69**	9	9	s.m.	..	Blacksod Bay, .	1	10	$\frac{1}{2}$	..	1	..	..	..	..	1 ♀	..	..	1 Annelids.
25.	**74**	15	12	s.r.	..	Off Killary Bay, .	1	$8\frac{3}{4}$	$\frac{1}{2}$	1	..	..	1 ♂	..	..	..	..	..	1 Gephyrean.
	,,						1	11	$\frac{3}{4}$	..	1	..	..	..	..	1 ♀	..	..	1 Gephyrean.
32P.	**87**	30	..	..	..	Aran Islands, .	1	12	1	..	1	..	..	..	..	1 ♀	1	..	
Sh.	**97**	Aug. 11	..	..	..	Killeany Bay, .	1	18	..	..	..	..	..	..	..	..	..	..	
O.	**99**	12	..	..	..	Killeany Bay, .	2	11/12	1	..	1	..	..	..	..	1 ♀	..	1	
Sh.	**114**	19	80	m.s.	$\frac{3}{4}$	Off Skelligs, .	2	$1\frac{1}{4}$	..	..	..	..	..	..	..	..	..	..	
48.	**123**	1891. Mar. 21	27	f.s.	1	Ballinskelligs Bay,	1	13	1	..	1	..	1 ♀	..	..	..	1	..	
48.	**126**	28	26	m.	$1\frac{3}{4}$	Kenmare River, .	2	$8\frac{1}{2}$/10	..	..	2	..	..	*1 ♀	1 ♀	..	..	..	*(♀ 10 inches)
48.	**127**	28	21	m.	1	Kenmare River, .	1	10	..	1	..	..	..	..	1 ♂	..	..	..	1 Annelids.
48.	**132**	31	22/39	s.sh.	$1\frac{3}{4}$	Ballinskelligs Bay,	1	9	$\frac{1}{2}$	..	1	..	..	..	1 ♀	..	..	1	
48.	**133**	31	40	s.r.	$1\frac{3}{4}$	Dingle Bay, .	2	$8\frac{1}{2}$	..	1	1	..	..	..	1 ♂ 1 ♀	..	..	..	2 Sabella.
48.	**148**	April 9	38	s.	$1\frac{1}{2}$	Off Gregory Sound,	1	$9\frac{1}{2}$	..	..	1	..	..	..	1 ♀	..	..	..	1 Annelids.
48.	**153**	15	17/19	s.m.	2	Galway Bay, .	2	$8\frac{1}{2}$	..	1	1	..	..	..	1 ♂ 1 ♀	..	..	..	
	,,						2	10	..	1	1	..	..	..	1 ♂ 1 ♀	..	..	..	2 Annelids.
	,,						7	11	$\frac{1}{2}$	1	4	..	1 ♀	1 ♀	1 ♂ 2 ♀	..	..	..	5 Annelids.
	,,						2	$13\frac{1}{2}$	1	..	2	..	2 ♀	..	..	..	..	..	2 Annelids.
48.	**159**	17	4/9	m.	1	Cleggan Bay, .	3	$13\frac{1}{2}$	$\frac{3}{4}$	2	1	..	..	1 ♂	1 ♂ 1 ♀	..	..	..	3 Annelids.
48.	**163**	18	13/15	s.	$2\frac{1}{2}$	Clew Bay, . .	1	13	1	..	1	..	..	..	..	1 ♀	..	..	

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Females.	Condition of Reproductive Organs. Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	Nature of Food and Remarks. 0.	?	
					Lemon Dab—*continued.*													
48. **169**	April 21	5/7	s.	..	Blacksod Bay, .	1	8	..	..	..	..	..	..	..	..	..	..	
,,						2	14	1	..	..	..	..	..	..	..	..	..	
48. **180**	29	14	s.gr.	1	Ballynakill, . .	1	$12\frac{1}{2}$	$\frac{3}{4}$	..	1	..	..	..	1 ♀	..	..	..	1 Annelids.
,,						1	14	1	..	1	..	..	..	1 ♀	..	..	..	1 Annelids.
48. **204**	May 14	32	s.	2	Donegal Bay, .	4	$9\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
48. **205**	14	30/19	m.s.	2	Donegal Bay, .	2	$8\frac{1}{2}$/9	..	..	..	..	..	..	..	..	..	..	
,,						2	$11\frac{1}{2}$/12	..	..	1	..	1 ♀	..	..	..	1	..	
,,						1	14	..	..	1	..	..	1 ♀	..	..	1	..	
48. **207**	15	16/14	s.m.	1	Killybegs Harbour (outer).	3	6/8	..	..	..	..	..	..	..	..	..	..	
,,						1	14	$1\frac{1}{4}$	..	1	..	..	..	1 ♀	..	..	..	1 Annelids and Crustaceans.
48. **212**	18	31/30	s.gr. f.s.r.	$\frac{3}{4}$	Donegal Bay, .	1	8	..	..	1	..	..	..	1 ♀	..	..	1	
48. **215**	19	35/28	s.	$1\frac{1}{4}$	Off Teelin, . .	1	8	..	..	..	..	..	..	..	..	..	..	
,,						1	12	..	1	..	..	..	..	1 ♂	..	..	..	1 Annelids.
48. **219**	20	22/26	f.s.	1	Off Teelin, . .	1	$7\frac{1}{2}$	..	1	..	..	..	..	1 ♂	..	1	..	
,,						1	14	$1\frac{1}{2}$	..	1	..	..	1 ♀	..	..	1	..	
48. **221**	21	19/5	s.	2	Loughrosmore Bay,	1	13	..	1	..	..	..	..	1 ♂	..	..	1	1 Chiton.
48. **222**	21	22/20	s.	$1\frac{1}{2}$	Boylach Bay, .	1	8	..	..	..	..	..	..	..	..	..	..	
48. **223**	21	9/4	s.	$1\frac{3}{4}$	Loughrosmore Bay,	1	11	..	..	1	..	..	..	1 ♀	..	..	..	1 Annelids.

POLE DAB (**White or Witch Sole**)—*Pleuronectes cynoglossus* (Linn.).

25.	**53**	1890. June 25	25	s.m.	2	Inver Bay (outside),	125	11/15	½/1¼	16	4	..	..	..	15 ♂ ..	1 ♂ 4 ♀ 3 ♂	..	..	Annelids, Crabs, Gammarids, and Lamellibranchs.
25.	**55**	26	32	g.s.	2	Donegal Bay, .	11	11/14	½/1	7	1	..	..	2 ♂	2 ♂ 1 ♀	..	..	..	8 Annelids.
182.	**63**	July 4	220	f.s.	2¾	Off Achill Head, .	4?	Rather small		..	..	..	..	..	..	..	..	..	
182.	**64**	4	144	f.s.	2½	Off Achill Head, .	3	5/6	..	..	..	..	..	..	..	..	..	..	
Sh.	**114**	Aug. 19	80	m.s.	¾	Off Skelligs, .	5	1½	..	..	..	..	..	..	..	..	..	..	
25P.	**130**	1891. Mar. 30	24	m.	2	Kenmare River, .	1	13½	..	1	..	..	..	..	1 ♂	..	..	..	1 Annelids and Crustaceans.
48.	**143**	April 7	46/44	..	¾	Off Inishmore, .	1	12	..	1	..	..	..	..	1 ♂	..	..	1	
48.	**146**	8	38	s.m.	1¼	Off Gregory Sound,	4	10/15	¼/¾	4	..	..	..	..	4 ♂	..	1	1	1 Amphiura. 1 Annelids.
48.	**149**	9	39/36	s.	1	Off Gregory Sound,	1	12	½	1	..	..	..	1 ♂	..	..	..	..	1 Amphiura.
48.	**154**	15	33	s.	¾	Off Foul Sound, .	1	12	½	1	..	..	..	..	1 ♂	..	..	..	
48.	**204**	May 14	32	s.	2	Donegal Bay, .	1	10	..	..	..	..	..	..	..	..	..	..	
	,,						14	12	..	2	..	..	1 ♂	..	1 ♂	..	..	..	2 Annelids and Crustaceans.
	,,						22	14	¾	5	2	..	1 ♂	1 ♂	3 ♂ 1 ♀	1 ♀	..	..	
	,,						1	16	1	..	1	..	..	1 ♀	..	..	..	..	1 Annelids and Crustaceans.
	,,						1	17	1½	1	..	..	..	..	1 ♂	..	..	1	
48.	**205**	14	30/19	m.s.	2	Donegal Bay, .	12	13	..	4	..	..	..	..	3 ♂	1 ♂	..	..	4 Annelids.
	,,						4	15	..	3	1	..	..	..	3 ♂	1 ♀	..	1	1 Amphiura. 3 Annelids. 1 Tellina.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Number Examined. Females.	Condition of Reproductive Organs. Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					COMMON DAB—*Pleuronectes limanda* (Linn.).													
25. **1**	1890. May	7	m.	$\frac{1}{2}$	Kenmare River,	16	5/10	..	7	9	..	..	..	♂ ♀	♂ ♀	..	..	
25P. **3**	9	10	m.	$1\frac{1}{2}$	Kenmare River,	1	12	..	..	1	..	..	..	..	1 ♀	..	..	1 Ophiurians.
25. **4**	9	20	m.s.	2	Kenmare River,	4	9/14	..	2	2	..	..	..	2 ♂ 7 ♀	2 ♀	..	1	3 Ophiurians.
25. **5**	10	6	s.	$1\frac{1}{4}$	Ballinskelligs Bay,	16	$9\frac{1}{2}$/14	..	4	12	..	..	..	4 ♂	5 ♀	..	..	16 Eunice and Nereis.
25. **7**	12	22	s.	4	Dingle Bay,	2	$7\frac{1}{2}$	..	2	..	..	..	..	2 ♂	..	..	..	2 Arenicola.
,,						3	8	..	..	3	2 ♀	..	..	1 ♀	..	..	..	3 Arenicola.
,,						2	10	..	2	..	..	..	..	2 ♂	..	..	..	2 Arenicola.
25. **12**	20	53	d.g.s.	3	Off Dingle Bay,	1	8	..	..	..	..	..	..	..	..	..	..	
18. **17**	27	6/15	s.	1	Smerwick Harbour,	4	4	..	..	..	..	..	..	..	..	..	..	
,,						1	11	..	1	..	..	..	..	..	1 ♂	..	..	1 Pagurus.
25. **21**	June 2	16	s.	$3\frac{1}{2}$	Galway Bay,	19	6/12	..	8	11	..	..	..	8 ♂	11 ♀	..	..	19 Annelids.
25. **24**	5	13/20	f.s.	1	Inside Aran Islands,	3	$7\frac{1}{2}$	..	1	2	..	..	..	..	1 ♂ 2 ♀	..	..	3 Annelids.
25. **25**	5	20	f.s.	2	Off Greatman's Bay,	4	$7\frac{1}{2}$/$8\frac{1}{2}$	..	2*	2*	..	..	..	..	2 ♂ 2 ♀	..	..	4 Aphrodite. *(♂ $7\frac{1}{2}$, ♀ $8\frac{1}{2}$).
25. **38**	13	7	f.s.	$1\frac{1}{2}$	Blacksod Bay,	4	8/10	0/$\frac{1}{4}$	..	3	..	..	..	..	3 ♀	..	..	
25. **40**	16	4/10	s.m.	3	Blacksod Bay,	6	$6\frac{1}{2}$/$7\frac{1}{2}$	..	6	..	3 ♂ ?	..	..	3 ♂	..	..	..	Philine aperta. 1 Sertularian. 1 Loligo. 1 Ulva.

	,,						19	8/10	$\frac{1}{4}/\frac{1}{2}$	2	17	..	..	..	2 ♂	17 ♀	..	..	Ophioglypha. Aphrodite. Pagurus. Stenorhynchus. Thracia. Solen ensis.
25.	**41**	16	9	s.m.	2	Blacksod Bay, .	15	11/12	$\frac{1}{2}$	1	12	..	..	..	..	1 ♂ 12 ♀	..	..	O. albida. Aphrodite. Pagurus. Loligo. Philine. Sertularia.
25.	**42**	16	9	s.m.	2	Blacksod Bay, .	35	..	..	..	..	..	..	..	..	..	..	..	
25.	**43**	16	9	s.m.	2	Blacksod Bay, .	12	..	..	..	..	..	..	..	..	..	..	..	
25P.	**44**	17	9	s.m.	$1\frac{1}{2}$	Blacksod Bay, .	4	10	..	..	..	..	..	..	..	..	..	..	
25P.	**45**	17	6	s.m.	$\frac{1}{2}$	Blacksod Bay, .	5	..	..	..	..	..	..	..	..	..	..	..	
25P.	**48**	20	25	m.s.	2	Inver Bay (outside),	2	10	$\frac{1}{2}$	..	1	..	..	..	..	1 ♀	..	..	
25P.	**49**	20	8/13	m.s.	1	Inver Bay (inside),	14	8/13	..	13	1	..	..	..	2 ♂	11 ♂ 1 ♀	..	..	Stenorhynchus. Pagurus (with Turritella). 1 Sertularia.
Sh.	**51**	23	1/4	m.	..	Killybegs H. (inner),	1	$13\frac{1}{2}$	..	..	1	..	..	..	..	1 ♀	..	..	1 Palæmon, Portunus, Bulla hydatis.
25.	**53**	25	25	s.m.	2	Inver Bay (outside),	9	9	..	..	..	..	..	..	..	..	..	..	
	,,						19	12/14	$\frac{1}{2}/1$	11	7	..	..	1 ♂ ..	1 ♂ ..	9 ♂ 7 ♀	..	..	Annelids and Crustaceans.
25.	**54**	25	8/13	m.s.	2	Inver Bay (inside),	14	9	..	..	..	..	..	..	..	..	..	..	
	,,						53	10/13	$\frac{1}{4}/1$	2	8	..	..	..	1 ♂ ..	1 ♂ 8 ♀	..	..	
25.	**55**	26	32	g.s.	2	Donegal Bay, .	96	$6/11\frac{1}{2}$	$0/\frac{1}{2}$	..	..	..	..	..	..	..	..	..	
25.	**56**	26	10/13	m.s.	..	Off Doran Head, .	1	5	..	..	..	..	..	..	..	..	..	..	
	,,						15	small	..	..	..	..	..	..	..	..	..	..	
	,,						2	$10\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
25.	**58**	30	22/18	f.s.	$2\frac{1}{2}$	Clew Bay, . .	26	$7\frac{1}{2}/12$	$\frac{1}{4}/\frac{1}{2}$	8	11	..	..	..	2 ♂ ..	6 ♀ 11 ♀	..	..	O. albida. Crabs. Venus. Nucula. Sandeels.
25.	**59**	30	11/16	s.r.	1	Clew Bay, . .	2	$8/8\frac{1}{2}$	..	2	..	..	..	..	2 ♂	..	..	..	2 Ophioglypha..

Fishing Implement and Station No.		Date.	Depth in fathoms.	Nature of bottom.	Hours down.	LOCALITY.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Females.	Condition of Reproductive Organs. Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	Nature of Food and Remarks. O.	?	
						COMMON DAB—*continued.*													
25.	**60**	July 1	18/17	f.s.	2	Clew Bay, . .	24	8/11	¼/½	3	5	..	..	..	1 ♂	2 ♂ 3 ♀	..	..	Ophioglypha. Pagurus. Lamellibranchs.
25.	**61**	1	15	f.s.r.	¾	Clew Bay, . .	3	8/10	..	3	..	..	..	..	2 ♂	1 ♂	..	..	3 Ophioglypha.
25.	**65**	5	5	m.f.s.	1	Blacksod Bay, .	7	5½/11½	0/3	..	..	..	..	..	..	..	..	..	
O.	**66**	7	..	..	..	Blacksod Bay, .	20	..	..	..	..	..	..	..	..	..	..	..	
25.	**67**	5	4½	c.s.	2	Blacksod Bay, .	12	7/11	0/½	..	..	..	..	..	..	..	..	..	
25.	**68**	9	14/12	f.s.gr.	2	Blacksod Bay, .	7	8	..	2	2	..	..	..	..	2 ♂ 2 ♀	..	..	2 O. albida, O. lacertosa. 2 Crabs and Tellina.
25.	**69**	9	9	s.	1¼	Blacksod Bay, .	12	8/13	¼/1	2	5	..	..	..	..	2 ♂ 5 ♀	..	..	O. albida. Pagurus.
25.	**73**	12	15/9	m.	1	Killary Bay, .	16	7½/12¼	1¾	7	2	5 ♂	..	..	2 ♂	2 ♀	..	..	Amphiura. Lamellibranchs.
25.	**74**	15	12	s.r.	1	Off Killary Bay, .	2	5½	..	2	..	1 ♂	..	..	1 ♂	..	..	..	2 Echinoderms and Annelids.
	,,						4	8¾	½	..	2	..	..	..	..	2 ♀	..	..	2 Solen ensis.
25.	**77**	15	7/12	s.	¾	Cleggan Bay, .	3	9½	½	3	..	..	..	..	3 ♂	..	..	..	3 Ophioglypha.
	,,						9	..	..	..	..	..	..	..	..	..	..	..	
	,,						3	13	1	..	3	..	..	..	..	3 ♀	..	..	3 Amphiura.
25.	**83**	25	20	m.s.	½	Galway Bay, .	1	7¾	..	..	1	..	..	..	..	1 ♀	..	..	1 Crustaceans and Lamellibranchs.
32P.	**84**	28	24	s.	2¼	Galway Bay, .	1	9	¼	..	1	..	..	..	..	1 ♀	1	..	1 Crustaceans, Pleurotoma? Natica alderi, Turritella. 1 soft gray sand.
	,,						2	10½/11	½/¾	..	2	..	..	..	..	2 ♀	..	..	

32P.	**85**	28	19/15	s.	2	Galway Bay, .	3	9½	½	1	2	..	..	1 ♂	..	2 ♀	2	..	1 Lamellibranchs.
	,,						5	10½/11	½/¾	1	4	..	..	..	1 ♂	4 ♀	2	..	3 Annelids and Crustaceans. 2 Fish.
Sh.	**91**	Aug. 7	14	s.sh.	½	Galway Bay, .	1	2¼	..	..	..	..	..	..	..	..	..	..	
32P.	**94**	8	9	m.r.	½	Casheen Bay, .	1	9	..	..	1	..	..	..	..	1 ♀	..	..	1 Crab and Lamellibranchs.
28P.	**98**	11	16/18	g.s.	¾	Off Inishmaan, .	2	10/11	½/¾	..	2	..	..	..	..	2 ♀	2	..	
Sh.	**101**	13	20	g.s.	..	Off Ventry, . .	2	1¼	..	..	..	..	..	..	..	..	..	..	
Sh.	**103**	13	9/7	m.f.s.	..	. . . .	53	3½	..	..	..	..	..	..	..	..	..	..	
28P.	**106**	16	26/23	s.sh. s.m.	2	Kenmare River, .	8	10/12	½/1	2	4	..	..	1 ♂	1 ♂	4 ♀	..	..	3 Amphiura and Portunus.
Sh.	**108**	16	..	..	..	Killmakalogue Bay,	3*	1¾/3	..	..	..	..	..	..	..	..	..	..	*(2 at 3 inches).
Sh.	**109**	18	2½	m.	..	Kenmare River, .	53	1½/2¼	..	..	..	..	..	..	..	..	..	..	
28P.	**110**	18	10/13	m.	1	Kenmare River, .	1	8	..	..	1	..	..	..	..	1 ♀	1	..	
Sh.	**111**	18	13	m.	..	Kenmare River, .	8	1½/2½	..	..	..	..	..	..	..	..	..	..	
28P.	**112**	18	25/23	m.s.	1¼	Kenmare River, .	2	10/12	½/1	1	1	..	..	..	1 ♂	1 ♀	1	..	1 Amphiura.
28P.	**116**	21	5/8	s.	1	Ballinskelligs Bay,	1	8	..	..	..	..	..	..	..	..	..	..	
O.	**117**	21	6	s.	1¼	Ballinskelligs Bay,	2	9	..	..	..	..	..	..	..	..	..	..	
	,,						2	11½	1	..	..	..	..	..	..	..	..	..	
28P.	**118**	21	32/28	s.m.	1	Ballinskelligs Bay,	7	4½/10	..	..	..	..	..	..	..	..	..	..	
	,,						1	8	..	..	..	..	..	..	..	..	..	..	
	,,						2	9½	..	..	..	..	..	..	..	..	..	..	
Sh.	**119**	23	1/2	..	¼	Ballinskelligs Bay,	3	2/2¼	..	..	..	..	..	..	..	..	..	..	

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Females.	Condition of Reproductive Organs. Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	Nature of Food and Remarks. 0.	?	
					COMMON DAB—*continued.*													
48. **126**	1891. Mar. 28	26	m.	1¾	Kenmare River, .	2	8/9½	..	..	2	*1 ♀	..	..	1 ♀	..	..	..	*(♀ 8 inches).
48. **127**	28	21	m.	1	Kenmare River, .	4	6½	..	4	..	..	..	..	4 ♂	..	..	..	4 Amphiura.
,,						16	9	..	3	1	..	..	..	2 ♂	1 ♂ 1 ♀	..	..	4 Amphiura.
,,						11	10½	..	1	2	..	..	..	1 ♀	1 ♂ 1 ♀	2	1	
,,						4	12	..	2	2	..	1 ♀	1 ♀	2 ♂	..	..	..	3 Amphiura. 1 Echinoderms.
,,						4	13½	1	1	3	..	2 ♀	..	1 ♂ 1 ♀	..	..	1	3 Amphiura.
48. **128**	28	10	m.	1¼	Kenmare River, .	3	small	..	..	..	..	..	..	..	..	..	..	
,,						4	8	..	..	..	..	..	..	..	..	..	..	
,,						4	11½	..	..	..	..	..	..	..	..	..	..	
,,						2	13½	1	1	1	..	..	..	1 ♂ 1 ♀	..	..	..	
Sh. **129**	30	4/5	m.	..	Kenmare River, .	4	2/2½	..	..	..	..	..	..	..	..	..	..	
,,						2	3	..	..	..	..	..	..	..	..	..	..	
,,						2	5/6	..	..	..	..	..	..	..	..	..	..	
25P. **130**	30	24	m.	2	Kenmare River, .	1	12	..	..	1	..	..	..	1 ♀	..	..	..	1 Amphiura and Pagurus.
18. **135**	April 2	6/8	s.	¼	Smerwick Harbour,	1	4	..	..	..	..	..	..	..	..	..	..	
,,						2	12	..	..	2	..	1 ♀	..	..	1 ♀	1	..	1 Annelids.

48. **146**	8	38	s.m.	$1\frac{1}{4}$	Off Gregory Sound,	1	8	..	..	1	..	..	..	..	1 ♀	..	..	1 Amphiura.
48. **147**	8	25/20	s.	$1\frac{1}{2}$	South Sound, .	3	$3\frac{1}{2}/4\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						5	5	..	..	5	..	..	..	..	..	..	..	
,,						6	6	..	2	2	..	..	..	1 ♂	1 ♂ 2 ♀	..	..	
,,						5	7	..	5	..	..	..	..	3 ♂	2 ♂	..	..	
,,						5	9	..	4	1	..	..	..	3 ♂ 1 ♀	1 ♂	..	..	
,,						4	10	..	1	3	..	..	..	1 ♂	3 ♀	..	..	
,,						1	11	..	..	1	..	..	..	1 ♀	..	..	..	
48. **148**	9	38	s.	$1\frac{1}{2}$	Off Gregory Sound,	2	6	..	..	1	1 ♀	..	..	..	..	..	..	1 Amphiura.
,,						2	$10\frac{1}{2}$	..	..	2	..	..	..	..	2 ♀	..	..	2 Amphiura.
48. **149**	9	39/36	s.	1	Off Gregory Sound,	1	8	..	1	..	..	..	..	..	1 ♂	..	..	1 Amphiura.
,,						1	$11\frac{1}{2}$	$\frac{1}{2}$	..	1	..	..	..	..	1 ♀	..	..	1 Amphiura.
Sh. **152**	15	15	s.	$\frac{1}{4}$	Galway Bay, .	4	$3\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
48. **153**	15	17/19	s.m.	2	Galway Bay, .	16	6	..	..	..	..	..	..	..	..	..	..	
,,						9	$6\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						6	7	..	..	..	..	..	..	..	..	..	..	
,,						1	8	..	..	..	..	..	..	..	..	..	..	
,,						4	$9/10\frac{1}{2}$	..	..	2	..	..	..	..	2 ♀	..	..	1 Annelids. 1 Pagurus.
48. **154**	15	33	s.	$\frac{3}{4}$	Off Foul Sound, .	2	9	..	..	..	..	.	..	..	..	..	..	
48. **159**	17	4/9	m.	1	Cleggan Bay, .	4	7	..	..	..	..	..	..	..	..	..	..	
,,						3	10/11	..	2	..	..	..	..	2 ♂	..	..	..	2 Amphiura.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	LOCALITY.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined.		Condition of Reproductive Organs.					Nature of Food and Remarks.		
									Males.	Females.	Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	0.	?	
					COMMON DAB—*continued.*													
48. **163**	April 18	13/15	s.	$2\frac{1}{2}$	Clew Bay, . .	6	6	..	..	..	..	..	..	..	..	..	..	
,,						7	8	..	..	..	..	..	..	..	..	..	..	
,,						3	$10\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						19	12	½	4	6	..	..	..	3 ♂ 3 ♀	1 ♂ 3 ♀	..	..	4 Ophioglypha. 2 Amphiura. 3 Echinoderms. 1 Philine.
,,						2	13	1	..	2	..	..	..	2 ♀	..	..	..	1 Ophiothrix. 1 Lamellibranchs.
48. **164**	20	18	s.	$1\frac{1}{2}$	Clew Bay, . .	3	11	..	1	2	..	1 ♀	..	1 ♂	1 ♀	..	..	1 Amphiura. 1 Nephthys. 1 Pagurus.
,,						2	$12\frac{1}{2}$	..	1	1	..	1 ♀	..	1 ♂	..	1	..	1 Lamellibranchs and Molgula.
Sh. **167**	21	3/4	s.	..	Blacksod Bay, .	3?	small	..	..	..	..	..	..	..	..	..	..	
48. **168**	21	5/7	s.	$1\frac{1}{2}$	Blacksod Bay, .	1	2	..	..	..	..	..	..	..	..	..	..	
,,						7	$7\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						3	$9\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						5	12	..	4	1	..	..	..	3 ♂ 1 ♀	1 ♂	3	..	2 Pagurus. 1 Philine.
,,						1	$13\frac{1}{2}$	1	..	1	..	1 ♀	..	..	..	..	..	1 Echinoderms and Annelids
48. **169**	21	5/7	s.	..	Blacksod Bay, .	3	6	..	..	..	..	..	..	..	..	..	..	
,,						5	10	..	..	..	..	..	..	..	..	..	..	
48. **176**	25	25	f.s.	$1\frac{1}{4}$	Broadhaven, .	12	5	..	..	..	..	..	..	..	..	..	..	
,,						6	$7\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	

	,,						8	9	..	2	2	1 ♀	..	..	2 ♂ 1 ♀	..	1	..	2 Amphiura. 1 Molgula.
	,,						5	10	..	1	4	..	1 ♀	..	1 ♂ 1 ♀	2 ♀	..	..	5 Amphiura.
48.	**177**	25	20/18	m.s.	1	Off Downpatrick H.,	15	7/8½	..	3	1	..	..	..	3 ♂	1 ♀	..	..	1 Amphiura. 1 Annelids. 1 Lamellibranchs. 2 Ulva.
	,,						3	11	..	1	2	..	..	..	1 ♂ 2 ♀	..	3	..	
48.	**178**	28	9/5½	s.	2	Blacksod Bay, .	8	6	..	..	..	..	..	..	..	..	..	..	
	,,						9	9½	..	1	2	..	..	..	1 ♂	2 ♀	..	2	1 Molgula.
	,,						6	11½	..	2	1	..	..	..	1 ♂ 1 ♀	1 ♂	..	..	1 Sabella. 2 Pagurus. 1 Molgula (?).
Sh.	**179**	28	5	s.	½	Blacksod Bay, .	8	3	..	..	..	..	..	..	..	..	..	..	
	,,						1	4½	..	..	..	..	..	..	..	..	..	..	
48.	**180**	29	14	s.gr.	1	Ballynakill, .	4	6/8	..	..	..	..	..	..	..	..	..	..	
	,,						3	10/10½	..	1	..	..	..	..	1 ♂	..	..	..	
	,,						1	12	..	1	..	..	..	..	1 ♂	..	..	..	1 Amphiura. 1 Echinoderms.
48.	**181**	30	30	s.r.	½	Off Davalaun, .	2	8/10	..	1	..	..	..	..	1 ♂	..	..	..	1 Annelids.
48.	**182**	30	8/11	s.m.	1	Cleggan Bay, .	1	12	..	1	..	..	..	..	1 ♂	..	..	..	1 Amphiura.
Sh.	**185**	May 2	½/2	s.	..	Ballynakill Harb.,	10	1/1½	..	..	..	..	..	..	..	..	..	..	
48.	**188**	5	9/7	s.	1¼	Blacksod Bay, .	3	3½	..	..	..	..	..	..	..	..	..	..	
	,,						10	6½	..	..	..	..	..	..	..	..	..	..	
	,,						2	9	..	..	..	..	..	..	..	..	..	..	
	,,						3	11/12	..	..	..	..	..	..	..	..	..	..	1 Annelids. 1 Porcellana longicornis. 3 Pagurus. 1 Tellina. 3 Solen ensis. 1 Philine.
48.	**190**	5	4	m.s.	1¾	Blacksod Bay, .	11	11/12	..	1	2	..	..	..	1 ♀	1 ♂ 1 ♀	..	..	
	,,						1	14	1	..	1	..	..	..	1 ♀	..	..	..	1 Philine.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Females.	Condition of Reproductive Organs. Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	Nature of Food and Remarks. 0.	?	
					COMMON DAB—*continued.*													
48. **193**	May 7	20	s.r.	..	Blacksod Bay, .	3	5/9	..	..	..	..	..	..	..	..	..	..	
48. **204**	14	32	s.	2	Donegal Bay, .	40	6/9	..	..	..	..	..	..	..	..	..	..	
,,						50	$9\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						50	11	..	..	..	..	..	..	..	..	..	..	
48. **205**	14	30/19	m.s.	2	Donegal Bay, .	67	$6\frac{1}{2}/8\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						23	9/10	..	..	..	..	..	..	..	..	..	..	
48. **206**	15	14/16	st.m.	$\frac{3}{4}$	Killybegs H. (outer),	1	9	..	..	..	..	..	..	..	..	..	..	
48. **207**	15	16/14	s.m.	1	Killybegs H. (outer),	8	5/9	..	..	..	..	..	..	..	..	..	..	
48. **212**	18	31/30	s.gr. f.s.r.	$\frac{3}{4}$	Donegal Bay, .	11	6/7	..	..	..	..	..	..	..	..	..	..	
,,						12	$8/9\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						2	$11\frac{1}{2}$	..	1	1	..	..	..	1 ♂	1 ♀	..	..	1 Amphidotus. 1 Annelids. 1 Lamellibranchs. 1 Crystallogobius.
48. **214**	19	37/33	m.s.	2	Off Teelin, . .	1	$9\frac{1}{2}$	..	..	1	..	..	..	..	1 ♀	..	..	1 Annelids and Fish.
48. **215**	19	35/28	s.	$1\frac{1}{4}$	Off Teelin, . .	20	$6\frac{1}{2}/7\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						5	$9\frac{1}{2}$	..	1	..	..	..	..	1 ♂	..	..	..	1 Amphidotus.
,,						3	$10\frac{1}{2}$	..	2	1	..	..	..	1 ♂	1 ♂ 1 ♀	..	1	2 Annelids. 1 Crustaceans.
48. **216**	20	8/13	m.s.	$1\frac{1}{4}$	Inver Bay (inside),	19	8/9	..	..	..	..	..	..	..	..	..	..	
,,						4	12	..	..	..	..	..	..	..	..	..	..	

48.	**217**	20	13/10	m.s.	2	Off Doran Head, .	24	4/5	..	..	..	..	..	..	..	..	..	..	
	,,						25	7½	..	..	..	..	..	..	..	..	..	..	
	,,						6	9½	..	..	..	..	..	..	..	..	..	..	
	,,						11	12	..	2	3	..	..	..	1 ♂ ..	1 ♂ 3 ♀	..	2	1 Annelids. 1 Pagurus. 1 Loligo media.
48.	**219**	20	22/26	f.s.	1	Off Teelin, . .	12	7/7½	..	..	..	..	..	..	..	..	..	..	
	,,						9	9	..	..	..	..	..	..	..	..	..	..	
	,,						1	12½	..	..	1	..	..	..	..	1 ♀	..	..	
48.	**221**	21	19/5	s.	2	Loughrosmore Bay,	18	7/11½	..	..	..	..	..	..	..	..	..	..	
48.	**222**	21	22/20	s.	1½	Boylach Bay, .	20	6/7½	..	..	..	..	..	..	..	..	..	..	
	,,						12	8½	..	..	..	..	..	..	..	..	..	..	
	,,						5	9	..	..	..	..	..	..	..	..	..	..	
	,,						1	11	..	..	1	..	..	1 ♀	..	..	..	..	1 Annelids.
48.	**224**	22	9/4½	s.	1½	Boylach Bay, .	1	10½	..	..	..	..	..	..	..	..	..	..	
	,,						2	12½	..	1	1	..	..	..	1 ♂	1 ♀ 2 ♂	..	..	2 Idotea.
48.	**225**	22	32/25	s.r.	1	Rosses Bay, .	4	7¼	..	2	2	..	..	..	1 ♀	1 ♀	..	..	
	,,						1	9½	..	..	1	..	..	..	..	1 ♀	..	..	
L.	**228**	26	6/8	s.	..	Gola Roads, .	1	12	..	..	..	..	..	..	..	..	..	..	
	232	28	9/10	s.r.	1½	Off Horn Head, .	1	6	..	..	..	..	..	..	..	..	..	..	
	,,						1	9½	..	..	1	..	..	..	..	1 ♀	..	..	1 Annelids.
48.	**233**	28	22/13	s.	1	Sheephaven, .	7	7	..	..	..	..	..	..	..	..	..	..	
	,,						2	10½/12½	..	..	..	..	..	..	..	..	..	..	

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Females.	Condition of Reproductive Organs. Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	Nature of Food and Remarks. 0.	?	
					Common Dab—*continued*.													
48. **235**	May 29	13	s.	1	Downies Bay, .	5	8	..	..	..	..	..	..	..	..	..	..	
,,						4	10/11	..	..	..	..	..	..	..	..	..	..	
,,						6	12	..	2	..	..	..	..	1 ♂	1 ♂	..	2	
,,						1	14	..	..	1	..	..	..	..	1 ♀	..	..	1 Lamellibranchs (siphons).
48. **236**	29	$10\frac{1}{2}/4$	s.	1	Downies Bay, .	12	7/8	..	..	..	..	..	..	..	..	..	..	
,,						2	11	..	1	1	..	..	..	1 ♂	1 ♀	..	..	1 Annelids. 1 Pagurus.
,,						3	$12\frac{1}{2}$	..	..	3	..	..	..	..	3 ♀	..	..	1 Annelids. 3 Idotea. 2 Pagurus.
48. **238**	30	8/12	s.	2	Lough Swilly, .	16	6/8	..	..	..	..	..	..	..	..	..	..	
,,						20	10/11	..	2	4	..	..	..	2 ♂	4 ♀	..	..	1 Alcyonidium. 3 Pagurus. 1 Portunus. 1 Gammarid.
48. **239**	30	$7\frac{1}{2}/5\frac{1}{2}$	s.	1	Lough Swilly, .	5	6/7	..	..	..	..	..	..	..	..	..	..	
,,						1	8	..	..	..	..	..	..	..	..	..	..	
,,						2	11	..	..	..	..	..	..	..	..	..	..	
,,						4	$12\frac{1}{2}$	..	..	3	..	..	..	..	3 ♀	1	..	1 Idotea. 1 Solen ensis. 1 Ulva.
48. **240**	June 1	$6/8\frac{1}{2}$	s.	$1\frac{1}{4}$	Lough Swilly, .	6	6/7	..	..	..	..	..	..	..	..	..	..	
,,						2	8	..	..	..	..	..	..	..	..	..	..	
,,						5	$9/9\frac{1}{2}$	..	3	2	..	..	..	..	3 ♂ 2 ♀	..	..	3 O. albida. 1 Gammarids. 1 Lamellibranchs. 1 Philine.
,,						4	10	..	..	4	..	..	..	..	4 ♀	..	1	3 O. albida. 3 Lamellibranchs. 1 Buccinum

48.	**242**	2	8	s.	..	Off Portstewart, .	18	6/8	..	..	..	..	..	..	..	..	..	..	
	,,						4	10	..	..	..	..	..	..	..	..	..	..	
	,,						4	11/12	..	..	..	..	..	..	..	..	..	..	
						FLOUNDER—*Pleuronectes flesus* (Linn.).													
25.	**40**	1890. June 16	9	s.m.	2	Blacksod Bay, .	1	10	$\frac{1}{4}$	..	1	..	..	..	..	1 ♀	1	..	
48.	**127**	1891. Mar. 28	21	m.	1	Kenmare River, .	1	10	..	1	..	..	..	1 ♂	..	..	..	1	
	,,						1	14	..	1	..	..	..	..	1 ♂	..	..	..	
48.	**128**	28	10	m.	$1\frac{1}{4}$	Kenmare River, .	1	$14\frac{1}{2}$	..	..	1	..	..	..	1 ♀	..	..	..	
S.	**172**	April 23	$0/1\frac{1}{2}$	..	$\frac{1}{4}$	Dugort Bay, .	6	3/6	..	..	..	..	..	..	..	..	..	..	
48.	**222**	May 21	22/20	s.	$1\frac{1}{2}$	Boylach Bay, .	1	9	..	..	1	..	..	..	..	1 ♀	..	1	
48.	**236**	29	10/4	..	1	Downies Bay, .	2	$10\frac{1}{2}/11\frac{1}{2}$	..	1	1*	..	..	..	..	1 ♂ 1 ♀	..	..	1 Terebella. 1 Sandeels. * (♀ $11\frac{1}{2}$ in.).
	,,						5	$12\frac{1}{2}$	..	3	2	..	..	..	..	3 ♂ 2 ♀	2	..	2 Idotea. 1 Sandeels.
	,,						3	14	..	2	..	..	..	..	..	2 ♂	..	..	1 Idotea linearis and Sp. 1 Sandeels.
	,,						2	15	..	2	..	..	..	..	..	2 ♂	..	..	1 Idotea linearis and Sp. 1 Crangon. 1 Sandeels.
						COMMON SOLE—*Solea vulgaris* (Quensel).													
25.	**1**	1890. May 8	7	m.	$\frac{1}{2}$	Kenmare River, .	3	16/18	..	1	2	..	..	..	..	1 ♂ 2 ♀	3	..	
25.	**2**	8	7	m.	1	Kenmare River, .	1	13	..	1	..	..	..	..	..	1 ♂	1	..	

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Number Examined. Females.	Condition of Reproductive Organs. Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					Common Sole—*continued.*													
25P. **3**	May 9	10	m.	$1\frac{1}{2}$	Kenmare River, .	1	14	..	1	..	1 ♂	..	..	..	..	..	..	1 Brittlestars.
						6	15/19	..	..	6	..	2 ♀	2 ♀	2 ♀	..	..	..	6 Brittlestars.
25. **4**	9	20	m.s.	2	Kenmare River, .	1	17	..	1	..	..	..	1 ♂	..	..	..	..	1 Brittlestar.
25. **5**	10	6	s.	$1\frac{1}{4}$	Ballinskelligs Bay,	1	17	..	..	1	..	..	..	..	1 ♀	..	..	1 Annelids.
O. **6**	10	5	s.	1	Ballinskelligs Bay,	1	18	..	..	1	..	..	..	..	1 ♀	..	1	
25. **7**	12	22	s.	4	Dingle Bay, .	8	11/15	..	7	1	..	..	..	7 ♂ 1 ♀ *	..	..	8	* (Female nearly spent. 15 in.)
25. **12**	20	53	d.g.s.	3	Off Dingle Bay, .	2	12/16	..	2	..	..	..	2 ♂	..	..	..	2	
,,						4	17	..	..	4	..	..	..	1 ♀	3 ♀	..	4	
25. **13**	20	50	d.g.s.	$1\frac{3}{4}$	Off Dingle Bay, .	1	..	..	..	..	..	..	..	..	..	..	..	Echini. Crangon. Portunus? Sandeels. Sea Bottles.
25. **18**	27	9/16	rd.s.	1	Brandon Bay, .	10	11/17	..	7*	2*	..	..	..	..	7 ♂ 2 ♀	..	..	* (♂ 13 to 17 in. ♀ 11 and 15 in.).
25. **21**	June 2	16	s.	$3\frac{1}{2}$	Galway Bay, .	6	12/16	..	..	6	..	..	..	..	6 ♀	..	..	3 Nephrops. 3 Crystallogobius.
25. **24**	5	13/20	f.s.	1	Inside Aran Islands,	4	15/16	..	4	..	..	..	..	..	4 ♂	..	..	4 Annelids and Crustaceans.
,,						2	15/19	..	..	2	..	..	..	..	2 ♀	..	..	2 Sandeels.
25. **25**	5	20	f.s.	2	Off Greatman's Bay,	2	16/19	..	..	2	..	..	..	1 ♀	1 ♀	..	..	2 Fish.
O. **29**	9	4/12	s.	$\frac{3}{4}$	Gorteen Bay, .	1	19	$2\frac{1}{2}$	..	1	..	..	..	..	1 ♀	..	..	1 Echinoderms and Annelids.
25. **31**	9	7/13	m.r.	$\frac{1}{2}$	Birturbuy Bay, .	1	15	..	1	..	..	..	..	..	1 ♂	..	..	

25.	**38**	13	7	f.s.	1½	Blacksod Bay, .	2	13	½	..	2	..	..	..	..	2 ♀	2	..	
	,,						4	15/16	1¼/1½	4	..	..	..	..	..	4 ♂	1	..	2 Arenicola. 2 Gammarids.
	,,						3	17	1½	..	3	..	..	..	..	3 ♀	..	..	3 Philine aperta.
25.	**40**	16	4/10	s.m.	3	Blacksod Bay, .	3	..	..	..	..	..	..	..	..	..	..	..	
25.	**41**	16	9	s.m.	2	Blacksod Bay, .	10	..	..	..	..	..	..	..	..	..	..	..	
25.	**42**	16	9	s.m.	2	Blacksod Bay, .	24	..	..	..	..	..	..	..	..	..	..	..	
25.	**43**	16	9	s.m.	2	Blacksod Bay, .	3	13/14½	¾/1	3	..	..	..	..	..	3 ♂	..	..	1 Aphrodite. 1 Gammarids. 1 Tapes and Solen ensis.
	,,						14	..	..	..	..	..	..	..	..	..	..	..	
25P.	**44**	17	9	s.m.	1½	Blacksod Bay, .	3	13/14	..	..	..	..	..	..	..	..	..	..	
25P.	**45**	17	6	s.m.	½	Blacksod Bay, .	10	14	1¼	..	..	..	..	..	..	..	..	..	
25P.	**47**	18	25	s.	1¼	Broadhaven, .	1	..	..	..	..	..	..	..	..	..	..	..	
25P.	**49**	20	13	..	1	Inver Bay (inside),	1	19	2¼	..	1	..	..	..	..	1 ♀	1	..	
25.	**53**	25	25	s.m.	2	Inver Bay (outside),	2	17/18	1½/2	..	2	..	..	..	..	2 ♀	..	..	2 Arenicola and Nereis.
25.	**54**	25	..	..	2	Inver Bay (inside),	3	14/18	1/2	..	3	..	..	1 ♀	..	2 ♀	..	..	3 Annelids?
25.	**55**	26	32	g.s.	2	Donegal Bay, .	5	14/15	1/1½	..	2	..	..	..	..	2 ♀	..	..	2 Nereis.
	,,						4	16	..	4	..	..	..	..	..	4 ♂	..	..	2 Aphrodite. 2 Gammarids.
25.	**56**	26	..	..	..	Off Doran Head, .	1	15	1¼	1	..	..	..	..	..	..	1	..	
25.	**59**	30	11/16	s.r.	1	Clew Bay, . .	2	14/15	1¼/1½	1	1*	..	..	..	..	1 ♂ 1 ♀	2	..	* (♀ 15 in.).
25.	**60**	July 1	18/17	f.s.m.	2	Clew Bay, . .	4	12/13½	..	4	..	..	..	..	..	4 ♂	..	..	2 Aphrodite. 2 Amphipods. 2 Solen.
Sh.	**57A**	2	4	m.	..	Innishlyre Roads, .	1	5	..	..	..	..	..	..	..	..	..	..	
25.	**65**	5	5	f.s.	1	Blacksod Bay, .	1	11	½	1	..	..	..	..	..	1 ♂	..	..	1 Nephthys.
	,,						5	15/17	2/2½	..	5	..	..	..	..	5 ♀	..	..	1 Pagurus. 1 Stenorhynchus. 3 Lamellibranchs.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Females.	Condition of Reproductive Organs. Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	Nature of Food and Remarks. 0.	?	
					COMMON SOLE—*continued.*													
25. **69**	July 9	9	s.m.	1¼	Blacksod Bay, .	5	12	½	4	..	..	..	..	..	4 ♂	..	..	4 Annelids.
,,						8	16	1¾	..	8	..	..	..	..	♀	..	..	3 Lamellibranchs. 3 Philine. 3 Sandeels.
25. **73**	12	15/9	m.	..	Killary Bay, .	2	12½	¾	2	..	..	..	..	..	2 ♂	2	..	
,,						3	15/18½	1½/2	..	3	..	..	..	..	3 ♀	2	..	1 Amphiura and Annelids.
25. **75**	15	5	s.st.	¼?	Cleggan Bay, .	1	17½	2	..	1	..	..	..	..	1 ♀	..	..	1 Amphiura and Lamellibranchs.
25. **77**	15	7/12	s.	¾	Cleggan Bay, .	4	12½/16	1/1¾	..	4	..	..	..	..	4 ♀	..	..	Amphiura. Solen.
O. **81**	19	8	..	1½	Casheen Bay, .	6	..	..	..	..	..	..	..	..	..	..	..	
O. **86**	29	20/7	s.sh. crl.	..	Off Inishmaan, .	2	14½/16½	1¼/1½	..	2	..	..	..	..	2 ♀	1	..	1 Solen.
32P. **88**	30	..	..	..	Aran Islands, .	1	13	1	1	..	..	..	..	..	1 ♂	1	..	
,,						1	14½	1¼	..	1	..	..	..	..	1 ♀	..	..	1 Annelids and Cardium.
,,						4	16	1½/1¾	2	2	..	..	..	..	2 ♂ 2 ♀	2	..	2 Annelids.
,,						2	17/17½	2	..	2	..	..	..	..	2 ♀	2	..	
,,						3	18/20	2¾/3	..	3	..	..	..	..	3 ♀	1	..	1 Annelids. 1 Sipunculus.
32P. **94**	Aug. 8	9	m.r.	½	Casheen Bay, .	4	17/18	2/2½	..	4	..	..	1 ♀	..	3 ♀	1	..	1 Amphiura. 1 Annelids. 1 Nucula.
28P. **98**	11	16/18	g.s.	¾	Off Inishmaan, .	3	15½/18½	1¾/2½	..	3	..	..	..	..	3 ♀	1	..	1 Ophiurian. 1 Solen.
28P. **106**	16	26/23	s.sh. s.m.	2	Kenmare River, .	2	13/14	1/1¾	..	2	..	..	..	..	2 ♀	1	..	1 Amphiura.

28P.	**107**	16	8/5	m.	¾	Kenmare River, .	1	13½	..	..	1	..	..	..	..	1 ♀	..	1	
Sh.	**109**	18	2½	m.	..	Kenmare River, .	1	6	..	..	1	1 ♀	..	..	..	..	..	..	
28P.	**110**	18	10/13	m.	1	Kenmare River, .	2	14	1¼	..	2	..	..	..	..	2 ♀	1	..	Amphiura. Aphrodite. Amphipods. Solen.
	,,						4	18	3	..	4	..	..	..	..	4 ♀	..	..	Amphiura. Crustaceans. Solen. Philine.
28P.	**112**	18	24	m.s.	1¼	Kenmare River, .	3	13/13½	1/1½	3	..	..	..	..	..	3 ♂ 1 ♂	..	..	2 Amphiura. 1 Annelids, Crustaceans, and Solen.
	,,						2	19	2½	1	1	..	..	..	..	1 ♀	..	..	1 Amphiura. 1 Annelids.
28P.	**116**	21	5/8	s.	1	Kenmare River, .	1	14½	1¾	..	1	..	..	..	..	1 ♀	..	..	1 Ophiurian, Lamellibranchs, and Philine.
	,,						1	18	3	..	1	..	..	..	..	1 ♀ *	..	..	1 Lamellibranchs. * (Just spent.)
28P.	**118**	21	32/28	s.m.	1	Ballinskelligs Bay,	1	15	1½	1	..	..	..	..	..	1 ♂	1	..	
48.	**123**	1891. Mar. 21	27	f.s.	1	Ballinskelligs Bay,	8	11	¾	4	..	..	2 ♂	2 ♂	..	..	2	..	
	,,						9	13	1	4	..	..	1 ♂	1 ♂ 3 ♂	1 ♂	1 ♂	..	..	1 Echinoderms. 3 Crustaceans.
	,,						17	15½	1¾	3	1	..	..	1 ♀ 1 ♂	.. 1 ♂	..	1	..	1 Echinoderms. 2 Annelids.
	,,						17	17	2¼	2	8	..	1 ♀	6 ♀	1 ♀	..	6	1	3 Annelids.
	,,						5	18/19½	2½/3½	..	5	..	2 ♀	2 ♀	..	1 ♀	4	..	1 Annelids.
48.	**126**	28	26	m.	1¾	Ballinskelligs Bay,	1	12	½	1	..	..	1 ♂	..	..	..	..	..	1 Lamellibranchs and Nassa.
	,,						5	12/13½	½/1	5	..	..	1 ♂	2 ♂ 2 ♂	1 ♂	1 ♂	1	..	4 Annelids. 1 Crustaceans.
	,,						5	15½	1¼	3	2	..	1 ♂	1 ♀	..	1 ♀	1	2	1 Ophioglypha albida. 1 Annelids. 2 Mud.
	,,						7	16/17	2	1	4	..	4 ♀	..	1 ♂	..	..	..	3 O. albida. 2 Annelids. 1 Gastropods.
	,,						4	18/19	2/3	1	3	..	3 ♀	..	1 ♂	..	1	..	3 Annelids. 1 Crustacean. 1 ♀ with stones in bladder.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Number Examined. Females.	Condition of Reproductive Organs. Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	Nature of Food and Remarks. 0.	?	
					Common Sole—*continued.*													
48. **127**	Mar. 28	21	m.	1	Kenmare River, .	9	15	$1\frac{1}{2}$	3	2	..	2 ♀	3 ♂	..	..	..	..	3 Amphiura. 2 Annelids. 1 Crangon.
,,						1	$16\frac{1}{2}$	$1\frac{3}{4}$	..	1	..	1 ♀	..	..	..	1	..	
,,						2	18	2	..	2	..	2 ♀	..	..	..	..	..	2 Amphiura. 1 Annelids. 1 Gammarids. 1 Crangon.
48. **131**	30	45/48	s.	2	Kenmare River, .	3	$15\frac{1}{2}$	$1\frac{1}{4}$	..	3	..	1 ♀	..	..	2 ♀	..	..	2 Amphiura. 1 Annelids. 1 Gammarids.
,,						1	18	2	..	1	..	..	..	..	1 ♀	..	..	1 Gammarids.
48. **132**	31	23/29	s.sh.	$1\frac{3}{4}$	Ballinskelligs Bay,	1	10	..	1	..	..	..	1 ♂	..	..	1	..	
,,						5	12	..	..	5	..	..	1 ♀	..	4 ♀	3	1	1 Gammarids.
,,						13	14/15	$1/1\frac{1}{4}$	3	8	..	1 ♂ *2 ♀	2 ♂ 3 ♀ 1 ♂	†3 ♀ 2 ♂	..	6	1	2 Echinoderms. 2 Annelids. 1 Gammarid. †(1 ♀ nearly spent). *(2 ♀ 14 inches).
,,						8	17	2	3	3	..	..	1 ♀	2 ♀	..	1	2	1 Annelids. 1 Crangon. 1 Tellina.
,,						4	19	3	..	4	..	..	4 ♀	..	..	4	..	
48. **133**	31	40	s.r.	$1\frac{3}{4}$	Dingle Bay, .	2	$13\frac{1}{2}/17$	..	..	2	..	..	..	..	2 ♀	..	..	1 Amphiura. 1 Annelids.
O. **137**	April 3	7	m.	$\frac{1}{2}$	Casheen Bay, .	1	$16\frac{1}{2}$	$1\frac{3}{4}$	..	1	..	..	..	..	1 ♀	..	..	
48. **147**	8	25/20		$1\frac{1}{2}$	South Sound, .	5	11/15	$\frac{1}{2}/1$	5	..	..	..	..	..	5 ♂	5	..	
,,						2	16	$1\frac{1}{2}$	1	1	..	..	..	..	1 ♂ 1 ♀	2	..	
48. **153**	15	17/19	s.m.	2	Galway Bay, .	2	$11/13\frac{1}{2}$	$\frac{3}{4}/1$	2	..	..	..	..	..	2 ♂	..	..	2 Annelids.
,,						1	16	$1\frac{1}{2}$	..	1	..	..	..	..	1 ♀	..	..	1 Amphiura and Annelids.

48. **154**	15	33	s.	¾	Off Foul Sound, .	1	17½	1½	1	..	..	..	..	..	1 ♂	..	..	1 Annelids.
48. **159**	17	4/9	m.	1	Cleggan, . .	2	16½	1½	..	2	..	2 ♀	..	..	..	..	..	1 Amphiura. 1 Annelids.
,,						2	18/19	2/2¼	1	1	..	..	..	1 ♂	1 ♀	..	..	2 Amphiura.
48. **163**	18	13/15	s.	2½	Clew Bay, . .	4	11/12	½	4	..	..	1 ♂	1 ♂	1 ♂	1 ♂	2	1	1 Amphiura.
,,						16	15	1	7	1	..	..	..	6 ♂	1 ♂ 1 ♀ 1 ♂	..	1	3 Amphiura. 4 Annelids. 1 Lamellibranchs.
,,						11	16½	1½/1¾	3	8	..	4 ♀	..	2 ♀	2 ♀	..	2	1 Annelids.
,,						1	18	2	..	1	..	1 ♀	..	..	..	..	..	1 Annelids.
48. **164**	20	18	s.	1½	Clew Bay, . .	3	13½/15½	¾/1¼	3	..	..	..	..	3 ♂	..	..	..	3 Annelids.
,,						1	19	2½	..	1	..	..	..	..	1 ♀	..	..	1 Lanice.
48. **168**	21	5/7	s.	1½	Blacksod Bay, .	1	11½	½	..	1	..	..	..	..	1 ♂	1	..	
,,						11	14	1	6	1	..	1 ♂	..	1 ♂ 1 ♀	4 ♂	5	..	1 Echinoderms. 1 Annelids.
,,						4	15½/16½	1/1¾	..	4	..	..	..	2 ♀	2 ♀	2	..	1 Echinoderms. 1 Philine.
,,						2	19	2½	..	2	..	..	..	1 ♀	1 ♀	2	..	
48. **169**	21	5/7	s.	..	Blacksod Bay, .	1	12	..	..	1	1 ♀	..	..	..	..	..	..	1 Annelids.
,,						4	17/18	..	..	4	..	..	..	1 ♀	3 ♀	3	..	1 Annelids.
48. **176**	25	25/19	f.s.	1¼	Broadhaven, .	3	12	½	..	..	..	..	..	..	..	..	..	
,,						4	14	¾	3	1	..	..	1 ♂ 1 ♀	2 ♂	..	3	..	1 Amphiura.
,,						3	15½	1¼	2	1	..	..	..	2 ♂	1 ♀	2	..	1 Amphiura.
,,						4	17	1¾	..	4	..	1 ♀	2 ♀	..	1 ♀	1	..	2 Amphiura. 1 Annelids.
48. **178**	28	9/5½	s.	2	Blacksod Bay, .	19	16	1½	..	..	..	..	..	..	..	..	..	
,,						3	17½	1¾	..	3	..	..	..	1 ♀	2 ♀	..	2	1 Amphiura.
,,						1	20½	3	..	1	..	..	..	..	1 ♀	..	1	

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	LOCALITY.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Females.	Condition of Reproductive Organs. Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	Nature of Food and Remarks. 0.	?	
					COMMON SOLE—*continued.*													
48. **180**	April 29	14	s.gr.	1	Ballynakill, .	4	15½	1¼	3	1	..	..	3 ♂ 1 ♀	..	..	3	..	1 Annelids.
,,						2	18½/19	2¼/2½	..	2	..	2 ♀	..	..	..	..	..	3 Annelids.
48. **181**	30	30	s.r.	½	Off Davalaun, .	1	14	1	..	1	..	..	..	..	1 ♀	..	..	1 Annelids.
48. **188**	May 5	9/7	s.	1¼	Blacksod Bay, .	4	11½/14	¾/1	4	..	..	3 ♂	..	1 ♂	..	3	..	1 Amphiura.
,,						7	15½	1¼	2	3	..	1 ♀	1 ♀	2 ♂	1 ♀	..	2	1 Amphiura. 8 Annelids.
,,						2	18	2¼	..	2	..	1 ♀	..	..	1 ♀	..	..	1 Gammarids. 1 Philine.
48. **190**	5	4	m.s.	1¾	Blacksod Bay, .	1	11	..	..	..	..	..	..	..	..	..	..	
,,						1	14½	1	1	..	..	..	..	..	1 ♂	..	..	1 Annelids.
,,						2	17½	2	..	2	..	..	..	..	2 ♀	..	..	2 Annelids. 1 Philine.
48. **204**	14	32	s.	2	Donegal Bay, .	4	16/17	1/1½	1	3	..	..	..	..	1 ♂ 3 ♀	..	1	2 Annelids. 1 Lagis. 1 Crangon.
,,						4	18	2¼	..	4	..	..	1 ♀	..	3 ♀	..	..	3 Annelids. 1 Portunus.
48. **205**	14	30/19	m.s.	2	Donegal Bay, .	2	16	1½	..	2	..	1 ♀	1 ♀	..	..	2	..	
48. **207**	15	16/14	s.m.	1	Killybegs H. (outer),	3	15½/18	1½/2¼	..	3	..	..	..	*1 ♀	2 ♀	..	..	2 Annelids. 1 Fish. * (Female 18 in., nearly spent).
48. **212**	18	31/30	s.gr. f.s.r.	¾	Donegal Bay, .	5	16	1½	2	3	..	2 ♀	..	1 ♂	1 ♂ 1 ♀	1	..	1 Annelids. 1 Lanice. 3 Philine.
48. **215**	19	35/28	s.	1¼	Off Teelin, . .	1	19	2½	..	1	..	..	..	..	1 ♀	..	..	1 Aphrodite.
48. **216**	20	8/13	m.s.	1¼	Inver Bay (inside),	4	17/18	2/2½	..	4	..	..	..	1 ♀	3 ♀	..	..	4 Annelids.
48. **217**	20	13/10	m.s.	2	Off Doran Head, .	2	13½	1	..	..	..	..	..	..	..	..	..	

	,,						5	15½	1½	2	1	..	..	1 ♀	..	2 ♂	1	..	1 Annelids. 1 Crab.
	,,						4	17/18½	2/2½	..	4	..	1 ♀	1 ♀	..	2 ♀	..	..	4 Annelids.
	,,						1	20⅜	3¾	..	1	..	1 ♀	..	..	..	1	..	
48.	**219**	20	22/26	f.s.	1	Off Teelin, . .	6	13/15½	¾/1¼	5	1*	..	1 ♀	1 ♂	2 ♂	2 ♂	..	1	5 Annelids. * (Female 15½ inches).
48.	**223**	21	9/4	s.	1¾	Loughrosmore Bay,	1	8	..	..	1	1 ♀	..	..	..	..	..	..	1 Sandeels.
	,,						2	13/14	¾/1	1	1	..	1 ♂ 1 ♀	..	..	..	..	..	2 Sandeels.
	,,						1	16	..	..	1	..	..	1 ♀	..	..	..	..	1 Sandeels.
48.	**224**	22	9/4½	s.	1½	Boylach Bay, .	2	11½	½	1	1	1 ♂ 1 ♀	..	..	..	..	1	..	1 Amphiura.
	,,						2	13	¾	1	1	1 ♀	..	..	1 ♂	..	1	..	1 Gammarids.
	,,						4	15	1	4	..	..	..	..	2 ♂	2 ♂	3	1	
	,,						3	16½	1½	..	3	..	..	2 ♀	..	1 ♀	..	1	2 Annelids.
	,,						1	18	2½	..	1	..	..	..	..	1 ♀	1	..	
48.	**225**	22	32/25	s.r.	1	Rosses Bay, .	3	14½/16	1/1½	3	..	..	..	1 ♂	1 ♂	1 ♂	3	..	
48.	**233**	28	22/13	s.	1	Sheephaven, .	2	17	2	2	..	..	..	..	..	2 ♂	..	..	1 Echinoderms. 1 Amphiura.
48.	**235**	29	13	s.	1	Downies Bay, .	3	13/15	¾/1	3	..	..	..	..	1 ♂	2 ♂	1	..	2 Amphiura.
48.	**236**	29	10/4½	s.	1	Downies Bay, .	2	13	¾	..	..	..	..	..	..	..	..	..	
	,,						8	14½/15½	..	3	1	..	..	..	1 ♂	2 ♂ 1 ♀	1	1	1 Nephthys. 2 Sandeels.
	,,						13	17/18	2/2½	2*	5	..	1 ♀	2 ♂ 1 ♀	..	3 ♀	3	1	1 Nephthys. 3 Sandeels. * (1 male, 18 inches).
48.	**239**	30	7½/5½	s.	1	Lough Swilly, .	1	17	2	..	1	..	..	..	1 ♀	..	..	1	
48.	**242**	June 2	8	s.	..	Off Port Stewart, .	6	11/12	..	..	..	..	..	..	..	..	..	..	
	,,						3	13/14	..	..	..	..	..	..	..	..	..	..	
	,,						3	17	..	..	..	..	..	..	..	..	..	..	

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	LOCALITY.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined.		Condition of Reproductive Organs.					Nature of Food and Remarks.		
									Males.	Females.	Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	0.	?	
					§ LEMON SOLE—*Solea lascaris* (Risso.).													§ Not the Lemon Dab, or "Lemon Sole" of fishmongers.
S. **172**	1891. April 23	0/1½	s.	¼	Dugort Bay, .	1	8	..	1	..	..	..	..	1 ♂	..	..	..	
48. **178**	28	9/5½	s.	2	Blacksod Bay, .	1	9½	..	..	1	1 ♀	..	..	..	..	..	..	
„						1	10½	..	1	..	..	..	..	1 ♂	..	..	..	
					SOLANETTE—*Solea lutea* (Risso).													
25. **21**	1890. June 2	16	s.	3½	Galway Bay, .	3	..	..	..	3	..	..	..	3 ♀	..	..	..	
25. **40**	16	4/10	s.m.	3	Blacksod Bay, .	3?	..	..	..	..	..	..	..	..	..	..	..	
Sh. **91**	Aug. 7	14	s.sh.	½	Galway Bay, .	63	2¼/4½	..	9*	7*	..	..	..	..	9 ♂ 7 ♀	..	..	*(♂ 2½ to 3¼. ♀ 2½ to 4½.)
48. **146**	1891. April 8	38	s.m.	1¼	Off Gregory Sound,	1	3¾	..	..	..	1	..	1 ♀	..	..	..	..	
48. **147**	8	25/20	s.	1½	South Sound, .	4	2½	..	..	..	..	..	..	..	..	..	..	
„						1	3	..	..	..	..	..	..	..	..	..	..	
„						1	4½	..	..	..	1	..	..	..	1 ♀	..	..	
Sh. **152**	15	15	s.	¼	Galway Bay, .	2	1¾	..	..	..	..	..	..	..	..	..	..	
„						5	2½	..	..	..	..	..	..	..	..	..	..	
„						5	3	..	..	..	..	..	..	..	..	..	..	

	,,						4	$3\frac{1}{2}$	..	..	..	2	..	..	..	2 ♀	..	..
	,,						1	$3\frac{3}{4}$	..	..	..	1	..	..	..	1 ♀	..	..
48.	**153**	15	17/19	s.m.	2	Galway Bay, .	1	$1\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..
	,,						2	3	..	..	..	..	..	..	..	..	..	..
Sh.	**179**	28	5	s.	$\frac{1}{2}$	Blacksod Bay, .	2	$2/3\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..
Sh.	**218**	May 5	8	m.s.	..	Off Rossnoleagh Pt.	3?	..	..	..	..	..	..	..	..	..	..	..

CONGER—*Conger vulgaris* (Cuv.).

L.	**8**	1890. May 16	74/80	s.m.	$1\frac{1}{4}$	Off Skelligs, .	5	47/54	20	..	..	..	..	..	..	..	..	..
L.	**9**	19	40	..	..	Off Benacry Head,	38	30/61	3/22	..	..	..	..	..	..	..	..	..
L.	**14**	21	30	s.r.	..	Off Cooshcroon, .	12	26/54	8	..	..	..	..	..	..	..	..	..
L.	**15**	22	74/80	s.m.	$1\frac{1}{4}$	Off Dingle Bay, .	7	42/54	..	..	..	..	..	..	..	..	..	..
25.	**24**	June 5	13/20	f.s.	1	Inside Aran Islands,	3	36/44	8	..	..	..	..	..	..	..	..	..
L.	**46**	18	30	r.	$1\frac{1}{2}$	Off Erris Head, .	18	37/48	4/13	..	..	..	..	..	..	..	..	..
25P.	**49**	20	..	..	1	Inver Bay (inside),	1	46	12	..	..	..	..	..	..	..	..	..
25.	**53**	25	..	s.m.	2	Inver Bay (outside),	2	42	6	..	..	..	..	..	..	..	..	..
25.	**55**	26	32	g.s.	2	Donegal Bay, .	1	44	$6\frac{1}{2}$	..	..	..	..	..	..	..	..	..
25.	**56**	26	..	..	..	Off Doran Head, .	3	41	12	..	..	..	..	..	..	..	..	..
L.	**78**	July 16	35	..	..	Off Slyne Head, .	3	36	4	..	..	..	..	..	..	..	..	..
	,,						4	36/48?	..	..	..	..	..	..	..	..	..	..
	,,						6	48	12	..	..	..	..	..	..	..	..	..
32P.	**84**	28	24	s.	$2\frac{1}{4}$	Galway Bay, .	2	51	$13\frac{1}{2}$	..	..	..	..	..	..	..	..	..

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Number Examined. Females.	Condition of Reproductive Organs. Immature	Condition of Reproductive Organs. $\frac{1}{2}$ Ripe.	Condition of Reproductive Organs. $\frac{3}{4}$ Ripe.	Condition of Reproductive Organs. Ripe.	Condition of Reproductive Organs. Spent.	Nature of Food and Remarks. 0.	Nature of Food and Remarks. ?	Nature of Food and Remarks.
					Conger—*continued.*													
32P. **87**	30	..	..	..	. . . .	1	49	10	..	..	..	..	..	..	..	..	..	
28P. **106**	Aug. 16	26/23	s.shl. s.m.	2	Kenmare River, .	2	68	25	..	..	..	..	..	..	..	..	..	
28P. **110**	18	10/13	m.	1	Kenmare River, .	2	49	13	..	..	..	..	..	..	..	..	..	
L. **136**	1891. April 2	70	..	$2\frac{1}{4}$	Off Loop Head, .	1	45	$9\frac{1}{2}$	..	..	..	..	..	..	..	..	..	
,,						2	50/51	12/13	..	..	..	..	..	..	..	..	..	
,,						2	61/63	30/37	..	..	..	..	..	..	..	..	..	
48. **148**	9	38	s.	$1\frac{1}{2}$	Off Gregory Sound,	1	33	..	..	..	..	..	..	..	..	..	..	
,,						3	44	..	..	..	..	..	..	..	..	..	..	
,,						2	46/49	..	..	..	..	..	..	..	..	..	..	
48. **149**	9	39/36	s.	1	Off Gregory Sound,	1	36	..	..	..	..	..	..	..	..	..	..	
L. **150**	9	34/31	s.r.	3	Off Gregory Sound,	1 escaped		..	..	..	..	..	..	..	..	..	..	
L. **161**	18	5/10	s.r.	11‡	Off Boffin, . .	1	37	$4\frac{1}{2}$	..	..	..	..	..	..	..	..	..	
,,						3	44	..	..	..	..	..	..	..	..	..	..	
L. **171**	23	5	s.	11‡	Blacksod Bay, .	1	30	..	..	..	..	..	..	..	..	..	..	
L. **191**	May 5	..	..	11‡	Off Cleggan, .	4	30	..	..	..	..	..	..	..	..	..	..	
L. **195**	8	..	g.s.	11‡	Off Boffin, . .	3	34/44	..	..	..	..	..	..	..	..	..	..	
,,						2	53	..	..	..	..	..	..	..	..	..	..	

L.	**199**	9	5/7	..	11‡	Ship Sound, .	3	31/50	..	..	..	..	..	..	..	..	..	..	
L.	**200**	9	45/60	gr.	1	Off Clare Island, .	1	36	..	..	..	..	..	..	..	..	..	..	
L.	**226**	23 ?	..	r.	24	Burton Port, .	14	..	..	..	..	..	..	..	..	..	..	..	
L.	**237**	29	..	..	11‡	Lough Swilly, .	2	33	..	..	..	..	..	..	..	..	..	..	
	,,						2	40	..	..	..	..	..	..	..	..	..	..	
	,,						1	51	..	..	..	..	..	..	..	..	..	..	
L.	**241**	June 2	22/23	st.gr.	11‡	Off Malin Head, .	1	55	..	..	..	..	..	..	..	..	..	..	
		1890.				**GREY SKATE**—*Raia batis* (Linn.).													
25.	**4**	May 9	20	m.s.	..	Kenmare River, .	1	75	..	..	..	..	..	..	..	..	..	..	
25.	**7**	12	22	s.	..	Dingle Bay, .	2	28/38	..	..	2.	1 ♀	..	..	1 ♀	..	..	..	Crustaceans and Fish.
L.	**8**	16	74/80	s.m.	..	Off Skelligs, .	?*	28/60	..	..	..	..	..	..	..	..	..	..	* (20 Skate in all, but some were *Raia oxyrhynchus*).
25.	**12**	20	53	d.g.s.	..	Off Dingle Bay, .	1	48	..	1	..	..	..	..	..	..	..	..	
L.	**14**	21	30/35	s.r.	..	Off Cooshcroon, .	5	26/56	..	..	5	..	..	5 ♀	..	..	..	..	Crabs and Sandeels.
18.	**16**	23	74/80	g.s.	..	Off Dingle Bay, .	1	..	..	..	..	..	..	..	..	..	..	..	
25.	**18**	27	9/16	rh.s.	..	Brandon Bay, .	12	17/31	..	5	7	..	5 ♂ 7 ♀	..	..	..	..	..	12 Sandeels.
25.	**19**	27	10	f.s.	..	Off Kilcroher Head,	1	35	..	..	1	..	..	..	1 ♀	..	..	..	1 Flustra, Stenorhynchus, Fusus, and Sandeel.
25.	**24**	June 5	13/20	f.s.	..	Aran Islands, .	1	16	..	1	..	1 ♂	..	..	..	..	..	..	1 Crustaceans.
25.	**25**	5	20	f.s.	..	Off Greatman's Bay,	5	7/10	..	2	3	..	..	..	..	..	..	..	
25.	**58**	30	20	f.s.	..	Clew Bay, . .	1	36	$9\frac{1}{2}$	..	1	..	..	..	..	1 ♀	..	..	1 Sandeels.
181.	**63**	July 4	220	f.s.	$2\frac{3}{4}$	Off Achill Head, .	1	..	..	..	..	..	..	..	..	..	..	..	
181.	**70**	10	500	g.s.r.	1	Off Achill Head, .	2	28	..	1	1	1 ♂ 1 ♀	..	..	..	..	..	..	

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Females.	Condition of Reproductive Organs. Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					Grey Skate—*continued.*													
L. **80**	July 18	55	..	..	Off Slyne Head,	2	54/57	37/40	1	1	..	..	..	..	1 ♂ 1 ♀	..	..	1 Crabs. 1 Sandeels and Fish.
O. **81**	19	8	..	..	Casheen Bay,	1	?	150	..	..	..	..	..	..	..	..	..	
25. **82**	25	48	m.s.	..	Off Gregory Sound,	3	23/26½	2½/4	..	3	3 ♀	..	..	..	..	..	..	
,,						2	37/41	12/14	..	2	..	..	..	..	2 ♀	..	..	2 Crabs and Crangon. 1 Witch.
28P. **106**	Aug. 16	26/23	crl. s.sh.	..	Kenmare River,	1	35	10½	..	1	1 ♀	..	..	..	..	..	..	1 Fish.
L. **113**						1	40	20	..	1	..	..	..	..	1 ♀	..	1	
,,						3	53/57	30/48	2	1	..	..	..	..	2 ♂ 1 ♀	..	..	1 Shrimps and Prawns. 3 Fish.
,,						1	64	68	..	1	..	..	..	..	1 ♀	..	..	1 Fish.
48. **123**	1891. Mar. 21	27	f.s.	1	Ballinskelligs Bay,	1	33	8	1	..	..	1 ♂	..	..	..	..	..	1 Fish.
,,						1	48	40	1	..	..	1 ♂	..	..	..	1	..	
48. **126**	28	26	m.	1¾	Kenmare River,	1	29	6	..	1	..	1 ♀	..	..	..	..	..	1 Palæmon and Portunus.
,,						1	39½	11½	..	1	..	1 ♀	..	..	..	..	..	1 Palæmon and Portunus.
48. **127**	28	21	m.	1	Kenmare River,	1	30	28	..	1	..	1 ♀	..	..	..	..	..	1 Crangon.
,,						1	46	35	1	..	*1 ♂	..	..	..	..	..	..	1 Whiting. *(Claspers very small).
,,						1	54	40	..	1	..	1 ♀	..	..	..	..	..	1 Whiting and Flounder.
48. **131**	30	45/48	s.	2	Kenmare River,	4	24	..	2	2	..	..	..	..	..	1	..	1 Pandalus. 2 Crangon. 1 Fish.

48.	**132**	31	23/29	s.sh.	$1\frac{3}{4}$	Ballinskelligs Bay,	1	24	2	1	..	1 ♂	..	..	..	..	..	..	1 Sandeels.
48.	**133**	31	40	s.r.	$1\frac{3}{4}$	Dingle Bay, .	2	35/38	..	1	1	1 ♂ 1 ♀	..	..	..	..	..	..	1 Palæmon. 1 Crangon. 1 Callionymus. 1 Argentina.
L.	**136**	April 2	70	..	$1\frac{1}{4}$	Off Loop Head, .	1	52	..	1	..	..	1 ♂	..	..	..	1	..	
48.	**143**	7	46/44	..	$\frac{3}{4}$	Off Inishmore, .	3	22/38	..	..	3	3 ♀	..	..	..	..	3	..	
48.	**148**	9	38	s.	$1\frac{1}{2}$	Off Gregory Sound,	1	44	19	1	..	..	1 ♂	..	..	..	..	..	1 Fish.
	,,						2	$29\frac{1}{2}$	7	2	..	2 ♂	..	..	..	..	1	..	1 Crustaceans.
L.	**150**	9	34/31	s.r.	3	Off Gregory Sound,	4	49/55	30/44	..	..	..	..	..	..	..	..	..	
	,,						1	$67\frac{1}{2}$	119	..	..	..	..	..	..	..	..	..	
L.	**161**	18	5/10	s.r.	11‡	Off Boffin, . .	1	$83\frac{1}{2}$	195	..	1	..	..	..	1 ♀	..	..	..	1 Crangon, Portunus and Pollack.
L.	**165**	20	154	s.	$2\frac{3}{4}$	Off Achill Head, .	1	58	..	1	..	..	..	..	1 ♂	..	1	..	
L.	**200**	May 9	45/60	gr.	..	Off Clare Island, .	11	56	..	2	1	1 ♀	1 ♀ ?	..	2 ♂	..	3	..	
	,,						1	59	..	1	..	..	..	..	1 ♂	..	..	..	1 Fish.
	,,						1	70	..	1	..	..	..	..	1 ♂	..	..	..	1 Fish.
L.	**231**	27	..	..	11‡	Off Tory Island, .	1	60	..	..	..	..	..	..	..	..	..	..	
L.	**241**	June 2	..	..	11‡	Off Malin Head, .	1	43	..	..	..	..	..	..	..	..	..	..	
	,,						1	53	..	..	..	..	..	..	..	..	..	..	
	,,						1	60	..	1	..	..	..	..	1 ♂	..	1	..	

FLAPPER SKATE—*Raia macrorhynchus* (Raf.).

L.	**171**	1891. April 23	5	s.	11‡	Blacksod Bay, .	2	58/79	..	..	..	..	..	..	..	..	..	..	

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined.		Condition of Reproductive Organs.					Nature of Food and Remarks.		
									Males.	Females.	Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	0.	?	
					SHARP-NOSED SKATE—*Raia oxyrhynchus* (Linn.).													
L. **8**	1890. May 16	74/80	s.m.	..	Off the Skelligs, .	?	?/60	..	..	..	..	..	..	..	..	..	..	
25. **53**	June 25	25	s.m.	..	Inver Bay (outside),	1	63	46	..	1	..	..	..	1 ♀	..	..	..	1 Cepola.
48. **146**	1891. April 8	38	s.m.	$1\frac{1}{4}$	Off Gregory Sound,	1	53	32	..	1	..	1 ♀	..	..	..	..	..	
L. **150**	9	34/31	s.r.	3	Off Gregory Sound,	1	48	25	1	..	..	..	..	..	..	..	..	
,,						1	53	..	..	1	..	..	..	..	..	..	..	
18. **201**	May 5	500/375	s.f.gr.	3	Off Blackrock, .	1	$51\frac{1}{2}$	..	..	1	..	1 ♀	..	..	..	..	..	
					SHAGREEN RAY—*Raia fullonica* (Linn.).													
L. **113**	1890. Aug. 19	80	m.s.	..	Off Skelligs, .	2	36/38	9/11	1	1	..	..	..	..	1 ♂ 1 ♀	..	..	2 Fish.
L. **136**	1891. April 2	70	..	..	Off Loop Head, .	2	35/41	..	1	1*	..	1 ♀	..	1 ♂	..	2	..	*(♀ 41 inches.)
L. **141**	7	52/50	m.s.	$4\frac{1}{4}$	Off Inishmore, .	1	30	..	1	..	..	..	..	..	..	..	..	
48. **148**	9	38	s.	$1\frac{1}{2}$	Off Gregory Sound,	1	40	12	..	1	1 ♀	..	..	..	..	..	..	1 Callionymus.
48. **149**	9	39/36	s.	1	Off Gregory Sound,	1	30	..	1	..	1 ♂	..	..	..	..	..	..	
L. **165**	20	154	s.	$4\frac{3}{4}$	Off Achill Head, .	1	44	..	..	1	..	..	1 ♀	..	..	..	1	
48. **204**	May 14	32	s.	2	Donegal Bay, .	1	36	..	..	..	..	..	..	..	..	..	..	
48. **206**	15	14/16	st.m.	$\frac{3}{4}$	Killybegs Harbour (outer).	1	23	..	..	..	..	..	..	..	..	..	..	

25.	**1**	1890. May 8	7	m.	½	Kenmare River, .	4	33/37	..	2	2	..	..	..	..	2 ♂ 2 ♀	..	..	3 Crabs. 1 Cod.
25.	**2**	8	7	m.	1	Kenmare River, .	2	..	..	..	..	..	..	..	..	..	..	..	
25P.	**3**	9	10	m.	1½	Kenmare River, .	2	30/34	..	1	1	..	..	..	1 ♂ 1 ♀	..	..	2	
25.	**4**	9	20	m.s.	2	Kenmare River, .	1	..	..	..	..	..	..	..	..	..	..	..	Arenicola. Crabs. Buccinum. Siphons of Lamellibranchs.
25.	**5**	10	6	s.	1¼	Ballinskelligs Bay,	2	33/36	..	..	2	..	1 ♀	1 ♀	..	..	..	..	
L.	**8**	16	74/80	s.m.	..	Off Skelligs, .	5	22	..	..	..	..	..	..	..	..	..	..	
25.	**12**	20	53	d.g.s.	3	Off Dingle Bay, .	2	17/19	..	1	1	..	1 ♀	..	1 ♂	..	..	..	
	,,						3	26/37	..	1	2	..	2 ♀	..	1 ♂	..	..	..	Aphrodite. Eledone?
25.	**13**	20	50	d.g.s.	1¾	Off Dingle Bay, .	2	14/46	..	..	..	..	..	..	..	..	..	..	
L.	**14**	21	30	s.r.	..	Off Cooshcroon, .	4	26/37	..	1*	3	1 ♂	1 ♀	..	2 ♀	..	..	..	* (♂ 27 in.).
L.	**15**	22	74/80	s.m.	..	Off Dingle Bay, .	35	24/35	..	18	17	..	♂ ♀	♀	♂ ♀	..	..	..	Echinoderms. Crustaceans, Gastropods. Sandeels and Fish.
18.	**16**	23	74/80	g.s.	..	Off Dingle Bay, .	2	..	..	..	..	..	..	..	..	..	..	..	
25.	**21**	June 2	16	s.	3½	Galway Bay, .	3	27/31	..	2	1	..	2 ♂	..	1 ♀	..	..	..	Crustaceans. Gastropods and Fish.
18.	**26**	6	4/8	crl. s.m.	..	Kilkieran Bay, .	3	30	..	3	..	..	..	..	..	..	..	..	
0.	**29**	9	4/12	s.	¾	Gorteen Bay, .	1	32	..	1	..	..	..	..	1 ♂	..	..	..	1 Sandeels.
Sh.	**33**	11	6	s.m.	..	Clifden Harbour, .	1	32	..	..	1*	..	..	..	1 ♀	..	..	..	*(Very dark specimen).
18.	**34**	11	6	m.s.	¼	Clifden Harbour, .	1	18	..	1	..	1 ♂	..	..	..	..	..	..	1 Fish.
25.	**38**	13	7	g.s.	1½	Blacksod Bay, .	2	28	..	1	..	..	..	..	1 ♂ 3 ♀	..	1	..	
25.	**40**	16	4/10	s.m.	3	Blacksod Bay, .	20	26/43	..	3	4	..	..	..	3 ♂	1 ♀	..	..	Pagurus. Mysis. Solen. (Buccinum). Sandeels.
25.	**41**	16	9	s.m.	2	Blacksod Bay, .	12	..	..	..	..	..	..	..	..	..	..	..	
25.	**42**	16	9	s.m.	2	Blacksod Bay, .	3	27/30	7	2	1	..	..	..	2 ♂ 1 ♀	..	..	..	Nereis. Pagurus. Lamellibranchs.

Fishing Implement and Station No.		Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined.		Condition of Reproductive Organs.					Nature of Food and Remarks.		
										Males.	Females.	Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	0.	?	
						Thornback—*continued.*													
25P.	**44**	17	9	s.m.	1½	Blacksod Bay,	8	..	..	..	..	..	..	..	..	..	..	..	
25P.	**45**	17	6	s.m.	½	Blacksod Bay,	3	..	..	..	..	..	..	..	..	..	..	..	
25P.	**49**	20	..	..	1	Inver Bay (inside),	3	34	..	..	2	..	..	..	..	2 ♀	..	..	
25.	**53**	25	25	s.m.	2	Inver Bay (outside),	3	30/42	5½/18	1	2	..	..	..	1 ♂	2 ♀	..	..	3 Nephrops.
25.	**54**	25	..	..	2	Inver Bay (inside),	2	35	10	..	..	..	..	..	..	..	..	..	
25.	**58**	30	22/18	f.s.	2½	Clew Bay,	3	19	2	..	2	2 ♀	..	..	..	..	..	..	2 Crabs.
25.	**59**	30	11/16	s.r.	1	Clew Bay,	1	26	..	1	..	..	..	..	1 ♂	..	..	..	1 Aphrodite and Portunus.
25.	**60**	July 1	18/17	f.s.	2	Clew Bay,	3	38	9	..	3	..	..	..	1 ♀	2 ♀	..	..	Crustaceans and Lamellibranchs.
25.	**61**	1	15	s.r.	¾	Clew Bay,	1	18	..	..	1	1 ♀	..	..	..	..	..	..	1 Wrasse.
25.	**65**	5	5	f.s.m.	1	Blacksod Bay,	13	?/30	..	7	3	2 ♀	..	..	7 ♂ 1 ♀	..	..	..	Aphrodite. Pagurus. Stenorhynchus. Lamellibranchs (Siphons). Sandeels.
25.	**67**	5	4½	cr.s.	2	Blacksod Bay,	21	..	..	14	7	7 ♂ 4 ♀	..	..	7 ♂ 3 ♀	..	..	..	Annelids. Crustaceans. Sandeels. Sprats.
25.	**68**	9	14	f.s.	2	Blacksod Bay,	3	12	..	..	1	..	..	..	1 ♀	..	..	..	1 Lamellibranchs (Siphons) and Dab.
	,,						1	32	..	..	1*	..	..	..	1 ♀	..	..	..	1 Pagurus. * (♀ 36 in.).
25.	**69**	9	9	s.	1¼	Blacksod Bay,	2	12/36	?/10	4	..	..	1 ♂	3 ♂	..	..	..	..	4 Pagurus.
25.	**73**	12	15/9	m.	1	Killary Bay,	4	29	5½	..	6	..	..	6 ♀	..	..	6	..	
	,,						6	36	12	1	1	..	..	1 ♂	1 ♀	..	..	..	2 Mya (Siphons).
25.	**74**	15	12	s.r.	1	Off Killary,	2	31/39	..	..	..	..	..	..	..	..	..	..	

0.	**81**	19	8	..	$1\frac{1}{2}$	Casheen Bay, .	5	..	..	..	5	5 ♀	..	..	..	..	..	..	1 Amphipods, Shrimps, Lamellibranchs.
25.	**82**	25	48	m.s.	..	Gregory Sound, .	5	7	..	..	1	1 ♀	..	..	..	..	..	..	1 Annelids, Crab and Amphipods.
32P.	**87**	30	..	..	..	Aran Isles, . .	1	12	..	..	..	..	..	..	..	..	..	..	
32P.	**90**	31	15	s.m.	1	Galway Bay, .	5	..	..	1	..	..	..	..	..	1 ♂	..	..	1 Pagurus.
28P.	**95**	Aug. 9	24	f.s.	..	Aran Isles, . .	1	31	$6\frac{3}{4}$	1	..	..	..	..	..	..	..	..	1 Corystes cassivelaunus, Gebia and Sandeels.
28P.	**98**	11	16	g.s.	$\frac{3}{4}$	Aran Isles, . .	1	19	2	1	1	..	..	1 ♂	..	1 ♀	..	..	1 Crab. 1 Lamellibranchs (Siphons).
,,							2	33/37	10/15	..	..	..	..	..	..	..	..	..	
0.	**99**	12	..	s.	$\frac{1}{4}$	Aran Isles, . .	3	small	..	..	1	..	..	..	..	..	..	..	1 Crab.
28P.	**106**	16	8/5	m.	2	Kenmare River, .	1	25	4	1	1	..	..	..	..	1 ♂ 1 ♀	..	..	1 Portunus, Palæmon and Gonoplax. 1 Buccinum.
28P.	**110**	18	10/13	m.	1	Kenmare River, .	2	$28\frac{1}{2}/34$	$6\frac{1}{2}/13$	..	..	..	..	..	..	..	..	..	
28P.	**112**	18	25/23	m.s.	$1\frac{1}{4}$	Kenmare River,	2	29/34	7/11	1*	1	1 ♂	..	1 ♀	..	..	..	..	1 Annelids. 1 Gonoplax. *(♂ 29 inches.)
28P.	**115**	20	62/52	m.s.	1	Off Skelligs, . .	3	31/35	9/10	1	2	..	..	..	..	1 ♂ 2 ♀	..	..	2 Portunus. 1 Shrimp and Eledone.
28P.	**118**	21	32/28	s.m.	1	Ballinskelligs Bay,	2	19/28	2/5	1	1	1 ♂ 1 ♀	..	..	..	..	..	..	2 Crabs.
48.	**123**	1891. Mar. 21	27	f.s.	1	Ballinskelligs Bay,	1	18	..	1	..	1 ♂	..	..	..	..	..	..	
48.	**126**	28	26	m.	$1\frac{3}{4}$	Kenmare River, .	6	$6/7\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,							1	35	12	..	1	..	..	..	1 ♀	..	..	..	1 Nephthys.
48.	**127**	28	21	m.	1	Kenmare River, .	1	$10\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,							3	31/36	..	2	1	..	1 ♀	1 ♂	1 ♂	..	..	..	1 Aphrodite. 1 Nephrops. 1 Crangon. 1 Portunus.
48.	**128**	28	10	m.	$1\frac{1}{4}$	Kenmare River, .	4	27	..	3	1	..	..	..	..	..	..	..	
,,							1	31	..	..	1	..	..	..	..	..	..	..	
25P.	**130**	30	24	m.	2	Kenmare River, .	1	34	..	..	1	1 ♀	..	..	..	..	..	..	1 Aphrodite, Palæmon, Gonoplax and Nephrops.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	LOCALITY.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Number Examined. Females.	Condition of Reproductive Organs. Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					THORNBACK—*continued.*													
48. **131**	Mar. 30	45/48	s.	2	Kenmare River, .	4	33	10	1	3	..	..	..	..	..	..	..	2 Aphrodite. 2 Cymothoa. 3 Crangon. 2 Pagurus. 1 Gonoplax. 1 Atelecyclus.
48. **132**	31	23/29	s.sh.	2	Ballinskelligs Bay,	1	33	10	..	1	..	..	1 ♀	..	..	..	..	1 Aphrodite, Palæmon and Atelecyclus.
48. **133**	31	40	s.r.	2	Dingle Bay, .	2	23/30	..	1	1*	1 ♂ 1 ♀	..	..	..	..	..	..	1 Annelids. 1 Atelecyclus. *(♀ 28 inches.)
,,						2	23/32	..	1	1*	1 ♀	..	..	1 ♂	..	..	..	2 Cymothoa. 1 Fish. *(♀ 32 inches.)
L. **136**	April 2	70	..	1	Off Loop Head, .	8	32	..	8	..	..	..	..	8 ♂	..	8	..	
,,						4	35	..	..	4	..	1 ♀	..	3 ♀	..	..	..	2 Aphrodite. 1 Cymothoa. 1 Crangon.
O. **137**	3	7	m.	$\frac{1}{2}$	Casheen Bay, .	1	4	..	..	..	..	..	..	..	..	..	..	
,,						1	24	..	..	..	..	..	..	..	..	..	..	
Sh. **138**	3	5	m.	..	Kilkieran Bay, .	1	4	..	..	..	..	..	..	..	..	..	..	
,,						1	10	..	..	..	..	..	..	..	..	..	..	
,,						1	22	..	..	..	..	..	..	..	..	..	..	
L. **141**	7	52/50	m.s.	$4\frac{1}{4}$	Off Inishmore, .	1	small	..	..	1	1 ♀	..	..	..	..	1	..	
,,						2	24/27	..	1	1*	1 ♀	..	1 ♂	..	..	1	..	1 Cymothoa. Mysis and Nephrops. *(♀ 24 inches.)
,,						3	33	..	..	3	..	2 ♀	1 ♀	..	..	2	..	1 Aphrodite, Gonoplax and Corystes.
48. **143**	7	46/44	..	$\frac{3}{4}$	Off Inishmore, .	2	22/27	..	1	1	..	..	..	..	..	..	..	
48. **146**	8	38	s.m.	$1\frac{1}{4}$	Off Gregory Sound,	3	23/29	..	..	..	..	..	..	..	..	..	..	
,,						3	33	..	..	..	..	..	..	..	..	..	..	

48.	**147**	8	25/20	s.	$1\frac{1}{2}$	South Sound, .	3	9/11	..	..	..	..	..	..	..	..	..	..	
	,,						2	30/33	..	..	..	..	..	..	..	..	..	..	
48.	**148**	9	38	s.	$1\frac{1}{2}$	Off Gregory Sound,	1	36	12	..	1	1 ♀	..	..	..	..	1	..	
48.	**149**	9	36/36	s.	1	Off Gregory Sound,	2	$18\frac{1}{2}/25\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
48.	**153**	15	17/19	s.m.	2	Galway Bay, .	3	30/32	..	..	1	..	1 ♀	..	..	..	..	..	1 Corystes.
	,,						1	38	..	..	1	..	1 ♀	..	..	..	..	..	1 Gebia and Corystes.
48.	**154**	15	33	s.	$\frac{3}{4}$	Off Foul Sound, .	1	$10\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
Sh.	**159**	17	4/9	m.	1	Cleggan Bay, .	2	12/18	..	..	..	..	..	..	..	..	..	..	
	,,						4	$24/26\frac{1}{2}$	..	1	3*	3 ♀	..	..	1 ♂	..	..	..	1 Annelids. 3 Portunus. 1 Lamellibranchs. *(♀ 24/26 in.)
L.	**161**	18	5/10	s.r.	11‡	Off Boffin, . .	1	24	..	1	..	1 ♂	..	..	..	..	1	..	
48.	**163**	18	13/15	s.	$2\frac{1}{2}$	Clew Bay, . .	4	16	..	..	..	..	..	..	..	..	..	..	
	,,						3	20	..	..	..	..	..	..	..	..	..	..	
	,,						5	$23\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
	,,						10	$31\frac{1}{2}$	..	..	2	..	1 ♀	1 ♀	..	..	1	..	1 Lamellibranchs.
48.	**164**	20	18	s.	$1\frac{1}{2}$	Clew Bay, .	1	26	..	..	..	..	..	..	..	..	..	..	
Sh.	**167**	21	3/4	s.	..	Blacksod Bay, .	2	4/6	..	..	..	..	..	..	..	..	..	..	
48.	**168**	21	5/7	s.	$1\frac{1}{2}$	Blacksod Bay, .	8	6	..	..	..	..	..	..	..	..	..	..	
	,,						2	12	..	..	..	..	..	..	..	..	..	..	
	,,						14	16/24	..	..	..	..	..	..	..	..	..	..	
	,,						16	27	..	..	..	..	..	..	..	..	..	..	
48.	**176**	25	25/19	f.s.	$1\frac{1}{4}$	Broadhaven, .	5	21/34	..	..	..	..	..	..	..	..	..	..	
48.	**177**	25	20/18	m.s.	1	Off Downpatrick Hd.	1	30	..	..	..	..	..	..	..	..	..	..	

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	LOCALITY.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Number Examined. Females.	Condition of Reproductive Organs. Immature	½ Ripe.	¾ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					THORNBACK—*continued.*													
48. **178**	April 28	9/5½	s.	2	Blacksod Bay, .	4	16	..	..	..	..	..	..	..	..	..	..	
,,						4	27½	..	..	..	..	..	..	..	..	..	..	
48. **180**	29	14	s.gr.	1	Ballynakill, .	9	30	..	..	..	..	..	..	..	..	..	..	
,,						2	36/43	..	..	..	..	..	..	..	..	..	..	
48. **182**	30	8/11	s.m.	1	Cleggan Bay, .	1	16	..	..	..	..	..	..	..	..	..	..	
Sh. **185**	May 2	½/2	s.	..	Ballynakill Harb.,	6	4	..	..	..	..	..	..	..	..	..	..	
48. **188**	5	9/7	s.	1¼	Blacksod Bay, .	5	4/5	..	..	..	..	..	..	..	..	..	..	
,,						6	6/10	..	..	..	..	..	..	..	..	..	..	
,,						1	16	..	..	..	..	..	..	..	..	..	..	
48. **190**	5	4	m.s.	1¾	Blacksod Bay, .	20	..	..	..	..	..	..	..	..	..	..	..	
L. **191**	5	..	..	11‡	Blacksod Bay, .	1	..	..	..	..	..	..	..	..	..	..	..	
48. **196**	8	16/13	s.r.	¼	Davalaun Sound, .	1	29½	..	..	1	..	..	..	..	1 ♀	..	..	1 Crustaceans and Lamellibranchs.
L. **200**	9	45/60	g.	..	Off Clare Island, .	7	34	..	..	..	..	..	..	..	..	..	..	
48. **204**	14	32	s.	2	Donegal Bay, .	3	8	..	..	..	..	..	..	..	..	..	..	
,,						1	13	..	..	..	..	..	..	..	..	..	..	
48. **205**	14	30/19	m.s.	2	Donegal Bay, .	1	40	..	..	1	..	..	..	..	..	..	..	1 Cepola rubescens.
48. **207**	15	16/14	s.m.	1	Killybegs H. (outer),	1	30	..	1	..	..	..	..	1 ♂	..	..	..	1 Fish.
48. **216**	20	8/13	m.s.	1¼	Inver Bay (inside),	4	28	..	..	..	..	..	..	..	..	..	..	

48. 221	21	19/5	s.	2	Loughrosmore Bay,	6	18	..	..	..	..	..	..	..	..	..	..	
,,						14	25	..	..	..	..	..	..	..	..	..	..	
,,						26	27	..	..	..	..	..	..	..	..	..	..	
48. 222	21	22/20	s.	1½	Boylach Bay, .	1	30	..	..	..	..	..	..	..	..	..	..	
48. 223	21	9/4	s.	1¾	Loughrosmore Bay,	1	18	..	..	..	..	..	..	..	..	..	..	
,,						2	26	..	..	..	..	..	..	..	..	..	..	
,,						3	30	..	..	..	..	..	..	..	..	..	..	
48. 224	22	9/4½	s.	1½	Boylach Bay, .	23	20/35	..	..	..	..	..	..	..	..	..	..	
48. 232	28	9/10	s.r.	1½	Off Horn Head, .	2	22/29	..	1*	1	1 ♂	1 ♀	..	..	..	..	..	1 Annelids. 2 Crustaceans. 1 Lamellibranchs. 1 Fish. * (♂ 22 in.).
48. 233	28	22/13	s.	1	Sheephaven, .	2	30	..	2	..	1 ♂	..	..	1 ♂	..	..	..	1 Crustaceans. 1 Lamellibranchs. 2 Sandeels. 1 Crystallogobius.
L. 234	28	12/14	..	11‡	Sheephaven, .	1	30	..	..	1	..	1 ♀	..	..	..	1	..	
48. 235	29	13	s.	1	Downies Bay, .	2	20	..	..	..	..	..	..	..	..	..	..	
48. 236	29	10/4½	s.	1	Downies Bay, .	2	5½	..	..	..	..	..	..	..	..	..	..	
,,						1	18	..	..	..	..	..	..	..	..	..	..	
,,						3	26	..	..	..	..	..	..	..	..	..	..	
,,						2	30	..	..	..	..	..	..	..	..	..	..	
48. 238	30	8/12	s.	2	Lough Swilly, .	16	12/36	..	..	..	..	..	..	..	..	..	..	
48. 239	30	7½/5½	s.	1	Lough Swilly, .	2	5	..	..	..	..	..	..	..	..	..	..	
,,						2	14	..	..	..	..	..	..	..	..	..	..	
,,						13	19/24	..	..	..	..	..	..	..	..	..	..	
,,						4	28	..	..	..	..	..	..	..	..	..	..	
,,						3	32	..	..	..	..	..	..	..	..	..	..	
,,						1	38	..	..	1	..	1 ♀	..	..	..	..	..	1 Annelids, Portunus, Corystes, and Fish.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	Locality.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined.		Condition of Reproductive Organs.							Nature of Food and Remarks.
									Males.	Females.	Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	0.	?	
48. **240**	June 1	$6/8\frac{1}{2}$	s.	$1\frac{1}{4}$	Lough Swilly,	2	20/24	..	..	..	..	..	..	..	..	..	..	3 Corystes. 1 Portunus. 2 Lamellibranchs (Siphons). 1 Herring.
,,						15	30/34	..	10	5	..	1 ♀	..	3 ♂ 2 ♀	..	1	..	
48. **242**	2	8	s.	1	Off Port Stewart,	26	20/40	..	..	..	..	..	..	..	..	..	..	
					SPOTTED RAY—*Raia maculata* (Mont.).													
O. **29**	1890. June 9	4/12	s.	$\frac{3}{4}$	Gorteen Bay,	1	26	4	1	..	..	..	..	1 ♂	..	..	..	1 Sandeels.
25. **37**	13	18	sh.	$\frac{1}{2}$	Off Cleggan Head,	2	24	6	1	1	..	..	..	1 ♂ 1 ♀	..	..	..	2 Sandeels.
25. **40**	16	4/10	s.m.	2	Blacksod Bay,	1	14	..	1	..	1 ♂	..	..	..	..	..	..	
,,						2	18	$1\frac{1}{2}$	..	2	2 ♀	..	..	..	..	1	..	1 Sandeels.
,,						38	26/42	5/17	4	6	..	..	..	4 ♂ 1 ♀	5 ♀	..	..	Pagurus. Mysis. Sandeels.
25. **43**	16	9	s.m.	2	Blacksod Bay,	1	34	11	..	1	..	..	..	..	1 ♀	..	..	1 Sandeels.
,,						3	42/44	17/22	1	1	..	..	..	1 ♂	1 ♀	..	..	2 Sandeels.
25. **58**	30	20	f.s.	$2\frac{1}{2}$	Clew Bay,	1	38	15	1	..	..	..	..	1 ♂	..	..	..	1 Sandeels.
25. **59**	30	11/16	s.r.	1	Clew Bay,	2	28	$5\frac{1}{2}$	1	1	..	..	..	1 ♂ 1 ♀	..	..	..	2 Annelids and Crustaceans.
25. **67**	July 5	$4\frac{1}{2}$	c.s.	2	Blacksod Bay,	12	?	..	2	10	2 ♂ 8 ♀	..	..	..	2 ♀	..	..	Annelids. Crustaceans. Sandeels. Sprats.
25. **68**	9	14	f.s.	2		3	very small		..	..	..	..	..	..	..	..	..	
,,						2	24/28	..	..	2	..	..	1 ♀	1 ♀	..	..	..	2 Nephthys.

25.	**74**	15	12	s.r.	1	Off Killary Bay, .	1	46	19	..	1	..	..	..	..	1 ♀	..	..	1 Sandeels.
25.	**77**	15	7/12	s.	$\frac{3}{4}$	Cleggan Bay, .	2	17	..	2	..	..	..	..	..	..	..	..	
25.	**79**	16	13	s.	$\frac{1}{2}$	Davalaun, . .	14	32	10	..	..	..	..	..	..	..	..	..	
O.	**86**	29	20/7	s.sh.	crl.	Off Inishmaan, .	2	21/24	$2\frac{1}{2}/3\frac{1}{2}$	..	2	2 ♀	..	..	..	..	..	..	2 Sandeels.
	,,						2	28/32	$6\frac{1}{4}/9\frac{1}{2}$	1	1	..	..	1 ♂	..	1 ♀	..	..	2 Sandeels.
	,,						2	41/43	19/22	1	1	..	..	1 ♂	..	1 ♀	..	..	2 Crustaceans and Mya (Siphons).
32P.	**87**	30	..	..	..	Aran Islands, .	1	27	5	1	..	..	..	1 ♂	..	..	..	..	1 Annelids, Crab, Lamellibranchs (Siphons).
32P.	**88**	30	..	..	..	Aran Islands, .	30	25	$4\frac{1}{2}$	22	8	..	..	..	..	..	..	..	Isopods. Amphipods. Crabs. Lamellibranchs. Herring.
28P.	**98**	Aug. 11	17	g.s.	$\frac{3}{4}$	Aran Islands, .	35	28	6	20	15	..	..	..	..	..	1	1	3 Solen. 9 Sandeels. (12 examined).
O.	**99**	12	..	s.	$\frac{1}{4}$	Aran Islands, .	1	..	..	..	..	..	..	..	..	..	..	..	
48.	**123**	1891. Mar. 21	27	f.s.	1	Ballinskelligs Bay,	4	29	$7\frac{1}{2}$	..	4	..	4 ♀	..	..	..	..	..	1 Crangon. 2 Portunus. 1 Sandeels. 1 Crystallogobius).
48.	**127**	28	21	m.	1	Kenmare River, .	1	26	..	1	..	..	..	..	1 ♂	..	1	..	
48.	**128**	28	10	m.	$1\frac{1}{4}$	Kenmare River, .	1	27	..	..	..	..	..	..	..	..	..	..	
48.	**131**	30	45/48	s.	2	Kenmare River, .	5	27	..	1	4	..	..	..	..	..	2	1	1 Annelids. 1 Gonoplax. 1 Portunus. 1 Atelecyclus. 1 Crangon.
48.	**132**	31	23/29	s.sh.	$1\frac{3}{4}$	Ballinskelligs Bay,	1	$24\frac{1}{2}$	$3\frac{1}{2}$	1	..	1 ♂	..	..	..	..	..	..	1 Sandeels.
	,,						1	$36\frac{1}{2}$	$6\frac{1}{2}$	..	1	..	..	..	1 ♀	..	..	..	1 Sandeels.
48.	**133**	31	40	s.r.	$1\frac{3}{4}$	Dingle Bay, .	1	15	..	..	..	..	..	..	..	..	..	..	
48.	**147**	April 8	25/20	s.	$1\frac{1}{2}$	South Sound, .	2	26	..	..	..	..	..	..	..	..	..	..	
48.	**149**	9	39/36	s.	1	Off Gregory Sound,	1	27	..	..	..	..	..	..	..	..	..	..	
48.	**154**	15	33	s.		Off Foul Sound, .	1	27	..	..	1	..	..	..	1 ♀	..	..	..	1 Annelid and Corystes.
48.	**159**	17	4/9	m.	1	Cleggan Bay, .	1	28	..	..	1	..	..	..	1 ♀	..	..	..	1 Sandeels.

Fishing Implement and Station No.	Date.	Depth in fathoms.	Nature of bottom.	Hours down.	LOCALITY.	Number.	Length in inches.	Weight in lbs. avdp.	Number Examined. Males.	Number Examined. Females.	Condition of Reproductive Organs. Immature	$\frac{1}{2}$ Ripe.	$\frac{3}{4}$ Ripe.	Ripe.	Spent.	0.	?	Nature of Food and Remarks.
					SPOTTED RAY—*continued*.													
48. **163**	April 18	13/15	s.	$2\frac{1}{2}$	Clew Bay, . .	1	$45\frac{1}{2}$	..	..	1	..	..	..	1 ♀	..	1	..	
48. **168**	21	5/7	s.	$1\frac{1}{2}$	Blacksod Bay, .	1	18	..	..	..	..	..	..	..	..	..	..	
,,						1	29	..	..	..	..	..	..	..	..	..	..	
48. **177**	25	20/18	m.s.	1	Off Downpatrick Hd.	3	37	..	..	..	..	..	..	..	..	..	..	
,,						1	39	..	..	..	..	..	..	..	..	..	..	
48. **178**	28	$9/5\frac{1}{2}$	s.	2	Blacksod Bay, .	1	$18\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						7	$26\frac{1}{2}$	..	..	..	..	..	..	..	..	..	..	
,,						8	39/47	..	..	..	..	..	..	..	..	..	..	
48. **180**	29	14	s.gr.	1	Ballynakill, . .	6	12	..	..	..	..	..	..	..	..	..	..	
,,						7	23	..	..	..	..	..	..	..	..	..	..	
,,						8	29	..	..	..	..	..	..	..	..	..	..	
,,						2	39	..	..	..	..	..	..	..	..	..	..	
48. **188**	May 5	9/7	s.	$1\frac{1}{4}$	Blacksod Bay, .	1	43	..	..	1	..	..	..	1 ♀	..	..	..	1 Sandeels.
48. **190**	5	4	m.s.	$1\frac{3}{4}$	Blacksod Bay, .	11	..	..	..	..	..	..	..	..	..	..	..	
48. **193**	7	20	s.r.	..	Blacksod Bay, .	2	30	..	..	..	..	..	..	..	..	..	..	
48. **196**	8	16/13	s.r.	$\frac{1}{4}$	Davalaun Sound, .	1	..	..	..	..	..	..	..	..	..	..	..	
48. **207**	15	16/14	s.m.	1	Killybegs Hr. (outer)	2	22	..	1	1	1 ♀	..	..	..	1 ♂	1	..	1 Fish.
,,						1	26	..	1	..	..	..	..	..	1 ♂	1	..	

48.	**221**	21	19/5	..	2	Loughrosmore Bay,	2	26	..	..	..	..	..	..	..	..	..	..	
48.	**222**	21	22/20	s.	1½	Boylach Bay, .	1	5¾	..	..	..	..	..	..	..	..	..	..	
48.	**232**	28	9/10	s.r.	1½	Off Horn Head, .	1	30	..	..	1	..	..	..	1 ♀	..	1	..	
48.	**238**	30	8/12	s.	2	Lough Swilly, .	2	26	.	..	..	..	..	..	..	..	..	..	
48.	**239**	30	7½/5½	s.	1	Lough Swilly, .	1	43	..	..	1	..	1 ♀	..	..	..	..	..	1 Sandeels.
48.	**242**	June 2	8	s.	1	Off Port Stewart, .	4	17/35	..	..	..	..	..	..	..	..	..	..	

OWL or PAINTED RAY—*Raia microcellata* (Mont.).

48.	**168**	1891. Apr. 21	5/7	s.	1½	Blacksod Bay, .	1	36½	..	..	1	..	..	..	..	..	..	..	
48.	**178**	28	9/5½	s.	2	Blacksod Bay, .	1	34	..	..	1	..	..	..	1 ♀	..	..	..	
48.	**221**	May 21	19/5	s	2	Loughrosmore Bay,	10	23/32	..	..	10	..	..	..	1 ♀	..	..	..	
48.	**223**	21	9/4	s.	1¾	Loughrosmore Bay,	2	30	..	..	..	..	..	..	..	..	..	..	
48.	**224**	22	9/4½	s.	1½	Boylach Bay, .	9	33	..	9	..	..	..	..	..	..	..	..	

SANDY RAY—*Raia circularis* (Couch.).

25.	**125**	1891. Mar. 23	115	..	1	Off Bolus Head, .	1	8	..	..	..	..	..	..	..	..	..	..	
48.	**146**	April 8	38	s.m.	1¼	Off Gregory Sound,	1	39	..	..	1	..	..	..	..	..	..	..	
L.	**165**	20	154	s.	2¾	Off Achill Head, .	1	44½	..	..	1	..	1 ♀	..	..	..	..	..	1 Acanthias.
18.	**166**	20	154	s.	2¾	Off Achill Head, .	1	22½	..	..	1	..	..	..	..	..	..	..	
48.	**225**	May 22	32/25	s.r.	1	Rosses Bay, .	3	24/26½	..	2	1*	..	..	..	..	..	..	..	*(♀ 24 inches.)
48.	**235**	29	13	s.	1	Downies Bay, .	1	44	..	..	1	..	1 ♀	..	..	..	1	..	

THE COMPARATIVE EFFICIENCY OF DIFFERENT BAITS USED IN LONG-LINE FISHING.

Except on a few occasions, specified below, the hooks used were such as are ordinarily employed in Cod Fishing.

Stations **8** to **113**. SS. "Fingal." 1890.

Station **8**. 500 Hooks. Mackerel Bait. *Down* $1\frac{1}{4}$ *hour in day-time.*

Gross number of Fish caught, 125 :—Round Fish, 17 (viz. 2 Grey Gurnard, 1 Cod, 4 Haddock, 5 Ling, 5 Conger) ; 25 Skate, 83 Dogfish (Small-spotted Dogs, Picked Dogs, and Topes).

Average per 100 hooks :—Any sort of Fish, 25 ; Round Fish, 3 + ; Skate, 5 ; Dogfish, 16 +.

Station **9**. 200 Hooks. Mackerel Bait.

Gross number of Fish caught, 61 :—Round Fish, 59 (viz. 3 Cod, 3 Haddock, 3 Pollack, 12 Ling, 38 Conger) ; 2 Small-spotted Dogs.

Average per 100 hooks :—All sorts of Fish, 30 ; Round Fish, 29 ; Dogfish, 1.

Station **10**. 320 Hooks. Mackerel Bait.

Gross number of Fish caught, uncertain :—Round Fish, 3 (viz. 2 Common Sea Bream, 1 Red Gurnard) ; Dogfish, many Picked Dogs.

Average per 100 hooks :—Round Fish, 1.

Station **11**. 160 Hooks. Mackerel Bait.

Gross number of Fish caught, 33 :—Round Fish, 33 (viz. 1 Cod, 1 Haddock, 1 Pollack, 6 Ling, 24 Conger). No Skates or Dogfish.

Average per 100 hooks :—Round Fish, 20 +.

Station **14**. 320 Hooks. Mackerel Bait.

Gross number of Fish caught, 63 :—Round Fish, 21 (viz. 3 Gurnard, 1 Cod, 1 Ling, 12 Conger) ; Skate 8 ; Dogfish 35 (Small-spotted Dogs, Picked Dogs, and Tope).

Average per 100 hooks :—Any sort of Fish, 19 ; Round Fish, 6 + ; Skate, 2 + ; Dogfish, 10 +.

Station **15**. 480 Hooks. Mackerel Bait. *Down* $1\frac{1}{4}$ *hour in day-time.*

Gross number of Fish caught, uncertain :—Round Fish, 35 (viz. 4 Haddock, 4 Hake, 16 Ling, 7 Conger) ; Skate, 35 ; Dogfish, many (Small-spotted Dogs, Picked Dogs, and Topes).

Average per 100 hooks :—Round Fish, 6 + ; Skate, 7 +.

Station **46**. 420 Hooks. Mackerel and Plaice Bait. *Down* $1\frac{1}{2}$ *hour in day-time.*

Gross number of Fish caught, uncertain :—Round Fish, 34 (viz. 1 Sapphirine Gurnard, 4 Grey Gurnard, 4 Cod, 7 Ling, 18 Conger); Dogfish, many (same as Station 15).

Average per 100 hooks :—Round Fish, 8+.

Note.—The cod and the gurnard, and most of the dogfish, were caught on the mackerel bait; the conger and ling mostly on the plaice bait.

Station **78**. 420 Hooks. Plaice and Dogfish Bait. *Down in day-time.*

Gross number of Fish caught, 50 :—Round Fish, 34 (viz. 1 Red Gurnard, 1 Cod, 13 Ling, 2 Torsk, 17 Conger); Flat-fish, 2, viz. 1 Halibut, 1 Turbot; Dogfish, 14 (same as Station 15). No Skate.

Average per 100 hooks :—Any sort of Fish, 11+; Round Fish, 8+; Flat-fish, 1−; Dogfish, 3+.

Station **80**. 420 Hooks. Conger Bait. *Down in day-time.*

Gross number of Fish caught, 46 :—Round Fish, 31 (viz. 1 Red Gurnard, 3 Cod, 1 Haddock, 3 Coal-fish, 23 Ling); Skate, 2; Dogfish, 13 (same as before).

Average per 100 hooks :—Any sort of Fish, 10+; Round Fish, 7+; Skate, 1−; Dogfish, 3.

Station **113**. 70 Hooks. Conger Bait. *Down in day-time.*

Gross number of Fish caught, 10 :—Round Fish (Haddock), 1; Picked Dogs, 9.

Average per 100 hooks :—Any sort of Fish, 14; Haddock, 1+; Picked Dogs, 12+.

140 Hooks. Witch Bait.

Gross number of Fish caught, 10 :—Round Fish (Ling), 2; Skate, 1; Dogfish, &c., 7, viz. 1 Spinous Shark, 6 Picked Dogs.

Average per 100 hooks :—Any sort of Fish, 7+; Ling, 1+; Skate, 1−; Dogfish, &c., 5+.

210 Hooks. Conger and Witch Bait.

Gross number of Fish caught, 16 :—Round Fish (Ling), 1; Skate, 6; Dogfish, 9 (Picked Dogs).

Average per 100 hooks :—Any sort of Fish, 7+; Ling, 1−; Skate, 2+; Dogfish, 4+.

Stations **136** to **241**.—SS. "Harlequin." 1891.

Station **136**. 170 Hooks. Mackerel Bait. *Down 2 hours in day-time.*

Gross number of Fish caught, 69 :—Round Fish, 46 (viz. 5 Cod, 1 Haddock, 32 Coal-fish, 3 Ling, 5 Conger); Skate, 15 ; Dogfish, 8 (Small-spotted Dogs, Picked Dogs, and Tope).

Average per 100 hooks :—Any sort of Fish, 40 +; Round Fish, 27; Skate, 8 + ; Dogfish, 4 +. * * *

102 Hooks. Conger Bait.

Gross number of Fish caught, 13 :—Round Fish (Coal-fish), 11; Dogfish, 2 (small Spotted Dog and Tope).

Average per 100 hooks :—Any sort of Fish, 12 +; Coal-fish, 10 +; Dogfish, 2.

Note.—The bones were not removed from the conger, and the baits were cut rather large. Many came up on the hooks untouched.

Station **141**. 272 hooks. Conger Bait. *Down $4\frac{1}{4}$ hours in day-time.*

Gross number of Fish caught, 20 :—Round Fish, 8 (viz. 2 Cod, 4 Coalfish, 2 Ling); Skate, 7 ; Dogfish, 4 (Small-spotted Dogs and Tope).

Average per 100 hooks :—Any sort of Fish, 7; Round Fish, 2 +; Skate, 2 +; Dogfish, 2.

Station **150**. 170 Hooks. Whiting Bait. *Down 3 hours in day-time.*

Gross number of Fish caught, 13 :—Round Fish, 7 (viz. 6 Ling, 1 Conger) ; Skate, 6.

Average per 100 hooks :—Any sort of Fish, 7 +; Round Fish, 4; Skate, 3 +. * * *

290 Hooks. Conger Bait.

Gross number of Fish caught, 17 :—Round Fish, 14 (viz. 1 Cod, 2 Coal-fish, 11 Ling) ; 2 Skate ; 1 Picked Dog.

Average per 100 hooks :—Any sort of Fish, 5 +; Round Fish, 4 +; Skate, 1 –; Dogfish, 1 –.

Station **155**. 560 Hooks. Conger Bait. *Down $2\frac{1}{4}$ hours in day-time.*

Gross number of Fish caught, 15 :—Round Fish, 15, viz. 1 Cod, 14 Ling.

Average per 100 hooks :—Round Fish, 2 +.

Station **161**. 35 Hooks. Plaice and Pollock Bait. *Down all night.*

Gross number of Fish caught, 9 :—Round Fish, 5 (viz. 1 Pollack, 4 Conger); Skate, 2 ; Dogfish, 2 (Picked Dogs).

Average per 100 hooks :—Any sort of Fish, 25 ; Round Fish, 14 ; Skate, 5 ; Dogfish, 5.

Note.—One large Grey Skate seized a dogfish already hooked.

Station **165.** 221 Hooks. Conger Bait. *Down* $2\frac{3}{4}$ *hours in day-time.*

Gross number of Fish caught, 32:—Round Fish, 5 (viz. 1 Haddock, 1 Hake, 2 Ling); Skate, 3; Dogfish, 24 (Small-spotted Dog, Black-mouthed Dogs, Picked Dogs and Topes).

Average per 100 hooks:—Any sort of Fish, 14 –; Round Fish, 5 +; Skate, 1 +; Dogfish, 10 +. * * *

68 Hooks. Whiting Bait.

Gross number of Fish caught, 14:—Round Fish (Ling), 2; Dogfish, 12 (Black-mouthed Dog, Picked Dogs, and Topes).

Average per 100 hooks:—Any sort of Fish, 20 +; Ling, 2 +; Dogfish, 17 +.

17 Hooks. Plaice Bait.

Gross number of Fish caught, 3:—Round Fish (Ling), 1, Picked Dogs, 2.

Average per 100 hooks:—Any sort of Fish, 17; Ling, 5 +; Dogfish 11 +.

Station **171.** 34 Hooks. Plaice Bait. *Down all night.*

Gross number of Fish caught, 10:—Round Fish (Conger), 1; Skate, 2; Dogfish, 7 (Picked Dogs and Small-spotted Dogs).

Average per 100 hooks:—Any sort of Fish, 29 +; Conger, 2 +; Skate, 5; Dogfish, 21.

Station **191.** 51 Hooks. Plaice Bait. *Down all night.*

Gross number of Fish caught, 18:—Round Fish (Conger), 4; Skate, 1; Dogfish 13 (Nurse Hounds, Topes, and small Spotted Dogs).

Average per 100 hooks:—Any sort of Fish, 35; Conger, 8 –; Skate, 2 +; Dogfish, 25.

Station **195.** 51 Hooks. Plaice Bait. *Down all night.*

Gross number of Fish caught, 8:—Round Fish, 7; 1 Cod, 1 Ling, 5 Conger; Dogfish, 1.

Average per 100 hooks:—Any sort of Fish, 16 –; Round Fish, 14 –; Dogfish, 2 –.

Station **200.** 51 Hooks. Plaice Bait. *Down in day-time.*

Gross number of Fish caught, 10:—Round Fish (Ling), 1; Skate, 1; Dogfish, 8 (Tope, Picked Dogs, and Small-spotted Dogs).

Average per 100 hooks:—Any sort of Fish, 20 –; Ling, 2 –; Skate, 2 –; Dogfish, 16 –. * * *

459 Hooks. Conger Bait.

Gross number of Fish caught, 61:—Round Fish, 15, viz. 2 Cod, 12 Ling, 1 Conger Skate, 20; Dogfish, 26, as before.

Average per 100 hooks:—Any sort of fish, 11 +; Round Fish, 3 +; Skate, 4 +; Dogfish, 5 +.

Station **203.** 100 Small Hooks. Conger Bait. *Down in day-time.*

Round Fish (Torsk), 1; Black-mouthed Dog, 1.

153 Large Hooks. Conger Bait.

Round Fish (Torsk), 1; Shark (*Centrophorus*), 1.

Average per 100 hooks:—Any sort of Fish, 2 –; Torsk, 1 –; Sharks and Dog-fish, 1 –.

Station **220.** 51 Hooks. Plaice Bait. *Down all night.*

Nothing caught.

Station **226.** 100 Hooks. Plaice Bait. *Down* 24 *hours.*

Conger, 14. = 14 per 100 Hooks.

Note.—Lines fouled by strong tide.

Station **227.** 100 small Hooks. Lugworm Bait. *Down about* 4 *hours in day-time.*
4 Plaice caught.

Station **228.** 100 small Hooks. Lugworm Bait. *Down about* 4 *hours in day-time.*
1 Dab caught.

Station **229.** 280 Hooks. Conger Bait. *Down* $1\frac{1}{2}$ *hours in day-time.*

Gross number of Fish caught, 6:—Round Fish, 6, viz. 3 Cod, 3 Ling.

Average per 100 Hooks:—Round Fish, 2 +.

Station **231.** 102 Hooks. Conger Bait, used for the second time. *Down all night.*

Gross number of Fish caught, 35:—Round Fish, 33 (viz. 1 Cod, 1 Coalfish, 31 Ling); Flat Fish, 1 (Halibut); Skate, 1.

Average per 100 hooks:—Any sort of Fish, 35 –; Round Fish, 33 –; Halibut 1 –; Skate, 1 –.

Station **234.** 180 Hooks. Conger Bait. *Down all night.*

Gross number of Fish caught, 8:—Round Fish, 4 (viz. 2 Cod, 2 Ling); Skate, 1; Dogfish, 3 (Tope and Small-spotted Dogs).

Average per 100 hooks:—Any sort of Fish, 4 +; Round Fish, 2 +; Skate, 1 –; Dogfish, 2 –.

Station **241.** 210 Hooks. Conger Bait. *Down all night.*

Gross number of Fish caught, 36:—Round Fish, 22 (viz. 3 Cod, 18 Ling, 1 Conger); Skate, 3; Dogfish, 11 (Tope and Small-spotted Dogs).

Average per 100 hooks:—Any sort of Fish, 17; Round Fish, 10; Skate, 1 Dogfish, 5.

SUMMARY.

Taking into consideration the occasions on which no confusion as to the Baits used can arise, we get the following figures :—

Mackerel Bait.—2150 Hooks shot. 214 Round Fish and 83 Skate caught; also a large number of Dogfish, not exactly recorded.

Average per 100 hooks :—Round Fish, 9 +; Skate, 3 +.

Conger Bait.—3409 Hooks shot. 303 Fish caught, viz. 167 Round Fish, 1 Flat-fish (Halibut), 39 Skate, and 91 Dogfish.

Average per 100 hooks :—Any sort of Fish, 8 +; Round Fish, 4 +; Skate, 1 +; Dogfish, 2 +.

Plaice Bait.—338 Hooks shot. 60 Fish caught, viz. 27 Round Fish, 4 Skate, and 29 Dogfish.

Average per 100 hooks :—Any sort of Fish, 17; Round Fish, 8; Skate, 1 +; Dog-fish, 8 +.

Whiting Bait.—238 Hooks shot. 27 Fish caught, viz. 9 Round Fish, 6 Skate and 12 Dogfish.

Average per 100 Hooks :—Any sort of Fish, 11 +; Round Fish, 3 +; Skate 2 +; Dogfish, 6 +.

Witch Bait.—140 Hooks shot. 10 Fish caught, viz. 2 Round Fish, 1 Skate, and 7 Dogfish, &c.

Average per 100 Hooks :—Any sort of Fish, 7 +; Round Fish, 1 −; Skate, 1 −; Dogfish, 5 +.

Lugworm Bait.—200 Hooks shot. 5 Flat-fish caught.

Average per 100 Hooks :—Flat-fish, 2.

XXIX.

SURVEY OF FISHING GROUNDS, WEST COAST OF IRELAND, 1890–1891. REPORTS ON THE SCIENTIFIC EVIDENCE BEARING ON THE ECONOMIC ASPECTS OF THE FISHES COLLECTED DURING THE SURVEY. By ERNEST W. L. HOLT, Assistant Naturalist to the Survey.

(COMMUNICATED BY PROFESSOR A. C. HADDON, M.A., F.Z.S.)

[Read NOVEMBER 18, 1891.]

INTRODUCTORY.

IN drawing up this Report I have endeavoured, as far as possible, to follow Dr. Wemyss Fulton in the arrangement and treatment of the various branches of inquiry. Such a course is manifestly for the convenience of those interested in the subject; and, moreover, in the very valuable papers alluded to (Fulton, 8th Ann. Rep. S. F. B.) we are fortunate in possessing an excellent model.

I have therefore divided my remarks under the following headings:—

(i.) The Spawning Period and Distribution of Spawning Fish (p. 339).

(ii.) The definition of Immature Fish, and comparison of the Habitats of Mature and Immature Fish (pp. 418, 428).

(iii.) The effect of different Nets upon the capture of Immature Fish (p. 454).

(iv.) The Food of Fishes (p. 457).

(v.) Suggestions offered as to the possible utility of some unsaleable Fish (p. 471).

The results are given in tabular form when this appears desirable. Wherever percentages are employed the actual numbers may be found in the context.

All conclusions given, except where expressly stated to the contrary, are meant to apply solely to the west coast of Ireland.

Unfortunately pressure of time prevents me from following Dr. Fulton on the interesting question of the Proportions of the Sexes.[1]

The Report ends with some general conclusions upon measures for the protection of immature fish and the increase of the fish supply. For the opinions expressed in this, as in other parts of the Report, I am alone responsible.

(i.)—THE SPAWNING PERIOD AND DISTRIBUTION OF SPAWNING FISH ON THE WEST COAST.

The observations contained in this Report show that whilst different kinds of fish have different times for spawning, and in the case of each kind the period is more or less protracted, yet on the whole the bulk of the more valuable fish spawn in the spring.

With regard to the spawning grounds in relation to the territorial limits, dealt with by D. Wemyss Fulton for the east coast of Scotland, in the 8th Annual Report of the Scotch Fishery Board, 1890, the conditions are so different on the coast now under consideration that a comparison can hardly be instituted.

The off-shore grounds, such as the Smith Bank, on the east coast of Scotland, which are the resort of spawning Plaice, &c., on that coast, are hardly at all represented outside the limits on our own coast.

It appeared to me that the main grounds to which such fish as migrate seawards at the spawning period resort at that time are three in number, viz. Donegal Bay, the ground west of the (Galway) Aran Islands, and the deeper part of Ballinskelligs Bay. Doubtless there are many others, such as the outer part of Dingle Bay; but of these I have no personal experience. That a large number of Plaice do resort to the first three localities to spawn is a matter of which I have little doubt; but as unfortunately our observations commenced in each year too late to include much of the spawning season of this fish, I have at present no means of confirming my opinion. It seems certain that Soles visit Ballinskelligs Bay for the purpose of spawning, as they are enormously abundant on certain deep ground in that bay during the spawning season, and do not appear to be found there at any other time. On the other hand, a number of Soles do not appear to migrate at all for spawning purposes, and to a certain extent the same is true of Plaice also.

Now, of the trawling grounds, on the west coast of which we have acquired or had previously any knowledge, only those westward of the Aran Islands lie outside the territorial limits.[2] I have entered at some detail into the question of these limits elsewhere (p. 428), and shall therefore abstain from further remark here.

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[1] I have only been able to refer very briefly to several important Papers by the same author in the 9th Ann. Rep. S. F. B., 1891, since the latter did not appear until this Paper was in the press.

[2] Some parts of Donegal Bay are outside the limits, but the trawling ground is mainly inside them.

SAPPHIRINE GURNARD—*Trigla hirundo.*

Total number caught, 12.

Number examined, 11—Males, 5. Females, 6.

In March none were examined. In April 1 male and 1 female were approaching ripeness. In May 1 male was ripe and one half ripe; 2 females were approaching ripeness (1 nearly ripe) and 1 was immature. In June 2 males were ripe, and 1 female was spent, and in August 1 female was spent. In July I saw a nearly ripe female in a Dublin fishmonger's shop, and was told of the occurrence of another with spawn running a few days previously. It would appear that spawning takes place in the summer both on the east and west coasts, but our evidence is not sufficient for any exact definition of the period. Professor M'Intosh has recorded nearly ripe females in June on the east coast of Scotland. According to Couch, the spawning period is from January to June.

RED GURNARD—*Trigla cuculus.*

Total number caught, 12.

Number examined, 8—Males, 3. Females, 5.

In April 1 male was half ripe. In May 1 male was ripe, 2 females ripe, and 1 female spent. In July 1 male was nearly ripe, and 2 females ripe. The pelagic eggs were taken in the first and third weeks in April. It appears, therefore, that spawning takes place from April to July, but we have no evidence before or after that period. Cunningham found this species spawning in April and May in the neighbourhood of Plymouth. Couch found well-developed ova as early as January.

Distribution of Spawning Fish.

The ripe females were caught between 13 and 35 fathoms. A male was ripe in 10 to 13 fathoms, and another nearly ripe at 35 fathoms. The eggs were taken outside the Aran Islands and in Clew Bay.

GREY GURNARD—*Trigla gurnardus.*

Total number caught, 812.

Number examined, 227—Males, 66. Females, 155. Sex uncertain, 5.
Number approaching Ripeness, 48 (1 doubtful)—Males, 15 (1 doubtful). Females, 34.
Number Ripe, 75—Males, 16. Females, 59.
Number Spent, 80 (or 81 ?)—Males, 22 (or 23 ?). Females, 58.

The remainder of those examined were Immature.

TABLE SHOWING THE DISTRIBUTION IN MONTHS.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
No. Examined, ..	20	23	10	16	14	56	16	51	6	10	0	0
No. approaching Ripeness,	6	3	1	5	7	24	0	2	1?	0		
No. Ripe, ...	9	10	0	9	3	18	4	21	0	1		
No. Spent, ..	1	7	7	2	4	13	6	27	4 (5 ?)	9		

TABLE SHOWING PERCENTAGE OF NUMBER OF SAME SEX IN MONTH.

Month, ..	March.		April.		May.		June.		July.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Approaching Ripeness,	30	13	10	31	50	42	0	2	16?	0
Ripe, ...	45	43	0	56	21	32	25	42	0	10
Spent, ...	5	30	70	12	28	23	37	54	66 (83 ?)	90

The pelagic eggs were abundant in the tow-nets from March until the end of June.

It appears that the Gurnard spawns on the west coast during the months of March to July, inclusive, and probably to some extent in August and the latter part of February, but chiefly in March, April, May, and June. On the east coast of Scotland Fulton found ripe females from March to July, inclusive, and the ova have been taken in the Moray Firth by Mr. Scott as early as January. M'Intosh and Prince, to whom I am indebted for the last reference, give April to June as the spawning period for St. Andrew's Bay.

DISTRIBUTION OF SPAWNING FISH.

Of the 59 Ripe females, 18, at most, were taken in depths less than 20 fathoms, of which perhaps 12 were above the 10 fathom line, viz. in Blacksod, Inver, and Downies Bays, and in Lough Swilly. 6 were between 45 and 53 fathoms, and the remainder at 20 to 38 fathoms. 2 females were nearly ripe in 80 fathoms. The ripe males, much fewer in number, were pretty evenly distributed over the different depths. Thus on the West coast spawning seems to take place mostly in comparatively deep water, *i. e.* in the more open parts of the sea. On the East coast of Scotland, according to Fulton, it takes place both in territorial and off-shore waters, and the ova have been taken in the tow-net 65 miles off shore.

PIPER—*Trigla lyra.*

28 Pipers were caught, and 25 examined—6 males and 19 females. In March, 4 females were half ripe. In July 1 female was spent. In August, 2 males were nearly ripe, and 3 were ripe, and 1 spent. 14 females were spent. The Piper appears to spawn in the summer, and probably in fairly deep water, as none were taken in less than 23 fathoms. The eggs are unknown.

MACKEREL—*Scomber scomber.*

On the 1st April 1 male was half ripe, and 5 were three parts ripe. 9 females were half ripe. All 16 inches in length. On 12th May at Valencia about 50 were examined. All the males were ripe. The females were half and three-quarters ripe mostly, but a few were ripe. At Broadhaven, on 18th June, 17 males at 13 inches were half ripe, three-quarters ripe, and ripe. 15 females of the same size were half and three-quarters ripe, and 1 was ripe, and 1 spent. 4 females, from 9 to 11 inches, appeared to be spent. The pelagic eggs occurred in the tow-nets at the end of April, and the beginning of May, 1891, in the neighbourhood of Boffin Island,[1] and off the Skelligs on the 16th, and between Arran and Moher on the 28th May, 1890.

It appears that successive shoals approach the coast at different points, and spawn in its neighbourhood, the larger fish being the first to arrive.

SCAD—*Caranx trachurus.*

A male and a female were spent on 30th July off the Aran Islands. Day states that spawning takes place in June, July, and August. I examined 2 males and 5 females at Penzance on the 16th June. Both males were ripe. Of the females two were half ripe, 2 were three parts ripe, and 1 was nearly ripe. In the last specimen some of the eggs were almost transparent. I concluded that when perfectly ripe they would be pelagic, and similar to that of the mackerel, but smaller.[2]

JOHN DORY—*Zeus faber.*

Total number caught, 33.

Number Examined, 31—Males 13. Females 18.
Number approaching Ripeness, 14—Males 7. Females 7.
Number Ripe 8—Males 3. Females 5.
Number Spent 5—Males 1. Females 4.

The remainder of the fish examined were very small and immature.

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[1] Several thousand mackerel had been taken in a bay on Boffin Island a few days previously,

[2] In the most advanced the diameter was ·84 mm., that of the single oil globule ·24 to ·27 mm.

TABLE SHOWING THE DISTRIBUTION IN MONTHS.

Month, ..	March.		April.		May.		June.		July		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
No. Examined, ..	0	0	8	5	0	2	1	3	1	6	3	2
No. approaching Ripeness,	0	0	5	5	0	1	1	1	1	0	0	0
No. Ripe, ...	0	0	0	0	0	0	0	0	0	4	3	1
No. Spent, ...	0	0	0	0	0	0	0	1	0	2	0	1

The numbers are very small. It appears that the spawning takes place in June, July, and August; chiefly in July, as far as one may judge. The eggs have not been described. Day mentions that Mr. Dunn thinks that spawning takes place in winter (on the Cornish coast).

DISTRIBUTION OF SPAWNING FISH.

One ripe female was taken in Ballinskelligs Bay in 5 to 8 fathoms, the others in the neighbourhood of the Aran Islands. The depth is not recorded. 2 ripe males were got off Inishmaan in 16 to 18 fathoms, the other one in Casheen Bay, at about 8 fathoms.

SAND SMELT—*Atherina presbyter.*

2 males were ripe, and 1 female approaching ripeness on the 1st April in Smerwick Harbour. They were taken in a seine at the sandy margin. This fish is stated, by Andrews, to spawn in spring in Dingle Bay, and by Couch in June, July, and early August on the Cornish coast. The eggs are not known. I think they are demersal, as in the American genus, Atherinichthys.

ANGLER—*Lophius piscatorius.*

Eight were examined. A male of 25 inches was ripe (at 115 fathoms), and a female of 40 inches spent in March. A female of 21 inches was immature in April. In June a female of 30 inches was spent; and two specimens, 10 and 19 inches, were so immature that the sex was not determinable. The same was the case in a specimen of 12 inches in July, and in the same month a male of 10 inches was immature.

This species appears to spawn in the early summer;[1] the eggs are pelagic, and are imbedded in huge sheets of a purplish gelatinous matter.[2] They are not often found.

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[1] Thompson, however, found a female with well-developed ova in December.

[2] They were described by Agassiz and Whitman in American waters.

Mr. Green observed such a sheet off Queenstown harbour, and they have been observed in a few instances off the east coast of Scotland. I have heard of the occurrence of what could only be the egg-mass of this fish in the salmon stake-nets at the mouth of the Forth in June. They were regarded by the fishermen as jelly-fish of a probably dangerous nature, and left until the tide washed them away.[1]

FRECKLED GOBY—*Gobius minutus.*

Some males and females from the tidal pools of Lough Atalia were nearly ripe on 9th May. On the same date eggs, probably belonging to this species, were found attached to the "root" of a Laminaria,[2] brought in by the kelp boats. This species appears to spawn in May and June, and probably in July.

Aphia pellucida.

A few males and females were in breeding condition, and ripe, or nearly so, in Killybegs harbour in June.

Crystallogobius nilssonii.

Some males and females were in a condition similar to the above in August. (For an account of the habits and breeding of these two species see *Day* ("British Fishes," vol. i.).

DRAGONET—*Callionymus lyra.*

Some females examined in April were spent. The pelagic eggs occurred in the tow-nets from March to June, most abundantly in April.

LESSER WEEVER—*Trachinus vipera.*

The pelagic eggs were abundant in the tow-nets in the latter part of June and the beginning of July, always rather near land. A female was nearly ripe in May, off the Donegal coast. According to Day, spawning takes place in Spring. Fulton obtained ripe females from Dunbar at the end of June.

DOUBLE-SPOTTED SUCKER—*Lepadogaster bimaculatus.*

A specimen was found guarding its eggs in a whelk shell at 7 fathoms in Clifden Harbour in June (*vide* "Scientific Transactions," vol. iv. s. 3, 1891, Pt. VII.). Other eggs were found on a shell of a Gaper (Mya) in Birturbuy Bay, in the same month.

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[1] The spawn has been taken several times during last year, in February, March, and May, by officials of the Scotch Fishery Board, and is described by Fulton and by Prince in the 9th Ann. Rep. S. F. B., 1891.

[2] *L. bulbosa.*

RED RIBAND FISH—*Cepola rubescens.*

A ripe female occurred in the stomach of a Sharp-nosed Skate,[1] in Inver Bay, at 25 fathoms, in June. The eggs appear to be pelagic (*vide* "Scientific Transactions," vol. iv., s. 3, 1891, Pt. vii.). According to Risso, spawning takes place at the end of spring in the Mediterranean.

SEA STICKLEBACK—*Gastrosteus spinachia.*

Some females were almost ready to spawn on May 2, 1891, in Ballynakill Harbour. The nesting habits of this species are well known.

BALLAN WRASSE—*Labrus maculatus.*

On 15th April a female was half ripe. On the 17th April 3 males and 2 females were three parts ripe. On the 30th April 2 females were half ripe, 1 was three parts ripe, and 2 were ripe or very nearly so. 2 males appeared to be three parts ripe and ripe. On the 8th July several males and females examined were spent. Day says that spawning takes place on the Galway coast about June. There is record of spawning in June and July in Scotch waters.

Spawning takes place between tide-marks, where the parents form nests for the reception of the demersal eggs (*vide* Matthews, Report S. F. B. 1887).

COOK WRASSE—*Labrus mixtus.*

A male was half ripe on the 18th May. According to Moreau, this species also makes nests. It spawns, according to Day, in April and May.

CORK-WING WRASSE—*Crenilabrus melops.*

A male was half ripe and another three parts ripe on the 15th April. Several females were ripe on the 12th June, in Clifden Bay. On the 7th June, 1 male was partly spent, 1 female three parts ripe, and several females spent. The eggs of some other members of this genus are demersal, but not adhesive. The Cork-wing is said to spawn in April and May on the Cornish coast.

GOLDSINNY—*Ctenolabrus rupestris.*

A male of 8 inches was spent on the 11th August. The eggs have not been definitely identified, but I believe that some small pelagic ova, which occurred in the tow-nets in June, will prove to belong to this species (*vide* "Scientific Transactions," vol. iv., s. 2, 1891, Pt. vii.). Day records a ripe, or nearly ripe, female at Dublin in June, and says that on the south coast of Great Britain spawning takes place in April and May.

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[1] In the "Scientific Transactions" the species of Skate is wrongly recorded.

COD—*Gadus morrhua.*

Total number caught, 163.

Number Examined, 62—Males, 29. Females, 33.
Number approaching Ripeness, 1—Males, 0. Females, 1.
Number Ripe, 13—Males, 9. Females, 4.
Number Spent, 37—Males, 12. Females, 25.

The remainder of those examined were immature.

TABLE SHOWING THE DISTRIBUTION IN MONTHS.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
No. Examined, ..	3	0	9	11	14	20	2	2	1	4	0	0
No. approaching Ripeness,	0		0	0	0	1	0	0	0	0		
No. Ripe, ...	3		6	4	0	0	0	0	0	0		
No. Spent, ...	0		3	7	6	12	2	2	1	4		

From this table it appears that spawning takes place in April, and earlier; whilst the occurrence of a half-ripe female in the early part of May shows that some fish must spawn as late as the end of that month, or in June, although from the preponderance of spent fish in May and afterwards, we gather that spawning is mostly over. The pelagic eggs were plentiful in the tow-nets in the later part of March and in April. The spawning period probably commences in February, though of this we have no evidence (except from post-larval stages in the tow-nets in March), and is continued to some extent until June, but is chiefly in March and April.

On the coast of Scotland, according to Fulton,[1] "the cod begins to spawn at the beginning of February, but the great period is March; large numbers spawn in April"; and ripe males and females have been caught as late as 9th May, but nearly all are spent in that month.

DISTRIBUTION OF SPAWNING FISH.

Of the ripe males 1 occurred at 9 to $5\frac{1}{2}$ fathoms in Blacksod Bay, and the remainder between 23 and 70 fathoms. One ripe female was in 14 fathoms off Ballynakill, 1 in 38 fathoms, and 2 in 70 fathoms. I do not think the presence of a ripe male in Blacksod Bay is any indication that spawning takes place there; it seems more probable that the spawn is shed in comparatively open waters, for the most part at considerable depths. Fulton remarks that "cod appears sometimes to spawn on the West coast (of Scotland) much nearer shore than on the East coast." I think this may probably be explained by the deep water being closer in shore on the West coast.

[1] 8th Ann. Rep. S. F. B., 1890.

HADDOCK—*Gadus æglefinus.*

Total number caught, 112.

Number examined, 58—Males, 19. Females, 39.
Number approaching Ripeness, 4—Males, 3. Females, 1.
Number Ripe, 10—Males, 0. Females, 10.
Number Spent, 39—Males, 14. Females, 25.

The remainder of those examined were immature.

TABLE SHOWING THE DISTRIBUTION IN MONTHS.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
No. Examined, ..	1	1	6	15	8	19	1	0	3	2	0	1
No. approaching Ripeness,	0	0	0	1	0	0	0		3	0		0
No. Ripe, ...	0	0	0	8	0	2	0		0	0		0
No. Spent, ...	0	1	6	6	8	14	0		0	2		1

TABLE SHOWING PERCENTAGE TO NUMBER OF SAME SEX EXAMINED IN MONTH.

Month, ..	March.		April.		May.		June.		July,		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Approaching Ripeness,	0	0	0	6	0	0	0	.	100	0	.	0
Ripe, ...	0	0	0	53	0	10	0	.	0	0	.	0
Spent, ...	0	100	100	40	100	73	0	..	0	100	.	100

These observations only show that spawning takes place in April and May. However, the pelagic ova were extremely abundant at the surface at the end of March. I do not know what significance ought to be attached to the occurrence of half-ripe males in July. Probably the spawning period extends from February[1] to May, inclusive, but is chiefly in March and April. In Scotch waters, Fulton says that this fish begins to spawn to a slight extent at the end of January, but spawns chiefly in February, March, and April.

DISTRIBUTION OF SPAWNING FISH.

The ripe fish, all females, occurred at considerable depths, viz. 2 at 38 fathoms, 1 at 46 to 44 fathoms, 3 at 70 and 80 fathoms, and 4 at 154 fathoms. Ova were taken near the surface above these last. Fulton does not seem to consider his evidence on the spawning places in Scotch waters conclusive; but it appears that spawning is not confined to the off-shore waters, and the same is probably the case with regard to the Irish coast, although the majority probably spawn at considerable depths.

[1] Post-larval haddock (?) appeared in the tow-nets at the end of March.

WHITING POUT—*Gadus luscus.*

2 males were ripe on the 12th May at 22 fathoms in Dingle Bay. This fish, from Fulton's observations, appears to spawn in March, April, and May, on the east coast of Scotland. It is said to spawn on the Cornish coast towards the end of winter.

POOR COD—*Gadus minutus.*

A ripe female occurred on the 8th April at 38 fathoms off Gregory Sound. The pelagic eggs, which exactly resemble those of the whiting in their earlier stages, were not recognized (with certainty) in the tow-net collections, but perhaps occurred in April.

WHITING—*Gadus merlangus.*

Total number caught, 81.

Number Examined, 39—Males, 7. Females, 32.
Number approaching Ripeness, 9—Males, 0. Females, 9.
Number Ripe, 12—Males, 2. Females, 10.
Number Spent, 18—Males, 5. Females, 13.

Table showing the Distribution in Months.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
No. Examined, ..	0	9	3	14	4	8	0	1	0	0	0	0
No. approaching Ripeness,		3	0	5	0	1		0				
No. Ripe, ...		5	2	5	0	0		0				
No. Spent, ..		1	1	4	4	7		1				

Table showing percentage to Number of same Sex Examined in Month.

Month, ..	March.		April.		May.		June.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀
Approaching Ripeness,		33	0	35	0	12		0
Ripe, ...		55	66	35	0	0		0
Spent, ...		11	33	28	100	87		100

It appears that *during the period of observation* the whiting spawns chiefly in March and April, whilst the occurrence of a ½ ripe female towards the end of April shows that spawning is carried on to some extent as late as June. The pelagic eggs were very abundant in the tow-net in the latter part of March and in April. From Fulton's observations it appears that in Scotch waters spawning takes place from the end of February or beginning of March until June, chiefly, perhaps, in April.

DISTRIBUTION OF SPAWNING FISH.

No ripe fish were in very shallow water. 1 male was ripe in 17 to 19 fathoms, and 1 in 38 fathoms. 2 ripe females were in 25 to 10 fathoms, 5 in 26 to 27 fathoms, and 1 in 38 fathoms. 2 females were nearly ripe in 17 to 19 and 38 fathoms. Thus it would appear that the shallow bays are not frequented by spawning whiting on this coast. On the East coast of Scotland Fulton records ripe examples from both territorial and off-shore grounds.

COAL-FISH—*Gadus virens.*

Total number caught, 231 (mostly very small).

24 coal-fish were examined during the months of April and May, 12 males and 12 females. 1 male was ripe at the beginning of April; all the rest were spent. Fulton records, on the authority of Fishery Officers, ripe specimens (*male or female?*) in February, March, April, and July. The italics are mine. I believe that the coal-fish spawns chiefly at the beginning of the year. Ewart and Fulton, however, obtained two ripe examples (sex not mentioned) in April and July respectively, and conclude that spawning takes place much later than in the cod, chiefly in June (*vide* 7th Ann. Rep. S. F. B., 1889, p. 195). The ova have never been described. In all probability they are pelagic, like those of the other members of the genus Gadus, and it is by no means unlikely that they are very hard to distinguish from those of one or other of the most closely allied species.

The adults appear to inhabit moderate depths, and presumably spawn there. Ewart and Fulton think that spawning takes place at considerable distances from shore on the east coast of Scotland, which, bathymetrically, amounts to much the same thing.

NORWAY POUT—*Gadus esmarkii.*

A female, $4\frac{1}{4}$ inches, was ripe on the 7th April, at 50 fathoms off Inishmore; and another, $4\frac{1}{2}$ inches in length, was ripe on the 8th of April at 38 fathoms off Gregory Sound. Another female, considerably larger, was spent on 4th July at 144 fathoms, 30 miles off Achill Head. The pelagic eggs were taken, in small numbers, in April. They are very similar, at all stages, to those of the whiting, but are smaller.[1] This species, though not recognised as Irish before last year, appears to be not uncommon in the rather deep water to which it seems to be confined.

[1] The diameter is ·95 to ·98 mm.

POLLACK—*Gadus pollachius.*

Total number caught (and identified[1]), 122.

Number Examined, 44—Males, 19. Females, 25.
Number approaching Ripeness, 7—Males, 1. Females, 6.
Number Ripe, 6—Males 4. Females, 2.
Number Spent, 17—Males, 5. Females, 12.

The remainder of those examined were immature.

TABLE SHOWING THE DISTRIBUTION IN MONTHS.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
No. Examined, ..	1	0	11	17	7	6	0	0	0	1	0	1
No. approaching Ripeness,	0	0	0	4	1	2				0		0
No. Ripe, ...	1	0	2	2	1	0				0		0
No. Spent, ...	0	0	2	6	3	4				1		1

The numbers are so small that a percentage table would be of little value. It appears that the pollack spawns in April, and probably as late as June, as a half-ripe female occurred after the middle of May. As the number of spent fish of both sexes is as high as that of the ripe, and fish approaching ripeness in April, it is likely that spawning takes place to some extent before that month. Thus the spawning period would seem to be from March to June, chiefly in April, but our evidence is very insufficient; Fulton's is entirely negative. The eggs of the pollack are pelagic, and do not differ much in size from those of the whiting and poor cod, from which they are not otherwise distinguishable in the early stages. I know nothing of the later and larval and post-larval stages,[2] and no eggs were recognised in the tow net collections.

DISTRIBUTION OF SPAWNING FISH.

Of the 4 ripe males 1 occurred in 19 to 30 fathoms, and 3 in 38 to 40 fathoms. One ripe female was in 5 to 10 fathoms, and the other in 38 fathoms. Another female was nearly ripe at the same place. Hence it appears that spawning takes place both in shallow and comparatively deep water, but our evidence is insufficient to indicate a preponderance either way.

SILVERY POUT—*Gadus argenteus.*

Some considerable number, examined on the 4th July, from 220 and 144 fathoms, appeared to be spent.

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[1] There appears to be a number of very small examples amongst the tow net collections.

[2] The diameter is 1·11 to 1·16 mm.

HAKE—*Merluccius vulgaris.*

Total number caught, 31.

Number Examined, 22—Males, 9. Females, 13.
Number approaching Ripeness, 7—Males, 2. Females, 5.
Number Ripe, 2—Males, 1. Females, 1.
Number Spent, 13—Males, 6. Females, 7.

In March, 2 males were approaching ripeness (1 nearly ripe), and 1 male and 1 female were spent. In April, 1 male was spent, 2 females were half ripe, and 1 female was spent. In May, 2 females were nearly ripe, and 2 were spent. In June (last week), 1 female was half ripe, 1 was ripe, and 1 spent. In August, 1 male was ripe, and 4 males and 2 females were spent. Thus it appears that spawning is protracted from the end of March, if not earlier, until July, but the evidence is insufficient to indicate a preponderance of spawning fish in any particular month. The pelagic eggs did not occur in the tow-nets. Professor M'Intosh has recorded a ripe male in August on the east coast of Scotland. Further than this there is no definite information on the spawning of this fish in British waters. Ewart and Fulton (7th Ann. Rep. S. F. B., 1889) think that spawning takes place " late."

DISTRIBUTION OF SPAWNING FISH.

One male was ripe in 25 fathoms, and 1 nearly ripe in 115 fathoms. One female was ripe at 25 fathoms, 2 nearly ripe at 74 to 80 fathoms. Three were half ripe at 25, 38, and 154 fathoms respectively. On the other side of the Atlantic, fish have been found spawning at a maximum depth of 487 fathoms, so that the vertical range of spawning fish is enormous; but no spawning seems to take place in shallow water (less than 25 fathoms perhaps), though it may occur at a comparatively short distance from the shore (*vide* St. 53).

LING—*Molva vulgaris.*

Total number caught, 203.

Number Examined, 137—Males, 59. Females, 78.
Number approaching Ripeness, 21. Males, 6. Females, 15.
Number Ripe, 42—Males, 37. Females, 5.
Number Spent, 70—Males, 15. Females, 55.
The remainder of those examined were immature.

TABLE SHOWING THE DISTRIBUTION IN MONTHS.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
No. Examined, ..	0	1	18	13	26	42	3	2	8	9	2	1
No. approaching Ripeness,		1	0	7	4	6	0	1	2	0	0	0
No. Ripe, ...		0	15	2	18	3	2	0	2	0	0	0
No. Spent, ...		0	3	3	3	31	1	1	4	9	2	1

TABLE SHOWING PERCENTAGE TO NUMBER OF SAME SEX EXAMINED IN MONTH.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Approaching Ripeness,		100	0	53	15	14	0	50	25	0	0	0
Ripe, ...		0	83	15	69	7	66	0	25	0	0	0
Spent, ...		0	16	23	11	73	33	50	50	100	100	100

It appears that spawning takes place in April and May, and as late, in some instances, as July, as a female was only half ripe about the middle of June. From the considerable percentage of spent females in April, spawning must take place to some extent in March. The percentage of ripe males diminishes gradually from April to June (in May a small percentage of immature has to be considered), and falls more rapidly in July. Considering the evidence of both sexes, we may suppose that the period is March to July, chiefly in April and May, but further evidence in the earlier months is needful. The pelagic eggs were not obtained in the tow-nets. From Fulton's observations in Scotch waters it appears that the Ling begins to spawn there in February, but spawns chiefly in April and May.

Ewart and Fulton (7th Ann. Rep. S. F. B.) record ripe examples, on the authority of Fishery Officers, in June.

DISTRIBUTION OF SPAWNING FISH.

One male was ripe in 12 to 14 fathoms in Downies Bay, Sheephaven. Ripe males were found in the open waters at all depths: between 21 and 38 fathoms, between 45 and 60 fathoms, at 74 to 80 fathoms, and at 154 fathoms. One female had ripe, but diseased, ovaries in 21 to 29 fathoms. Other 3 females were ripe at 28 to 35 fathoms, and 1 at 70 fathoms, and nearly ripe females occurred at 31 to 34, 70 to 80, and 154 fathoms. All the above females were in open waters; and it seems probable that spawning does not take place at all in the shallow in-shore waters. In the diseased female many of the ripe eggs seemed to be undergoing decomposition, and would probably not be shed, and thus we have no record of a spawning female in less than 31 fathoms, whilst it is probable that some spawn at over 100 fathoms. On the East coast of Scotland Fulton found that spawning takes place from 10 to 170 miles from shore (presumably in fairly deep water).

TORSK—*Brosmius brosme.*

A male and a female were spent on the 16th July.

On the East coast of Scotland Fishery Officers report ripe examples in April and May (most in May.—7th Ann. Rep. S. F. B., 1889).[1] The Torsk is rather rare on the West coast of Ireland, and seems there confined to rather deep water, where it presumably spawns. Day says that the Torsk has been observed to breed in northern seas in April to May amongst the Fuci. The statement stands in need of confirmation.

Macrurus æqualis.

A female was spent on the 10th July, 1890, at 500 fathoms, 54 miles off Achill Head.

Macrurus rupestris.

Two males were ripe, and 1 female approaching ripeness on the same occasion.

[1] Fulton records a partly spent female in April, and gives 1·4 to 1·32 mm. as the diameter of ripe or nearly ripe eggs (9th Ann. Rep. S. F. B., 1891).

HALIBUT—*Hippoglossus vulgaris.*

Three female Halibut were captured. One was half ripe in the middle of April, another was not quite three parts ripe at the end of May, and the other was spent in the middle of July. Ripe examples (sex not mentioned) are recorded in the seventh and eighth Reports of the Scotch Fishery Board, in March, May and June, on the authority of Fishery Officers. Spawning probably takes place in fairly deep water (at great distance from land on the Scotch coast). The eggs are not known.[1] Spawning is said to take place in April off the coast of Cornwall.

LONG ROUGH DAB—*Hippoglossoides limandoides.*

Total number caught, 53.

Number Examined, 12—Males 3. Females 9.
Number Ripe, 7—Males 2. Females, 5.
Number Spent 4—Males 0. Females 4.
The remaining fish is recorded as immature.

TABLE SHOWING THE DISTRIBUTION IN MONTHS.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
No. Examined, ..	0	1	2	7	1	1						
No. approaching Ripeness,		0	0	0	0	0						
No. Ripe, ...		0	1	5	1	0						
No. Spent, ...		1	0	2	0	1						

The small number examined, and the fact that none were examined from June to August, prevents the Table from being much good as a guide to the spawning season.

The Pelagic eggs were taken at the surface in April off Inishmore. They are characterized by a very large perivitelline space, and though hitherto not identified with this species, have been described by Mr. J. T. Cunningham and by Professor M'Intosh. (*Vide* M'Intosh, 9th Ann. Rep. S. F. B., 1891, p. 319).

The fish seems to be rather rare on the western Irish coast. In Scotch waters, according to Fulton, the spawning period appears to be rather extended, ripe fish occurring from February to May, and in August and November, chiefly in March.

DISTRIBUTION OF SPAWNING FISH.

All the ripe females were taken at some distance outside the Aran Islands, in from 36 to 38 fathoms. The ripe males were in 32 and 38 fathoms. According to Fulton, the species spawns both in territorial waters, and far from shore, in fact wherever it happens to be.

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[1] They appear to be large. (*Vide* Fulton, *loc. cit.*)

TURBOT—*Rhombus maximus.*

Total number caught, 59.

Number Examined, 55—Males, 27. Females, 28.

Number approaching Ripeness, 12—Males, 6. Females, 6.

Number Ripe, 11—Males, 11. Females, 0.

Number Spent, 13—Males, 5. Females, 8.

The question of spent fish is, as in some other instances, complicated by the possibility of error between spent and immature. Two females of 17½ inches are entered as spent, probably with reason. The remaining females so entered are all 18 inches or more (one 18 inches, the rest 19½ to 25½ inches), and therefore possibly mature. All the males so entered are within the limits of possible maturity (*vide* remarks on definition of Immature Turbot).

The remainder of those examined were immature.

Table Showing the Distribution in Months.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
No. Examined, ..	2	0	8	4	11	15	4	4	1	3	1	1
No. approaching Ripeness,	1		2	1	3	3	0	2	0	0	0	0
No. Ripe, ...	1		4	0	2	0	3	0	0	0	0	0
No. Spent, ..	0		0	2	3	6	0	0	1	0	1	0

The evidence is lamentably meagre; but it appears that spawning takes place during the months of April, May, and June, and perhaps both earlier and later. The small pelagic eggs were obtained in the tow-nets only in March, if at all. Ripe females have been obtained off the east coast of Scotland in May and July, but nothing definite is known about the spawning period there.

Distribution of Spawning Fishes.

On this subject our evidence is negative, as no ripe females were obtained. All the nearly ripe females were between 8 and 13 fathoms. Fulton concludes that Turbot spawn in his district at great distance from the shore. We obtained all our ripe males between 16 and 38 fathoms (the greatest depth at which any Turbot were obtained), which is to some extent confirmatory of Fulton's opinion, as, owing to the rapid declivity of the bottom on the west coast of Ireland, the distance from shore is not comparable to that on the east coast of Scotland.

BRILL—*Rhombus lævis.*

Total number caught, 94.

Number Examined, 79—Males, 39. Females, 40.
Number approaching Ripeness, 20—Males, 15. Females, 5.
Number Ripe, 17—Males, 5. Females, 12.
Number Spent, 29—Males, 16. Females, 13.

The smallest spent male is 12 inches, the rest from 14 to 15 inches. No spent females are less than 15 inches.

The remainder of the fish examined are recorded as immature, viz. 2 males and 7 females, in May.

Table Showing the Distribution in Different Months.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
No. Examined, ..	3	1	9	7	8	14	11	7	7	10	1	1
No. approaching Ripeness,	2	0	7	2	2	3	4	0	0	0	0	0
No. Ripe, ...	1	0	1	5	1	3	0	3	2	1	0	0
No. Spent, ..	0	1	1	0	3	1	7	4	5	9	1	1

Table Showing Percentage to Number of Same Sex Examined in Month.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Approaching Ripeness,	66	0	77	28	25	21	63	0	0	0	0	0
Ripe, ...	33	0	11	71	12	21	0	42	28	10	0	0
Spent, ...	0	100	11	0	37	7	36	57	71	90	100	100

The pelagic eggs were only recognised once, in June, in the tow-nets, and then rather doubtfully.

It appears from the above that spawning is carried on during the months of April, May, June, and July, and probably in March, but principally in April, May, and June. The absence of any females approaching ripeness in the last three months probably indicates that spawning is not carried on later than July or only in a very few cases. Fulton got a ripe female in May[1] on the east coast of Scotland.

Distribution of Spawning Fish.

Of the ripe females 8 occurred in Blacksod Bay in 4 to 10 fathoms; 1 in Lough Swilly in 8 to 12 fathoms; 1 in the Kenmare River in 20 fathoms; 1 in Inver Bay in 25

[1] Other examples have since been taken in May and June.

fathoms, and 1 in Donegal Bay in about 30 fathoms. It appears, therefore, that this fish spawns both in shallow and comparatively deep water, and perhaps most frequently in the former. On the east coast of Scotland Fulton remarks that "there is little doubt . . . that Brill spawn chiefly at a considerable distance from shore." Upon what grounds he arrives at this conclusion I have no means of judging, as it appears that the only ripe example which came under his notice was taken within two miles of land. I think it is probable, in Irish waters at least, that no migration takes place in connection with spawning.

WITCH (Sail Fluke)—*Arnoglossus megastoma*.

Total number caught, 287.

Number Examined, 204—Males, 43. Females, 160.
(In one the sex could not be determined.)

Number approaching Ripeness, 5—Males, 1. Females, 4.
Number Ripe, about 27[1]—Males, 19. Females, 8.
Number Spent, about 171[1]—Males, 23. Females, 148.
(Six males, of 8½ inches, recorded as spent in July, may have been immature.)

Table Showing the Distribution in Months.

Month, ..	March.		April.		May.[1]		June.		July.		August.	
Sex,	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
No. Examined, ..	2	5	6	30	25	21	2	3	6	5	2	96
No. approaching Ripeness, ..	0	0	0	0	0	4	1	0	0	0	0	0
No. Ripe, ...	2	2	5	1	12	5	0	0	0	0	0	0
No. Spent, ..	0	3	1	29	13	12	1	3	6	5	2	96

The numbers are not sufficient for a fair conclusion, but it appears that the Witch spawns in March, April, and May, and probably to some extent in June.[2] The pelagic eggs[3] were not recognised in the tow-nets.

Distribution of Spawning Fish.

Ripe females were taken at 53, 154, and 200 fathoms. Some were nearly ripe at 22 fathoms. A male was nearly ripe at 13 to 20 fathoms; one was ripe at 38 fathoms, and the rest at the same depths as the females. Spawning thus appears to take place only in moderately or very deep water, and therefore necessarily at some distance from the shore: probably always at great distances on coasts where the declivity is very gradual.

SCALD FISH—*Arnoglossus laterna*.

A male 5 inches long was ripe on the 8th April at 38 fathoms off Gregory Sound. Another, 4 inches long, was half ripe on 15th April.

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[1] The exact numbers are uncertain, owing to a want of detail in the entries under station 12.

[2] Thompson has recorded a recently spent female at Belfast in October.

[3] They are very translucent, and, like those of the Brill, have a single oil globule. Diameter 1·08 to 1·13 mm. Oil globule, diameter, ·30 mm.

PLAICE—*Pleuronectes platessa.*

Total number caught, 1504.

Number Examined, 533—Males, 262. Females, 271.
Number appoaching Ripeness, 16—Males, 16. Females, 0.
Number Ripe, 56—Males, 45. Females, 11.

With the exception of 14, entered as immature, all the other fish in which the reproductive organs were examined are entered as spent. I believe the percentage of error, with regard to the females, is rather high, and, as it is impossible, owing to confusion, in the earlier entries, to ascertain the exact number at different sizes, I shall omit the spent fish from this Table. It is worthy of remark, however, that one male, 16 inches, and five females, 16 to 18 inches, are recorded in August as just spent.

TABLE SHOWING THE DISTRIBUTION IN MONTHS.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
No. Examined, ..	14	7	36	44	60	96	66	62	46	24	40	38
No. approaching Ripeness, ..	2	0	0	0	1	0	2	0	3	0	8	0
No. Ripe, ...	11	3	4	3	13	0	12	0	2	0	3	5

Owing to the uncertainty attaching to the spent fish, a table of percentages would not be of much use. The large pelagic eggs occurred several times in the tow-nets in March.

Dr. Fulton (8th Ann. Rep. S. F. B., p. 261) considers that in Scotch waters plaice "spawn chiefly during January, February, and March; but that the time may vary in different years." So far as we can judge, the period is probably much the same in Ireland; but the occurrence of ripe and recently spent females in August is a feature of interest. Fulton found nearly ripe males and females in October and November, and it may be that in this species there are two distinct spawning periods, as with the herring. Of this there is no further evidence. I do not consider that the occurrence of ripe males throughout the period of observation is of much guidance for determining the time of spawning, as in the Pleuronectidæ, more noticeably in the dab than in this species, it is a common experience to find more or fewer ripe males at times when all the females are spent. As a rule the males of each species ripen before the females, as far as the bulk of both are concerned, but here we seem rather to meet with retardation, though, as it is frequent in very small examples, it may sometimes be in reality attributable to precocity.[1]

DISTRIBUTION OF SPAWNING FISH.

The ripe females occurred both in shallow water near the shore, and in deeper water, viz. 3 in April, in Blacksod Bay; 1 in March, in the Kenmare River; in August, 1 in

[1] A record of the occurrence of half-ripe females in Cork Harbour in September, which has been recently communicated to me by Mr. D. H. Lane, seems to indicate that we have still much to learn as to the spawning of this fish.

Killeany Bay; and 5 in the inner part of Ballinskelligs Bay, all soundings between 5 and 10 fathoms. In March, 3 in the outer part of Ballinskelligs Bay, soundings 26 to 35 fathoms. Fulton, after reviewing his evidence, concludes "that plaice do not spawn in territorial waters on the east coast of Scotland." Our evidence, as far as it goes, shows that this does not hold good for the west coast of Ireland. Owing to the rapid declivity of the bottom we meet with no such grounds as the Smith Bank (18 to 20 fathoms) at any considerable distance from land, and must look for their equivalents rather in such grounds as the outer part of Ballinskelligs Bay, and those off the Arran Islands and in the open part of Donegal Bay. The soundings here are about 25 to 30 fathoms.[1] I think it very probable that if experiments could be made on these grounds in January, February, and the early part of March, we should find a large number of plaice spawning there.

LEMON DAB (Lemon "Sole")—*Pleuronectes microcephalus.*

Total number caught, 99.

Number Examined, 65—Males, 22. Females, 43.
Number approaching Ripeness, 11—Males, 2. Females, 9.
Number ripe, 41—Males, 19. Females, 22.
Number Spent, 13—Males, 1. Females, 12.

Table Showing the Distribution in Months.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
No. Examined, ..	2	5	5	13	7	7	6	13	2	4	0	1
No. approaching Ripeness,	0	2	1	4	0	3	0	0	1	0		0
No. Ripe, ...	2	3	4	8	7	4	5	7	1	0		0
No. Spent. ..	0	0	0	1	0	0	1	6	0	4		1

The pelagic eggs were taken in the tow-nets in April, May, and June.

It appears that the spawning period is from March to July, principally in April, May, and June. On the East coast of Scotland, according to Fulton, spawning takes place in May, June, and July, but chiefly in June.

Distribution of Spawning Fish.

Of the 22 ripe females taken, 4 or 5 were in less than 10 fathoms of water; 8 or 9 between 10 and 20 fathoms; 4 between 20 and 30 fathoms; and 5 at 30 to 40 fathoms. It is noticeable that no ripe females ever occurred in the same haul with spent fish, which were all in the neighbourhood of the 10 fathom line. We have, therefore, evidence of a change of habitat, taking the form mostly of a migration into deeper water (as noticed by Fulton in Scotch waters), in connection with the spawning instinct;

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[1] It appears that plaice do spawn in the territorial waters of the Pentland Firth, where I suppose the declivity of the bottom is more rapid than on the east coast of Scotland. (*Vide* Ewart & Fulton, 7th Ann. Rep. S. F. B., 1889, p. 188.)

Fulton remarks on the East coast of Scotland that, while the Lemon Dab "may spawn to a slight extent on the margin of the territorial waters, it spawns mainly off shore." Owing to the different nature of the two coasts, this does not hold good for the West coast of Ireland, though the principle is evidently the same; and by substituting shallow for "territorial," and moderately deep for "off-shore," we make the statement equally true for this coast.

POLE DAB (Witch "Sole")—*Pleuronectes cynoglossus.*

Total number captured, 211.

Number Examined, 55—Males, 46. Females, 9.
Number approaching Ripeness, 7—Males, 6. Females, 1.
Number Ripe, 37—Males, 35. Females, 2.
Number Spent, 11—Males, 5. Females, 6.

Table Showing the Distribution in Months.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
No. Examined, ..	1	0	7	0	15	4	23	5	0	0	0	0
No. approaching Ripeness,	·0		1		3	1	2	0				
No Ripe, ...	1		6		11	1	17	1				
No. Spent, ..	0		0		1	2	4	4				

Table Showing Percentage to Number of Same Sex Examined in Month.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Approaching Ripeness,	0		14		20	25	9	0				
Ripe, ...	100		86		74	25	74	20				
Spent, ...	0		0		6	50	17	80				

In the above Table we have direct evidence that the Pole Dab spawns in May and June, and from the large proportion of ripe males in April we may reasonably suppose that spawning takes place also to some extent in that month. We have no evidence as to the later months. On the East coast of Scotland Fulton remarks that the spawning period appears to be May, June, July, and perhaps August.

Distribution of Spawning Fish.

The ripe females were taken in Donegal Bay, in 32 fathoms. Of the ripe males, one was taken in a haul, from 30 to 19 fathoms, in the same Bay; the others, between

24 and 46 fathoms in Donegal Bay, off the Aran Islands, and (one) in the Kenmare River. The fish taken in deeper water, 80 to 220 fathoms, were mostly small, and their reproductive organs were not examined. On the East coast of Scotland, Fulton concludes that this fish "spawns off-shore, and not in the territorial waters." His spawning females appear to have occurred in about 20 fathoms.

COMMON DAB—*Pleuronectes limanda.*

Total number caught, 1674.

Number Examined, 396—Males, 170. Females, 226.
Number approaching Ripeness, 13—Males, 3. Females, 10.
Number Ripe, 130—Males, 97. Females, 33.
Number Spent, 229—Males, 61. Females, 168.

The remainder of those examined were immature.

TABLE SHOWING THE DISTRIBUTION IN MONTHS.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
No. Examined, ..	12	12	39	41	33	55	59	82	24	27	3	9
No. approaching Ripeness,	0	4	0	5	0	1	1	0	1	0	1	0
No. Ripe, ...	10	5	31	13	23	15	21	0	10	0	2	0
No. Spent, ..	2	2	8	21	10	37	34	82	7	27	0	9

TABLE SHOWING PERCENTAGE TO NUMBER OF SAME SEX EXAMINED IN MONTH.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Approaching Ripeness,	0	33	0	12	0	2	2	0	4	0	33	0
Ripe, ...	83	41	79	31	69	27	35	0	41	0	66	0
Spent, ...	16	16	20	51	30	67	57	100	29	100	0	100

The pelagic eggs were abundant in the tow-nets at the end of March.

From the evidence of the females it appears that *during the period of observation* spawning was carried on during March, April, and May, the number of spawning fish diminishing with each month, whilst that of the spent fish increased. Probably very little spawning takes place later than May, but the period probably commences as early as the end of February. Numbers of eggs were taken in the tow-net at the commencement of fishing operations. The occurrence of so large a number of ripe males throughout the cruise is puzzling. During the later months I think it is extremely improbable that the milt is ever utilized in fertilization, except in isolated instances, where the spawning of a female is retarded, as happens occasionally in most species. In all Pleuronectidæ, as I remarked when dealing with the Plaice, ripe males are found to a greater or less extent at times when there appears to be no use for them, and on this account I do not think it advisable to depend much upon the evidence of the male when considering the spawning period.

On the East coast of Scotland Fulton considers that the spawning period is from March to June or July, probably chiefly in May. He found ripe individuals of both sexes in August; only one female, I think. I should say that, on the whole, the spawning period is rather earlier on the West coast of Ireland, and takes place principally in March and April.

DISTRIBUTION OF SPAWNING FISH.

Females were found ripe at from 4 to 32 fathoms, and showed no marked predilection for any particular depth, but were perhaps more frequent in shoaler waters. As Fulton remarks, this species "seems to spawn almost anywhere."

FLOUNDER—*Pleuronectes flesus.*

Number caught, 27—Number examined, 16.

All the above were mature, the sizes from 9 to 15 inches. Only 1 male and 1 female were ripe, both in March. In the same month 1 male was approaching ripeness. The rest were spent, viz. 8 males and 4 females in May, and 1 female in June.

Thus it would appear that this fish, which must be regarded as rather rare on the West coast, spawns there during the early part of the year. Fulton remarks that it spawns in Scotch waters from February to the beginning of June. From my own experience I should say March and April were the principal months.

DISTRIBUTION OF SPAWNING FISH.

The ripe female was taken in the Kenmare River in 10 fathoms. I have taken ripe males in the inner harbour at St. Andrew's, where the water is at low tide almost fresh, so that the presence of ripe examples of this sex cannot probably be taken as a guide to the spawning place. I think that there is no doubt that a migration seawards takes place at the approach of the spawning season, as a large number of flounders habitually live in brackish or even perfectly fresh waters, where it is perhaps reasonable to suppose that they do not spawn. Flounders are comparatively common as high up the Thames as Richmond-bridge. It is well known that they have frequently been placed and have lived for many years in land-locked waters, but I am not aware of any evidence as to their reproduction under such conditions.

COMMON SOLE—*Solea vulgaris.*

Total number caught, 588.

Number Examined, 414—Males, 169. Females, 245.
Number approaching Ripeness, 116—Males, 40. Females, 76.
Number Ripe, 57—Males, 36. Females, 21.
Number Spent, 233—Males, 88. Females, 145.

One Sole recorded as spent is of a less size than that of the smallest nearly ripe specimen of the same sex (female), and was most probably really immature.

The remainder of those examined were immature.

TABLE SHOWING THE DISTRIBUTION IN MONTHS.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
No. Examined, ..	34	54	41	44	57	70	18	26	14	31	5	20
No. approaching Ripeness,	25	37	7	14	11	23	0	1	0	0	0	1
No. Ripe, ...	7	6	10	8	19	6	0	1	0	0	0	0
No. Spent, ..	2	11	24	22	27	40	18	24	14	30	5	19

TABLE SHOWING PERCENTAGE TO NUMBER OF SAME SEX EXAMINED IN MONTH.

Month, ..	March.		April.		May.		June.		July.		August.	
Sex, ..	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Approaching Ripeness,	73	68	17	31	19	32	0	3	0	0	0	5
Ripe, ...	22	11	24	18	33	8	0	3	0	0	0	0
Spent, ...	5	20	58	50	47	57	100	92	100	96	100	95

Owing to the small size of the male reproductive organs in this species, and the difficulty in distinguishing readily between the various conditions, it is safest, in computing the spawning season, to rely chiefly on the statistics of the females. The whole number examined is too small, and the period of observation too short for a satisfactory conclusion, but we may say that our evidence shows that spawning takes place from March to June, and a few individuals (as evidenced by the occurrence of a nearly ripe female early in that month) spawn as late as August. March and April appear to be the principal months, and spawning is mostly over by June. The pelagic eggs were taken in the tow-net in March and April.

On the East coast of Scotland this fish seems to be rather rare. Fulton records a half ripe example in October, and one nearly ripe in March. I obtained a single ripe female in May, and Professor M'Intosh records one taken on the 1st August. Thus the period seems to be much the same as on the West coast of Ireland.

Distribution of Spawning Fish.

Though a certain number of spawning females occurred at almost every depth at which the mature examples were found, I think that the presence of very large numbers in the outer part of Ballinskelligs Bay, 26 to 27 fathoms, is to be connected with the spawning instinct. No immature forms were found amongst them, and very few were spent, the great majority being nearly ripe or ripe: they do not seem to be found there at any other part of the year. Thus it seems probable that some soles spawn in their ordinary habitat, as in Blacksod Bay, and others move into deeper water for that purpose, or at all events undergo a migration in one direction or the other. The actual distribution of ripe females was as follows:—Blacksod, Inver, and Clew Bays, Kenmare River, and Killybegs Harbour, 12, between 5 to 15 fathoms; Ballinskelligs Bay and Dingle Bays, 7, between 22 and 35 fathoms; off Dingle Bay, 1, at 53 fathoms. The range of spawning fish appears thus to be coextensive with that of the mature forms.

LEMON SOLE—*Solea lascaris.*

2 males were ripe in Blacksod Bay in the last week in April. Depths 0 to 1½ and 5½ to 9 fathoms.

SOLANETTE (Little Sole)—*Solea lutea.*

In April, 4 females were spent, and 1 was nearly ripe. 3 females were ripe in June, and 9 males and 7 females were spent in August. The ripe females occurred at 16 fathoms in Galway Bay. The eggs have not been definitely identified, but I believe that certain small pelagic eggs (which were obtained abundantly in June, and the beginning of July) belong to this species. (See *Sci. Trans.*, vol. iv., s. 3, pt. vii.). April, June, and July appear to constitute the spawning period, probably the last two months especially. Ewart and Fulton suppose that in the Moray Frith spawning takes place chiefly in July, and in the off-shore waters. I have found eggs identical with those alluded to in St. Andrew's Bay at the end of July.

HERRING—*Clupea harengus.*

2 ripe females were taken from the stomach of a Hake on 16th August at 23 to 26 fathoms in the Kenmare river.

The Herring is known to spawn at different places in different parts of the year. On the East coast of Scotland the spawning period is divisible into a spring and an autumn season. It is hardly necessary to say that the eggs are demersal and adhesive. They were not brought up by the trawl or dredge on any occasion during the survey.

SPRAT—*Clupea sprattus.*

The Pelagic eggs occurred in the tow-nets in March, April, May, and June, chiefly in March and April. From Cunningham's observations, the sprat seems to spawn off Plymouth in January. At St. Andrew's it apppears to spawn chiefly in April and May, but eggs are found as late as July.

CONGER—*Conger vulgaris.*

Conger were examined in each month. All were females. The reproductive organs were in different stages of development, but none could be described as ripe.

The stages fall roughly under three headings:—

a. Ovaries rather small, ova not distinguishable to the naked eye.

b. Ovaries still rather small, but ova visible as minute specks.

c. Ovaries moderately large, but not crowding the abdominal cavity; ova still very small.[1]

In addition to these stages, 9 are described as immature. The length of these was from 36 to 48 inches.

No small examples were examined, which accounts for the absence of males.

In March, 1 female at stage *a*. In April, 7 at stage *a*. In May, 9 at stage *a*, and 4 at stage *c*. In June, 4 at stage *a*, and 4 at stage *b*. In July, 2 at stage *b*, 1 at stage *c*, and 9 immature (as above). In August, 2 at stage *a*, and 1 at stage *c*.

Cunningham, to whose researches (Journ. M. B. A., vol. II., N. S., No. 1, March, 1891) I would refer readers for the most recent information on this subject, is of opinion that the Conger spawns in summer and autumn from about April to October, and always dies after spawning. The ripe eggs of the Conger are not yet identified with absolute certainty, but Cunningham believes that certain eggs, having a very large perivitelline space, and no oil globule belong to this fish. Such eggs have hitherto only been obtained in the Mediterranean.

BROAD-NOSED PIPE-FISH—*Siphonostoma typhle.*
GREAT PIPE-FISH—*Syngnathus acus.*
SNAKE PIPE-FISH—*Nerophis æquoreus.*
WORM PIPE-FISH—*Nerophis lumbriciformis.*

In April females of the above several species were ripe. In May and June all males observed were carrying either eggs or young. The eggs, therefore, seem to be transferred to the care of the male in April. All were found in shallow water, amongst weeds, or under stones (Worm Pipe-fish).

SHORT SUN-FISH—*Orthagoriscus mola.*

A female, about 6½ feet in length, appeared to be recently spent on 13th June, near Achill Island. The eggs are not known, nor is there any definite information as to the spawning of this fish.

SHARKS AND DOG-FISH.

TOPE—*Galeus vulgaris.*

In April, 3 males were approaching ripeness, and 1 female appeared to be spent. In May, 3 males were about half ripe, 2 were nearly, and 2 quite ripe, and 1 was spent. A male was immature. In June, 6 males and 1 female appeared to be spent. In July, 4 males were approaching ripeness, and 1 appeared spent. The young are produced alive, in the summer months, according to Couch.

SMOOTH HOUND—*Mustelus vulgaris.*

In April a male was immature. In June a male was ripe. In July, 1 male was ripe, and another three parts ripe. The young are brought forth alive. Couch records some nearly ready for extrusion in November.

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[1] The largest eggs of which I have a record measured ·54 mm. in diameter.

BASKING SHARK—*Selache maxima.*

The only specimen I had an opportunity of examining was a female, about 22 feet long, that had been killed about a week previously (in April), and was in a semi-putrid condition. The ovaries had apparently been removed with the liver. The oviducts were wide and very thick-walled distally. Proximally there was a slight thickening in the position of the oviducal gland, but the whole structure was so far gone, that I could not be certain as to its nature. There was nothing in either oviduct. Two other specimens, killed and examined by Sir Henry Gore-Booth in May, were males.

It has been conjectured that the annual appearance of this shark upon this coast has some connection with reproduction; on this subject there is no evidence one way or the other. Pennant speaks of an embryo, about a foot in length, being found in one of these fishes.

SMALL SPOTTED DOG—*Scyllium canicula.*

In March, 2 females were approaching ripeness. In April, 7 males and 1 female were approaching ripeness, and 5 females were ripe. In May, 2 males and 2 females were approaching ripeness, and 5 males and 6 females were ripe. In June, 3 females were not yet ripe, and 4 males and 5 females were ripe. In July, 2 males were nearly ripe; 1 female was ripe, and a male and a female were spent and ripe respectively. It is not clear to which sex the entries apply. In August, 2 females were nearly ripe. The egg-purses were frequently trawled, attached to sea-weed in Blacksod Bay and similar shallow weedy ground. According to Dr. Harmer the eggs take 156 to 186 days to hatch; 7 to 10 months according to observations at Southport Aquarium.

NURSE—*Scyllium catulus.*

On the 5th May a female contained fully developed purses, at 2 to 3 fathoms in Blacksod Bay. According to Costa the eggs take 9 months to hatch.

BLACK-MOUTHED DOG—*Pristiurus melanastomus.*

A female of 29 inches contained fully-developed purses on the 12th May, at 250 fathoms. The species probably spawns only in deep water on this coast.

PICKED DOG—*Acanthias vulgaris.*

In March a female contained advanced embryos. In April, 3 females were ripe; 1 of them had eggs, and another embryos in the oviducts. In May, 1 male was approaching ripeness, and 12 were ripe. 3 females were ripe, and 2 of them contained embryos. In June, 1 male was spent, 12 females were ripe; 5 of them had eggs, and 7 had embryos in the oviducts. In July, 20 females were ripe, and in August, 15 were ripe, and 3 were spent. It appears probable that the young are mostly liberated in the summer (summer and autumn, according to Day), and perhaps to some extent all the year round. Nothing definite seems known as to the period of intra-oviducal development.

SPINOUS SHARK—*Echinorhinus spinosus.*

A female of 96 inches was spent on the 19th August.

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ANGEL RAY—*Rhina squatina.*

A male of 34 inches was immature in May. A male of 36 and a female of 27 inches were spent in July. Bloch says this fish brings forth its young in the Spring and Autumn.

TORPEDO—*Torpedo nobiliana* (?)

A female of 32 inches was half ripe in May. This is an oviparous form.

GREY SKATE—*Raia batis.*

43 mature examples were examined, of which 18 were males and 26 females. In March, 2 males and 4 females were approaching ripeness; in April, 2 males were approaching ripeness, and 1 male and 1 female were ripe; in May, 5 males and 7 females were approaching ripeness; 2 males and 4 females were ripe, and 5 females nearly ripe; in June, 1 male was ripe, and 1 female was spent; in July, 2 females were ripe, and 1 male and 1 female were spent; in August, 2 males and 3 females were spent. The species appears to spawn therefore in the spring and early summer, as far as our observations help us; but Beard has shown that on the Scotch coast spawning goes on to some extent all the year round, but principally, according to his experience, in March and April. 1 female was ripe at 5 to 10 fathoms, 1 at 10 fathoms, and 8 between 20 and 50 fathoms. It would seem therefore that the Grey Skate spawns sometimes in shallow, but probably more usually at some considerable depth.

Some females were probably ripe in May at 74 to 80 fathoms; but as there is a confusion between several species in the records, I have omitted them from consideration.

SHARP-NOSED SKATE—*Raia oxyrhynchus.*

3 females were examined.[1] 1 was half-ripe at 38 fathoms in April; 1 was in the same condition at 375 to 500 fathoms in May, and 1 was ripe at 25 fathoms in June. The species appears to be everywhere confined to rather deep water, and probably there is no special habitat for spawning, which seems to take place during the Summer.

SHAGREEN RAY—*Raia fullonica.*

7 were examined, of which 2 were immature. In April, 1 male was ripe, and 2 females were approaching ripeness (1 nearly ripe). In August, 1 male and 1 female were spent. The ripe male occurred at 70 fathoms, and the nearly ripe female at 154 fathoms. None were taken in less than 32 fathoms.

THORNBACK—*Raia clavata.*

In March, 1 male and 3 females were approaching ripeness, and 2 males and 1 female were ripe. In April, 1 male and 8 females were approaching ripeness, 1 male and 11 females ripe.[1] In May, 8 females were approaching ripeness, 6 males and 3 females ripe, 3 males and 2 females spent; 18 males are recorded as ripe and spent, and 17 females as nearly ripe, ripe and spent in the same month. In June, 2 males and 1 female were approaching ripeness, 11 males and 6 females ripe, 1 male and 7 females

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[1] Dr. Scharff tells me that some large skate, which after examination of a "Harlequin" specimen he thinks must have belonged to this species, was amongst those captured in 74 to 80 fathoms off the Skelligs in May, 1890 (St. 8). From the records it appears that of 20 skates and rays, examined "*en bloc,*" 11 females were half ripe and 6 were ripe, all males being immature.

spent. In July, 4 males and 6 females were approaching ripeness, 14 males and 8 females ripe, and 1 male and 2 females spent. In August, 1 male and 1 female were approaching ripeness, and 2 males and 4 females spent. Thus individuals are ripe as early as March, spent examples begin to occur in May, and some are still not quite ripe in August, so that the spawning period is a long one, but seems to be chiefly in the Spring and Summer. Beard obtained eggs (purses) in January, and from that month in increasing numbers until June, from the Scotch coast. Ripe females were found between 4 and 26 fathoms, and at 70 to 80 fathoms. Others were nearly ripe at intermediate depths. Ripe males occurred at almost every depth between 4 and 70 fathoms, and nearly ripe examples were found at 74 to 80 fathoms. Thus the thornback appears to spawn wherever it happens to be, whether in shallow or deep water, or quite near the land or at some distance from it.

SPOTTED RAY—*Raia maculata.*

None were identified in May, 1890. During the remainder of the operations 43 mature examples were examined. In March, 4 females were approaching ripeness, and 1 male and 1 female were ripe. In April, 3 females were ripe. In May, 1 female was approaching ripeness, 2 females were ripe, and 2 males spent. In June, 9 males and 3 females were ripe, and 7 females spent. In July 3 males and 1 female were approaching ripeness, 1 female was ripe, and 5 females spent. This species probably spawns throughout a considerable period, chiefly perhaps in the spring and early summer.

DISTRIBUTION OF SPAWNING FISH.

Ripe females were found at 4 to 33 fathoms, but were most abundant between 4 and 15 fathoms. No examples were met with at more than 48 fathoms. On several occasions the egg-purses were deposited on deck in Blacksod Bay. Thus it appears that they spawn, as they live, chiefly in the shallower waters, and therefore, on this coast, in shallow bays and inlets, such as Blacksod and Cleggan Bays, or, if in open water, always rather near the land.

OWL RAY—*Raia microcellata.*

2 ripe females were examined. One occurred at 9 to $5\frac{1}{2}$ fathoms in Blacksod Bay in April, and the other at 19 to 5 fathoms in Loughrosmore Bay in May. In each case the egg-purses were protruding when the ray was brought on deck. The species appears to be confined to shallow water on this coast.

SANDY RAY. *Raia circularis.*

The 7 mature examples occurred at a maximum and minimum depth of 154 and 13 fathoms. Only 1 was in less than 25 fathoms. The only immature representative, 8 inches long, occurred at 115 fathoms.

Day remarks that this ray is found mostly in sheltered bays, in which Beard, on account of the tenderness of the egg-purse, supposes that it spawns.

Professor M'Intosh, in his report to the Trawling Commission, records the occurrence of both mature and young examples between 13 and 34 fathoms, from Aberdeen Bay. During 1889 the Scotch Fishery Board tender "Garland" captured 4 examples, all immature. Of these, 2 specimens of under 4 inches were respectively obtained at 11 fathoms in St. Andrew's Bay, and 25 fathoms on the Smith Bank, off the Moray Firth. The other 2, 11 and 15 inches long, were at 11 and 13 fathoms.

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[1] Egg-purses were deposited on deck in Blacksod Bay on more than one occasion.

On the whole, it seems that this ray for the most part inhabits moderately deep water. The only sheltered bay in which we found it was Downies Bay, where a single large specimen occurred. None of the localities from which it has been recorded on the East coast of Scotland can be so described. The younger immature forms appear to have no special habitat, and may probably be found at any depth or locality inhabited by the mature form.

(ii.)—DEFINITION OF IMMATURE FISH.

The term immature is here used in the same sense as by Dr. Wemyss Fulton, viz. it is restricted "to young fish which have never developed milt or roe," and which therefore have not become adult.

To Fulton belongs the credit of being the first to endeavour to arrive at a standard of maturity of other than a purely arbitrary character. It appears to me, however, that his method is open to some slight improvement. As far as I can judge from his tables and remarks his limit is derived from a consideration of the smallest sizes of ripe or nearly ripe fish, without regard to sex.[1] Now if there is a difference in the sizes at which the sexes arrive at maturity, as indeed appears from Fulton's own remarks, a limit so arrived at must necessarily exclude from its benefits some immature forms of the sex which grows to the largest size before becoming mature. To me it appears preferable to fall into the opposite error, and, by fixing the limit at what appears to be the minimum size of the larger sex, to include among the immature some mature members of the smaller sex. The former method appears to have an especial disadvantage, since, if the capture of fish so comprised as immature could be prevented, no protection would thereby be afforded to members of the larger sex (*i.e.* the female in almost all cases) at the very time when they would most appear to need it, viz. when, having safely passed through the manifold dangers of early existence, they are just about to become mature, and are infinitely more likely to survive to reproduce their species than small fish at the mercy of every enemy, a point which is emphasized by Fulton himself. (*Vide op. cit.*, pp. 195, 196).

With the intention, therefore, of exhibiting the difference between the sizes of the sexes in relation to maturity, I have prepared five tables.

The first two omit the question of sex, which is dealt with in the third and fourth, whilst the fifth shows the conclusions arrived at, and the difference, if any, between those of Dr. Fulton and myself on our different methods of inquiry. The third column shows the limit fixed at the recent Fishery Conference. This last limit neither has, nor professes to have, any biological significance, and in the case of Turbot and Brill is obviously too small to have much beneficial effect should it ever be acted upon. I have added a few remarks in further evidence on some of the forms dealt with.

It will be noticed that I have spoken of fish approaching ripeness in place of nearly ripe fish, as used by Dr. Fulton. By the former term I mean to include such fish as are half ripe or more, since I do not think it probable that a very material elongation takes place during the period which elapses before spawning.

My conclusions are given in all diffidence, since the materials at my disposal in the case of many species are altogether insufficient. They must be looked on rather as additions to the evidence on this subject so ably set forth by Dr. Fulton. The possible existence of local variation must not be forgotten.

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[1] Dr. Fulton has since informed me that the above surmise is correct, and that, as a matter of fact, his smallest specimens were almost always (or perhaps always) males.

TABLE I.—MAXIMUM AND MINIMUM LENGTH[1] (IN INCHES) OF FISH APPROACHING RIPENESS.

Name of Fish.	Largest.	Smallest.	Number.	Number Examined.
Red Gurnard,	16½	13	2	8
Sapphirine Gurnard,	23	12	5	11
Grey Gurnard,	17½	6	48	227
Piper,	18½	13	6	25
Lesser Weever,	4½	..	1	1
John Dory,	20	11	14	31
Sand Smelt,	5	..	1	3
Ballan Wrasse,	17	12½	13	about 20
Corkwing,	8	4¾	5	..
Cod,	35	..	1	62
Haddock,	13½	12	4	58
Whiting,	16	11½	9	39
Pollack,	36	21	7	44
Hake,	30/43	28	7	22
Ling,	50	24	21	137
Halibut,	53	29	2	3
Turbot,	30	13	12	55
Brill,	24	10½	20	79
Witch (Sail-fluke),	16	10	5	204
Plaice,	16	14	16	533
Lemon Dab (Lemon Sole),	13½	8¾	7	65
Pole Dab (Witch Sole),	16	11	7	55
Common Dab,	14	6½	13	396
Flounder,	10	..	1	16
Common Sole,	19	10	116	414
Solanette,	3¾	..	1	24

[1] All measurements given are from the tip of the snout to the end of the tail-fin.

TABLE II.—MAXIMUM AND MINIMUM LENGTH (IN INCHES) OF RIPE FISH.

Name of Fish.	Largest.	Smallest.	Number Ripe.	Number Examined.
Red Gurnard,	17½	13	5	8
Sapphirine Gurnard,	22	14	3	11
Grey Gurnard,	18½	7	75	227
Piper,	18	13	3	25
Angler,	25	..	1	8
John Dory,	21	12½	8	31
Sand Smelt,	5	5	2	3
Corkwing,	9	4½	..	..
Cod,	37	25	13	62
Haddock,	28	13	10	58
Whiting Pout (Brassie),	17	13	2	2
Poor Cod,	6½	..	1	1
Whiting,	17	10	12	39
Coalfish,	39	..	1	24
Norway Pout,	4½	..	2	2
Pollack,	33	22½	6	44
Hake,	39 to 43 40 (?)	28½	2	22
Ling,	54	29	42	137
Long Rough Dab,	9	6	7	12
Turbot,	25	18	11	55
Brill,	25	15	17	79
Witch (Sail-fluke),	16	10½	19	204
Plaice,	26	10	56	533
Lemon Dab (Lemon Sole),	15	7½	41	65
Pole Dab (Witch Sole),	17	11	37	55
Common Dab,	14	5½	130	396
Flounder,	14½	14	2	16
Common Sole,	18	11½	57	414
Lemon Sole,	10½	8	2	3

TABLE III.—SHOWING THE DIFFERENCE BETWEEN THE MINIMUM LENGTHS (IN INCHES) OF MALES AND FEMALES APPROACHING RIPENESS.

Name of Fish.	Smallest size of Male.	Smallest size of Female.	Difference.	Number of Males.	Number of Females.
Red Gurnard,	13	..	..	2	0
Sapphirine Gurnard,	12	20	8	2	3
Grey Gurnard,	6	11	5	15	34
Piper,	13	..	..	3	0
Lesser Weever,	..	$4\frac{1}{2}$*	..	0	1
John Dory,	11	15	4	7	7
Sand Smelt,	..	5†	..	0	1
Ballan Wrasse,	16	$12\frac{1}{2}$*	$3\frac{1}{2}$	5	8
Cook Wrasse,	..	11	..	0	1
Corkwing,	..	$4\frac{3}{4}$*	..	0	6
Cod,	..	35	..	0	1
Haddock,	12	12	0	3	1
Whiting,	..	$11\frac{1}{2}$	..	0	9
Pollack,	36	21	15	1	6
Hake,	28	39/43	?	2	5
Ling,	29	24	5	6	15
Halibut,	..	29	..	0	2
Turbot,	13†	$22\frac{1}{2}$†	9	6	6
Brill,	$10\frac{1}{2}$	20	$9\frac{1}{2}$	15	5
Witch (Sail-fluke),	10	12	2	1	4
Plaice,	14	..	..	16	0
Lemon Dab (Lemon Sole),	$8\frac{3}{4}$	11	$2\frac{1}{4}$	2	9
Pole Dab (Witch Sole),	11	16	5	6	1
Common Dab,	$6\frac{1}{2}$	9	$2\frac{1}{2}$	3	10
Flounder,	10	..	..	1	0
Common Sole,	10†	12†	2	40	76
Solanette,	..	$3\frac{3}{4}$	..	0	1

* Very nearly Ripe. † Nearly Ripe.

TABLE IV.—Showing the Difference between the Minimum Lengths (in Inches) of Ripe Males and Females.

Name of Fish.	Smallest Male.	Smallest Female.	Difference.	Number of Males.	Number of Females.
Red Gurnard,	13	13	0	1	4
Sapphirine Gurnard,	13	..	..	3	0
Grey Gurnard,	11	$9\frac{1}{2}$	$1\frac{1}{2}$	16	59
Piper,	13	..	..	3	0
John Dory,	$12\frac{1}{2}$	14	$1\frac{1}{2}$	3	5
Sand Smelt,	5	..	..	2	0
Corkwing,	$4\frac{1}{2}$	..	..	2	0
Cod,	25	30	5	9	4
Haddock,	..	13	..	0	10
Whiting Pout (Brassie),	13	..	..	2	0
Poor Cod,	..	$6\frac{1}{2}$	..	0	1
Whiting,	10	$11\frac{1}{2}$	$1\frac{1}{2}$	2	10
Coalfish.	39	..	..	1	0
Norway Pout,	..	$4\frac{1}{2}$	..	0	1
Pollack,	28	$22\frac{1}{2}$	$5\frac{1}{2}$	4	2
Hake,	$28\frac{1}{2}$	39/43*	..	1	1
Ling,	28	$36\frac{1}{2}$	$8\frac{1}{2}$	37	5
Long Rough Dab,	6	6	0	2	5
Turbot,	18	..	..	11	0
Brill,	15	15	0	5	12
Witch (Sail-fluke),	$10\frac{1}{2}$	12	$1\frac{1}{2}$	19	8
Plaice,	10	15	5	45	11
Lemon Dab (Lemon Sole),	$7\frac{1}{2}$	8	$\frac{1}{2}$	19	22
Pole Dab (Witch Sole),	11	14	3	35	2
Common Dab,	$5\frac{1}{2}$	$7\frac{1}{4}$	$1\frac{3}{4}$	97	33
Flounder,	14	$14\frac{1}{2}$	$\frac{1}{2}$	1	1
Common Sole,	$11\frac{1}{2}$	14	$2\frac{1}{2}$	36	21
Lemon Sole,	8	..	..	2	0

* Exact size not certain.

TABLE V.—The Limit between Mature and Immature Fish—*i.e.* the Minimum size[1] (in inches) of Mature fish of the larger sex (column 1); Dr. Wemyss Fulton's limit (column 2); the limit fixed by the Fishery Convention (column 3).

	1	2	3
Round Fish.			
Common Sea Bream, .	14?	..	..
Red Gurnard, . .	10?	..	..
Sapphirine Gurnard, .	14?	..	..
Grey Gurnard, . .	9	8	..
Angler, . . .	25?	..	..
Lesser Weever, . .	4?	..	..
John Dory, . .	14	..	..
Sand Smelt, . .	5?	..	..
Ballan Wrasse, . .	12?	..	..
Corkwing, . .	4½	..	..
Cod, ...	..	20	..
Haddock, ...	..	10	..
Poor Cod, . . .	6?	..	..
Whiting, ...	..	8	..
Coalfish, . . .	20?	..	..
Norway Pout (*Gadus esmarkii*).	4?	..	..
Pollack, . . .	18	..	..
Ling, ...	24	..	..
Silvery Pout (*Gadus argentus*).	4?	..	..

	1	2	3
Flat Fish.			
Halibut, . . .	23?	..	..
Long Rough Dab, .	6	6	..
Turbot, . . .	..	18	12
Brill, . . .	15	16	12
Witch (Sail-fluke), .	12?	9	..
Scaldfish, . . .	4?	..	..
Plaice, . . .	15	12	..
Lemon Dab (Lemon Sole).	8	8	12
Pole Dab (Witch Sole),	..	12	..
Common Dab, . .	7	6	..
Flounder, . . .	..	7	..
Common Sole, . .	12	..	10
Lemon Sole (*Solea lascaris*).	10?	..	..
Solanette (Little Sole),	..	3½	..
Skates and Rays.			
Grey Skate, . .	26	..	..
Shagreen Ray, . .	35?	..	..
Thornback, . .	19	..	..
Spotted Ray, . .	24	..	..
Owl Ray, . . .	24?	..	..
Sandy Ray, . .	24?	..	..

All measurements given are from the tip of the snout to the end of the tail-fin.

REMARKS.

ROUND FISH.

COMMON SEA BREAM—*Pagellus centrodontus.*

The observations upon which the tentative limit of 14 inches is based were made by Mr. D. H. Lane this autumn at Queenstown. Males of 12 inches were immature; males of 16 and 17 inches were spent. A female of 13½ inches was immature, and several from 15½ to 18 inches were recently spent. Thirteen fish in all were examined.

RED GURNARD—*Trigla cuculus.*

No red gurnard were taken under 13 inches, at which size both sexes were mature. I suspect the limit is about the same as in grey gurnard, or slightly higher, but have no evidence.

SAPPHIRINE GURNARD—*Trigla hirundo.*

The limit appears to be somewhere between 12 and 16 inches. Males were mature from 12 inches and above. None of less size were taken. A female of 12 inches was immature, and one of 16 inches spent. Other females between 20 and 23 inches were approaching ripeness.

JOHN DORY—*Zeus faber.*

The evidence is meagre, and the limit assigned therefore provisional, and probably too high.

COMMON OR GREY GURNARD—*Trigla gurnardus.*

The male appears to come to maturity at about 7 inches; but all females less than 9 inches which I examined were immature, as were also some a little larger. The smallest ripe female was 9½ inches. Fulton puts the limit at 8 inches.

COD—*Gadus morrhua.*

Amongst the 62 fish examined I can find no evidence of the female being mature at a length of less than 30 inches. Only seven of a less size were examined, and were all immature. They consist of two between 9 and 21 inches (exact size not recorded), one at 16½ inches, and four from 23½ to 25½ inches. All males above 24 inches were mature, *i. e.* were ripe or spent, except one at 35 inches. Seven males were immature, four between 9 and 21 inches, and three from 15½ to 16½ inches. No males between 21 and 25 inches, and no female between 25½ and 30 inches came under observation. As far as my evidence goes it seems to point to the fact that the male comes to maturity at a smaller size than the female, and I cannot help thinking that Fulton's limit of 20 inches is founded on a consideration of the male condition, and that to include the immature females it should be considerably higher; but in the absence of intermediate sizes and sufficient numbers of the smaller females, I am unable to propose any exact limit. It seems likely to be at about 26 or 27 inches.

HADDOCK—*Gadus oeglefinus.*

This is one of the species in which, according to Fulton, the size is the same in both sexes; but I do not know if this is intended to apply also to the size at which the sex reaches maturity. Fulton gives the limit at 10 inches. With the exception of one male at 6½ inches, none of our haddock were below 12 inches, at which size both sexes appeared to be mature, though as usual exceptions occurred, viz. one male at 12½ inches and three females from 13 to 15½ inches were immature.

WHITING—*Gadus merlangus.*

Of the whiting examined all males were over 9 inches, and all females over 11 in., and all mature. I have therefore no evidence as to the limit. Fulton's is 8 inches.

COAL-FISH—*Gadus virens.*

We have no evidence as to the size at which this fish arrives at maturity, and it is not included in Fulton's list. It is probably not far from 20 inches. The largest male taken (39 inches) was 3 inches larger than any female.

POLLACK—*Gadus pollachius.*

The limit of 18 inches assigned to this fish is purely tentative, but probably not far from the mark. It is the smallest size at which a female was found to be spent. Seven males were immature, between 13 and 17 inches, and one at 22 inches, five females were immature at 15 to 18 inches. The male appears to reach as large a size as the female; indeed our largest male (36 inches) was 2½ inches larger than any female.

LING—*Molva vulgaris.*

Five ling, under 24 inches, were examined. Of these a male at 17 inches was immature, and a male of 21 inches was spent, and three females, from 21 to 23½ inches, were immature. A female at 24 inches was half ripe. Females at 25 to 27 inches were spent. It would thus appear that the male comes to maturity at about 20 inches, and the female at about 24 inches, at which size I have placed the limit until further evidence is obtained.

FLAT FISH.

HALIBUT—*Hippoglossus vulgaris.*

The limit of 23 inches is founded on a half-ripe specimen recorded by Fulton, the few which we obtained being all larger. It is purely a conjecture, and only inserted in the hope of eliciting evidence from anyone who may be in a position to give it.

LONG ROUGH DAB—*Hippoglossoides limandoides.*

According to my limited experience this is a species in which the sexes come to maturity at the same size, viz. 6 inches. Fulton, who had the opportunity of examining many more ripe fish than I had, found none smaller than 6½ and no nearly ripe fish smalller than 5½ inches, and on his evidence also fixes the limit at 6 inches.

TURBOT—*Rhombus maximus.*

I do not consider that my evidence justifies me in interfering with Dr. Fulton's limit of 18 inches. The occurrence of a nearly ripe male of 13 inches may be exceptional, and in any case does not give any clue as to the smallest size of the mature female. The following fish are entered in the records as immature:—Males, two at 14 inches, one at 15 inches. Females, one at $11\frac{1}{2}$ inches, two at $12\frac{1}{2}$ inches, one at 13 inches, three at 14 inches, two at 15 inches, one at $15\frac{1}{2}$ inches, and one at $17\frac{1}{2}$ inches, whilst other two at the same size are entered as spent.

BRILL—*Rhombus lævis.*

The limit of 15 inches, which I have assigned to this species, represents the size of the smallest ripe female taken. Undoubtedly the male comes to maturity at a much smaller size, possibly about 11 inches in extreme cases, as we obtained a half-ripe specimen at $10\frac{1}{2}$ inches, which probably would grow very little before becoming fully mature. Others in the same condition were 13, 14, and up to 19 inches, whilst the smallest ripe male was, as in the case of the other sex, 15 inches in length. One male of 8 inches was immature, and six males from $10\frac{1}{2}$ to 13 inches, and two females of 12 and $12\frac{1}{2}$ inches were in the same condition, so that in this, as in other species of Pleuronectidæ, there is considerable individual variation, at any rate in the males, in the assumption of the mature condition.

The limit of 12 inches, fixed upon by the recent conference on fishery matters is certainly too small to protect immature females, but would protect immature males, with the exception of a certain proportion in which maturity is retarded.

WITCH—*Arnoglossus megastoma.*

Owing to some vagueness in the entries under station 12, I am unable to discover the exact size of the smallest mature female on that occasion. 12 inches is the smallest size of which I have a clear record. The males are mature at a smaller size, the smallest, perhaps, at $9\frac{1}{2}$ inches; but for the same reason this is doubtful. Therefore, although inclined to think that females do not become mature under 12 inches, I do not feel justified in making use of my own conclusions in preference to Fulton's.

PLAICE—*Pleuronectes platessa.*

From a consideration of all my evidence, I cannot help thinking that the female is never mature at a less size than 15 inches: smaller females are certainly recorded as spent in the Tables, but, as I have stated above (p.), I think this has been done in error. The male may be mature at 10 inches. The smallest ripe female mentioned by Fulton is $17\frac{1}{2}$ inches.

POLE DAB—*Pleuronectes cynoglossus.*

In this species it appears to me that the female is not mature at 12 inches, but my evidence on the subject is so meagre that I have preferred to abstain from interfering with Fulton's limit.

COMMON DAB—*Pleuronectes limanda.*

The male appears to come to maturity at a minimum length of about 5 inches, and the female at about 7 inches; $7\frac{1}{4}$ inches was the smallest size at which a ripe female was taken. Fulton puts the limit at six inches, without remark as to sex; the smallest ripe fish he got was $5\frac{1}{2}$ inches.

FLOUNDER—*Pleuronectes flesus.*

Not having examined a sufficient number of small fish, I have no evidence to offer with regard to this species. Fulton fixes the limit at 7 inches. M'Intosh and Prince, in their Edinburgh memoirs, speak of having got ripe eggs from females not more than $4\frac{1}{2}$ inches long, and at the reeent Conference Professor M'Intosh spoke of having got ripe males at about the same size.

SKATES AND RAYS.

My observations, as far as they go, show infinite individual variety, but no marked difference between the sizes of the sexes in relation to maturity.

GREY SKATE—*Raia batis.*

Some males and females were half ripe at 29 to 30 inches; a female was nearly ripe at 26 inches, and one was ripe at 36 inches; but I think the majority do not come to maturity until a much larger size is reached.

SHAGREEN RAY—*Raia fullonica.*

A male at 30 inches and a female at 40 inches were immature. A female of 38 inches was spent. Two females were half ripe and three quarters ripe at 41 and 44 inches, and a male of 35 inches was ripe. There seems, therefore, to be variation, as in other species, in the size at which this fish becomes mature.

THORNBACK—*Raia clavata.*

A Thornback may be mature, or nearly so, at 19 inches, but many at a much larger size are still quite immature. Besides the smaller forms, males from 19 to 29 inches, and females from 19 to 36 inches were still immature. Varieties probably exist in this species.

SPOTTED RAY—*Raia maculata.*

The question is here complicated by the existence of two varieties, which come to maturity at very different sizes. The smaller and darker variety is mature at about 24 inches, whilst the larger pale variety is immature up to about 40 inches, males and females alike.

OWL RAY—*Raia microcellata.*

The smallest ripe female observed was 32 inches; the species is probably mature at a smaller size.

SANDY RAY—*Raia circularis.*

Two males were mature at $26\frac{1}{2}$ inches. Two females were half ripe at 44 inches.

COMPARISON OF THE HABITATS OF MATURE AND IMMATURE FISH ON THE WEST COAST OF IRELAND.

Whenever the material is sufficient I have prepared a Table showing, in vertical columns, the size in inches of the fish, and in horizontal columns the depth in fathoms at which they were taken. A dotted line divides the mature from the immature, the limit being that laid down in the last Table (p. 300), without consideration of individual or sexual variation. Thus a number of really adult males are here classed as immature, since they fail to reach the standard of size adopted, whilst some few forms, which for some reason have failed to become adult, are nevertheless, on account of their exceeding the given standard of size, classed as mature.

On account of the number of different trawls used during the survey, I have given the actual numbers in preference to percentages. Since it occasionally happened that during a single haul we got soundings between which there was a difference of more than five fathoms, I have endeavoured to divide the number of fish so caught as equally as may be. So, also, in cases where the records do not show the exact numbers at each size. Where the soundings or sizes of fish are not given in the records, I have, of course, omitted the fish from consideration under this head.

Dr. Fulton, in his excellent Paper on the "Distribution of Immature Fish," treats the subject largely in reference to this occurrence within or without the territorial limits. I was anxious to follow him in this, and, being in doubt as to the interpretation of the laws on the subject, I wrote to him, and in reply received a most courteous explanation. In accordance with this guidance Mr. Beamish has kindly prepared for me a chart showing the limits on the West coast of Ireland.

From a glance at this it is at once evident that it is impossible to utilize the limit in the same manner as the East coast of Scotland. The coast is so broken, and so many islands, each with its own territorial area, intervene, that with the exception of the outer and less important part of Donegal Bay, and the long stretch of ground west of the (Galway) Aran Islands, there is not a single practical trawling ground which is not enclosed by the three-mile limit. The explanation is to be further sought in the rapid shelving of the bottom, and the almost entire absence of banks such as are met with in the North Sea (*vide* Mr. Green's Report, p. 51). Bearing in mind that the ground never rises outside the limit, at least in a manner practicable for trawlers, a list of the soundings (in fathoms) along the line may be instructive. Malin Head, 29 to 20. The ground north of this may be good or bad; at any rate it is not fished. Round Tory, 37 to 30; Tory to Aranmore, 27 to 19; Tory to Dawros Head, 32 to 27, except on Boylach Spit, a rocky prominence, with 14 fathoms; Dawros Head to Rathlin O'Birne, 46 to 32; Donegal Bay, 40, except where a narrow strip of extra-territorial water intervenes between the limits of the narrow part of the bay and those of Inishmurray, here the minimum soundings are 25; off Sligo and Killala Bays to Downpatrick Head, 33 to 26; Downpatrick to Erris Head, 45 to 30; off Broadhaven, 38; Erris Head to Black Rock, 49 to 37; off Blacksod Bay, 49, except a triangular patch of extra-territorial water which shoals to 39; Achill Head to Slyne Head, 58 to 49, except W. and N. W. of Clare Island, 29 to 18; Slyne Head to Inishmore, Aran Islands, 60 to 40; off the Aran Islands, 40 to 30; Aran to Loop Head, 40 to 30; Loop Head to Kerry Head, mouth of the Shannon, 49 to 19, the latter sounding being on a rocky bank; off Tralee (including Brandon) Bay, 36 to 19; Brandon Head to Sibyl Head, 60 to 36; off the Blaskets, 60 to 40; off Dingle Bay, 40 to 29; off Ballinskelligs Bay, 59 to 29; off the Kenmare River, 56 to 41; Dursey Head to Mizzen Head, off Bantry Bay, 48 to 33. It is not surprising, therefore, to find that, with the exception of such deep-sea forms as reside at all stages of their existence at great depths, the occurrence of immature fish outside the territorial limits is rare.

They comprise only the following :—Grey Gurnard, very few; Piper, one; John Dory, a few; Dragonet, several; Gobies, of an undetermined species, many; Lesser Three-bearded Rockling; Long Rough Dab, many; Witch, many; Scaldfish, several; Plaice, very few, none small; Lemon Dab, some very small specimens; Pole Dab, many; Common Dab, a few; Grey Skate, Thornback, Spotted Ray (one ?); Sandy Ray, one.

I have, therefore, thought it unnecessary to refer to the distribution of each species inside and outside the territorial limits, and have treated only of the vertical distribution.

Pomatomus telescopium.

Two immature males, $5\frac{1}{4}$ to 8 inches in length, were trawled at 144 fathoms 30 miles off Achill Head. This fish grows to a length of about 2 feet, and is confined to deep water (144 to 250 fathoms seems to be the recorded range). It occurs in the Mediterranean, and off the Madeira and Canary Islands, and St. Helena.

Scorpæna dactyloptera.

This species was confounded, in this country, with the Norway haddock, and so labelled in the National collection, until Dr. Scharff pointed out the error last year. The two forms are much alike.

Numerous examples from $1\frac{1}{2}$ to 2 inches were obtained at 80 fathoms off the Skelligs; 3 specimens, from 5 to 8 inches, were at 220 fathoms, 50 miles off Bolus Head. A specimen of 11 inches occurred at 500 fathoms, and one of 12 inches at 154 fathoms, 54 and 28 miles off Achill.

Specimens have been obtained on various occasions off the S. W. coast at depths of 75, 200, 217, and 250 fathoms.

According to Günther the species is common in the Mediterranean and at Madeira (250 to 400 fathoms), and not rare on the coast of Norway (100 to 300 fathoms). It is also plentiful at the Canary Islands (200 fathoms).

Vaillant, on the "Talisman," obtained specimens at 54 to 527 fathoms, which represent the limits of the recorded vertical range.

This fish appears to reach a length of over two feet, and I think all our specimens were immature. Our information is not yet sufficient to show any marked difference in the habitats of the old and young forms.

RED GURNARD—*Trigla cuculus.*

Twelve mature examples were taken at intervals along the whole coast, at depths of 13 to 55 fathoms. They do not appear to enter shallow bays, as Blacksod and Lough Swilly, and are, perhaps, rather addicted to rocky ground. Like the Piper, they extend into considerable depths, a specimen having been taken by Vaillant in the Bay of Biscay at over 165 fathoms.

SAPPHIRINE GURNARD—*Trigla hirundo.*

Twelve were taken, of which one, a specimen 12 inches in length, was immature. No very small specimens were taken. All occurred at from 5 to 38 fathoms, the immature example at 10 to 13 fathoms in company with older ones. They appear to be distributed all along the West coast, but not very plentifully anywhere—unless by frequenting rocky ground they avoid capture in the trawl.

GREY GURNARD—*Trigla gurnardus.*

Depth in fathoms.	Length in inches.									
	0	1	2	3	4	5	6	7	8	9 and above.
0 to 5	4	..	..	..	..	..	..	..	1	8
5 to 10	..	1	..	..	..	2	..	..	..	55
10 to 15	..	4	..	..	..	..	..	1	1	45
15 to 20	..	..	..	..	..	6	3	9	6	72
20 to 25	..	..	..	14	116	110	28	33	19	37
25 to 30	..	..	..	..	..	..	6	..	2	38
30 to 35	..	..	..	..	2	2	4	12	7	52
35 to 40	..	..	..	..	..	1	..	7	2	55
40 to 45	..	3	..	..	..	1	1	..	..	2
45 to 50	..	..	..	..	..	..	2	..	2	22
50 to 55	..	..	..	..	..	..	..	..	..	10
74 to 80	..	..	..	..	..	..	1	..	..	3

812 gurnard were caught and 804 measured. Of these about 390, or less than half (48 per cent.), were mature, the remainder, about 52 per cent., being immature. The above Table shows a pretty general distribution of the species, both mature and immature, between 0 and 80 fathoms, as the zone between 55 and 74 fathoms was little explored by the trawl. The large number of small gurnard between 20 and 25 fathoms is due to a single haul (St. 147) in the Sth. Sound, between Aran and Moher, in which 300 specimens between 3 and $7\frac{1}{2}$ inches were taken. The smallest specimens, $\frac{1}{4}$ to $\frac{1}{2}$ inch, were taken in very shallow water, but the occurrences of specimens between 1 and 2 inches between 40 and 45 fathoms seems to show that the youngest stages are sometimes found in comparatively deep water. M'Intosh and Prince record specimens a little over $\frac{1}{4}$ inch from 25 fathoms. Fulton obtained most of his very small specimens (under 5 inches) in shallow water near shore, but a few were got in deep water at a distance from shore.

PIPER—*Trigla lyra.*

Of 28 piper taken only one was less than 12 inches, viz. a specimen (young) at 115 faths. (p. 150). The other occurred between 23 and 62 fathoms, except 2 at 144 faths. Thus, in all stages, this fish appears to be confined to rather deep water on this coast, where it appears to have not been much noticed hitherto, though apparently not rare. Vaillant found one at 222 fathoms in the Bay of Biscay, and it appears to be the most bathybial representative of the British gurnards. Day, and others, have noticed that it is subject to periodical disappearances, not easily accounted for, but give no record of the times of year when such take place. It perhaps eludes the fishermen by retreating into deeper water. During the "Fingal" cruise no piper were taken until the beginning of July, after which they were fairly abundant until the end of the cruise, and none were taken by the "Harlequin" after March.

SHORT-SPINED BULL-HEAD—*Cottus scorpius.*

Two specimens of 8 inches were trawled in Kilkieran Bay, at 5 fathoms. This species appears to be rather rare on the West coast.

LONG-SPINED BULL-HEAD—*Cottus bubalis*

Mature and immature specimens were everywhere common on weedy ground in shallow water, and amongst the rocks at the margin. The distribution of the two species on this coast presents a marked contrast to the condition on the East coast of Scotland, where the first species appears to be the more common.

ARMED BULL-HEAD—*Agonus cataphractus.*

A specimen, less than 1 inch in length, was trawled in Killeaney Bay in April, at 3 fathoms. Specimens, $1\frac{1}{2}$ and 2 inches, were at 9 to 7 fathoms in Dingle Bay in August. One of $3\frac{1}{2}$ inches was in 15 fathoms in Galway Bay in April. Larger examples were occasionally taken in shallow water amongst weeds. Fulton found examples under 2 inches in length, both in deep and shallow water, in-shore and off-shore, on the East coast of Scotland, where the species appears to be more abundant.

LESSER WEEVER—*Trachinus vipera.*

A few specimens were obtained from the stomachs of other fish at 8 and 9 to 10 fathoms, off Horn Head and off Port Stewart. The eggs were very abundant in Donegal and Inver Bays.

ANGLER—*Lophius piscatorius.*

Five immature examples, ranging from $8\frac{1}{2}$ to 21 inches, were at various depths from 16 to 38 fathoms. One of 12 inches occurred in rather shallow water off Aran (exact depth not specified). A mature specimen of 30 inches was taken at 4 to 12 fathoms, and 3 from 33 to 42 inches occurred between 32 and 48 fathoms. A mature male, 25 inches, was at 115 fathoms, 40 miles off Bolus Head. On the east coast of Scotland, where the species is much more abundant than, fortunately, appears to be the case on our ground, Fulton notes the remarkable paucity of small examples, and thinks that they must frequent the rocky in-shore grounds. The adults have an extensive vertical range. They have been taken by the "Research" on the south-west coast at 200 fathoms; by the "Talisman" at 411 fathoms; and on the other side of the Atlantic at 365 fathoms. On the other hand they are constantly caught in the salmon stake-nets on the East coast of Scotland.

LUMP-SUCKER—*Cyclopterus lumpus.*

This common littoral fish is only represented in our collections by 2 or 3 specimens less than an inch in length, which occurred in the surface-nets in June, always amongst floating weed, and an example about 2 inches, taken in the mackerel nets off Ridge Point, Blacksod Bay, probably also amongst weeds. A post-larval specimen was trawled in shallow water in Killeany Bay in April. The adults appear to live amongst the rocks, quite near the shore, but are not usual in the tidal pools except during the breeding season, when the male remains to guard the great masses of ova deposited between tide-marks. Great numbers of the fish are sometimes taken in the salmon stake-nets in St. Andrew's Bay. Very young examples, about half-an inch in length, may be usually taken in the summer and autumn on any coast amongst the fringes of Fucus, &c., at the edge of rock-pools. At a somewhat older stage they appear sometimes to swim in shoals.

JOHN DORY—*Zeus faber.*

Depth in fathoms.	Length in Inches.										
	4	5	6	7	8	9	10	11	12	13	14 and above.
0 to 5	..	..	..	..	..	..	..	..	..	..	..
5 to 10	..	2	..	..	..	..	..	..	..	..	4
10 to 15	..	..	..	..	..	..	..	..	1	1	3
15 to 20	2	..	..	..	..	..	..	..	1	2	2
20 to 25	1	..	..	..	..	..	..	..	..	..	..
25 to 30	..	..	..	..	..	..	..	..	..	..	..
30 to 35	..	..	..	..	..	..	..	..	..	..	..
35 to 40	..	..	..	..	..	..	..	1	1	..	6

As a matter of fact, with the exception of the five smallest specimens, all the fish examined were sexually mature, as all the specimens from 11 to 13 inches were males. As far as we can judge there is no great difference between the habitats of the young and old; but we have no evidence as to the very youngest stages. Fulton records a specimen three inches long from 10 fathoms.

Aphia pellucida.

4 adult examples were taken in Killybegs Inner Harbour in June, 1890. This is a very small fish, which had not previously been found in Irish waters. I never succeeded in getting any more specimens, though the shrimp trawl was worked over the same ground, and in many likely situations elsewhere. I therefore suppose that it is as rare here, as in other parts of Britain. It is apparently common on the Norwegian coast, where its habits have been observed by Collett, who concludes that it is an *annual vertebrate*, which spawns at the end of a year, and dies thereafter.

Crystalogobius nilssonii.

This is another very small fish, of which only one British specimen (from Banff) had been previously obtained. Collett drew the same conclusions from his observations of this form, as in the last. It is extremely abundant on the West coast of Ireland, and forms a frequent item of the food of some valuable fishes, but, as it always remains transparent, and in general appearance strongly resembles a very young herring or sprat, its neglect is easily understood.

In August a great number of all sizes, from adult and ripe males and females down to extremely minute individuals, were taken at 28 to 32 fathoms,[1] a fact which argues considerable latitude in the spawning season. In June a number were found in the stomachs of various fish in Galway Bay at 16 fathoms. Other specimens, either from the stomachs of fish, or in tow-nets attached to the trawl, were taken between 10 and 35 fathoms at Ballinskelligs Bay, Kenmare River, Galway Bay, Ballynakill Bay, off

[1] Since this, the first appearance of the species in Irish waters, was recorded, Mr. J. T. Cunningham has announced the capture of a large number off the Eddystone Lighthouse in 27 fathoms. He supposes that they are "fairly abundant between 20 and 30 fathoms on smooth sandy ground all along the British and Irish coasts." (*Vide* "Nature," vol. xliv., Sep. 1891, p. 482.) As far as concerns the West coast of Ireland, Mr. Cunningham's conjecture is more than confirmed, but the vertical range is a little more extended, and the species occurs on muddy as well as sandy ground.

Davalaun, Clew Bay, Broadhaven, Donegal Bay, Killybegs outer harbour, and Sheephaven. It is evidently a strictly bottom-haunting species, since, as Collett remarked, the air-bladder is almost always very much disturbed when brought to the surface from even such moderate depths.

DRAGONET—*Callionymus lyra.*

Immature dragonets were taken between 1 and 80 fathoms. The smallest, about 1 inch, was at 80 fathoms; others from 1 to 3 inches in 41 fathoms. One, about 2 inches, was at 55 fathoms, and many small specimens were at much less depths. Specimens of about 5 inches were very numerous in Boffin Harbour, 1 to 5 fathoms, and almost everywhere in less than 10 fathoms. Mature examples were taken at 25, and at 62 to 52 fathoms.

On the east coast of Scotland dragonets up to about half-an-inch are very numerous at the surface in St. Andrew's Bay and elsewhere late in the summer, and occur also at the bottom at various depths (about 4 to 7 fathoms in St. Andrew's Bay). Fulton obtained most of his immature examples (under 6 inches) at about 14 fathoms.

It appears that mature examples do not venture into very shallow water, whilst the immature extend from the margin into considerable depths.

SAND-SMELT—*Atherina presbyter.*

About 6 mature specimens of 5 inches and a specimen of 3 inches were taken in the seine on the sandy margin of Smerwick Harbour, 1st April, 1891. The species seems partial to such localities, but is rather local in its distribution. I have since taken post-larval examples in a rock-pool at the end of June.

WRASSES—*Labridæ.*

The Wrasses collected include the Ballan Wrasse, *Labrus maculatus;* Cook, *L. mixtus;* Corkwing, *Crenilabrus melops;* and Goldsinny, *Ctenolabrus rupestris.*

In their youngest stages the different members of this family are difficult to distinguish from each other, and as the adults principally affect rocky ground, inaccessible to the trawl, it is not possible to say much as to their comparative frequency. The Cook appears to be the rarest, only one mature example, a female of 11 inches, having been procured. This was at 30 to 31 fathoms, off St. John's Point, Donegal Bay, where the trawl hitched a rock. None of the other species were taken in more than 17 fathoms.

In August 25 examples, ranging from $\frac{3}{4}$ inch to $2\frac{1}{4}$ inches, were trawled amongs. weeds and Zostera in Kilronan (Aran) and Ballinskelligs Bays. They appear to be young Ballan Wrasse, with one young Cook, $1\frac{1}{4}$ inch, and perhaps a few very young Corkwings amongst them. Corkwings from $2\frac{1}{2}$ inches to 4 inches, occurred in one of the same hauls. In April Corkwing from 2 to 4 inches were taken in Boffin Harbour and Kilkieran Bay, with, at the last place, 2 Goldsinnies, $1\frac{3}{4}$ and $3\frac{1}{4}$ inches in lengtht In May young Ballan Wrasse of $3\frac{1}{2}$ inches, and Corkwings, from 2 to $2\frac{1}{4}$ inches, were numerous in Ballynakill Harbour. In June some young Corkwings were amongst the weedy fringes of rock pools at Killeany, and mature examples, $4\frac{1}{2}$ to $5\frac{1}{4}$ inches, were taken in Clifden Harbour, with young Ballan Wrasse, $3\frac{3}{4}$ inches long. In July Corkwings from $2\frac{3}{4}$ to 4 inches, and one of 9 inches, with young Ballan Wrasse of $4\frac{1}{2}$ inches, were amongst the Zostera beds in Inishlyre Roads and Blacksod Bay. The greatest depth was 6 fathoms, and all the hauls were on very weedy ground, so that it is evident that the shallow weedy ground in sheltered bays is the nursery of these two species. Larger examples of both forms were taken occasionally, always on weedy ground near rocks, and never, as I have said, at more than 17 fathoms. Probably they are frequent on the same ground as the younger, but too agile to be captured in our little shrimp-trawl. It is always noticeable that the colouration of these Wrasses, however striking it may be, is beautifully adapted to that of the particular kind of weeds amongst which they happen to be.

The Goldsinny appears to be less common than the Ballan Wrasse and Corkwing; I do not know at what size it becomes mature; our only large example, one of 8 inches, was trawled in Costello Bay. Young examples were taken on various occasions; though occurring on similar grounds they do not appear, as a rule, to consort with the young of the other Wrasses mentioned. Day remarks of this species that it "does not frequent tidal harbours, but appears to keep to deep water."

Another Wrasse, *Centrolabrus exoletus* (Linn.) has been recorded from the West Coast, but we failed to meet with it. It appears to be very rare in British waters.

COD—*Gadus morrhua.*

Depth in fathoms.	Length in Inches.																	
	1	2	3	4	9	11	13	15	16	17	19	21	23	24	25	28	29	30 and above.
0 to 5	69	15	6	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..
5 to 10	..	..	..	..	1	1	1	2	2	1	1	1	1	..	1	2	..	2
10 to 15	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1	1	..	4
15 to 20	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
20 to 25	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	8
25 to 30	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	8
30 to 35	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	8
35 to 40	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	8
40 to 45	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
45 to 50	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	1
50 to 60	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	5
60 to 70	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5
70 to 80	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5

6 fish are recorded as from 9 to 21 inches. I have divided these as equally as possible, between the two extremes, in the absence of more definite information. As I have reasons (see p. 152) for doubting the value of Fulton's limit of 20 inches, and have no certain knowledge of any mature female cod of less than 30 inches, I have given the distribution in detail up to that size. The first dotted line shows Fulton's limit, and the second shows about the size at which I think it possible that the female first comes to maturity.

Of 163 measured, 62 are more than 20 inches, 54 more than 26 inches, and 51 more than 29 inches. The Table shows a marked difference in habitat between those greater and less than 25 inches in length, but the numbers of moderate-sized cod observed are small. However, we may say that our evidence, such as it is, goes to show that cod of less than 25 inches do not extend into greater depths than 30 or 40 fathoms on this coast, at least during the period of observation, *which does not include the winter months.*

Again, cod of less than 20 inches appear to be confined to shallow water (with the same reservation). Fulton, however, records immature cod in all depths up to 55 fathoms, but the greatest number between 10 and 20 fathoms. As to the very small cod, below 5 inches, our evidence is comparatively satisfactory. The large number about an inch long, were taken in one haul in very shallow water, on muddy ground (peat) covered with a small woolly-looking dark-green weed, in company with many young Pleuronectids. This was in May. The larger specimens (2 to 4 inches) were mostly taken amongst the Zostera beds, so abundant in shallow bays on this coast, and most important as nurseries for the young of this and several others members of the genus Gadus. Others were taken amongst Laminaria and other brown weeds. Some post-larval stages (not included in the Table) occurred in the tow-nets.

On the east coast of Scotland, small specimens up to 3 or 4 inches are fairly abundant in the rock-pools at low water during the summer months, but much less so than the Coal-fish, and indeed than their older brethren on the deeper part of the Laminarian zone. For this fact Fulton's observations seem to account, since he tells us that whilst most of his specimens under four inches in length were found in comparatively shallow in-shore water (but by no means close to the margin). Some were also got at depths of twenty and fifty-five fathoms (in July). Thus, in Scotch waters, the very young cod have a pretty extensive vertical (and horizontal) range, a range of which we have no evidence on the west coast of Ireland.

The older immature cod, about 7 inches, and others from about 12 to 15 inches, haunt the outer Laminarian zone on the east coast of Scotland during the summer months, as also I believe in Ireland, and are variously known as Red or Rock Cod, and in Ireland as Tamlin Cod. Large mature cod also approach the shore so closely as to be occasionally caught in salmon stake-nets. Our largest example, 41 inches long, was got between 10 and 15 fathoms, and other mature specimens occurred between 5 and 10. Whether present or not in water of less than five fathoms cannot well be judged by our observations, since most of the hauls in such depth were made with a small shrimp-trawl, not efficacious for the capture of large and active fish During the summer months the cod is said to seek deeper water, and has been captured at depths exceeding 100 fathoms.

HADDOCK—*Gadus æglefinus.*

Depth in Fathoms.	Length in Inches.		
	—	6	12 and above.
10 to 15 . . .	..	..	2
15 to 20 . . .	..	..	7
20 to 25 . . .	..	..	18
25 to 30 . . .	..	1	13
30 to 35 . . .	..	..	32
35 to 40 . . .	..	..	18
40 to 45 . . .	..	..	2
45 to 50 . . .	..	..	6
at 55 . . .	..	..	1
at 70 . . .	..	..	1
70 to 80 . . .	..	..	9
at 154 . . .	..	..	4

112 Haddock were taken and measured. Only 1 was immature, viz. a specimen of 6 inches. The table shows that the vertical range of the adults is considerable; but that, on the coast examined, they do not appear to extend into very shallow water. The evidence of the trawl is not to be too implicitly relied on in the case of an active fish such as this; but the entire absence of Haddock above the 10 fathom line may perhaps be interpreted to mean that they do not enter shallow or more or less land-

locked bays, *e. g.* Blacksod and Cleggan Bays, &c., at least during the time that we visited them. As to the habitat of the immature Haddock our evidence is almost entirely negative. From Fulton's researches it appears, however, that they frequent comparatively deep water. His smallest specimens, under an inch in length, and unfortunately not preserved, occurred in 30 fathoms at 15 miles from shore. Günther has recorded 3 specimens, $2\frac{1}{2}$ to $3\frac{1}{2}$ inches, from 10, 15, and 90 fathoms, on the west coast of Scotland. From Irish waters our evidence, purely negative, goes to confirm the belief that the very small Haddocks certainly do not consort with the Cod, Coal-fish, and Pollack of the same size, in very shallow water, nor with the Whiting a little deeper. Moreover, they were not amongst the few very small Poor Cod taken at 23 to 26 fathoms, nor amongst the large number of minute *Gadus argenteus* (from $\frac{3}{4}$ inch to 3 inches), taken at 50 to 60, and 80 fathoms. Fulton considers that the very young Haddock "soon seek the bottom, and probably chiefly rocky ground (where the trawl cannot be used), at some distance from shore." The suggestion merits attention, and I think it may be said that all evidence, positive and negative, points to the moderate depth, say 20 to 50 fathoms, as the nursery of this species, the distance from land (and to some extent, the depth) of course depending on the declivity of the particular locality.

WHITING—*Gadus merlangus.*

Depth in fathoms.	Length in Inches.									
	1	2	3	4	5	6	7	8	9	10 and above.
0 to 5	1	9	1	..	..	1	..	..	..	..
5 to 10	..	..	..	..	..	..	..	..	..	..
10 to 15	..	..	..	..	..	..	..	..	..	2
15 to 20	..	..	..	..	..	..	..	..	..	7
20 to 25	..	..	..	..	..	2	..	..	..	13
25 to 30	..	..	..	..	..	..	..	..	..	12
30 to 35	..	..	..	..	..	..	..	..	..	13
35 to 40	..	..	..	..	..	..	..	..	..	17

Of 81 Whiting captured, measurements are given of 78, and 3 are recorded as small. 64 were mature; only 14 less than 7 inches, and 11 less than 4 inches. The least depth at which a mature form occurred is perhaps 5 fathoms, as one was taken in a haul at 19 to 5 fathoms. Otherwise the evidence seems to show that mature Whiting are must abuudant between the 20 and 40 fathom lines. Of the smallest examples taken one, $3\frac{1}{4}$ inches long, was found under the umbrella of a large jelly-fish (*Cyanœa*), and the remainder amongst the Zostera beds, in company with young Coal-fish, &c. Fulton gives most interesting observations on the distribution of immature whiting on the East coast of Scotland. He computes that in the autumn of 1889 above 230,000,000, mostly ranging from 3 to 5 inches, were present in the Firth of Forth and the neighbouring waters, chiefly in 15 to 30 fathoms, and comparatively scarce in shallow waters near the shore. Thus it would appear that whilst the youngest stages are pelagic, as demonstrated by Professor M'Intosh, the home of the bulk of the somewhat older forms is at a moderate depth, but few, such as those we met with in Blacksod Bay, occurring in the very shallow water. Great numbers of Whiting, about 4 to 7 inches, are sometimes caught on the haddock-lines, in or off St. Andrew's Bay, even as Professor M'Intosh remarks in his Report on the Trawling Commission, to the annoyance of the liners. They come chiefly, I think, from sandy ground at about 12 fathoms.

COAL-FISH—*Gadus virens.*

Depth in fathoms.	Length in Inches.								
	1	2	3	—	15	27	28	—	32 and above.
0 to 5	93	62	9	..	..	..	..	..	..
5 to 10	..	..	..	..	2	..	..	..	2
10 to 15	..	..	..	..	..	1	1	..	2
20 to 30	..	..	..	..	..	..	..	..	1
30 to 35	..	..	..	..	..	..	..	..	2
50 to 52	..	..	..	..	..	..	..	..	4
at 70	..	..	..	..	..	..	..	..	43

Of 231 Coal-fish caught and measured, 174, or over 70 per cent. were less than 3 inches long, 2 were 15 inches, and the remainder above 26 inches long. Probably the limit of maturity occurs somewhere between 15 and 27 inches. The Table shows that all the very smallest specimens occurred in 5 or less than 5 fathoms ; those at 15 inches in less than 10 ; whilst the majority of the larger examples were in 70 fathoms ; and only 1 (perhaps) in less than 5 (10 to 4½), 8 fathoms being otherwise the least depth at which any were captured.

Neither the eggs nor larval or post-larval stages of this fish have as yet been recognised, but the habitat of the young (from 1 inch upwards) is well known. I have reason to suppose that up to about an inch the young are pelagic, but as my identification of the various very small fish taken in the tow-nets is not yet complete, I have omitted them from this Report. Fulton remarks that it is "known that, at certain parts of the (Scotch) coast young coal-fish swarm around the shores, especially on rocky tangle-covered ground." At St. Andrew's, shoals of little coal-fish, about 1 to 2 inches long, begin to appear amongst the rocky pools in the early summer, and even enter the inner harbour at high water, haunting the Ulva along the sides.[1] This is also the case on the west coast of Ireland. Besides those accounted for by the shrimp trawl, I have seen numbers about the pier at Killybegs in May, and in the ruined harbour at the west of Achill in June, and at many other parts of the coast. At our anchorage in Killybegs harbour, in June, great numbers of these fish, 2 to 3 inches long, were darting about at the surface in company with young Pollack, eagerly pursuing a shoal of small Sandeels. In the winter, these very young fish appear to desert the extreme margin for slightly deeper water. We have no evidence of the habitat of the next older stages in Irish waters, but at St. Andrew's, in the summer, large numbers, between 4 and 7 inches long (evidently consisting, partly at least, of the same fish which haunted the rock-pools in the previous summer) enter the harbour (and also, I believe, the docks at Dundee) with the flood tide, and are largely caught by youthful sportsmen with a mussel bait. Occasionally specimens as large as 10 inches are taken in the harbour; but these are usually to be found, in company with somewhat larger ones, on the rocky tangled-covered ground, in 2 or 3 fathoms, at a short distance from shore, where they consort with the young (Tamlin) cod. On a calm sunny morning I have seen the whole surface of the water in this neighbourhood broken by the small Coal-fish, similar to those found in the harbour, which were rising like trout at some small surface organisms, apparently larval crustaceans. Specimens of about 15 inches are also caught in the autumn at low water, from the ends of the long ridges of rock which run out into the sea. It would

[1] I have also taken Coal-fish, about an inch long, swimming at the surface about two miles from land, in about 7 fathoms, in July. These occurred singly and not in shoals.

appear that their usual haunt at this stage is similar to that of the Pollack, viz. on rocky ground, or in its neighbourhood, at no great depth. Being an exceedingly active fish they are less liable even than the Pollack to be captured in the trawl. It is almost certain that the Coal-fish, of the last stage mentioned, retire into deeper water in the winter, and never thereafter resort to the shallow water to such an extent as before. They cannot be looked upon as strictly bottom fish at any stage of their career, although never pelagic to the same extent as the mackeral and herring.

NORWAY POUT—*Gadus esmarkii.*

Two specimens, 4 and $6\frac{1}{2}$ inches, were found in the stomach of a Gurnard, trawled at 45 to 48 fathoms at the mouth of the Kenmare River on the 30th March. In April, 3 of about 4 inches, were in the stomach of a Tope from 50 fathoms off Inishmore; several of the same size in the stomach of a Witch, at 45 to 50 fathoms off Inishmore; another was trawled, and several occurred in the stomachs of Cod, Whiting, and Turbot at 38 fathoms, off Gregory Sound; and on the same ground others were taken from the stomachs of Pollack, Ling, and Turbot. In July, another of the same size was in the stomach of a Cod taken on the long lines, at 45 to 50 fathoms, 15 miles off Beetle Head, Clare Island; and one of $6\frac{1}{2}$ inches was trawled at 144 fathoms, 30 miles off Achill Head. All these were mature, as this fish reaches maturity at about 4 inches. This fish, though not previously noticed in Irish waters, seems thus to be fairly abundant in the deep and moderately deep water to which it is confined. Günther, in 1888, was the first to notice its occurrence in British waters, from the North-west coast of Scotland, where it seems to be abundant at from 26 to 80 fathoms. It was previously known from the Norway coast, "where it occurs locally in deep water in the winter months" (Günther), and from the neighbourhood of the Faröe Islands.

POLLACK—*Gadus pollachius.*

Comparison of Habitats of Mature and Immature Pollack.

Depth in fathoms.	Length in Inches.												
	0	1	2	3	4	6	10	13	14	15	16	17	18 and above.
0 to 5	1	9	19	12	4	1	1	..	..	..	..	..	..
5 to 10	..	..	..	..	..	..	..	7	7	7	7	2	7
10 to 15	..	..	..	..	..	..	..	..	..	..	..	3	9
15 to 20	..	..	..	..	..	..	..	..	..	..	..	..	1
20 to 25	..	..	..	..	..	..	..	..	..	..	..	..	1
25 to 30	..	..	..	..	..	..	..	..	..	..	..	..	1
30 to 35	..	..	..	..	..	..	..	..	..	..	..	..	2
35 to 40	..	..	..	..	..	..	..	..	..	..	..	..	14

The habitat of the older stages of the Pollack is pretty well known. They are to be found amongst the rocky weed-covered ground on almost every coast, in shallow or moderate depths; their vertical range being co-extensive most probably with that of the sheltering vegetation. It does not appear that the very large (mature) forms frequent the shallower waters close to the shore to such an extent as the smaller ones. Their habit appears to be to lie hidden amongst the weeds during the day-time, darting out at prey on occasions, whilst in the evening and night they rise into midwater and to the surface, and lead a pelagic existence. Thus, all the Pollack between 13 and 17 inches (except 3) and 4 mature forms were caught in the mackerel nets one night in Killeany Bay. It seems hardly necessary to say that their movements are doubtless regulated by those of their prey, which is mainly of a pelagic nature, as indeed the structure of their jaws would seem to indicate sufficiently. The presence of a considerable number of very large forms on sandy ground, between 35 and 40 fathoms, may be partly connected with the spawning instinct, as many of them were ripe or approaching ripeness, or may be a normal habitat insufficiently understood owing to the activity of the fish aiding it to avoid the trawl. During the winter months, the Pollack are not much in evidence, presumably because the organisms on which they prey do not affect the upper waters and shore margins during that period. I gather from the tow-net collections, not included in the above table, that the very young Pollack, less than an inch long, are pelagic, and to some extent shelter themselves under the umbrellas of the large jellyfish (Cyanœa), like the young of some other members of the genus. Specimens of about an inch and less appear amongst the rock pools and Zostera beds somewhat later than the young Coal-fish, a fact to be connected probably with the difference in the spawning periods of the two forms. They are abundant in such localities, up to 3 or 4 inches, during the late summer and autumn, and a few larger specimens, 4 to 10 inches, were found with them. On the Cornish coast I have seen numbers about 6 inches long darting about at the surface close to rocks, in the evening in autumn. Young Mackerel-midges, which were rather plentiful, appeared to be the object of this activity. On the east coast of Scotland the fish seems to be rare, and the only specimen I have seen at St. Andrew's was a large fish taken in the salmon stake-nets in May.

SILVERY POUT—*Gadus argenteus.*

In August, great numbers, from less than 1 up to about $2\frac{1}{4}$ inches, were trawled at 62 to 52 and 80 fathoms, off the Skelligs. In April a specimen of about 4 inches was taken from the stomach of a Witch from 166 fathoms, 20 miles off Black Rock. In July, a few, from $4\frac{1}{2}$ to 5 inches occurred at 220 fathoms, and a great number at 144 fathoms, 40 and 30 miles off Achill Head.

This species, which does not seem to attain a greater length than $5\frac{1}{2}$ inches, is thus extremely abundant locally on this coast, and appears to be gregarious at all stages. It is noticeable that the very young forms are found in shallower water than seems to be frequented by the adults. It has been known in the neighbourhood of Ireland since 1869, when the "Porcupine" took an example from 183 fathoms off the south-west coast. Bourne, in the "Research," obtained 2 near the same place in 1889, and some years before, Day had recorded a single example cast up on the beach after a storm, at Aberdeen. It was discovered in the Mediterranean by Guichenot, and has more recently been obtained there again by Giglioli. Vaillant found it very numerous on the north-west coast of Africa. The recorded range seems to be from 52 to 220 fathoms.

MORO.—*Mora mediterranea.*

Two young examples, 9 and 12 inches, and an adult of 29 inches, were trawled at 500 fathoms, 54 miles off Achill Head. This is an exclusively deep-sea form, and is found in the Mediterranean, off Madeira, where it is common in 300 to 400 fathoms, and off the Canary Islands, where it is taken all the year round in 200 fathoms. It has not been taken in British waters before.

HAKE—*Merluccius vulgaris.*

Of 31 Hake caught 7 were immature, viz. 3 at $1\frac{1}{4}$ to $1\frac{1}{2}$ inches in 80 fathoms, 1 at 6 inches in 115 fathoms, 1 at $7\frac{1}{2}$ inches in 40 fathoms, and 2 at 8 inches in 53 fathoms. Of 24 mature examples, 11 occurred at 25 to 27 fathoms, 4 at 38 fathoms, 1 at 62 fathoms, 4 at 70 to 80 fathoms, 2 at 115 fathoms, 1 at 154 fathoms, and 1 at 220 fathoms. It appears, therefore, that Hake, both mature and immature, avoid waters of less than 25 fathoms, whilst on the other hand they extend into great depths, having been taken on the other side of the Atlantic in over 400 fathoms. Professor M'Intosh records several Hake about 14 inches long, from 34 fathoms in Aberdeen Bay. Fulton records an example 4 inches long from 14 fathoms in the Forth, so that there appears to be variations in the immature habitat in British waters; but the evidence on this subject is very scanty. Mature and fairly large Hake are known to make periodical incursions towards the shore, and into comparatively shallow water at particular seasons of the year, when it is reasonable to suppose that they are following shoals of smaller fish. Rather small Hake are taken in considerable numbers in the mackerel nets, so that they are evidently nocturnally pelagic in their habits, though to some extent also bottom feeders.

FORKBEARD—*Phycis blennioides.*

A specimen of about 3 inches was taken from the stomach of a Witch from 154 fathoms, 28 miles off Achill Head in April. One of $3\frac{1}{2}$ inches was trawled at 26 fathoms in the Kenmare River in August. Five specimens, 9 to $12\frac{1}{2}$ inches, were at 220 fathoms, 40 miles off Achill Head in July, and one of $18\frac{1}{2}$ inches was trawled at 375 to 500 fathoms, 45 miles off Black Rock in May.

The Forkbeard is known as an occasional visitor to British shores, chiefly in the winter months. It is not uncommon in littoral waters throughout Europe, and is abundant in the Mediterranean (Day). On the Norway coast it is known to occur between 70 and 200 fathoms. Examples were obtained in deep water on the S.-W. coast of Ireland by the "Lord Bandon," and "Flying Fox." About 6 examples have been previously recorded from this country, but it is probably fairly plentiful in deep water. It appears, on our ground, to be a form which normally inhabits deep water, but occasionally ventures into comparatively shallow areas. It is said to reach a length of about two feet.

Haloporphyrus eques.

5 specimens, from $4\frac{5}{8}$ to 13 inches, were trawled at St., 500 fathoms, 54 miles off Achill Head.

This is an exclusively deep-sea fish, first obtained by the "Knight Errant," at 530 fathoms, in the Faroe Channel, and subsequently by the "Flying Falcon," in 750 fathoms, and the "Research," at 400 fathoms, off the South-west coast of Ireland.

FIVE-BEARDED ROCKLING—*Motella mustela.*

A few adults were found in the rock-pools in Killeany Bay, Aran, in June, and, in the "Mackerel Midge" condition, this species was exceedingly common at the surface during June, and the beginning of July. It was noticed that three young Rockling were most frequently taken amongst floating weed, beneath which they appeared to take shelter, as has been observed by others.

This species appears to be very common on all the coasts of this country. It resides usually, after the pelagic stage of its condition is passed, amongst the rocks near the margin.

LESSER THREE-BEARDED ROCKLING—*Motella tricirrata.*

A very small specimen was trawled at 4 to 12 fathoms in Gorteen Bay, and a "Mackerel Midge," 1½ inches in length, was taken at the surface on the 4th July, 40 miles from Achill Head (depth, 220 fathoms).

LING—*Molva vulgaris.*

203 Ling were caught, of which 6 were immature (less than 24 inches), viz. 1 at 17 inches, and 5 from 21 to 23½ inches. These occurred at depths between 16 and 55 fathoms, pretty evenly distributed. Of 197 mature examples, 66 were in less than 30 fathoms, including 6 in less than 30, of which 3 were in less than 10 fathoms, viz. at 5 to 7 fathoms in Ship Sound, Boffin. Forty were at depths exceeding 60 fathoms, including 8 at above 80 fathoms, viz. at 127 and 154 fathoms. The remainder (81) were at depths between 30 and 60 fathoms. Thus, the mature Ling on this coast appear to affect principally the deeper waters, and whilst venturing into the shallow area, avoid the inner waters of bays. As to the habitat of the smaller immature forms, our evidence is entirely negative, and on this subject such evidence as there is from other sources is of a conflicting nature. Thus, Günther, on the authority of Collett, remarks that "on the Norwegian coast young examples of the Ling are rarely found at a less depth than 100 fathoms. Fulton, in recording 3 examples, 7 to 12 inches, from "deep water at the mouth of the Forth" (about 30 fathoms ?) remarks that, "while very young Ling seem to be sometimes got among the tangle in shallow water, the presence of immature forms in the territorial waters may be considered uncommon." M'Intosh and Prince, however, state distinctly that Ling about 8 and 9 inches abundantly frequent the rocky margins. In the summer of 1890 I took two specimens, 8 and 12 inches long, the former in a rock-pool, and the latter towards the margin of the Laminarian zone, at St. Andrews, and have obtained a few others about the same size from the outer part of the bay. Mr. Green has taken an immature specimen in Queenstown Harbour. Thus there seems good reason to suppose that the young Ling are by no means uncommon near the shore, though, as I gather, principally approaching it in the summer. In very early life the Ling appears to be pelagic, and bears a strong resemblance to the younger "Mackerel Midge" stages Rockling.

Macrurus cœlorhynchus.

Several specimens from 5 to 9¾ inches were trawled at 220 fathoms 40 miles off Achill Head, on the 4th July. The largest appeared to be mature. Some small examples were also taken at 144 fathoms.

This species is known from the Mediterranean, and off Madeira, and is thought by Collett to have occurred off the Norway coast. Like all the members of this genus, it is an exclusively deep-sea form.

Macrurus æqualis.

A mature specimen of 11½ inches, and 6 young examples, from 5½ to 8 inches, were trawled at 500 fathoms, 54 miles off Achill Head, on the 11th July.

This species was first taken by the "Challenger" 600 fathoms off the coast of Portugal. It has not previously been taken in British waters.

Macrurus rupestris.

Four specimens, 26½ to 38 inches, were taken at 500 fathoms, 54 miles off Achill Head, on the 11th July. This species has been taken on the Norway coast, and in the Faröe channel (200 to 500 fathoms), on the American side of the Atlantic (524 fathoms). Our largest example represents the largest size of which I can find a record.

Macrurus lœvis.

Sixteen examples, 10 to 21½ inches, were trawled at 220 and 144 fathoms, 40 and 30 miles off Achill Head, on the 4th July. One of 15 inches occurred at the former depth 50 miles off Bolus Head, on the 23rd March, and eight, about the same size, at 154 fathoms, 26 miles off Achill Head, on the 20th April. Specimens were previously taken off the S.W. coast at 200 to 250 fathoms, by the "Flying Fox" and "Research." The species may be said to be cosmopolitan. It is known from Madeira and the Mediterranean, and examples have been recorded from the coast of Denmark (Lütken), off Pernambuco (Challenger), and from the Andaman Sea (Alcock). The size of our largest specimen appears to represent the full dimensions, as far as they are known.

LONG ROUGH DAB—*Hippoglossoides limandoides.*

Depth in fathoms.	Length in Inches.						Remarks.
	1	2	3	4	5	6 and above.	
20 to 25	..	..	..	..	..	3	
25 to 30	..	..	..	..	..	..	
30 to 35	..	..	..	..	..	8	
35 to 40	..	..	1	..	1	8	
40 to 45	..	..	..	..	..	1	
45 to 50	..	..	..	..	..	1	
50 to 60	13	..	..	..	..	..	3 very small; exact size not recorded.
60 to 70	..	..	..	..	..	..	
70 to 80	5	..	3	..	..	..	7 very small; exact size not given.

This table points to the fact that the younger stages of existence are passed in deep water, the fish gradually approaching the shore as it grows older. Fulton on the East coast of Scotland found hardly any very small specimens at a less depth than 12 fathoms, the majority being in about 20 fathoms, and some occurring at 55 fathoms.

TURBOT—*Rhombus maximus.*

Depth in fathoms.	Length in Inches.											
	1	—	—	—	11	12	13	14	15	16	17	18 and above.
0 to 5	..	..	..	..	..	..	..	2	1	..	..	..
5 to 10	..	..	..	..	1	2	5	3	2	3	2	6
10 to 15	..	..	..	..	..	..	..	..	..	..	2	6
15 to 20	..	..	..	..	..	..	..	..	1	..	..	3
20 to 25	..	..	..	..	..	..	..	..	1	..	1	5
25 to 30	..	..	..	..	..	..	..	..	..	..	..	2
30 to 35	..	..	..	..	..	..	..	..	..	..	..	1
35 to 40	..	..	..	..	..	..	..	..	..	..	..	4

This table, so far as it goes, appears to show that no mature Turbot penetrate into quite such shallow water as some of the immature forms, and also that no immature forms get into such deep water as a proportion of the mature. It would also appear that the closing of waters within the 10 fathom line would protect a very large proportion of the immature forms, though at the same time, in the case of such places as Lough Swilly, a large number of fine fish might thereby be prevented from reaching the market. Fulton is of opinion that on the East coast of Scotland the majority of the young Turbot are on the off-shore grounds. It seems to me that the evidence is all to the contrary. Fulton finds a difficulty in accepting the statement that "thousands of young Turbot may be found at some places in the shallow waters and pools on the beach, and that they are largely destroyed by shrimp-fishers." I have myself taken Turbot about 2 inches long at the sandy margin, at half tide, opposite the Laboratory at St. Andrews whenever I made use of a fine seine net at that place (in September and October), and do not doubt that such smaller forms as Buckland describes occur there in the earlier part of the year.[1]

BRILL—*Rhombus lævis.*

DEPTH in fathoms.	Length in Inches.											
	1	2	—	—	8	9	10	11	12	13	14	15 and above.
0 to 5	..	1	..	..	..	..	..	..	..	..	1	4
5 to 10	..	..	..	..	1	..	2	1	5	5	2	25
10 to 15	..	..	..	..	..	..	1	..	..	..	1	18
15 to 20	..	..	..	..	..	..	..	..	1	..	..	9
20 to 25	..	..	..	..	..	..	..	..	..	..	..	9
25 to 30	..	..	..	..	..	..	..	..	..	..	..	2
30 to 35	..	..	..	..	..	..	..	..	..	..	..	2
35 to 40	..	..	..	..	..	..	..	..	..	..	..	4

It appears that the immature Brill are most frequent about the 10 fathom line, when between 8 and 14 inches long. The young (exclusive of the larval and post-larval) stages appear to be passed at the sandy margins, and the life history generally seems to be much the same as in the Turbot.

At St. Andrews I have taken a few small Brill, about 2 inches long, in company with Plaice and Turbot, about the same size, at the edge of the sands, and I do not know of their occurrence in deeper water. I think it probable that Fulton's opinion that the young are chiefly to be found at considerable distances from land will be seriously modified when more evidence has been obtained.[2]

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[1] On looking over the bottom tow-net collections, made on the Donegal coast in May, I have found a number of minute post-larval forms, ranging from $\frac{1}{5}$ to about $\frac{7}{16}$ inch, which may perhaps belong to this species. They occurred at various depths between 10 and 32 fathoms. I believe that after the completion of the post-larval period the young Turbot at once approach the margin, and reach it before the end of the first year of their life. Otherwise I do not see how the absence of intermediate forms from our collections is to be accounted for. They do not occur amongst the young Plaice in shallow water, nor amongst the young Dabs, which extend into depths of about 30 fathoms, nor in the deeper water, down to 80 fathoms, frequented by the young of the Witch, Pole Dab, Lemon Dab, and Long Rough Dab. We have, in fact, no record of their occurrence except at the margin.

[2] Post-larval forms, which I believe to be Brill, of about the same size as the Turbot, were taken in the bottom tow-net in May on the Donegal coast between 10 and 22 fathoms.

WITCH—*Arnoglossus megastoma.*

Depth in fathoms.	Length in Inches.											
	0	1	2	3	4	5	7	8	9	10	11	12 and above.
4 to 9	..	..	..	..	..	..	..	..	..	..	..	1
15 to 20	..	..	..	..	..	..	..	..	..	1	..	1
20 to 25	..	..	..	..	..	..	..	..	..	..	..	93
25 to 30	..	1	..	1	4	..	..	..	..	..	..	3
30 to 35	..	..	..	..	..	..	..	..	..	..	..	3
35 to 40	..	..	..	..	..	..	..	..	..	..	..	1
40 to 45	..	..	1	..	..	..	..	..	..	..	..	1
45 to 50	..	..	..	..	..	..	..	..	..	12	5	..
50 to 60	..	..	..	..	..	1	..	..	4	4	4	37
70 to 80	1	7	7	..	2	..	1	..	..	2	..	..
115 to 127	..	..	..	..	1	..	..	1	1	1	1	4
at 154	..	..	..	..	..	..	..	..	..	3	..	44
at 220	..	..	..	..	..	..	..	..	..	..	1	7

The Witch has been taken at a maximum depth of 315 fathoms on this coast. It is not possible to define a habitat of the immature as apart from that of the mature, but it appears that the younger stages never come so near the shore as some of the latter. Very few seem to get above the 20 fathom line. It is noticeable that this fish spawns in deep water, and that the young are found there, as in the case of the Hake and some other forms, whereas in the case of the Turbot, which is supposed by Fulton to spawn in comparatively deep water, and at great distances from land, the young are at all events frequent in very shallow water.

The first dotted line indicates Fulton's limit. The second line shows what I am inclined to think is the limit of mature females.

SCALDFISH—*Arnoglossus laterna.*

Specimens are taken as follows:—In April, 1, $4\frac{3}{4}$ inches, at 25 to 20 fathoms off Gregory Sound; 1, $4\frac{1}{2}$ inches, at 25, $1\frac{1}{2}$ to $2\frac{1}{2}$ inches, at 15 fathoms, in Galway Bay; 1, 2 inches, at 5 fathoms, in Blacksod Bay. In May, 1, $2\frac{3}{4}$ inches, at 3 fathoms, in Teelin Harbour; 7, $2\frac{1}{2}$ inches, 2, $4\frac{1}{2}$ inches, 1, 5 inches, at 3 fathoms, off Rossnalegh Point, Donegal Bay. In August, 5, $3\frac{1}{2}$ inches, at 14 fathoms, in Galway Bay, and 4, 1 inch, and 6, 4 inches, at 41 fathoms, on the Nymph Bank, Ballycotton. It thus appears that this fish is pretty generally distributed along the coast, always in rather shallow water, and there is no apparent difference in the haunts of the young and the older stages. Cunningham records that they are exceedingly abundant at "all sizes from about three quarters of an inch long up to the full size of about 6 inches" in Cawsand Bay, Plymouth Sound, where they are looked upon by local fishermen, in common with the solanette, as the young of the common sole.

BROAD SCALDFISH—*Arnoglossus grohmannii.*

A specimen of 5 inches was trawled at 6 fathoms in Clifden Harbour, between the anchorage and the north shore, on the 11th June, 1890. Three young examples, $1\frac{5}{8}$ to $1\frac{3}{4}$ inches, occurred at 4 to $5\frac{1}{2}$ fathoms in the Inner Harbour, Killybegs, on the eastern side near the entrance, on the 16th May, 1891. This species was previously known in British waters from a specimen taken by Mr. Green, in the Kenmare River, and another described by Mr. Cunningham, from Cawsand Bay. It seems to affect shallow and rather stony ground, amongst weeds. It is probably pretty generally distributed in suitable localities on the west coast, and may prove to be less rare than is at present supposed. It is well known in the Mediterranean.

NORWAY TOPKNOT.—*Rhombus norvegicus.*

The only specimen of this fish, which has not previously been recorded from Irish waters, occurred at 30 to 31 fathoms, off St. John's Point, in Donegal Bay, the soundings being sand, gravel, and rock.; it was $3\frac{1}{8}$ inches in length. A specimen has been obtained from the Bristol Channel (Couch), and a few have been taken on the Scotch Coast and off the Shetlands, in various depths, 6 to 18, 43, 45 and 90 fathoms (Günther). It is not very rare on the northern shores of Norway, and, on account of its small size, and possible predilection for rocky ground or its neighbourhood, may have been to some extent overlooked in British waters.

PLAICE.—*Pleuronectes platessa.*

Depth in fathoms.	Length in Inches.														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15 and above.
0 to 5	9	15	10	10	..	18	4	3	10	7	18	6	20	23	26
5 to 10	..	..	10	10	1	39	37	31	22	30	42	52	155	100	264
10 to 15	..	..	..	..	..	2	..	1	1	9	15	23	37	31	134
15 to 20	..	..	..	..	..	..	..	..	1	3	6	12	13	9	9
20 to 25	..	..	..	..	..	..	..	..	1	4	5	10	20	10	35
25 to 30	..	..	..	..	..	..	..	..	..	..	1	1	3	2	9
30 to 35	..	..	..	..	..	..	..	..	..	..	..	..	4	10	25
35 to 40	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
40 to 45	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
45 to 50	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..

Some 50 or 60 Plaice had to be omitted, as either the measurements or the soundings are not forthcoming. The table bears out Fulton's statement that the shallow inshore waters may be regarded as the nursery of this species. It also shows that on this coast large Plaice are very abundant in the inshore waters *during the period of observation*, which does not include much of the spawning period. Dr. Fulton tells me that this is also the case, *except at spawning time*, on the East coast of Scotland. In evidence given before the Inspectors of Irish Fisheries, the captain of a steam trawler recorded the capture, during a total of 30 days' fishing in the months of July, August, September and October, 1890, of no less than 6060 plaice, which were almost all obtained in Downies Bay. This number includes only the saleable forms, *i. e.* fine fish, since the smaller ones are not worth sending to market at that distance. Downies Bay is an inner recess of Sheephaven, and thus well within any territorial limits; and Mr. Green tells me that the ground on which this trawler worked was above the 10-fathom line. A glance at the results of our own fishing in the same bay, at the end of May, shows that fine plaice are fairly abundant at that season also, whilst immature forms are also present. In Blacksod and Cleggan Bays we also found numbers of fine fish, and immature fish also. Thus, we cannot distinguish on this coast between the habitats of mature and immature Plaice, that is, if we wish the distinction to be equally applicable throughout all seasons of the year. Our observations show, during the period which they comprehend, a scarcity of Plaice in more than 35 fathoms of water; but I do not doubt that if observations could be systematically carried out throughout the year, we should find a considerable migration seawards of the larger fish towards the spawning season. The very young fish, which here, as on the East coast of Scotland, inhabit the sandy margins, are, in the absence of any shrimping industry, in no way molested by man. Post-larval examples were frequent in shallow water, ½ to 9 fathoms, in April and May.

LEMON DAB.—*Pleuronectes microcephalus.*

DEPTH in fathoms.	Length in Inches.							
	1	2	3	4	5	6	7	8 and above.
0 to 5	..	..	..	..	..	..	..	2
5 to 10	..	..	..	..	..	..	..	16
10 to 15	..	..	..	..	..	..	..	17
15 to 20	..	..	..	..	..	..	..	21
20 to 25	..	..	..	..	..	..	1	17
25 to 30	..	..	..	..	..	..	..	5
30 to 35	..	..	..	..	..	..	..	11
35 to 40	..	..	..	..	..	..	..	3
40 to 70	..	..	..	..	..	..	..	..
70 to 80	2	..	..	..	..	..	..	..

Only four examples below 8 inches were obtained. Of these one is a ripe male, 7½ inches, and the others are less than 2 inches, and were taken in 62 to 52 and 80 fathoms. Fulton found his smallest specimens, 2 inches, in about 20 fathoms, and others of 4½ inches at about the same depth on the Smith Bank. Thus, the life history of this species seems to be similar to that of the Long Rough Dab, the earliest stages being passed in deep water, and the fish gradually approaching the shore as development proceeds. The Lemon Dab, however, penetrates into much shoaler water than the Long Rough Dab appears to do on this coast. Günther has recorded specimens from 40 to 60 fathoms, and both mature and immature from 30 to 35 on the north-west coast of Scotland.

POLE DAB—*Pleuronectes cynoglossus.*

DEPTH in fathoms.	Length in Inches.									
	1	—	5	6	—	10	11	12	13	14 and above.
19 to 25	..	..	..	..	..	..	25	25	32	27
25 to 30	..	..	..	..	..	..	..	..	6	2
30 to 35	..	..	..	..	..	1	2	18	3	27
35 to 40	..	..	..	..	..	1	..	2	1	1
40 to 45	..	..	..	..	..	..	..	1	..	..
45 to 70	..	..	..	..	..	..	..	..	..	..
70 to 80	5	..	..	..	..	..	..	..	..	..
at 144	..	..	2	1	..	..	..	..	..	..
at 220	..	..	..	..	..	..	4 rather small			..

The youngest stages are evidently passed in deep, or rather deep, water, the fish only penetrating into comparatively shallow water when of considerable size. Fulton obtained two immature specimens at 20 fathoms. The species is known to reach depth of over 700 fathoms.

COMMON DAB—*Pleuronectes limanda.*

Depth in fathoms.	Length in Inches.						
	1	2	3	4	5	6	7 and above.
0 to 5	38	34	11	1	1	1	51
5 to 10	..	1	56	3	8	38	266
10 to 15	4	5	4	14	15	6	214
15 to 20	2	..	..	..	3	29	136
20 to 25	..	..	2	1	16	27	222
25 to 30	..	..	..	1	1	20	49
30 to 35	..	..	..	..	..	42	249
35 to 40	..	..	..	..	..	..	6
40 to 50	..	..	..	..	..	..	..
at 53	..	..	..	..	..	..	1

Of 1674 Dabs caught, 1575 were measured, of which about 1190 were mature, and about 380 immature.[1] It will be seen that whilst the immature forms are most numerous in shallow water, even the smallest sizes extend into considerable depths (20 fathoms), thus presenting, as Fulton remarks, a marked contrast to the small Plaice. Fulton remarks that they appear to occur in patches, which is also my experience. I think it probable that this adaptability of the young stages to such a wide vertical distribution is one of the causes of the great abundance of this species. According to Fulton it is by no means one of the most fecund of Flat-fishes (9th Ann. Rep. S. F. B., 1891).

FLOUNDER—*Pleuronectes flesus.*

Depth in fathoms.	Length in Inches.						
	1	2	3	4	5	6	7 and above.
0 to 5	..	5	2	2	1	1	..
5 to 10	..	..	..	..	..	..	14
10 to 15	..	..	..	..	..	..	..
15 to 20	..	..	..	..	..	..	..
20 to 25	..	..	..	..	..	..	2

The very young Flounders frequent the margins of estuaries, or near the mouths of small streams, and like the adults penetrate into perfectly fresh water. Very small examples, less than an inch long, may be met with in the summer in rock pools, and on fine calm days swimming at the surface at some little distance from land in St. Andrew's Bay. It is only when mature that this species again ventures into comparatively deep and quite salt water.

On the Survey no mature examples were captured at a less depth than 5 fathoms. All immature examples were found in less than 5 fathoms.

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[1] As some of the entries include fish between two sizes, as from 6 to 8 inches, it is not possible to give the exact numbers of mature and immature. But the numbers given are probably sufficiently accurate.

COMMON SOLE—*Solea vulgaris.*

Depth in fathoms.	Length in Inches.								
	—	5	6	7	8	9	10	11	12 and above.
0 to 5	..	1	1	..	..	..	..	2	10
5 to 10	..	..	..	..	1	..	..	8	162
10 to 15	..	..	..	..	..	..	..	3	83
15 to 20	..	..	..	..	..	..	..	1	28
20 to 25	..	..	..	..	..	..	..	4	61
25 to 30	..	..	..	..	..	..	1	11	125
30 to 35	..	..	..	..	..	..	..	..	15
35 to 40	..	..	..	..	..	..	..	..	2
40 to 45	..	..	..	..	..	..	..	..	..
45 to 50	..	..	..	..	..	..	..	..	4
50 to 53	..	..	..	..	..	..	..	..	6

It appears that mature Sole are to be found at all depths between 4 and about 60 fathoms, whilst the possibly immature fish do not seem to extend below the 30 fathom line. As a matter of fact almost all the fish of 10 and 11 inches taken were males, and therefore possibly mature. Speaking generally, I think the normal habitat of the larger soles on this coast is in rather shallow water, and not far from the shore, whilst there is some reason to suppose that this is one of the species in which a partial migration into rather deeper water takes place in the spawning season. Of the very young stages we collected no evidence, except a few pelagic larval forms. Cunningham has recorded a specimen, less than an inch in length, from the tidal pools of Mevagissey Harbour, and Fulton obtained examples, from less than 2 to 8 inches, in 1 to 2 fathoms. Our smallest specimens, 5 and 6 inches, occurred at less than 5 fathoms, so that there seems reason to believe that the very young (asymmetrical) stages are passed in very shallow water near the margin.[1]

THICKBACK—*Solea variegata.*

The only example,[2] 4 inches in length, was taken at 40 fathoms in Dingle Bay in March. It appears to be rather rare on this coast, and is known to descend to considerable depths, a specimen having been trawled by Mr. Green at 150 fathoms. Immature specimens have been taken on the west coast of Scotland at 65 fathoms (Günther), and at over 100 fathoms by Vaillant off the north-west coast of Africa. It is very plentiful off Plymouth in deep water (Cunningham).

Argentina sphyræna.

Numerous examples, about $1\frac{1}{2}$ inch in length, were taken in the trawl at 62–52, and 80 fathoms. The remains of rather larger specimens were in the stomach of a Sharp-nosed Skate at 375 to 500 fathoms. Three examples of $3\frac{1}{4}$ inches were trawled at 40 fathoms in Dingle Bay, and one of $5\frac{1}{2}$ inches occurred at the same locality at

[1] Cunningham, however, believes that the first year of life is not passed in water of less than 10 fathoms. (*Vide* "Nature," Sept. 17, 1891, p. 482).

[2] I have since found a specimen, about 1 inch in length, which was taken from the stomach of a Piper, trawled at 62 to 52 fathoms in August.

53 fathoms. A specimen of $5\frac{3}{4}$ inches was in the stomach of a Pollack at 36 to 39 fathoms off Gregory Sound.

It thus appears that this fish is moderately abundant in deep and fairly deep waters on this coast, as seems to be also the case on the West coast of Scotland, where Dr. Murray got a number at 32 to 37 fathoms. Günther remarks that some of the latter had not yet spawned in February.

ANCHOVY—*Engraulis encrasicholus.*

At Killybegs in May, 1891, we were told that a good many of these fish had been recently taken. Our informant was a local pilot, who appeared to know the fish.

SPRAT—*Clupea sprattus.*

Sprats, of various sizes, were constantly found in the stomachs of larger fish. They appear to be everywhere very plentiful, especially at the mouths of bays.

HERRING—*Clupea harengus.*

Small Herring and a few large ones were found in the stomachs of fish on various occasions. Our captures in the nets were limited to small scaleless examples.

The most interesting thing that we learnt about this fish was that it is in the habit of ascending a narrow arm of the sea, about 9 miles long, and very sinuous, which runs out of Achill Sound, near the Bull's Mouth, nearly severing a considerable piece from the mainland, and terminates in an expansion known as Bellacragher Bay. The bay is 19 fathoms deep, and the bottom consists of extremely soft black mud. It appears that the Herring run up here every autumn, and yield a profitable fishery.

SHORT SUN-FISH—*Orthogoriscus mola.*

The Sun-fish observed were about 4 in number. One was captured near Achill Island, and the others were seen at the surface, between Inishkeagh and Clew Bay, all in June.

KING OF THE HERRINGS—*Chimæra monstrosa.*

Five were caught at depths of 144, 175, and 220 fathoms. One was a mature male, 33 inches in length (a part of the whip-like prolongation of the tail-fin had been broken off). Two females, about 30 inches, were immature, as were also two males, somewhat smaller. The "Knight Errant," and "Triton" obtained specimens at 505 to 555 fathoms, including some very young forms. Vaillant records others, some very small, between 433 and 670 fathoms off the north-west coast of Africa. Mr. Green got an egg case at 315 fathoms in the "Flying Fox." Thus it appears, as might be expected, from the structure of the fish, that all stages are passed in deep water. Little is known of the habits of this fish. It has been said to follow and prey on the shoals of Herrings, but this seems very unlikely.

BASKING SHARK—*Selache maxima.*

On the 15th April a Basking Shark was seen off Foul Sound, Aran. About the 28th April several were observed, and one (a female about 22 feet) harpooned, by the Shark Islanders. The shoal then appears to have moved northwards, as we heard of a number of these fish off the Mayo Coast from the Captain of H.M.S. "Grappler" a short time afterwards. On the 4th May the Inishkeagh Islanders told us that sharks had been about for some days, the last having been seen a few hours before our arrival from the South. At Gola Island none seemed to have been observed when we visited it on the 26th of May, and we failed to hear of them further north. It may be remarked incidentally that the Gola Islanders, at any rate, do not seem to distinguish between this fish and the Killer or Grampus.[1] At least such was my impression after questioning the Gola pilot about the latter, two specimens of which were in sight at the time. I was convinced that some of his remarks about these cetaceans referred really to the sharks, whilst others appeared appropriate to the subject. "Stinker" is the not particularly euphonious name which is locally in use for the Killer, or Basking Shark, or both.

Sir Henry Gore-Booth, who accompanied us during our cruises about the Boffin Islands after sharks, remained behind at Boffin, and killed two males during the middle of May, and saw several others.

The annual visits of this shark to the West Coast are matters of common knowledge. It appears that they strike the coast, or are first seen, off the Aran Islands, about the beginning of April, and are then said to pass north. At the end of April they are looked for off the Boffin archipelago; nowhere do they seem to stay for more than a few days; and it is a curious fact that the first shoal, here at any rate, is always succeeded by what is supposed to be a second shoal some little time afterwards. Thus the fish killed by the islanders of Shark this year was one of the first shoal, whilst those killed by Sir H. Gore-Booth belonged to a later detachment. It is noticeable that the first was a female, and the other males, but in the absence of any statistics of the sex of fish killed in previous years, this affords no safe ground for conjecturing that the females arrive before the males, and I merely throw out the suggestion in the hope of attracting attention to the subject in future years.

It is generally supposed, and with a fair show of evidence, that the fish pass northwards along the coast, past the Hebrides, and so to Norway.

As to the cause of this annual migration shorewards, we have no information. It is similar in many points to that of the Mackerel, which is often attributed to the spawning instinct. But Mackerel arrive on the coast long before they are ready to spawn, but not before the minute organisms (Copepods), which certainly form a large proportion of their food, have become plentiful in the coast waters; and it appears to me that spawning (if not only an incident of) is by no means the sole cause of their arrival. So with our sharks. At the time they arrive off Boffin Mackerel are plentiful there. So it follows, to the popular mind, that the shark pursues the Mackerel, Herrings, &c., for predacious purposes.

Day, after considering the structural evidence—the large size of the gill openings, the small size of the teeth,[2] and the peculiar straining apparatus of the gill-arches, together with such evidence as could be had on the contents of stomach after death, concluded that this fish is "not a rapacious monster, but a devourer of minute animals, and perhaps herbage." As to the latter, the evidence rests principally on Pennant's diagnosis of "some green stuff, the half-digested parts of Algæ, and the like," which he found in the stomach of one. Several observers speak of a reddish fluid mass, and such was present in the dead example which I examined at Shark Island, and in the stomachs of the two killed by Sir Henry Gore-Booth. Sir Henry kindly sent me some

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[1] *Orca gladiator* (Lacép).

[2] It seems to me that the enormous gape is important evidence in the same direction (*cf.* the Right Whale, &c.).

of the latter, and, examined under the microscope, it proved to consist of fragments of Copepods. During the time we were in the neighbourhood of Boffin, Copepods (principally Calanus) were enormously abundant at and near the surface, and even when living were distinctly reddish (bright red when a number were close together in a small vessel): as is well known, when dead, these Copepods give off a large amount of bright red oily matter. On the 16th of May, 1890, a great number of bright-green Copepods were taken in the tow-nets, and I would suggest the possibility of such organisms having affected the colouration of the stomach-contents of Pennant's specimen. This year we found minute green algoids (Halosphœra) enormously abundant both near the shore and 45 miles from it. Statistics as to the relative abundance of all such pelagic organisms, whether animal or vegetable, during the different months of the year, might prove of great use in helping us to understand the migrations of such larger forms as are known to prey on them. The algæ, I imagine, are only indirectly the food of fish, by serving as food for the minute crustaceans (to which perhaps they impart their own colour).

In northern latitudes we know that minute organisms are extremely abundant in the Summer months, and are preyed on by the Right Whale, to whose huge gape the "whale-bone" fringe is the exact analogue of the gill rakers in our shark. It may be remarked that these structures, present to some extent in all bony fishes, are much more developed (forming a finer sieve) in such forms (as the Herring) as prey on minute organisms.

Having left the Boffin neighbourhood, the sharks appear to move northwards. They have been counted in shoals of 60 to 100 off Tory Island in June. One has been observed in Lough Foyle in the same month (Day). In the same month, according to Pennant, they make their appearance off the Firth of Clyde and the Hebrides, and continue there until the end of July. Off the Orkneys they were formerly common, but appear to be rarer in recent years. This may be due to the fact that little or no fishing is done on the West and North-west coast of the Islands after the spring, so that the sharks might occur off those coasts without anyone seeing them (Mr. W. Irvine Fortescue, *in litt.*). They are said to appear off the Norway coast at the end of the dog-days (August). Whilst there is, and can be no absolute evidence that the same fish are seen at these different places, against the hypothesis that it is the same fish that are seen at these different places at different times of the year, it may be urged that since if a given number of fish were to start eastward from some part of the Atlantic, those that steered the more southerly course would, of course, strike land sooner than the rest, and each detachment would arrive at its proper spot a little later, according to the degree of north in its direction; or that, since the warmth of summer is later in making itself felt as the latitude rises, it is natural to expect the fish to be later in arriving at each place the further north it be. There is, however, no such appreciable difference either of distance or temperature, between the Aran Islands and the more northern points of the West Coast, at which these observations have been made; and granting the migration northward as proved for this coast, it is reasonable to suppose it extends along the rest. On the South Coast of Ireland a specimen has been taken at Courtmacsherry in August (Day). They are said to be not uncommon in the summer on the Cornish coast (Couch), and have been occasionally taken on the East Coast of England. In the Irish Channel, Pennant speaks of vast shoals having entered the Bays of Carnarvonshire and Anglesey in the summer of 1756. They remained only during the hot months, leaving the coast about Michaelmas (end of September), as if intolerant of cold. Possibly an increase of traffic in more recent years may have induced them to pursue a more northerly course.

BLACK-MOUTHED DOGFISH—*Pristiurus melanostomus.*

Four mature examples, about 30 inches, were caught on conger-bait, 3 at 154 fathoms, 28 miles off Achill Head, and 1 at 250 fathoms 45 miles off Black Rock. An immature example, 8 inches, was trawled at 144 fathoms, 30 miles off Achill Head. Mr. Green took one at 150 fathoms in the "Flying Fox," and it has been taken off Norway at 250 fathoms. Thus, this species, which is a common littoral form in the Mediterranean, appears to be more or less restricted to considerable depths in northern waters.

Centrophorus squamosus.

This species is represented by a mature male, 43 inches in length, which was taken on conger bait at 250 fathoms, 45 miles off Black Rock, on the 12th May. It was previously known from the coast of Portugal and elsewhere. All the members of the genus appear to be confined to deep water, and none have previously been taken in British waters.

SKATES and RAYS.

Speaking generally, my observations lead me to the same conclusion as Fulton, that "immature skates and rays are found almost equally in-shore and off-shore," so far as concerns those species which inhabit both zones.

GREY SKATE—*Raia batis.*

Mature examples were found at all depths from 5 to 80 fathoms, and at 154 fathoms. Very small skate, 5 at 7 to 10 inches, were got at 20 fathoms. Larger immature examples were co-extensive in vertical range with the adults, and occurred also at 500 fathoms.

SHARP-NOSED SKATE—*Raia oxyrhynchus.*

Mature examples only were obtained, at 25, 31 to 38, 74 to 80, and 375 to 500 athoms. This species appears to be always confined to rather deep water. It has hitherto been overlooked by Irish naturalists.

FLAPPER SKATE—*Raia macrorhynchus.*

Two mature examples were taken at night in 4 to 5 fathoms in Blacksod Bay.

SHAGREEN RAY—*Raia fullonica.*

Mature examples were taken between 29 and 80 and at 154 fathoms. A specimen, 25 inches long, was at 14 to 16 fathoms in Killybegs Harbour. Two large, but immature, specimens were at 36 to 38 fathoms. No very small specimens were taken.

THORNBACK—*Raia clavata.*

Mature and tolerably large immature thornbacks were at every depth from 4 to 80 fathoms. Very small examples, 4 to 6 inches in length, some with the yolk-sac still visible, occurred in Ballynakill Harbour, ½ to 2 fathoms; Blacksod Bay, 3 to 9 fathoms; Kilkieran and Casheen Bays, 5 and 7 fathoms; Downies Bay, 13 fathoms; and Lough Swilly, 5 to 7 fathoms. Specimens, 6 to 8 inches, were in the Kenmare

River, 26 fathoms; off Gregory Sound, 48 fathoms; and Donegal Bay, 32 fathoms. Specimens 9 to 14 inches, were in Kilkieran Bay, 5 fathoms; off the Aran Islands and in Donegal Bay, 20 to 33 fathoms; and at 53 fathoms off Dingle Bay. Our experience is thus contrary to that of Fulton, who found that on the East Coast of Scotland immature Thornback are rather more abundant in the deep off-shore water. This may be partly accounted for by our having used the shrimp net almost always in shallow water, and also by the comparative scarcity of weeds on the deeper grounds, whereby the very young forms are less liable to be entangled, and so brought up in the ordinary trawl.

SPOTTED RAY—*Raia maculata.*

No examples were found at a greater depth than 48 fathoms; but both the mature and larger immature stages occurred at all depths between that and 4 fathoms. They appear to chiefly affect a depth of less than 20 fathoms, and, like the last species, are especially abundant in Blacksod Bay and similar places. The smallest examples, about 5 inches, were met with in 20 to 22 fathoms in Boylach Bay, and all stages, from about 8 inches upwards, were found in Blacksod Bay. A specimen of 15 inches was in 40 fathoms in Dingle Bay, and 1 of 12 inches in 14 fathoms off Ballynakill.

OWL RAY—*Raia microcellata.*

All examples were between 5 and 19 fathoms. No small specimens were observed. The vertical range is probably very similar to that of the spotted ray; but it appears to be very local in its horizontal distribution (having been taken only in Blacksod, Boylach, and Loughrosmore Bays), a fact which probably accounts for it having hitherto escaped the notice of naturalists in this country.

SANDY RAY—*Raia circularis.*

The 7 mature examples occurred at a maximum and minimum depth of 154 and 13 fathoms. Only 1 was in less than 25 fathoms, viz. at 13 fathoms in Downies Bay, all the others occurring in open waters, and 2 at 28 miles from land. The only immature representative, 8 inches long, was at 115 fathoms, 40 miles from land.

According to Day, this species is mostly found in sheltered bays; but such evidence as I can collect on the subject tends to show that the preponderance is rather the other way. Thus, Professor M'Intosh, in his Report to the Trawling Commission records a number of mature and young examples from Aberdeen Bay, 13 to 34 fathoms. During 1889 the Fishery Board tender, "Garland," obtained 4 examples in St. Andrew's Bay, Aberdeen Bay, the Moray Frith, and at the Smith Bank, 25 fathoms, and 16 miles from land. The smallest specimens were under 4 inches (in breadth), and occurred at the place last mentioned,[1] and in St. Andrew's Bay, in 11 fathoms. None of the localities enumerated, except Downies Bay, can be termed sheltered; and I should think that this ray is more abundant in deep, or moderately deep, water than near the shore. Of the immature forms it appears that their range is as extensive as that of the adults.

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[1] In the Record of Observations (8th Rep. S. F. B., 1890, p. 208), the specimen referred to is entered as a sand ray; and in the absence of any interpretation in the list of common and scientific names (*op. cit.*, p. 40), is, I suppose, intended for this species.

(iii.)—NOTES ON THE EFFECT OF DIFFERENT NETS UPON THE CAPTURE OF IMMATURE FISH.

Experiments were made during the cruise of the "Fingal" to test the "Comyn's Patent Discriminating Trawl" against a trawl of ordinary construction and mesh. The object of the former net is to avoid the capture of small fish. The mesh is larger than that of an ordinary trawl net, and is netted on the square instead of diamond-wise. The body of the net is more ample, does not taper towards the cod end, and is shorter. In lieu of pockets, there is a large funnel at the mouth of the net.

On the 8th May, 1890, a haul was made in the Kenmare River with the ordinary net. This was then unbent, and the patent net substituted, and hauled back over the same line.

The results were as follows:—

Ordinary Net, ½ *hour*.	*Patent Trawl*, 1 *hour*.
6 Cod, mostly immature.	
33 Plaice, 9 to 21 inches.	13 Plaice, 10 to 20 inches.
16 Common Dab, 5 to 10 inches.	3 Plaice, 4½ inches.
3 Common Sole, mature and fine.	1 Common Sole, mature and fine.
4 Rays.	2 Rays.

The next experiment was made in Blacksod Bay. On the 16th June 3 hauls were made with the ordinary net on the same line. On the 17th June the patent net was bent on, and two hauls made over the same line. At the end of the second haul the funnel was found choked with weeds.

The results were as follows;—

Ordinary Net, average of 3 *Hauls*, 2 *hours each*.	*Patent Net*, 2 *Hauls*, 1½ *and* ½ *hour*.
Grey Gurnard, 2, mature.	Brill, 3, immature.
Brill, 2, 1 mature, 1 immature.	Plaice, 41, most immature.
Plaice, 55, most immature.	Common Dab, 9, mature.
Common Sole, 17, nearly all mature.	Common Sole, 13, mature.
Rays, 6.[1]	Rays, 11, mature.
	Gunnell, 1.

In Inver Bay, on the 20th June, hauls were made with the Patent Net on two lines, one at the mouth and the other inside the trawling limits in that Bay. On the 25th hauls were made on the same lines with the ordinary net. A westerly gale had been blowing in the interval, which may have affected the distribution of fish.

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[1] Fish which were not represented in every haul are omitted.

The results were as follows:—

Outside the Limits.

Ordinary Net, 2 hours.

12 Grey Gurnard, mature.
2 Anglers.
1 Cod, mature.
1 Haddock, mature.
1 Whiting, mature.
3 Hake, mature.
3 Long Rough Dabs, mature.
2 Brill, mature.
2 Witch, mature.
23 Plaice, immature.
6 Lemon Dab, mature.
125 Pole Dab, mature.
28 Common Dab, mature.
2 Common Sole, mature.
2 Conger, large
2 Skates and Rays.
2 Spotted Dogs.

Patent Net, 2 hours.

1 Brill, mature.
2 Common Dab, mature.

Inside the Limits.

Ordinary Net, 2 hours.

18 Grey Gurnard, mature.
1 Brill, mature.
12 Plaice, immature, 9 to 11 inches.
8 Lemon Dab, mature.
67 Common Dab, mature.
3 Common Sole, mature.
2 Rays.

Patent Net, 1 hour.

1 Grey Gurnard, mature.
1 Turbot, mature.
7 Plaice, immature, 12 inches.
1 Lemon Dab, mature.
14 Common Dab, mature.
1 Common Sole, mature.
1 Conger, large.
3 Rays.

These were the only instances in which the two trawls were specially tested against each other on the same lines. I think that as to the general efficiency of the two nets the results may be allowed to speak for themselves. In the Inver Bay experiments, however, I cannot help thinking that the difference in the catches depends upon something more than the difference of the nets used. The results in Blacksod Bay are fairly equal.

As regards the efficiency of the Patent Net, for its special object, that of avoiding the capture of small fish, it may be advisable to say a few words. The Patent Net never caught an immature Sole. During the whole survey only 33 immature Soles were caught, and 2 of these were taken in the Shrimp Net, so that the ordinary trawl would not appear to be very destructive to the immature members of this species, or else the immature forms are uncommon on the ordinary trawling grounds. I think, however, that the explanation lies either in the extraordinary agility of the Sole, and its power of wriggling out through any possible loop-hole of escape. In the case of Turbot and Brill, it is not reasonable to suppose that any net will retain *only* the mature examples of these forms, which reach maturity at 18 and 15 inches respectively, but it may be supposed that, on perfectly clean ground, the one net would retain a smaller proportion of very small ones than the other. In regard to Plaice it does not appear that the Patent Net has much advantage over the other; both capture a large proportion of immature forms, and our experiments do not show much difference in the size of the smallest captured. Indeed, in the case of the Kenmare River Trial, the Patent Net caught the smallest, only $4\frac{1}{2}$ inches long. The great difficulty lies in the weeds; with a bag full of weeds any trawl will hold small fish, except, perhaps, Soles.

On the whole it may be said that on clean ground the Patent Trawl is likely to catch less small fish than an ordinary one, and would probably be very harmless to small round fish. It is open to doubt, however, whether its general efficiency as a fishing implement is such as to commend it to practical fishermen, at least in its present condition. On this subject Mr. Green has already published a report, suggesting improvements. The net appears to represent the first practical attempt to solve the difficulty of the capture of immature fish, and all credit is on this account due to the inventor. During the latter part of the cruise of the "Fingal" Mr. Green had the net remounted, and bent on to a 32 feet Beam. Though supplied to fit a 25 feet Beam, it appeared more at its ease on the larger one (shortly reduced by accident to 28 feet), and Mr. Green tells me that it fished better. The results may be seen in the list of Stations (Appendix A); no opportunity occurred of testing it, in its new condition, against an ordinary trawl.

An 18 feet Beam trawl, lined with sprat mesh, was used in deep water, and on one occasion in Killybegs harbour. The results are of no special interest in this connection.

A Shrimp trawl, 8 feet Beam, was in frequent use. It captured a vast amount of very small fish, including Gurnards, Wrasse, Cod, Whiting, Pollack, Coal-fish, Silvery Pout, Witch, Long Rough Dab, Scald-fish, Plaice, Common Dabs, Solanettes, and a few Lemon Dabs, Pole Dabs, and Flounders, &c. Many of these were extremely small, less than an inch long. Two common Soles about six inches were caught. With the exception of a large Lemon Dab, a large common Dab, and a number of Thornbacks of considerable size, no large fish were caught in this net. As a rule, although the hauls were always short, the very small gadoids and flat fish did not survive removal from the net. Young Plaice and Common Dabs, two or three inches long, appeared usually not much the worse when placed in water, and young Wrasse, Bull-heads, Sticklebacks, &c., and Rays were in no way injured.

A small seine net, with a calico bunt, 13 yards by 2 yards, with a large bag in the centre, was used on certain occasions during the cruise of the "Harlequin." The wings were of herring mesh. This net was originally constructed with a view to the capture of very small Herrings (for scientific purposes), in which it was very successful. It was also very efficient in the capture of Sand-eels of all sizes (*A. tobianus*), and caught large numbers of small flat fish, Plaice and Flounder, and a certain number of very small Turbot and Brill. At Smerwick a few Sand-smelts, and at Dugort a Lemon Sole (*S. lascaris*) was caught. Unless meshed in the wings, which only happens in the case of such larger flat fish as may be near the margin, fish (except very small Herrings) are not in any way injured by this method of fishing. Very similar nets are, I believe, in some places used for the capture of Sandeels for bait.

The effect of capture in the trawl on fish appears to vary with the species. No special records were kept on this subject, but the vitality of certain forms was a matter of constant comment. Turbot were almost invariably lively and vigorous when brought on board, and exhibited as a rule no injury. Brill seemed a little less hardy, but were always alive. Soles appeared to be the most hardy of all, and it required violent blows to disable them. Frequently several escaped while the net was being hauled. Occasionally they were injured by being knocked against the ship's side whilst entangled in the pockets. Large Plaice seemed rather subject to injury, smaller examples less so. Large common Dabs were frequently dead, or nearly so, when brought on board, but small examples were constantly seen to escape and swim away, apparently uninjured, whilst the trawl was being boarded. John Dory were usually rather injured, the fins being broken, and young examples did not survive for long, even when placed in water. Small Gurnard often escaped out of the net and swam away. Haddock and Whiting were usually nearly dead, and would certainly not survive if returned. Of course in cases in which the net got full of weeds and mud, fish of all sorts were much injured, even Rays being almost cut to pieces by pressure against the meshes.[1]

(iv.)—ON THE FOOD OF FISHES ON THE WEST COAST.

These notes have been compiled from the records kept on board the "Fingal" and "Harlequin." They are of necessity inconclusive, since the amount of material is small, and scattered over a considerable area of ground; and, moreover, the period of observation is confined to the months of March to August inclusive. The most satisfactory arrangement would be to divide the coast into different districts (as is done by the officials of the Scotch Fishery Board on their own coast), and to treat of each district separately. Such a course, however, if pursued with our available material, would render the observations in each district so meagre as to be hardly worth recording. I have therefore treated the whole coast as a single district. The records will remain, and if, as is sincerely to be hoped, this and other branches of Fishery inquiries are carried on in future years, they will presumably be at the service of future workers.

In comparing my results I have confined my attention almost entirely to the work of recent observers, especially the papers of Mr. W. Ramsay Smith, in the Eighth Annual Report of the Scotch Fishery Board, 1890,[2] and the observations of Mr. J. T. Cunningham, in his Monograph of the Common Sole.

Examination of the structure, and especially that of the jaws and teeth, of different fishes usually furnishes us with a clue to the feeding habit. Such clues, however, prove not infrequently misleading. Thus amongst the flat fish one is apt to suppose that those forms with large mouths and jaws more or less equally developed on either side are especially fitted for the capture of such active prey as fish, but we find that the Long Rough Dab preys almost exclusively on small Crustaceans and Echinoderms, whilst, according to Day and others, even the mighty Halibut exhibits a great partiality for Crustaceans, though apparently more than any other flat fish it is fitted for the pursuit of an active prey. Examination of the food pretty well bears out the conclusions formed upon the structure of the Plaice, Flounder, &c., in which the teeth are much reduced on the upper side of the jaw, as also in the case of the Sole, where the highest degree of specialization on this line is found, the upper sides of the jaws being destitute of teeth, and the lower side of the head covered with sensory processes. This fish, however, seems to be able to capture the evasive Sand-eel, and is altogether more agile than its appearance would lead one to suppose. Turning to the Cod family, amongst Round fishes, we find a number of them with overhanging upper jaws, and barbels on the chin, suggesting a bottom-feeding habit, with a diet of somewhat sluggish invertebrates. This is borne out well enough in the case of the Haddock and Cod, but seems to fail in the case of the Ling, which, although the best provided in

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[1] Dr. Fulton has recently published a most valuable report upon "the Retention of Vitality of Trawl-caught Fish" (9th Ann. Rep. S. F. B., 1891, p. 202).

[2] Pressure of time does not permit me to refer to Mr. Smith's most recent contribution to this subject (9th Ann. Rep. S. F. B., 1891, p. 222), which has appeared since this went to press.

the matter of barbel, seems to feed extensively on large and active fish. In the Whiting we meet with a fish very usually provided with a barbel in its younger existence; but, in the adult condition, usually, though not invariably, destitute of such an appendage, and furnished with powerful teeth. It appears to prey chiefly on fish. The Pollack is a fish which throughout life has a considerably projecting under jaw, and seems always to seek a more or less pelagic diet. The Coal-fish presents us with both conditions. Having a barbel and protruding upper jaw in its young condition (up to about 12 inches in length), it certainly derives a considerable proportion of its food on the bottom, whilst in approaching the adult stage the under jaw outgrows the upper, and the barbel becomes the merest rudiment; and the full-grown fish, pre-eminently suited for an active life, becomes one of the greatest persecutors of the Herring. In the Herring and Mackerel we find the under jaw protruding; both are well known to derive their food from pelagic sources—copepods and the like. The adult Herring being destitute of teeth, whilst in the transparent postlarval condition, living near bottom and preying upon relatively large organisms, it is furnished with rather powerful teeth. In fine, the projecting under jaw is almost always associated with a pelagic diet. It is found, I believe, in the pelagic postlarval stages of all bony fishes, whether or no it persists in the adult. Unfortunately our observations during the Survey were almost entirely confined to the food of mature or fair-sized fish.

RED GURNARD—*Trigla cuculus.*

During the Survey 7 stomachs were examined. 2 were empty. Of the remaining 5, **Crustaceans** occurred in 4; unidentified crabs in 3; Common Shrimps in 2. *Galathœa* in 1. **Fish**, Sand-eels in 1.

So far as they go, these observations appear to show that the Red Gurnard feeds more on crustaceans and less on fish than the Grey and Sapphirine Gurnards.

SAPPHIRINE GURNARD—*Trigla hirundo.*

During the Survey 10 stomachs were examined. 4 were empty. Of the remaining 6, **Annelids** (*Nereis*) occurred in 1; **Crustaceans** in 2; Swimming Crabs (*P. holsatus*), Mask Crabs (*Corystes*) and Common Shrimps each in 1; **Lammellibranchs**, Razor Shells (*Solen*) in 1. **Fish** in 4; Sand-eels in 2; Lesser Weever in 1; unidentified fish in 1.

The figures are too small to be much of a guide. The food seems to be much the same as that of the Grey Gurnard.

GREY GURNARD—*Trigla gurnardus.*

In 1890 64 stomachs were examined. 10 were empty, and in 3 the nature of the food was undistinguishable. The records do not show the exact distribution of the different sorts of food in the remaining 51. **Annelids** occurred in 3; **Crustaceans** in about 28; Crabs in 6; Shrimps (*Crangon*) in about 5; *Mysis* in 2; Amphipods, chiefly Gammarids, in about 4; Zoëæ in 2; unidentified Crustaneans in 9; **Fish** in about 30; Sand-eels in about 18; Sprats in about 5; *Crystallogobius* in 2; Dabs and Dragonets each in 1; unidentified fish in 3.

In 1891 110 stomachs were examined. 33 were empty. In 1 the nature of the food was not distinguishable. Of the remaining 76, **Annelids** occurred in 1; **Crustaceans** in 39, 51 per cent.; Shrimps (*Crangon*) in 23; Schizopods in 10; Prawns, *Palæmon* and *Pandalus*, each in 1; Swimming Crabs and *Zoëæ* each in 1; unidentified Crustaceans in 4; **Cephalopods**, Squid (*L. media*) in 1; **Fish** in 41, 53 per cent.; Sand-eels in 21; *Crystallogobius* in 3; Norway Pout, Dab, and Dragonet, each in 1; unidentified fish in 11.

It appears, therefore, that Fish and Crustaceans together contribute almost the whole of the food, the proportion of the former slightly exceeding that of the latter, whilst Annelids and Molluscs—small Squids, are occasionally eaten. Of the fish Sandeels appear to be most sought after, *Crystallogobius*, Sprats, Norway Pout, Dragonet and small Dabs being less preyed upon. Of **Crustaceans** the more active kinds seem to be the chief sufferers, especially Common Shrimps, and, to a less degree, Schizopods.

Smith's observations in the Firth of Forth are much to the same effect, but the proportion of fish seems to be higher than that of Crustaceans, whilst he found Hermits contributing a rather large share of the latter, whereas they do not appear in our observations. He notices a single occurrence of an Echinoderm out of 407 stomachs which contained food.

PIPER—*Trigla lyra.*

During the Survey 21 stomachs were examined. In 1 the nature of the food was indistinguishable. Of the remaining 20, **Echinoderms** (Brittle Stars) occurred in 16, 80 per cent.; *Ophioglypha lacertosa* in 15; *O. albida* in 2, and *Amphiura* in 1; **Crustaceans** in 14, 70 per cent.; Hermits in 11; Crabs in 4, viz. *Gonoplax* in 2; Swimming Crabs in 1, and unidentified Crabs in 1; Common Shrimps in 1; unidentified Crustaceans in 2; **Gastropod** shells (*Natica, Turritella* and *Aporrheus*) in 3, probably the "Houses" of Hermits; **Fish** in 1.

It appears, therefore, that the Piper is the most exclusive bottom feeder of its genus (as indeed its structure would seem to indicate) and derives its food almost entirely from Echinoderms (thus markedly differing from *T. gurnardus*) and Crustaceans. Of the former, *O. lacertosa*, and of the latter, Hermits are evidently preferred.

ANGLER—*Lophius piscatorius.*

During the Survey 7 stomachs were found to contain food. The contents were in all cases fish. Sprats, Common Dab, Pole Dab, and Sole occurred each in 1; unidentified fish in 5.

Smith concludes that without doubt fish forms almost the whole food of the Angler, having only found an invertebrate, a Hermit, in one stomach out of 33 which contained food. Day has collected a number of instances in which this fish has been known to swallow various sea birds, and other objects of no service as food, and remarks, on the authority of Pennant and another, that they are returned to sea by fishermen in certain localities on account of their eating Dogfish. This may, perhaps, be looked upon as somewhat doubtful policy.

Mr. Lane made some experiments with one of these fishes on the deck of the "Harlequin." He found that on touching the top of the erected filament with a stick the Angler immediately made a snap, closing his jaws so as to exactly catch that part of the stick which had touched the filament. This was continued until the fish became exhausted. It may, therefore, be that the action of the fish is to some extent involuntary, and that the filament serves not only as a lure, but to direct the snap. It would seem unlikely that a dying fish would voluntarily snap at any object, and contact of the stick on any other part had no effect in stimulating it.

MACKEREL—*Scomber scom*

88 stomachs were examined in 1890. All contained Copepods, mostly *Calanus.* Sand-eels were present in several.

JOHN DORY—*Zeus faber.*

The stomachs of 22 were examined. 9 were empty. All the rest contained fish, including Sand-eels in 3, and Herrings in 2, and unidentified fish in 8. It appears therefore that the Dory preys solely on fish, for the capture of which the protrusible jaw apparatus, capable of very sudden and violent snaps, is eminently suitable.

COD—*Gadus morrhua.*

In 1890 the stomachs of 17 Cod were examined. 2 were empty. **Annelids** occurred in 1; **Crustaceans**, Swimming Crabs, in many; Shrimps, Hermits, *Munida*, and Shore Crabs in several; **Gastropods**, Whelks, in a few; **Cephalopods**, *Eledone*, in a good number; **Fish**, Sand-eels, Dabs and Whiting Pout in about as many.

In 1891 47 were examined. 7 were empty. Of the remaining 40, **Echinoderms** occurred in 7, 17 per cent.; Brittle Stars, *Ophiothrix*, in 4; (*O. fragilis* in 3); *Amphiura* in 2; *Echinus* in 1; **Annelids** in 2; *Aphrodite* and *Nereis* each in 1; **Nemerteans**, *Cerebratulus* in 1; **Crustaceans** in 28, 70 per cent.; *Munida* in 11; *Xantho florida* in 8; Mask Crab (*Corystes*) in 5; Swimming Crabs (including *P. arcuatus*, *P. corrugatus*, and *P. puber*) in 5; Norway Lobster in 4; *Hyas* in 2; Gammarids, Shrimps, Prawns, Hermits, Spider Crabs (*Stenorhynchus*); Edible Crabs, *Gonoplax*, *Atelecyclus heterodon*, and *Galathæa* each in 1; **Lamellibranchs** in 3; Gapers (*Lutraria*) in 2; **Gastropods** in 2; (*Turritella* and *Aporrhais*, perhaps associated with Hermits); **Cephalopods** in 2; Squid (*L. media*) and *Eledone* each in 1; **Fish** in 18, 45 per cent.; Sand-eels in 4; (Great Sand-eel; *A. lanceolatus* in 1); Norway Pout in 2; Haddock, Wrasse, *Solea*, Sprat, Dragonet, Gunnel and *Crystallogobius*, each in 1; unidentified fish in 7. In 1 were several stones; in 1 a fragment of Nullipore, and in 1 the sternum of some bird of the duck family.

We may, therefore, conclude that Crustaceans, principally Decapodous forms, the kind varying with the depth, form nearly half the food of the Cod. Fish, mostly such as live at the bottom, form the next most considerable item, something under a third, Crustaceans and fish together contributing a little over two-thirds. Molluscs come next with a much smaller contribution, though Cephalopodous forms seem to be preyed on when attainable. Echinoderms form a rather smaller contribution, *Ophiothrix* appearing to be the most in request.

Smith's observations in the Firth of Forth differ chiefly from the above in the greater rarity of Echinoderms as articles of food. Two stomachs contained *Medusidæ*.

HADDOCK—*Gadus æglefinus.*

During the Survey 55 stomachs were examined, 9 were empty. **Echinoderms** occurred in 24; Brittle Stars; *Amphiura* in 15; *Ophioglypha* in 2; unidentified Echinoderms in 7; **Annelids** in 11; Lugworm in 1; unidentified Annelids in 10; **Crustaceans** in 13; Hermits and Swimming Crabs each in 2; Isopods (chiefly *Cymothoa*) in 3; Amphipods, *Gebia* and Mask Crabs each in 1; unidentified Crustaceans in 3; **Lamellibranchs** in 3; *Corbula* and *Tellina* each in 1; unidentified Lamellibranchs in 1; **Gastropods** in 5; Sea Hares (*Aplysia*) in 3; unidentified Gastropods in 2; **Fish**, *Crystallogobius*, in 1.

The Haddock, therefore, appears to be entirely a bottom feeder. Echinoderms contribute nearly half the items of food. Brittle Stars, and especially *Amphiura*, seem to be the most sought after. Crustaceans and Annelids together contribute about as much, the former a little more than the latter. Gastropods and Lamellibranchs appear to be less appreciated, though the protective squirt apparatus of the Sea Hare seems to fail against this enemy. Of fish only the minute and helpless *Crystallogobius* appears to suffer.

Smith, in the Frith of Forth, found Haddock "perhaps the most equal or indiscriminate feeders." But his observations differ from ours in that the proportions of Crustaceans and Echinoderms are reversed, whilst the proportion of Molluscs is rather higher than in ours. He notices, also, the absence of fish as an article of diet, though the number of fish examined was much greater than came under our own observation.

Medusidæ and Ctenophores occurred in a few stomachs.

WHITING—*Gadus merlangus.*

During the Survey 45 stomachs were examined. 26 were empty. In 1 the food was indistinguishable. Of the remaining 18 **Echinoderms**, *Amphiura* occurred in 1; **Crustaceans** in 4; *Mysis* in 3, and Shrimps (*Crangon*) in 1; **Fish** in 12; Sprats in 4; Herring, Sand-eels, Norway Pout, and *Crystallogobius* each in 1; unidentified fish in 4. One Whiting, in very bad condition, had only some stones in its stomach.

It appears, therefore, that the Whiting feeds very largely on fish, to a much less extent Crustaceans (Shrimps of various kinds), and very little on Echinoderms (Brittle Stars). The number examined, however, is much too small for a satisfactory conclusion.

Smith, after examining a much larger number in the Frith of Forth, concludes that Whiting feed chiefly on fish: less on Crustaceans, and very little on Molluscs and Annelids. The two latter were not found at all during our own observations, whilst Smith, on the other hand, found no Echinoderms. The stomach of one was found to be full of Herring eggs.

POUTASSOU—*Gadus poutassou.*

In July, 1891, I examined the stomachs of several immature *Poutassou*, about 6 inches long, which formed part of a shoal observed at the surface over 175 fathoms of water. They contained Crustaceans, *i.e.* the remains of Copepods and other small Pelagic Crustaceans.

COALFISH—*Gadus virens.*

In 1891, 24 stomachs of large Coalfish were examined. 7 were empty. Of the remaining 17, **Crustaceans** occurred in 10, *Mysis* in 8, **Fish** in 9, Sprats in 3, Sandeels and *Crystallogobius* each in 1, unidentified fish in 4. The stomachs of several contained stones, and many were infested with *Ascaris*. Thus it appears that the food is limited to fish and Crustaceans, especially *Mysis*. Probably fish is the principal food. Certainly to live upon Schizopods alone would entail considerable activity upon so large a fish as this.

POLLACK—*Gadus pollachius.*

During the Survey, 37 stomachs were examined. 5 were empty. Of the remaining 32 **Annelids** occurred in 1; **Crustaceans** in 13; Gammarids in 6; *Zoëæ* and *Mysis*, each in 5; Prawns, *Palæmon* and *Pandalus*, each in 1; unidentified Crustaceans in 3; **Cephalopods**, Squid (*Sepiola*) in 1; **Fish** in 20: Sand-eels in 4; (great Sandeel, *A. lanceolatus* in 1); Sprats in 2; *Crystallogobius* in 2; Norway Pout, Scald-fish, Gurnard, and White Bait (very young Herrings or Sprats), each in 1; unidentified fish in 10.

The Crustaceans, Annelids, and Molluscs were only found in the stomachs of certain individuals, 14 in number and mostly immature, which were caught in the Mackerel nets at night at the mouth of Killeany Harbour. The other Pollack ex- ined were all large specimens trawled in the day-time, and in deeper water mostly.

It appears, therefore, that the Pollack, in its adult condition, feeds mainly upon ; our observations do not show that there is a marked preference for any particular kind. Crustaceans especially, if not exclusively, those of the more active kind, such as Prawns and Shrimps and the Pelagic Schizopods, are also preyed upon to a large extent, in all probability chiefly at night, when these forms appear to be most active.

HAKE—*Merluccius vulgaris,*

During the Survey, 18 stomachs were examined. 10 were empty. **Echinoderms**, Brittle Stars (*O. albida*) occurred in 1; **Fish** in 6; Herring in 3; Sprats and Whiting each in 1; unidentified fish in 1.

As far as they go our observations show that the Hake feeds mainly on fish.

LING—*Molva vulgaris.*

During the whole Survey 143 stomachs were examined. 101 were empty. In 1 the nature of the food was not recognized. **Crustaceans**, Norway Lobster occurred in 1; **Cephalopods** in 8; *Eledone cirrhosa* in 7; Common Squid (*Loligo forbesii*) in 1; **Fish** in 33; Mackerel in 6; Flat fish, Witch, and Dab in 3; Gurnard and Haddock, each in 2; Scad and Norway Pout, each in 1; unidentified fish in 19.

Thus the food of the Ling appears to consist almost entirely of fish. Cephalopods especially *Eledone*, appears to be appreciated, and probably Crustaceans (and other forms) are preyed on to a larger extent than is shown by the Records, since the Ling, when hooked in even very moderate depths, usually arrives at the surface with its stomach everted, so that the records of its food are necessarily imperfect.

LONG ROUGH DAB—*Hippoglossoides limandoides.*

Only 3 stomachs were examined. **Echinoderms**, Brittle Stars (*Amphiura*) occurred in all; Annelids in 1.

Smith notices that "in the Firth of Forth no other fish, with perhaps the solitary exception of the Haddock, feeds so largely on Echinoderms." Crustaceans "(especially *Crangon* and hermits) form a rather larger proportion of their food; while annelids, molluscs, and fish form a very small part indeed. In St. Andrew's Bay these fish seem to live almost exclusively on Echinoderms, Sand Stars being found in above 80 per cent. . . . *Crangon* . . . in from 7 to 15 per cent.; annelids and fish were rarely found, molluscs not at all."

Such being the case, this fish, when abundant (as it is far from being on the West Coast), must be a serious competitor of the Haddock, Plaice, Pole Dab, and Sole, as well as of the equally worthless Common Dab, since all these forms seem to derive a large proportion of their food, on our coast, from the same Sand Stars.

TURBOT—*Rhombus maximus.*

During the Survey, 53 stomachs were examined. 18 were empty. Of the remaining 35, **Annelids** were present in 1; **Lamellibranchs** in 1; **Cephalopods,** Squid (*Loligo*) in 1; **Fish** in 31, 88 per cent., viz.: Sand-eels in 19 (one stomach contained over 60); Sprats in 4; Norway Pout in 2; Dragonet in 2; Herring in 1; Red Riband fish (*Cepola*) in 1; Dab in 1, and Solanette in 1; unidentified fish in 3. Tapeworms were of frequent occurrence. It is evident that fish, and especially Sandeels, form the principal food of the Turbot on this coast. Cephalopods, Lamellibranchs, and Annelids form unimportant contributions.

Smith records Annelids from 1, and fish, including Sandeels, Dabs, and unidentified kinds, from 3 stomachs.

BRILL—*Rhombus lœvis.*

During the Survey, 78 stomachs were examined. 25 were empty. Of the remaining 53, **Crustaceans,** Common Shrimps, were present in 3; **Cephalopods,** Squid, in 4. **Fish** in 52, 98 per cent., viz.: unidentified in 3; Sandeels in 44; Sprats in 13; Solanette in 2; Herrings in 1, and Whitebait, very young herrings or sprats, in 1. Tapeworms were often present.

Like the Turbot, the Brill appears to feed almost entirely on fish, and chiefly on Sandeels. Clupeoids, especially Sprats, form the next important item. Shrimps and Squids are occasionally eaten.

WITCH—*Arnoglossus megastoma.*

In May and June, 1890, the exact number of stomachs examined is not certain. **Crustaceans** occurred in 3; **Cephalopods,** Squid, in several; **Fish** in 8.

During the remainder of the Survey, 112 stomachs were examined. 53 were empty. Of the remaining 59, **Annelids** occurred in 1; **Crustaceans** in 14, 23 per cent.: Shrimps (*Crangon*) in 8; *Munida* in 1; unidentified Crustaceans in 5; **Cephalopods,** *Sepiola,* in 1; **Fish** in 53, 86 per cent.: Whiting in 10; Sprats in 6; Sand-eels in 3; Gobies in 2; Norway Pout in 1; Silvery Pout (*Gadus argenteus*) in 3; Young Forkbeard in 1; Unidentified fish in 9.

It thus appears that the Witch feeds mainly on fish; the kind of fish depending on the depth of water. Thus in comparatively shallow water it subsists, like the Turbot and Brill, largely on Sandeels and Sprats; in deeper water, where such prey is not available, Norway Pout, Silvery Pout, and Young Forkbeards contribute to its diet.

Crustaceans (especially Shrimps) are sometimes eaten, and Annelids and Cephalopods occasionally.

LEMON DAB—*Pleuronectes microcephalus.*

During the Survey, the stomachs and intestines of 60 Lemon Dabs were examined. 5 were empty. In 9 the nature of the food was indistinguishable. Of the remaining 46, **Echinoderms,** Brittle Stars (*O. albida*) occurred in 1 ; **Annelids** in 36, 78 per cent.; *Sabella* in 2 ; *Nereis* in 1 ; unidentified Annelids in 33 ; **Gephyreans** in 2 ; **Crustaceans** in 5 ; Spider crabs (*Stenorhynchus*) in 1; unidentified Crustaceans in 4 ; **Lamellibranchs** in 2 ; **Gastropods,** *Philine aperta* in 1 ; **Fish,** Goby, in 1.

It appears, therefore, that whilst other groups of invertebrates and fish contribute an insignificant proportion, the bulk of the food is derived from Annelids. According to Smith the same appears to be the case in the Firth of Forth and St. Andrew's Bay. That observer notices that the relative proportions of some of the less important groups change with the change of locality. He records Sea Anemones from the stomachs of two examples.

POLE DAB—*Pleuronectes cynoglossus.*

In 1890 the stomachs and intestines of 27 were examined. **Annelids** occurred in most. **Crustaceans,** Gammarids, Prawns (*Palæmon*) and Crabs in a good many.

In 1891 21 were examined. In 6 the nature of the food was indistinguishable. Of the remaining 15, **Echinoderms,** Brittle Stars (*Amphiura*) occurred in 6, 40 per cent. ; **Annelids** in 12, 80 per cent. ; **Crustaceans** in 4, 26 per cent. ; **Lamellibranchs** (*Tellina*) in 1.

Thus it appears that the Pole Dab derives most of its food from Annelids, Echinoderms, and Crustaceans. As this fish has the greatest known vertical range of any British flat fish, it follows that its diet must be regulated by the invertebrate fauna of the depth at which it happens to be. In the comparatively shallow water (about 30 fathoms) from which the specimens which we examined came, it appears to exhibit an absolute preference for *Amphiura* amongst Echinoderms. As to the other groups our identification is insufficient to help us.

Smith found that "in the Firth of Forth these fish feed very largely, if not almost exclusively, on Annelids (especially *Sabella*) . . while Echinoderms and Fish are found on very rare occasions." Our observations, numerically rather less, show a greater frequency of Echinoderms.

PLAICE—*Pleuronectes platessa.*

During May, June and July, 1890, the alimentary viscera of 267 Plaice were examined. The Records do not show the exact numbers in which each sort of food occurred. It appears, however, that while a number were empty, Annelids and Lamellibranchs constituted the greater part of the food. Echinoderms contributed the next considerable quotum: then Crustaceans, whilst Fish and Gastropods furnished equally small proportions. Actinians, Polyzoans and Ascidians complete the list, each with a single occurrence.

In the different groups the identified forms had the following order of frequency:—**Actinians.** *Edwardsia.* **Echinoderms.** (1) Brittle stars, including *Amphiura filiformis* and *Ophioglypha lacertosa.* (2) *Spatangus* and *Synapta* (once each). **Annelids** (1) *Nereis* and *Nephthys* (2) ; Lugworm (*Arenicola*), *Lagis, Lanice,* Scale-back (*Harmothoe*) and Sea Mouse (*Aphrodite*). **Crustaceans** (1) Spider crab (*Stenorhynchus*) ; (2) Shrimps, Schizopods, Amphipods, Hermits and Shore Crabs. **Lamellibranchs** (1) Razor Shells (mostly *S. ensis*) ; (2) *Venus gallina* and *Nucula nucleus* ; (3) *Donax anatinus, Tapes* and *Tellina* ; (4) *Mactra solida, Pecten* and *Psammobia.* Siphons which appeared to belong to a Gaper occurred also. **Polyzoans.** *Membranipora.* **Gastropods** (1) *Trochus.* (2) *Philine aperta.* **Ascidians.** *Molgula.* **Fish.** Sandeels.

During the rest of the Survey, 285 were examined. 26 were empty, and in 4 the nature of the food was not recognised. Of the remaining 255, **Actinians,** *Cerianthus* occurred in 1; **Echinoderms** in 61, 23 per cent.; *Amphiura* in 38; *Ophioglypha* in 8; (*O. lacertosa* in 3 and *O albida* in 4); *Amphidotus* in 8; unidentified Echinoderms in 7; **Annelids** in 70, 27 per cent.; *Lagis* in 2, and *Nephthys, Nereis, Terebella, Serpula,* Sea Mouse each in 1, and unidentified Annelids in 65; **Crustaceans** in 21, 80 per cent.; Swimming Crabs in 5; Gammarids in 4; Shrimps, Hermits, Mask Crabs, *Ebalia, Munida* and *Idotea* each in 1; unidentified Crustaceans in 6; **Lamellibranchs** in 136, 53 per cent.; Razor Shells (mostly *S. ensis*) in 23; *Mactra* in very many; *Venus gallina* in 5; *Nucula* in 7; Tellina in 5; *Donax* in 3; Scallops and *Corbula,* each in 1; unidentified Lamellibranchs in 81;[1] **Gastropods** in 3; *Natica* in 2, and a shell, probably the "House" of a Hermit in 1. **Ascidians**; *Molgula* in 3; **Fish,** Sand-eels in 1; a piece of Sea-grass (*Zostera*) in 1.

It appears, therefore, that the Plaice feeds most largely on Lamellibranchs, especially Razor Shells (*Solen ensis*) and *Mactra.* Annelids and Echinoderms contribute each about half as much; of the latter, *Amphiura* appears to be most appreciated.

Crustaceans are a subsidiary article of diet, but many forms are considered palatable. Gastropods and Ascidians (*Molgula*) are occasionally eaten. Fish (Sandeels) and Actinians are rarely eaten, and Cephalopods apparantly not at all.

Smith's observations on the East Coast of Scotland have led him to a markedly different conclusion. He finds that Annelids are there the chief food; Molluscs contribute a little, and Crustaceans much less, whilst Echinoderms are of little importance.

Thus the food on the two coasts, except in the matter of Crustaceans and fish, seems to be quite different in its proportions. I suppose that the explanation may lie in the different conditions of competition.

COMMON DAB—*Pleuronectes limanda.*

In 1890, the stomachs and intestines of 217 Common Dabs were examined. 11 were empty, and in 1 the contents were indistinguishable. The Records do not show the exact numbers in which the different kinds of food occurred; but it appears that **Echinoderms, Annelids, Crustaceans** and **Lamellibranchs** furnished the bulk. Crustaceans appear to have been most abundant; Echinoderms hardly less so; Annelids and Lamellibranchs were about equally abundant, but considerably less than Echinoderms. Gastropods furnished a small contribution. Fish occurred in several stomachs, and Sertularians in several. One contained a fragment of Sloke Weed (*Ulva*), and one was full of soft grey mud.

Of **Crustaceans,** Hermits occurred most often. Small Crabs, including Swimming Crabs, were frequent. Spider Crabs (*Stenorhynches*) are recorded several times; Prawns (*Palæmon*) once.

Echinoderms consisted of Brittle Stars, *Ophioglypha* and *Amphiura.* The former (chiefly *O. albida*) were rather more frequent than the latter. **Annelids** consisted of Sea-mice (*Aphrodite*), *Nereis, Eunice,* and a number of unidentified forms. **Lamellibranchs** included several unidentified forms, and Razor Shells (*S. ensis*), Thracia, Venus, *Nucula,* and *Tellina.* **Gastropods** consisted of *Philine aperta* and *Bulla hydatis;* a specimen trawled in Killybegs Harbour contained a great number of the latter.

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[1] In some cases, perhaps, parts of tubes of *Lanice conchilegia.*

Pleurotoma, *Natica alderi*, and *Turritella terebra*, occurred also, probably in connexion with Hermits. **Cephalopods,** Squid (*L. media*) occurred in 1 stomach.

Fish, in about 3 or 4 stomachs, consisted of Sand-eels (in 2) and unidentified sorts.

In 1891, 117 stomachs were examined. 6 were empty. In 10 the nature of the food was indistinguishable. Of the remaining 101, **Echinoderms** occurred in 54, 53 per cent.; Brittle Stars, *Amphiura* in 39; *Ophioglypha albida* in 6; *Ophiothrix* in 1; Urchins (*Amphidotus*) in 2; unidentified Echinoderms in 6; **Annelids** in 14, 13 per cent.; *Nephthys* and *Sabella*, each in 1; unidentified Annelids in 12; **Crustaceans** in 27, 26 per cent.; Hermits in 17; Isopods (*Idotea*) in 4; Gammarids in 2; Swimming Crabs and *Porcellana longicornis*, each in 1; unidentified Crustaceans in 2; **Polyzoans,** *Alcyonidium* in 1; **Lamellibranchs** in 11, 10 per cent.; Razor Shells (*S. ensis*) in 4; *Tellina* in 1; unidentified Lamellibranchs in 6; **Gastropods** in 7, 6 per cent.; *Philine* in 5; Common Whelks and Nadibranchs (*Tritonia*)? each in 1; **Cephalopods,** Squids (*L. media*) in 1; Ascidians, *Molgula* in 4; **Fish** in 2; *Crystallogobius* in 1; unidentified fish in 1; Sloke Weed (*Ulva*) in 1.

The Results of the two years' observations differ somewhat. This would not be surprising, in view of previous experience, were the exact numbers given in each year. In the absence of such information in 1890, I am inclined to give more weight to the observations of 1891. I conclude that the Common Dab is a most promiscuous feeder. On this coast, Echinoderms (especially *Amphiura* and other Brittle Stars) are the most important food. Crustaceans (chiefly Hermits, but including many other forms) are of the next importance. Annelids and Lamellibranchs are much less eaten. Gastropods (chiefly *Philine*) and Ascidians (*Molgula*) are occasional articles of diet. Fish and Squids are rarely eaten.

Zoophytes and seaweed are occasionally found in the stomachs of these fish, as also on the East coast of Scotland; but whether they are to be regarded as food or as having been gulped down for the sake of organisms adhering to them is not certain, nor does the examination of the associated stomach-contents help us.

In the Firth of Forth and St. Andrew's Bay, Smith found that Crustaceans (chiefly Hermits) and Annelids were respectively the chief items of food, whilst in both cases Echinoderms occupied a subordinate position. This presents rather a contrast to our observations on the West Coast of Ireland. Can it be looked upon as in some sense a result of the almost entire absence, on the Scotch Coast of the Common Sole, a great competitor in the matter of Annelids; and on the Irish Coast, of the Long Rough Dab, a notable devourer of Echinoderms? The adaptability of the Common Dab to almost any sort of diet may account for the survival and abundance of such a defenceless and extensively persecuted fish, whilst it is also doubtless attributable to the competition of stronger forms.

COMMON SOLE—*Solea vulgaris*.

In 1890 the stomachs and intestines of 148 Common Sole were examined. 24 were empty. In 16 the nature of the food was indistinguishable. The exact distribution of the food in the remaining 108 cannot be gathered from the Records. It appears, however, that **Echinoderms** occurred in about 25, 23 per cent.; Brittle Stars (*Amphiura*) in 15; Ophioglypha in 2; unidentified Brittle Stars in 7; Urchins (*Echinus*) in several, and unidentified Echinoderms in 1; **Annelids** in about 55, 50 per cent., including Lugworms; Sea Mice (*Aphrodite*), *Nereis*, and many unidentified forms; **Gephyreans** (*Sipunculus*) in a few; Crustaceans, including Gammarids, Common Shrimps, Norway Lobsters (*Nephrops*), and unidentified Crabs, were less frequent than Echinoderms. **Lamellibranchs** occurred in about 19, 17 per cent.; Razor shells (*Solen*) in 11; Cockles and *Nucula*, each in 1; Gastropods (*Philine*), in about 10, 9 per cent.; **Fish** in about 19, 17 per cent.; *Crystallogobius* in 6; Sand-eels in the rest (about 13).

In 1891 the stomachs and intestines of 270 were examined. 82 were empty. In 25 the food was indistinguishable. Of the remaining 163 **Echinoderms** occurred in 38, 23 per cent.; Brittle Stars, *Amphiura*, in 27; *Ophioglypha albida* in 4; unidentified Echinoderms in 7; **Annelids** in 82, 49 per cent.; *Nephthys* and *Lanice*, each in 2. *Aphrodite* and *Lagis*, each in 1; unidentified Annelids in 77; **Crustaceans** in 19, 11 per cent.; Gammarids in 7; Common Shrimps in 4; Swimming Crabs and unidentified Crabs, each in 1; unidentified Crustaceans in 6; **Lamellibranchs** in 4; *Tellina* in 1; unidentified Lamellibranchs in 3; Gastropods in 8; *Philine* in 6; unidentified Gastropods in 2; **Fish** in 10, 6 per cent.; Sand-eels in 9; Unidentified Fish in 1. 3 contained nothing but mud, perhaps the remains of *Sabella* tubes, or gulped down with Annelids. In one was a fragment of Nullipore.

It appears, therefore, that Annelids form by far the most important item of the food, probably almost every polychœte is acceptable. Echinoderms (especially *Amphiura*) form an important item, but far smaller than the last. Crustaceans (chiefly Gammarids and Common Shrimps) and Fish (almost exclusively Sand-eels, with a few *Crystallogobuis*) are of less importance than Echinoderms. Lamellibranchs (chiefly small *Solens*) and Gastropods (chiefly *Philine*) contribute each a yet smaller share. Gephyreans (*Sipunculus*) are occasionally eaten.

Cunningham, in his monograph on this fish, records the food found in the stomachs and intestines of 36 Soles, examined by him at Plymouth. Annelids were present in 50 per cent., or (counting those that contained fragments of shells probably belonging to Annelid tubes) 77 per cent.; Ophiurids in 19 per cent.; Crustaceans in 11 per cent. Molluscs in 8 per cent.

Mr. Green tells me that in Youghal Bay and the neighbourhood, Soles feed very largely upon *Mactra stultorum*.

CONGER—*Conger vulgaris*.

Most of the stomachs examined were empty. About 20 or 26 contained food. Of these, **Crustaceans** occurred in 10 or 15; Norway Lobsters (*Nephrops*) in 3; unidentified Crabs in the rest. **Fish** occurred in 11; Sand-eels and Dragonet in 3; Common Dabs in 2; Gurnard in 1; Ling, already hooked, in 1; unidentified fish in 5.

From Day's observation it appears that the Conger will eat almost any sort of fish, and feeds also upon Crustaceans and Molluscs.

TOPE—*Galeus vulgaris*.

During the Survey the stomachs of 16 Tope were found to contain food. **Crustaceans** occurred in several; Shore Crab in 1; Fish in nearly all; Picked Dog, Sandeels, and Norway Pout each in 1; unidentified fish in about 9.

SMOOTH HOUND—*Mustelus vulgaris*.

The stomachs of 3 contained food which could be identified. It consisted solely of **Crustaceans**, Swimming Crabs, *Portunus arcuatus*, *P. corrugatus* and *P. sp.* in one; Mask Crabs (*Corystes*) in 2; Hermits (*P. bernhardus*) in 1.

Day remarks that this Dogfish feeds on Molluscs and Crustaceans.

SMALL-SPOTTED DOG—*Scyllium canicula.*

During the Survey, the stomachs of 70 were examined. Actinians (*Peachia*) occurred in 1; **Echinoderms** in 2, viz., *Psolus* and *Cucumaria*, each in 1; **Annelids** in 25, 35 per cent. Lugworm (*Arenicola* and *Nephthys*), each in 3; Sea Mouse (*Aphrodite*), *Nereis* and *Chætopterus*, each in 2; unidentified Annelids in 2 **Crustaceans** in 49, 70 per cent.; Hermits in 15; Prawns (*Palæmon*) in 7; Norway Lobsters (*Nephrops*) in 5; Shrimps (*Crangon*), *Munida* and *Mysis*, each in 4; Gammarids, Spider Crabs (*Stenorhynchus*), and unidentified Crabs, each in 2; *Galathæa*, Swimming Crabs (*Portunus*), Angular Crabs (*Gonoplax*), and Mask Crabs (*Corystes*) each in 1; unidentified Crustaceans in 10; **Lamellibranchs** in 7, 10 per cent.; Scallops (*P. opercularis*) in 3; Siphons of Gapers (*Mya*) in 2; unidentified Siphons in 2; **Gastropods** in 11; Whelks (*Buccinum*) in 8, and *Fusus* in 1; unidentified Gastropods in 2; most of the above were probably the "Houses" of Hermits; **Cephalopods** in 5, 7 per cent.; Squids (*Sepiola*) in 3; *Eledone* in 1; unidentified Cephalopods in 1; **Fish** in 24, 34 per cent.; Sand-eels in 7; Herring and Whiting, each in 1; unidentified fish in 15; **Polyzoans**, *Flustra* in 1.

It appears, therefore, that this Dogfish lives upon a varied diet, to which Crustaceans (especially Hermits, though the list is a long one) contribute the largest share. Annelids and fish contribute equal shares, each about half that of Crustaceans. Lamellibranchs and Cephalopods are of less importance. Echinoderms and probably Gastropods are only occasionally eaten.

Thus the Small-spotted Dog is infinitely less destructive to fish than the Picked Dog, and is chiefly harmful in consuming a large amount of valuable food, especially Crustaceans and Annelids.

PICKED DOG—*Acanthias vulgaris.*

During the Survey, 61 stomachs were examined. 13 were empty. 2 contained matter that could not be identified. Of the remaining 46, **Crustaceans**, Common Shrimps, occurred in 1, 2 per cent.; **Cephalopods** in 3, 6 per cent., viz.; *Eledone* in 2; Squids (*Loligo*) in 1; **Fish** in 44, 95 per cent.; Sprats in 13; Sand-eels, Whiting, and *Remora*, each in 1; unidentified fish in 35.

The food, therefore, appears to consist almost entirely of fish. On one occasion in Clew Bay, in the beginning of July, 1890, a number of Picked Dogs were so distended with young Sprats, that the latter streamed out of their mouths when thrown on the deck. It was a common experience when hauling the long lines to find ling and other valuable fish almost entirely destroyed, apparently by these fish, which frequently followed the baits up to the surface.

ANGEL RAY—*Rhina squatina.*

During the Survey, 3 stomachs were examined. **Cephalopods**, the pen of a Squid (*Loligo*) occurred in 1. **Fish**, only a number of crystalline lenses, in 1; Sea Grass (*Zostera*), in all 3.

The occurrence of Zostera, in company with the eyes and other remains of fish in the stomach of an Angel, has been recorded by Thompson. Fish seems to be the principal food, and, according to Day, especially Flat-fishes.

GREY SKATE—*Raia batis.*

During May, June, and July, 31 stomachs were examined. 4 were empty. The distribution of the food in the remaining 27 stomachs cannot be exactly gathered from the Records. It appears, however, that **Fish** occurred in about 50 per cent., Sandeels rather frequently, Witch in one. **Crustaceans** in about 40 per cent., chiefly unidentified Crabs and Common Shrimps. **Echinoderms** and **Gastropods** (including *Fusus*) were each found in one or two stomachs.

During the remainder of the Survey, 33 stomachs were examined. 11 were empty. 2 contained indistinguishable matter. Of the remaining 22, **Crustaceans** occurred in 11 stomachs, 50 per cent; Common Shrimps in 6; Prawns, *Palæmon*, in 4; *Pandalus* in 1; Swimming Crabs in 3; unidentified Crustaceans in 1; **Fish** in 15, 68 per cent.; Whiting in 2; Dragonet, Pollack, Sand-eels, Flounder, and *Argentina*, each in 1; unidentified fish in 7. One large example had seized a Picked Dog already hooked.

The Grey Skate thus appears to feed almost entirely on Fish and Crustaceans, with an occasional Mollusc and Echinoderm. The preference is somewhat in favour of fish, As Mr. Smith lumps all species of Skate together, his observations on the Scotch Coast do not help us.

SHARP-NOSED SKATE—*Raia oxyrhynchus.*

2 stomachs were examined. Both contained fish. Young *Argentina* were found in the stomach of a specimen from 375 to 500 fathoms; *Cepola rubescens* in one from 25 fathoms.

SHAGREEN RAY—*Raia fullonica.*

6 stomachs were examined. 3 were empty. The remaining 3 contained fish, viz.: Dragonet in 1; unidentified fish in 2.

THORNBACK—*Raia clavata.*

During May, June, and July, 1890, 119 stomachs were examined. 18 were empty. 3 contained matter which could not be identified. The distribution of the food in the remaining 108 stomachs cannot be exactly gathered from the Records. It appears, however, that **Crustaceans** formed the largest contribution, chiefly Hermits and Crabs, including a few Swimming Crabs and Spider Crabs (*Stenorhynchus*), with a certain number of Amphipods, Schizopods, and Common Shrimps. **Fish** contributed a slightly smaller share. Of these, Sand-eels were identified in several stomachs; Wrasse, Cod, and Dab, each in 1. **Annelids** and **Lamellibranchs** each contributed a smaller share; about 12 per cent. Of the former, Sea Mice (*Aphrodite*) were rather frequent, and Lugworms and Nereis occurred each in 1 stomach. Lamellibranchs consisted chiefly of Siphons (of *Mya* and other forms not identified), with some Scallops (*Pecten*) and Razor Shells (*Solen*). **Echinoderms, Gastropods** (Common Whelks), and **Cephalopods** were of very rare occurrence.

During the remainder of the Survey, 71 stomachs were examined. 17 were empty, and 1 contained indistinguishable matter. Of the remaining 53, **Echinoderms** occurred in 3, 5 per cent.; **Annelids** in 14, 26 per cent.; Sea Mice (*Aphrodite*) in 8; *Nephthys*, in 1; unidentified Annelids in 5; **Crustaceans** in 46, 86 per cent.; Swimming Crabs in 12; *Gonoplax* in 8; Common Shrimps and Mask Crabs (*Corystes*), each in 7; *Cymothoa* and Hermits, each in 6; Prawns (*Palæmon*) in 4; Norway Lobsters (*Nephrops*) and *Atelecyclus*, each in 3; *Gebia* and unidentified Crabs, each in 2; Schizopods in 1; unidentified Crustaceans in 6; **Lamellibranchs** in 8, 15 per cent.; Siphons of Gapers (*Mya*) in 1; unidentified Siphons in 2; unidentified Lamellibranchs in 5; **Cephalopods** (*Eledone*), in 1, 1 per cent.; **Fish** in 11, 20 per cent.; Sand-eels in 3; *Crystallogobius* in 2; *Cepola* and young Herrings or Sprats, each in 1; unidentified fish in 4.

It thus appears that the Thornback lives on a very varied diet, chiefly of Crustaceans (especially Swimming Crabs, Angular Crabs, Common Shrimps, Mask Crabs, and Hermits), and to a less and seemingly variable extent on fish. Annelids (chiefly Sea Mice) and Lamellibranchs are subsidiary articles of diet. Cephalopods and Echinoderms are rarely eaten. Gastropods are perhaps only represented by shells, the "houses" of Hermits.

SPOTTED RAY—*Raia maculata.*

During May, June, and July, 1890, 72 stomachs were examined. The exact distribution of the food cannot be gathered from the Records. It appears, however, that the majority contained **Fish**, chiefly Sandeels, with a few Sprats and Herring and unidentified forms. A much less number contained **Crustaceans**, including Norway Lobsters (*Nephrops*), Hermits, Crabs, Schizopods, Common Shrimps, Amphipods, and Isopods. Lamellibranchs, chiefly the Siphons of *Mya*, were about equally numerous with the last.

During the rest of the Survey, 36 stomachs were examined. 10 were empty, and 2 contained indistinguishable matter. Of the remaining 24, **Annelids** occurred in 1. **Crustaceans** in 7, 29 per cent.; Swimming Crabs in 3; Common Shrimps in 2; Mask Crabs (*Corystes*), *Gonoplax* and *Atelecyclus* each in 1; **Lamellibranchs**, Razor Shells (*Solen*) in 3, 12 per cent.; **Fish** in 15, 62 per cent.; Sand-eels in 13; *Crystallogobius* in 1; unidentified fish in 1.

It appears, therefore, that the diet of this Ray is less indiscriminate than that of the Thornback. Unlike the latter, the Spotted Ray feeds chiefly on fish, especially Sandeels, whilst Crustaceans, including much the same forms as the Thornback, form a less important article of diet. Lamellibranchs (Razor Shells) contribute very little, and Annelids hardly at all.

SANDY RAY—*Raia circularis.*

Of 2 stomachs examined, 1 was empty. The other, that of a large example from deep water (154 fathoms), contained the remains of a fair sized Picked Dog.

By taking the above observations in the inverse order we are better able to form an idea of the competition which exists for each kind of food.

Actinians. *Edwardsia* and *Cerianthus* occurred each on one occasion in a Plaice's stomach. *Peachia* once in the stomach of a Small-spotted Dog. *Edwardsia*, however, appears to be sometimes much eaten by the Common Dab on the Scotch Coast.

Hydroids. Occasionally eaten by the Common Dab.

Echinoderms. The chief food of the Piper, Haddock and Common Dab, Largely eaten by the Long Rough Dab, Plaice, Lemon Dab, Pole Dab and Common Sole. Occasionally by the Cod, Whiting, Hake, Small-spotted Dog and Grey Skate. Rarely by the Thornback.

Annelids. The chief food of the Lemon Dab, Pole Dab, and Common Sole. Largely eaten by the Haddock, Plaice and Small-spotted Dog. Moderately by the Common Dab. Occasionally by the Sapphirine Gurnard, Grey Gurnard, Cod, Pollack, Long Rough Dab, Turbot, Witch and Thornback. Rarely by the Spotted Ray.

Gephyreans. Occasionally eaten by the Plaice and Common Sole.

Nemerteans. Rarely eaten by the Cod.

Crustaceans. The chief food of the Cod, Long Rough Dab, Smooth Hound, Small-spotted Dog and Thornback. Largely eaten by the Red Gurnard, Sapphirine Gurnard, Grey Gurnard, Piper, Haddock, Witch, Common Dab, Conger, Grey Skate and Spotted Ray. Moderately by the Cod, Pollack, Plaice, Common Sole and Tope. Rarely by the Whiting, Ling, Brill, Lemon Dab and Picked Dog.

Lamellibranchs. The chief food of the Plaice. Largely eaten by the Spotted Ray. Moderately by the Sapphirine Gurnard, Cod, Haddock, Common Dab. Occasionally by the Turbot, Lemon Dab, Pole Dab, Small-spotted Dog. Rarely by the Spotted Ray.

Gastropods. Occasionally eaten by the Cod, Haddock, Plaice, Common Dab, Common Sole, Small-spotted Dog and Grey Skate.

Cephalopods. Moderately eaten by the Ling. Occasionally by the Grey Gurnard, Cod, Brill, Turbot, Witch, Small-spotted Dog and Picked Dog. Rarely by the Common Dab and Thornback.

Ascidians. *Molgula.* Occasionally eaten by the Plaice and Common Dab. On the East of Scotland, *Pelonaia* is eaten by the latter; it does not seem to occur on the West Coast of Ireland.

Fish. The chief food of the Red Gurnard? Sapphirine Gurnard, Grey Gurnard, Angler (almost the whole food), Dory (only food?) Whiting, Coalfish, Pollack, Hake, Ling, Turbot, Brill, Witch, Conger, Tope, Picked Dog, Angel Ray, Grey Skate, Spotted Ray, and probably also the Sharp-nosed Skate, Shagreen Ray and Sandy Ray. Largely eaten by the Cod, Small-spotted Dog and Thornback. Occasionally by the Piper, Haddock, Long Rough Dab, Lemon Dab and Common Sole. Rarely by the Plaice and Common Dab.

Sand-eels appear to be the fish most universally persecuted. Sprats and young Herrings are also frequently eaten, and it is noticeable that the Dragonet and Weever are not infrequent victims in spite of their formidable armature.

(v.)—SUGGESTIONS AS TO UNSALEABLE FISHES.

As I have remarked elsewhere, Anglers (*Lophius piscatorius*) are by no means so common on this coast as Professor M'Intosh has shown them to be on the trawling grounds on the East Coast of Scotland (*vide* Report of Trawling Commission). Professor M'Intosh mentions that the tail parts of Anglers were formally exported from Scotland to England for food; but though eaten within comparatively recent years in the south-west of England, they appear to be no longer appreciated.[1] I have been assured by those who made the experiment that they are extremely good, but have never tried them myself.

Another fish which was formerly esteemed is the Lumpsucker (*Cyclopterus lumpus*). From Buckland's experience it appears to be rather a rich food, which should only be indulged in in moderation. Professor M'Intosh has suggested that its thick gelatinous skin might be turned to some valuable use. On some parts of the West Coast this fish appears to be employed as bait for crab or lobster pots.

Hardly any use is made of the Skates and Rays which are so abundant on the West Coast. In most parts a strong prejudice appears to exist against eating them. The lobster fishermen of Aranmore, Donegal, were glad to take all we could give them as

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[1] Note added in the Press.—I find that they are regularly brought ashore to the Grimsby market, for sale to the fried fish shops.

bait for their pots, but elsewhere Skate seem not even to be used for that purpose. Skate command, of course, a ready sale in the English market, and there is no doubt that should the Fishing Company now being started prove a success, the Western fishermen will find an unexpected mine of wealth in this hitherto despised fish. Apart from their use as food, the liver contains a large quantity of oil which might surely be turned to some useful purpose.

Dogfish, including Topes, Picked Dogs, and Small-spotted Dogs, are only too abundant on the West Coast. They enjoy an evil reputation, not undeserved in the case of the two first species, for destroying more valuable fish, whilst all three kinds are a great nuisance to the line fisherman: they take greedily any bait that may be offered, forestalling more valuable fish, and mutilate many of the latter which may have been hooked, whilst, when captured themselves, they are not known, as a rule, to be of any value to the fisherman. The Small-spotted Dog is probably of very little value. It is sometimes used for cleaning woodwork, its skin making an excellent substitute for sand-paper, and, according to Couch, its flesh is more or less palatable. The liver, however, is small. The Picked Dog is more valuable. Whilst its flesh is eaten in a dried condition by the Cornish fishermen, and, to some extent, as I am told by Dr. Scharff, also on the South-west Coast of Ireland, the liver is large, and yields a supply of oil of a valuable nature. Mr. Cyril Allies, of Inishboffin, tells me that upon his islands the oil is used in the preparation of wool for weaving, and also for lamps. It appears to command a price which would at all events make it worth while for the fishermen to save the livers of any of these fish that might be caught, while the employment of improved methods of refining would materially increase the value of the product.

Doubtless the offensive odour of the Tope would deter most people from eating its flesh. But the liver is very large, and is valued upon the Boffin Islands. I think there is no doubt that the oil extracted from these two fish might be made to afford a considerable set-off to the harm which may be done by them.

The small deep-sea Shark, *Centrophorus squamosus*, which the Survey has been the means of adding to the British Fauna, belongs to a genus of which this and other members form the object of a regular deep-sea fishery at Setubal, on the coast of Portugal (E. P. Wright, Ann. Mag. Nat. Hist., vol. ii., 1868, and Vaillant, Exp. Sci., Talisman, Travailleur, Poiss. Paris, 1888). The gear in use resembles an ordinary long-line, but only the end first shot is weighted; no buoys are used, the end of what corresponds to the second buoy-rope being retained in the boat. The bait is pilchard or codling. The only saleable product is the skin, which is dried and sold for polishing wood. A dried skin fetches about 1½ francs, except in the case of *C. granulosus*, the skin of which is more valuable, as it is suitable for manufacture into the "shark-skin" of commerce. The flesh is dried and eaten, and the oil is used for lamps and for lubricating wooden machinery. On the whole Vaillant is inclined to doubt whether the industry is a paying one.

REMARKS UPON MEASURES FOR THE PROTECTION OF IMMATURE FISH, AND FOR THE INCREASE OF THE FISH SUPPLY.

So far as I know the only investigations that have hitherto been attempted in this country with a view to determining the damage done to immature fish by trawling were those carried out in Galway Bay, in the years 1873 to 1876, under the direction of Sir Thomas Brady. As a result of these experiments, it will be remembered that the Inspectors of Fisheries came to the conclusion that no substantial injury was done by trawling; but it must be borne in mind that the distinction drawn between fish of different sizes was based on their saleable qualities, and was therefore of a purely arbitrary nature, whilst as no distinct limits of size seem to have been laid down to divide the saleable and unsaleable forms, the standard may have varied a little with the ideas of the different Coast Guard officers who kept the records. Moreover, in the published results (Reports on Trawling Experiments in Galway Bay, Dublin, 1885) the depths are only given in the form of the amount of warp paid out whilst trawling, which is a rather unsatisfactory method, if it is desired to find out the exact depth at which the various fry were taken.

In the results of the trawling experiments carried out on the East Coast of Scotland and North-east Coast of England by Professor M'Intosh we have an extensive series of the most careful and accurate observations, but in this case also the distinction between mature and immature fish is designedly based upon their saleable qualities, and, as pointed out in the case of several species by Professor M'Intosh, the same distinction does not hold good with regard to sexual maturity.

Following Dr. Fulton, I have alluded elsewhere to the importance of the last-named point, which was, of course, not regarded in the framing of the size limits by the recent Fishery Convention.

On the West Coast of Ireland it may not seem to be very necessary to protect immature fish, since at present man is so little inclined to molest them. Prevention, however, is better, certainly easier, than cure; and the rapid decline of valuable food-fish[1] on other British coasts must surely soon attract the attention of fishermen to this part of the world. Indeed the attempts at the formation of various companies to fish the West Coast are all indications that our fish will not continue to enjoy immunity for much longer. The recent Fishery Convention seems to indicate that measures of an international character will be attempted for the revival of the fish supply, whenever the parties concerned can agree amongst themselves as to the method best calculated to secure the desired result.

It may, therefore, be as well to recapitulate briefly the various plans which have from time to time been put forward.

Legislation has been proposed in various directions:—

(1.) A close time for marine food fishes, usually rejected as impracticable.

(2.) Protective legislation for young fish, which falls under two heads: (*a*) Legislation as to sale, and (*b*) legislation as to size of mesh or hook, or nature of fishing implement generally.

(3.) Legislation as to locality.

On the second question laws have from time to time been passed in various countries restricting the sale of marine fish under certain sizes, but none are now in force in this country.[2]

The last method is the only one now in vogue, and legislation under this heading is of course always levelled at that piscatorial scapegoat—the beam trawler, and especially the steam trawler. It is now generally acknowledged that of his most heinous imputed

[1] The herring forms the only exception to this. In spite of the immense annual slaughter of herring and whitebait (the young of herring and sprats), the numbers appear to be increasing rather than diminishing.

[2] Under the Sea Fisheries Regulation Act, 1888, certain by-laws have recently been passed by the Local Fisheries Committees on various parts of the English Coast, restricting the size of Mesh, and prohibiting the landing and sale of Fish under certain sizes. Similar laws are in force in Denmark, France, and Italy.

crime, viz. the destruction of spawn, the trawler is wholly innocent. For the sake of his net, if for no other reason, it may be supposed that he would keep clear of the rough ground on which herring are known to deposit their spawn,[1] whilst in the case of all other food-fish of importance[2] (except skates), of whose reproduction we know anything, the spawn floats and cannot be hurt by the trawler. In spite of this, however, we find a gentleman, learned in the law, prepared to prove, at an inquiry held in 1890, that Mackerel deposit their eggs on a sandy bottom in shallow water. Comment is needless. That the beam trawl does capture a large number of fish not sexually mature is undeniable, and moreover is not denied by the trawlers themselves. It appears, however, that they take all possible steps, by returning the small fish to the sea as soon as possible, to minimise an evil from which they must needs be the principal sufferers. It would be needless recapitulation to insert here the number of immature fish which were taken during the Survey. The figures are sufficientiy apparent in my Appendix (A) on the Result of Fishing Operations.

Dr. Fulton remarks, "If immature flat-fish were special in their distribution, if their nurseries could be defined as apart from the habitats of the adults, the question could be easily solved by the prohibition of beam trawling in these areas."

Unfortunately, he thinks that it is not possible, even in the case of Plaice, on the East Coast of Scotland, and our evidence from the West Coast of Ireland shows that it is equally impossible there. This being the case it would appear that prohibition of this nature may even be dangerous, since, whilst not affording special protection to immature fish, or at most only to one species, it tends, by the restriction of the trawler to certain grounds, to force him to exhaust these, if exhaustible, more speedily than if he were allowed to go where he pleased. Doubtless such prohibition as exists on the Irish coast is intended more for the benefit of the local line-fisherman than for that of the immature fish; but the relative merits of the line-fisherman and the trawler, as apart from their power of destroying young fish, is a purely social question which does not enter into the scope of my remarks. I understand that in one place there exists a race of line-fishermen who make their living by the capture and sale of "tongues or slips," *i.e.* immature Sole. Surely, this is a case in which the trawler deserves protection from the liner, since it is on the former that we depend almost entirely for our supply of large Soles.

Prohibitive legislation has further shown a tendency, or has been invited to discriminate between the sailing and steam beam-trawler, the action of the screw "in stirring up the bottom in shallow water" being the principal cause of complaint on the part of local fishermen. It is extremely unlikely, however, that the skipper of a steam trawling vessel would risk his ship in water sufficiently shallow for the screw to have any effect. Doubtless the steam trawler is more destructive, because more efficacious, than the sailing trawler, but his greater powers of harm may be compensated by the

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[1] Exact information (such as is given by Dr. Fulton for the East Coast of Scotland in the 9th Ann. Rep. S. F. B.) is much needed as to the spawning places of Herring all round the Irish Coast. If such were forthcoming, the constant disputes between Trawlers and Herring-fishermen could be definitely set at rest.

[2] The Wolf-fish (*Anarrhichas lupus*) deposits its eggs on the ground. Wrasse, which have some value upon the West Coast, have also demersal eggs, but the latter are deposited amongst rocks and between tide-marks. The only fish-spawn trawled by ourselves was that of the minute Double-spotted Sucker (*Lepadogaster bimaculatus*), which on two occasions was brought up by the trawl attached to empty mollusc shells. Some spawn which I was asked to examine by a trawler in Blacksod Bay proved to be that of a mollusc.

greater supply of fish which he brings to the market. But it is only when we come to contrast the beam with the otter trawls in use amongst local fishermen in various parts of the coast that we find an essential difference in the destructiveness of steam[1] and sailing trawlers. I shall have occasion to refer to this later. We will now consider legislation as regards mesh. Now it is obvious that a net which would let all immature Turbot escape, would catch very little else except skates. I have endeavoured to show that the ordinary trawl-mesh does not capture a large percentage of immature Soles, whilst the patent net we used caught none at all. A net, however, that would retain only mature Plaice would be almost useless.

Dr. Fulton says, in substance, that beyond the biological statement that a Plaice under 12 inches (under fifteen inches in my own opinion), a Haddock under 10 inches, and a turbot under about 18 inches, are immature; "there is the economic side, which must necessarily be the final appeal." Putting aside the case of the Herring, I would submit that there is no such appeal, or rather that the biological and the economical interests are identical. No doubt many immature fish are marketable; but we are face to face with the fact that the supply of prime fish is diminishing. It is acknowledged that remedial measures must be taken, and the consensus of opinion points to any measure that will protect the immature forms. What further need of argument? It is surely a self-evident fact that they must be protected, else has the fable of the goose with the golden eggs been written in vain.

The difficulty is to find any method for preventing their destruction. Fulton's opinion is that the limitation of the mesh will not alone solve the problem, and I think the arguments he advances are not to be controverted. Moreover, the designing of a mesh or of a trawl which would retain only fish of a given size, and yet be sufficiently effective on larger fish to meet with the approbation of fishermen, does not appear to be an easy matter, though probably a practical net maker, taking advantage of such steps as have already been accomplished in this direction, might be able to overcome most of the difficulties. In the meantime it is very desirable that investigations should be made in order to establish the relationships, if any, between the size of the mesh and the size of fish caught thereby. Experiments of this nature form part of the programme of the forthcoming investigations of the Marine Biological Association in the North Sea.

It appears to me that if we are successful in establishing such a relationship as I have alluded to, much good might be done by a restriction as to the size of the mesh, combined with prohibition of the sale or possession of fish under a certain size, whilst even more beneficial results would be likely to follow were it possible by any means to restrict the time during which a trawl should be allowed to be on the ground, especially on trawling grounds which are known to be haunted by young fish. It is in fact desirable on all very shallow grounds. In Downies Bay, for instance, large Plaice are so abundant that it is hardly desirable to abstain from trawling for the sake of the immature forms which may be caught at the same time, if means can be adopted to prevent any very great percentage of injury to the latter. I have endeavoured to show that in the short hauls which we made it was usual to find Turbot, Brill, Sole, and some other kinds of fish little, if at all, injured. I have no doubt that the great majority of these would have survived if returned, though Mr. Cunningham found that trawled Sole did not survive in the Plymouth Aquaria if the skin had been in any way abraded. This, nevertheless, is not invariably the case under natural conditions, as we trawled a fine Sole which had completely recovered from a wound involving the

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[1] There is, however, no reason why a steam trawler should not carry an otter trawl for use on grounds where beam trawling is likely to be harmful.

loss of a considerable part of the ventral fin and interspinous region, and, I have amongst the collections of the Survey, a specimen of the Lemon Sole (*Solea lascaris*) which exhibits a healed wound of a less severe nature.

It is in the necessity of making short hauls only, and of avoiding weedy ground that the merits of the otter trawler are conspicuous. It is obvious that a fish is less liable to be injured in 20 minutes than in 4 hours.[1] This being the case it appears that in the absence of a time restriction upon beam trawling, a measure which should exclude the latter from very shallow grounds near the shore, while allowing full scope to the use of the otter trawl, would have merits quite apart from the social side of the question, *but only if combined with prohibition of the sale of immature fish.* The deeper grounds must be left to the beam trawler. They are inaccessible to any other method of fishing, and our knowledge of the distribution of immature fish upon these grounds is even yet so imperfect that I hesitate to go beyond the suggestions which I have thrown out in the preceding pages.

As to shrimp trawling, no such industry exists on the West Coast, and long may it be absent. Whilst Fulton (*op. cit.* p. 206) has shown that little injury is done to Plaice, &c., of $1\frac{1}{2}$ inch and upwards, if they are at once returned to the sea, my own observations convince me that the smaller forms are destroyed by the net.[2] Shrimping at the margin with hand nets appears to be also unknown, and this method must be more or less destructive, though I suppose a great number of the young Plaice, &c., so caught would survive, if returned. It may be remarked indeed that the Shrimp (Crangon) appears to have no commercial value upon the West Coast, whilst Prawns (Palæmon, not Nephrops, the Dublin Bay Prawn or Norway Lobster) are only valuable in places where they are required as bait for Salmon. It was somewhat remarkable to find on Gorumna Island an active industry in the collection of Periwinkles for exportation to England, whilst the really valuable Prawns were permitted to swarm unmolested in the same pools.

As to destructiveness of different kinds of hooks in line-fishing, our observations only show that the kind which we used, viz. large cod hooks, are not destructive to the immature forms of valuable fish, or at all events very little so; that they should capture a number of immature Skate and Dogfish may be well supposed, and in the latter case is no matter for regret. The haddock hooks in use on this coast appear to be considerably larger than those used by the line-fishermen of the East Coast of Scotland; I do not know what size of hook is or was employed in the capture of soles, which seems from the evidence given at various fishery inquiries, to have at one time been a profitable branch of line-fishing in Galway and other Bays.

While I think it may be said that a close time for marine fish is impracticable, the more especially as the spawning period of the more valuable forms more or less coincides with Lent, yet it is possible that restrictive measures of a mild nature might be beneficially exercised. Thus if it be found that the bulk of the fish on any ground at a particular time of the year are spawning (*e.g.* Soles in part of Ballinskelligs Bay in March and April), that ground might well be closed to trawlers for a limited period, if of small extent, whilst in the case of larger grounds, such part of it might be closed as would lend itself most easily to the enforcement of the law. By this means no

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[1] This is well illustrated in Fulton's recent report (9th Ann. Rep. S. F. B., 1891, p. 205), but it is also shown that the mortality amongst trawled fish (especially flat fish) is much less than might be supposed.

[2] I do not know whether such minute forms are found on the grounds worked by Shrimp-trawlers. They are not mentioned in Fulton's lists, and the grounds upon which we made our experiments could not be said to abound in Shrimps.

serious loss would be caused to anyone; and the fact that on this coast, as I have shown elsewhere, almost all the known trawling grounds are within the territorial limits, offers advantages for the trial of such measures which do not exist on other coasts. Again, trawling on the West Coast is as yet in its infancy, so that practically no vested interests exist to complicate matters.

Much can probably be done by the fishermen themselves to increase the supply of fish, by artificially fertilizing the eggs of all ripe fish taken, and then throwing them into the sea. This suggestion, which originated, I believe, with the late Professor Baird on the other side of the Atlantic, has received its due share of attention from the Scotch Fishery Board.

The final resource lies in the artificial rearing of fish. This method has been found extremely successful in reviving the shad fisheries on the coast of the United States, whilst its success in the case of Salmon and of Trout, and certain other fresh water fish, has been established in our own country. The Shad, however, is to some extent an anadromous fish, as it enters the mouths of rivers to deposit its spawn, and thus presents peculiar advantages to the pisciculturist. That artificial rearing is also feasible in the case of purely marine fish, is shown by the measure of success which has attended the experiments carried on in Norway with the Cod. From the researches of Raffaele, M'Intosh, Cunningham, and others, we know how easy it is to rear the young of almost all food-fishes to a certain stage, even with the limited means at their disposal. But the matter has never been allowed a practical trial in this country.

Professor M'Intosh has repeatedly urged the desirability of establishing hatching and rearing stations on a scale sufficiently large to test, or rather to establish, and make use of the powers which lie at our disposal for the increase of our fish supply, but so far has met with no response. Recently he appears to incline to the opinion that expense might be saved by simply fertilizing the eggs of valuable fish upon a large scale, and transferring them to the waters in which it was desired to replenish the supply. Expense is undoubtedly the great obstacle in the way of artificial rearing, but it appears to me that there are places upon the West Coast of Ireland where the natural conditions would be particularly favourable for experiments of this nature.

XXX.

SURVEY OF FISHING GROUNDS, WEST COAST OF IRELAND, 1890–1891. TABLE OF TEMPERATURE AND SPECIFIC GRAVITY OF SEA-WATER. FROM OBSERVATIONS TAKEN ON BOARD THE "FINGAL," IN 1890. BY T. H. POOLE, B.E.

(COMMUNICATED BY REV. W. S. GREEN, DIRECTOR OF THE SURVEY.)

[Read NOVEMBER 18, 1891.]

Date.	Station No.	Position.	Bottom Temperature Fahr.	Surface Temperature Fahr.	Specific Gravity reduced to a mean of 63°·5 F.	Remarks.
May 26	17	Smerwick,	..	53	1·0264	
27		Smerwick,	..	..	1·0264	
,,	18	Brandon Bay,	..	54·5	1·0267	
,,	19	Off Kilclogher Head,	..	55	1·0256	Probably influence of river Shannon.
28	20	Between Moher and Aran,	49	53·5	1·0265	
30		In Outer Dock, Galway (L.W.),	..	..	1·0030	Almost fresh.
June 4	23	Killeany Bay,	..	55	1·0266	
5	24	Inside Aran Islands,	53	54·5	1·0265	
,,	25	Inside Aran Islands,	53	54·5	1·0265	
6	26	Kilkieran Bay,	..	55	1·0264	
7	27	Birturbuy Bay,	..	57	1·0228	
9	28	Roundstone Bay,	..	56	1·0256	
,,	29	Gorteen Bay,	..	56	1·0260	
,,	31	Birturbuy Bay,	..	56	1·0257	
11	33	Clifden Harbour,	..	57·5	1·0250	
12	35	Boffin Harbour,	..	57	1·0268	

,,	**37A**	At The Bills,	..	55·5	1·0262	
,,	**38**	Blacksod Bay,	..	59	1·0258	
14	**39**	Inside Cleggan Island,	..	59	1·0258	
21	**50**	Killybegs,	..	58	1·0253	
30	**58**	Clew Bay,	56	56·5	1·0263	
,,	**59**	Clew Bay,	56	56·5	1·0263	
July 1	**60**	Clew Bay,	56	56·5	1·0263	
,,	**61**	Clew Bay,	56	56·5	1·0263	
4	**63**	At 220 fathoms off Achill Head,	50	56	1·0272	
,,	**64**	At 144 fathoms off Achill Head,	..	56	1·0272	
5	**65**	Blacksod Bay,	..	56·5	1·0263	
,,	**66**	Blacksod Bay,	..	56·5	1·0263	
9	**68**	Blacksod Bay,	..	57	1·0265	
,,	**69**	Blacksod Bay,	..	57	1·0265	
10	**70**	54 Miles off Achill,	48	55·5	1·0272	Depth 500 fathoms.
,,	**71**	34 Miles off Achill,	50	56	1·0271	
,,	**72**	20 Miles off Achill,	..	56	1·0271	
12	**73**	Killary Bay,	..	59	1·0247	
15	**74**	Off Killary,	..	56	1·0265	
,,	**75**	Cleggan Bay,	..	56	1·0265	
,,	**76**	Cleggan Bay,	..	56	1·0265	
16	**78**	Long Line Ground off Clew Bay,	52	57	1·0267	
18	**80**	Off Slyne Head,	49	58·5	1·0269	
25	**82**	Outside Aran Islands,	58	61	1·0268	
,,	**83**	Inside Aran Islands,	..	60	1·0265	
28	**84**	Galway Bay,	..	58·5	1·0265	
,,	**85**	Galway Bay,	..	59	1·0263	
29	**86**	Inishmaan,	..	59	1·0264	
30	**87**	Inisheer,	..	59	1·0264	

Date.	Station No.	Position.	Bottom Tempera-ture Fahr.	Surface Tempera-ture Fahr.	Specific Gravity reduced to a mean of 63°·5 F.	Remarks.
July 30	**88**	Inishmaan, ...	..	59	1·0264	
31	**89**	Galway Bay, ...	..	60	1·0260	
August 7	**90**	Galway Bay, ...	..	60	1·0257	
,,	**92**	Galway Bay, ...	..	63	1·0247	
8	**94**	Casheen Bay, ...	..	63	1·0247	Sudden change. Air temp.
,,		Casheen Bay, ...	..	63	1·0263	72°, highest recorded in log.
9	**95**	South Sound, ...	59·5	61	1·0266	
11	**98**	Inishmaan, ...	..	61	1·0266	
13	**100**	Ventry Harbour, ...	..	55	1·0271	High for a harbour.
,,	**101**	Off Ventry, ...	52·05	55	1·0271	
,,	**102**	Off Anniscaul, ...	..	57	1·0269	
14	**104**	Off Valentia, ...	2	57	1·0268	
16	**106**	Kenmare River, ...	..	57	1·0268	
,,	**107**	Dinish Island, ...	..	57·5	1·0260	
18	**108**	Kenmare River, ...	..	60	1·0205	Influence of river.
,,	**109**	Blackwater, ...	57	60	1·0197	
,,	**112**	Kenmare River, ...	57	60·5	1·0251	
19	**113**	Off Skelligs, ...	49	57·5	1·0270	
20	**116**	Off Skelligs, ...	49	57·5	1·0271	
21	**118**	Ballinskelligs Bay, . . .	..	56·5	1·0268	
,,	**120**	Off Ballinskelligs Bay, . . .	..	57	1·0269	

XXXI.

SURVEY OF FISHING GROUNDS, WEST COAST OF IRELAND, 1890–1891. TABLE OF TEMPERATURE AND SPECIFIC GRAVITY OF SEA-WATER. FROM OBSERVATIONS TAKEN ON BOARD THE "HARLEQUIN," IN 1891. BY G. H. T. BEAMISH, C.E.

(COMMUNICATED BY REV. W. S. GREEN, DIRECTOR OF THE SURVEY.)

[Read NOVEMBER 18, 1891.]

Date.	Station No.	POSITION.	Bottom Temperature Fahr.	Surface Temperature Fahr.	Specific Gravity reduced to a mean of 63°·5 F.	REMARKS.
March 23	**124**	50 Miles W. of Bolus Head,	..	50·9	1·0276	
,,	**125**	40 Miles W. of Bolus Head,	..	50·4	1·0271	
28	**126**	Kenmare River,	..	46·8	1·0269	
,,	**127**	Kenmare River,	..	47·0	1·0274	
,,	**128**	Kenmare River, near Blackwater,	..	47·8	1·0266	
30	**130**	Kenmare River, off Sneem,	..	47·1	1·0269	
,,	**131**	Kenmare River, near Dursey,	..	47·8	1·0278	
31	**132**	Ballinskelligs Bay,	..	48·2	1·0275	
,,	**133**	Dingle Bay,	..	48·6	1·0274	
April 2	**135**	Smerwick,	..	47·7	1·0272	
,,	**136**	25 m. N.W. by W. from Mutton Is., Co. Clare,	48·0	47·8	..	
4	**138**	Kilkieran Bay,	..	46·4	1·0261	
7	**141**	West of Aran Islands,	..	48·6	1·0271	

Date.		Station No.	Position.	Bottom Temperature Fahr.	Surface Temperature Fahr.	Specific Gravity reduced to a mean of 65°·5 F.	Remarks.
April	8	**145**	Killeany Bay, ...	..	48·4	1·0269	
	,,	**147**	South Sound, ...	..	47·1	1·0269	
	9	**148**	West of Aran Islands, . . .	..	48·2	1·0270	
	16	**157**	Greatman's Bay, . . .	..	48·7	1·0265	
	17	**159**	Cleggan Bay, ...	..	48·6	1·0272	
	18	**163**	Clew Bay, ...	..	48·7	1·0270	
	20	**164**	Clew Bay, ...	45·1	47·1	1·0271	Depth 18 fathoms.
	,,	**165**	28 Miles N.W. by N. from Achill Head,	49·1	50·7	1·0278	Depth 154 fathoms.
	21	**168**	Blacksod Bay, ...	..	48·9	1·0268	
	23	**173**	French Port, ...	..	47·3	1·0274	
	25	**176**	Broadhaven, ...	..	47·3	1·0277	Air temp. 43°·7, lowest [in log.
	,,	**177**	Off Downpatrick Head, . . .	46·4	47·1	1·0275	Depth 20 fathoms.
	28	**178**	Blacksod Bay, ...	..	49·0	1·0272	
April	30	**180**	Off Ballynakill, ...	..	48·2	1·0273	
May	2	**184**	Ballynakill, ...	..	50·4	1·0266	
	,,	**185**	North of Ross Point, . . .	..	50·2	1·0266	
	,,	**188**	Blacksod Bay, ...	..	50·0	1·0272	
	,,	**192**	Bellacragher Bay, . . .	..	50·9	1·0265	
	,,	**193**	Near Bull's Mouth, . . .	..	48·2	1·0273	
	8	**195**	Off Innisboffin, ...	..	48·6	1·0272	
	,,	**197**	Near Innisturk, ...	..	50·0	1·0275	
	9	**200**	15 Miles W. by N. from Clare Island, .	..	49·5	1·0273	
	12	**201**	45 Miles N.N.W. from Black Rock, .	47·5	51·1	1·0276	
	,,	**202**	45 Miles N.N.W. from Black Rock, .	..	52·2	1·0274	
	14	**204**	Donegal Bay, ...	..	49·1	1·0265	
	15	**206**	Off Killybegs, ...	..	48·8	1·0266	

	18	**212**	Donegal Bay,	..	50·4	1·0266	
	19	**214**	Donegal Bay, off Teelin,	..	50·0	1·0265	
	20	**217**	Off Doorin Point,	..	48·2	1·0265	Low water. Specific Gravity taken after heavy shower.
	21	**221**	Loughrosmore Bay,	..	49·3	1·0257	
	,,	**222**	Boylach Bay,	..	49·1	1·0270	
	,,	**223**	Loughrosmore Bay,	..	49·1	1·0267	Flood tide.
	22	**224**	Boylach Bay,	..	49·0	1·0270	
	25		Burton Port,	..	51·1	1·0270	
	26	**228**	Gola Roads,	..	48·8	1·0271	
	27	**229**	Off Bloody Foreland,	..	48·2	1·0274	
	,,	**230**	Off Tory Island,	..	49·1	1·0270	
	,,	**231**	Off Tory Island,	..	49·7	1·0270	
	28	**232**	Off Ballynass,	..	50·0	1·0267	
	29	**235**	Sheephaven,	..	50·9	1·0266	
	,,	**236**	Sheephaven,	..	50·4	1·0264	
	,,	**238**	Lough Swilly,	..	50·5	1·0263	
June	1	**240**	Lough Swilly,	..	52·2	1·0261	
	2	**242**	Mouth of Lough Foyle,	..	50·0	1·0264	

XXXII.

REVOLVING MACHINERY FOR THE DOMES OF ASTRONOMICAL OBSERVATORIES. By SIR HOWARD GRUBB, F.R.S.

[Read MAY 22, 1891].

THE convenience and ease of motion of the Observatory Dome, though a secondary, is still a very important question to the astronomer.

To an engineer who has not had actual experience in the construction of such domes, the problem of designing a system of revolving machinery for carrying the weight of a few tons may seem a very simple one, and as a consequence of this, some lamentable failures have occurred in cases of roofs constructed from the designs of engineers of great eminence, indeed, but without experience of the special conditions required to be fulfilled.

In designing the revolving machinery for these roofs the general conditions are often assumed to be identical with that of a railway turn-table for locomotives; but there are many differences: for instance, in the latter case, it is possible to have a centre on which the table will revolve, which is clearly not possible in the case of observatory roofs. This is a most important difference, for in the first place any lateral pressure (which in the case of domes or drums is sometimes very heavy from wind or other causes) is borne on a central pin which is probably less than $\frac{1}{100}$th part of the diameter of the track of the wheels, and consequently moves 100 times slower; and also because it is then possible, in the case of live rollers of the form I shall presently explain, to centre the framing which connects these rollers together on the central pivot, and thus insure that the axes of the rollers are kept precisely radial, in which case the maximum of efficiency is attained.

In the construction of observatory roofs experience shows that due allowance must be made for alteration of form due to differences in temperature and hygrometric conditions of atmosphere or from variation of strains under differing conditions. It was from neglect of these precautions that the failure of some of the earlier domes is to be attributed. For instance, in the celebrated case of the dome constructed for Sir James South's telescope at Kensington, nothing could exceed the care and pains that were taken to ensure the most perfect accuracy and freedom of motion. Every part was made with the greatest pains. The rail on which the rollers ran was turned most carefully. The wheels were large in diameter, and their axes revolved, not in bearings, but on large friction rollers. The wood of which the dome was constructed was well seasoned, and put together in the most careful manner. The result was that the dome worked most beautifully when first laid on its rollers. After a few days, however, it became somewhat stiff, and a little later it got stiffer still, until finally it got so stiff as to be practically immovable. An attempt was made by the Rev. Dr. Robinson, some years after, to get the dome into order. It was again brought to its former state of efficiency, only to return as before to its inefficient state a few days after. The cause of this was that every part was fitted so accurately that no allowance was made for such alterations as are inevitable in such a structure from temperature and hygrometric changes; and the moment the slightest change occurred in the form of the dome, all the gearing became locked.

In the construction of modern domes, any danger of such locking is avoided by designing the revolving machinery in such a way that no alteration of the form of dome within moderate limits will affect the freedom of motion.

I now proceed to describe the various types of revolving gear used for observatory roofs. The simplest of all probably is that of three or more grooved wheels working in bearings fixed to domes, and rolling on a circular iron rail fixed to the walls (see fig. 1). This form answers fairly well for domes up to a ton or so in weight. The groove in the rollers should be considerably wider than the rail on which it rolls to allow for alteration in form of the dome. If instead of a simple piece of angle iron a cast iron wall-plate be used for this, planed on top and sides, this form answers perfectly for domes up to twelve or even fifteen feet diameter, but when necessary to use more than three rollers, it does not work as well, and there is considerable friction on side flanges from any wind pressure.

A better form is fig. 2, in which case there is no groove in the roller. Any lateral pressure is borne by the special lateral rollers, which revolve on a vertical stud attached to a bracket on the dome. This roller should not be in very close contact with the wall-plate, so as to allow, as before, of a little alteration of form of dome without danger of locking.

While speaking of lateral rollers, it may be observed that the practice of attaching the roller to a stud on the wall-plate to revolve against the dome, as shown in fig. 6, instead of as shown in fig. 2, is bad. If the dome go out of shape, the roller in fig. 2 can be adjusted, and will still have a true ring to revolve against, but in fig. 6 no adjustment of roller will cause the ring against which it rolls to touch the roller all round if it be not true in itself.

Fig. 3 is a modification of fig. 2, in which the roller is fixed in bearings on the wall. This is good in small domes, but necessitates that the rail on the dome which rolls on roller be very true. Either figs. 2 or 3 would make excellent designs for small domes if the bearings of rollers were carried on ball bearings, as in most modern bicycles.

In all the preceding forms it is necessary that the bearing surfaces of wheels be made very narrow, or there will be a considerable decrease of efficiency due to the fact that the outside edge of the wheel has a greater journey to perform than the inner. If unrestrained, such wheels would tend to roll on in a straight line, and consequently some power is lost in forcing them to roll round in the curve of the rail. To obviate this, taper wheels are sometimes made, as in fig. 4, in which case the wheel is so much taper, and has its axis so much inclined, that lines drawn as a continuation of the edges and of the axis would meet in the centre of the dome, and on a level corresponding to the top face of wall-plate. Made in this way there is no slippage necessary even in a wide roller, and consequently no loss of power from this cause.

We now come to a totally different system, viz. that commonly called the live roller system. The simplest form of this is shown in the figs. 5, 5*a*, and 5*b*. It consists of a set of spheres or cannon balls revolving in a grooved wall-plate, on which balls the dome itself revolves; the great advantage of this system being that there are no bearings, and therefore no sliding friction, and that no oiling is required.

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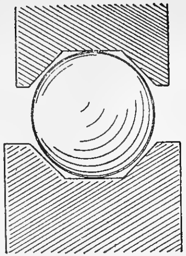

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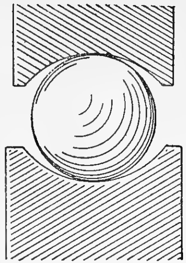

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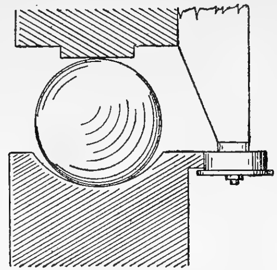

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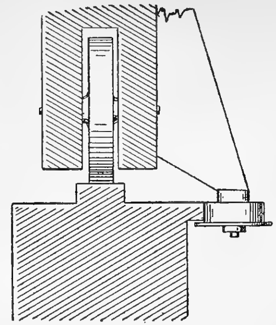

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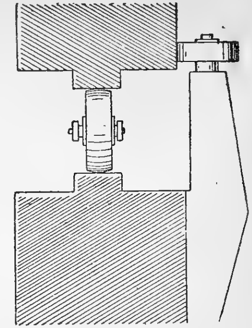

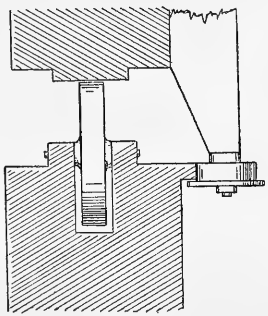

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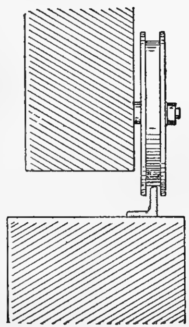

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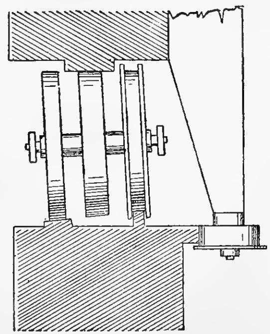

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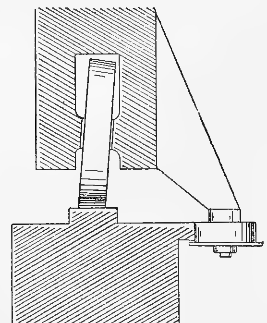

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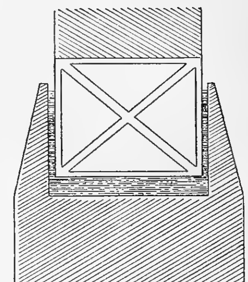

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Some of the earliest successful domes were made on this principle, and worked very much better than some of the elaborate systems of wheels or rollers. Figs. 5*a* and 5*b* show a slight modification of fig. 5. 5*b* is the best; because even if the dome slightly alters its form, it does not compel the ball to roll up one side of the groove, as in the other case; and if this form was carefully made there is no reason why it should not work well for moderate sized domes. When, however, it is necessary from the size of the dome to employ more than three balls one is apt to get loose occasionally and run out of its place and give much trouble to replace it.

This form of revolving gear got into discredit mainly because the wall-plates and sole-plates of domes were generally made of wood, and when the dome remained idle for many months the balls sunk into the wood, and left hollows here and there which soon reduced the efficiency. In order to obviate this, the form fig. 6 was proposed and carried out in many cases. This consisted of a set (any number according to size of dome) of rollers rolling on a cast-iron wall-plate, and on which rolled a cast iron sole-plate attached to the dome. These rollers were coupled together by a light framework to prevent any danger of their getting displaced. This form is better in theory than in practice. If the rollers be made wide, there is the loss from twisting spoken of in referring to figs. 2 and 3. Consequently the rollers must be made narrow, or at least bearing only toward their centres; and then it is found that wind pressure has a great effect on the dome, for the rollers have no base, and rock on the narrow central bearing. This causes strain on the connecting framework, and the system has not been found to work as well as might be expected, and has been little used.

Somewhere about the year 1870 my father, desiring to utilize to the full the undoubted advantages of the live roller system, designed the form fig. 7. In this case each roller consists of three parts, but except for sake of convenience in manufacture, these might all be cast and made in one piece, as they are bolted on one spindle and revolve together. An outer taper roller, and an inner taper and grooved roller revolve on two projecting rails on a cast-iron wall-plate, and a planed cast-iron rail on dome rolls on the centre roller of the three. By planing the rails and the wall-plate, and turning the wheels to the proper taper, there is no slippage necessary in order that the rollers may roll round in their proper curve, while there is ample base between the outer and inner wheels to ensure the steadiness of the dome. All the lateral pressure is borne by the lateral rollers. The only pressure on the flanges of the inner wheel is that due to any little want of perfection of the mechanism, or dirt on rails, and must be very small indeed. This is acknowledged to be by far the best arrangement of revolving gear for domes, and has been adopted in most of the large examples erected of late years, even in the Washington and Lick Domes in America.

In the former case, however, they omitted to plane the wall-plates, and, consequently, did not get quite as good results as in other cases; and in the case of the Lick Dome a considerable amount of complication was introduced, the value of which is doubtful.

While the undoubted advantages of this live roller system over others is freely acknowledged for large domes, and shown by the fact that it has been nearly always adopted for such, there are some who still appear to doubt its advantages, even in the case of moderate-sized domes. The reason of this is probably due to the fact that most small domes on the live roller principle have been constructed on one or other of the less efficient forms mentioned above, but if comparison be made between the best form of each, there can be little doubt of the great superiority of the live roller system.

It can never be expected that the rollers of a dome, which are compelled to travel on a circular railway, can run with quite the same freedom as if running on straight rails. 10 lbs. to the ton is considered a small tractive force on a straight rail. On a curved rail, under the best conditions, it is rarely less than 14 lbs. With the live roller system I have frequently found it to be in practice under 4 lbs. per ton, sometimes as low as 3·5 lbs. per ton. This is under the best conditions. Under any other conditions the live rollers must have still further the advantage, for here there is no oiling, because there are no bearings to oil. All that is required in the case of the live roller is to keep the tracks swept free from any coarse dirt.

There is only one disadvantage that I know of about this last—the triple roller system as it is generally called. It is a fault that is very common with apparatus that is the best, viz. it is very expensive to make, mainly because the wall-plates, having to be planed of the peculiar form described, are really portions of cones, and cannot be planed in any ordinary planing machine. A special machine had to be made, and as this machine has practically to be re-made for every different radius of dome constructed, the cost is very great. I have therefore designed a new form which, while equally efficient, can be constructed at a considerably less cost (see figs. 9 and 10).

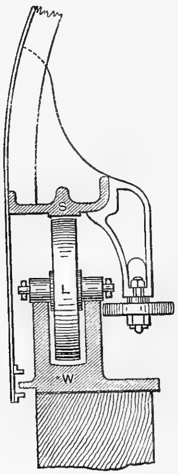


Fig. 9.

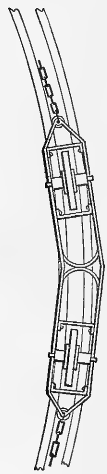


Fig. 10.

In this new form of revolving gearing, the wall-plate "W" consists of a cast-iron ring, something of the form of the letter U, with any necessary flanges for attachment to the wall. The top surface of the two vertical ribs, only, requires to be planed to a true surface. On these two planed edges roll the axes of a set of live rollers "L," on which rollers rolls the true cast-iron plate which forms the base of the dome "S" (see fig. 9).

The rollers forming the live ring are kept in their proper positions and distances from one another by a set of light wrought-iron frames (see fig. 10) coupled one to another by chains. It is preferable that the rollers be coupled together in pairs, as this ensures them against twisting, and thus avoids unnecessary friction on the flanges. It will be observed that in this form the great advantage of the live ring of rollers is secured, that is, that there is no friction but rolling friction, and also that there is no danger of any unsteadiness in the motion, such as is the case in form shown in fig. 6, as the base upon which the rollers stand is of good breadth. At the same time it is not necessary that the surfaces of the wall-plate should be planed to the troublesome conical form of that required in fig. 7. Strictly speaking, the upper surfaces of the wall-plate should be slightly conical, but the amount of this is so small (*i. e.* the proportion between half the diameter of the axis of the roller to that of half the diameter of the dome itself) that it may with perfect safety be neglected. As the working parts are all planed surfaces, the expense is very much less than that of the form shown in fig. 7.

The lateral rollers, to keep the dome from sliding horizontally, may be attached in any convenient position, such as is shown in fig. 9, and, if desirable, that portion of the wall-plate may be planed to a true circle. Each roller is supplied with a loose washer at the outside in order to reduce any friction which may occur between the inside edge of the groove and the shoulder of the roller, when from any cause the roller may rub against the wall-plate, but any friction here must be very small, because, for any given motion of the dome the live ring moves, not half, as in the case of fig. 7, but in a much smaller proportion, in fact only in the proportion of the necessary diameter of the axis to the diameter of the roller itself.

XXXIII.

ON AN IMPROVED EQUATORIAL TELESCOPE. By SIR HOWARD GRUBB, F.R.S.

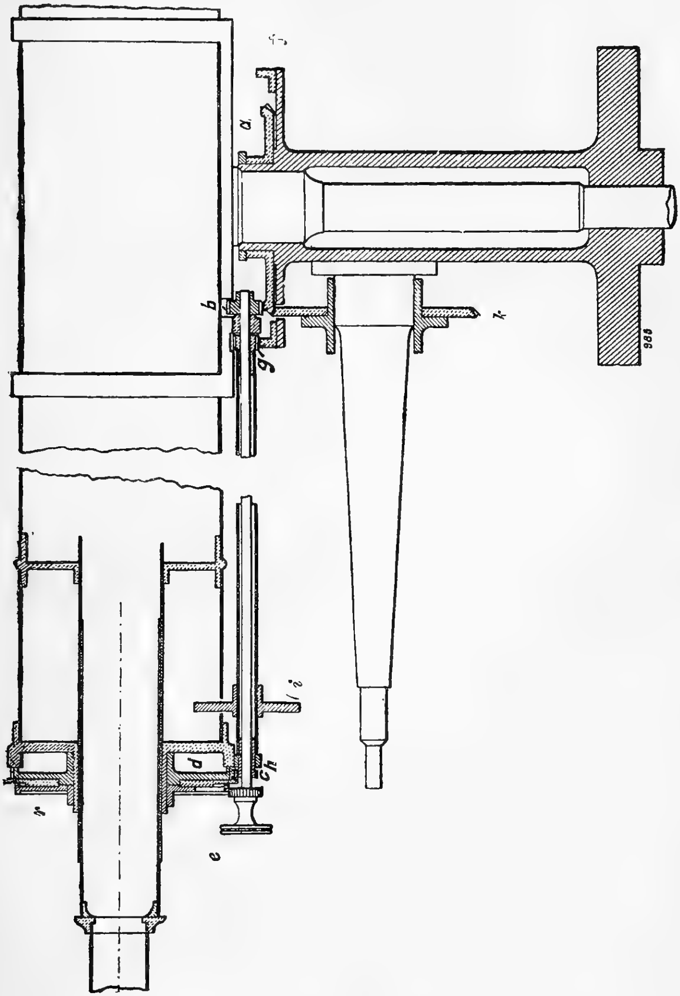
[Read January 20, 1892.]

The small equatorial carrying a 4-inch refractor, which I have the pleasure to exhibit to-night before the Royal Dublin Society, possesses some novel features which I expect will be found useful, more particularly for small instruments constructed for amateur work.

A large proportion of the trouble involved in working small instruments consists in the necessity for the observer to leave his observing chair continually for the purpose of reading the right ascension and declination circles of the instrument.

In large instruments this difficulty has of late years been met by introducing contrivances by which the reading of one or sometimes both circles can be effected from the eye-end of the telescope. This arrangement, however, would be almost as costly to attach to small instruments as to large, particularly as it also involves some illuminating arrangement to be brought simultaneously into action; consequently the proportion of cost of such an arrangement would be altogether excessive in the case of small instruments, although inconsiderable in the case of large. I have, therefore, endeavoured in this instrument to effect the same purpose by a different method. I have so constructed it that the ascension and declination circles are themselves at the eye-end of the telescope, and are caused to revolve to their proper angular positions by certain gearing which can best be described by the accompanying diagram.

Firstly for the declination circle. A toothed circle *ff* is attached to the cross head of the polar axis; into this toothed circle gears a pinion *g* on a hollow shaft, the other end of which is supported in a bearing *h* at the eye-end of the telescope. This hollow shaft carries a pinion *c* which gears into a circle *d*, fitted to and strung upon a portion of the casting which forms the eye-end of the telescope. If the proportion between the pinion *g* and its wheel *f* be the same as that between the pinion *c* and its wheel *d*, it is evident that any angular movement of the telescope upon its declination



IMPROVED EQUATORIAL TELESCOPE.

axis (which of course causes the pinion *g* to roll round in the teeth of its wheel *f*) will cause a precisely similar angular movement in the wheel *d* at the eye-end of the telescope. This wheel *d*, therefore, becomes the declination circle.

Similarly for the right ascension movement, a wheel *k* is attached to the frame in which the polar axis revolves, into which gears another wheel *a* fitted to and strung upon the neck of the cross head in which the declination axis revolves. Gearing into this wheel *a* is a pinion *b* fixed to a rod which passes through the hollow shaft above mentioned, as used for the declination movement, and carrying on its lower end a pinion and button-head *e* which gears into another wheel *r* also fitted to and strung upon the eye-end of the telescope, and in front of the declination circle *d*. It is evident that if the wheels *k* and *a* are equal in size, and that the proportion between *b* and these wheels is the same as between *e* and the wheel *r*, that this circle *r* will revolve at the same angular velocity as the telescope is revolved upon its polar axis; but it also happens that this wheel *r* will be rotated by movements of the telescope in declination as well as by movement in ascension, and, therefore, this wheel *r* cannot be used as an ascension circle if read by a fixed vernier, but differential readings between the wheel *r* and the wheel *d* give actual hour angles. Practically, the method of carrying this out is as follows :—

The wheel *d* has upon it a circle of silver, or white metal, divided on the edge to declinations and read by a fixed vernier. Further in, on the same white metal, is a set of divisions corresponding to hours and minutes of right ascension, and this is read by a vernier fixed to the circle *r*, which is cut away in two places to allow the divisions on *d* to be seen. In this way the right ascensions and declinations of objects can be read at the eye-end of the telescope, and at the same time by attaching milled heads to the outer and inner shafts, as at *i* and *e*, these button-heads can also be utilized for producing slow motions in declination and right ascension.

It will, no doubt, be objected that the unavoidable "*loss*" in the teeth in various parts of this gearing will cause so much error as to render the readings of these circles useless, and also that even if this could be eliminated, the velocity-ratio of these circles to that of the instrument on its axis will not be constant with any practical form of teeth.

It will be seen, however, on careful consideration, that whereas the error of, say, the declination circle would be the sum of the errors in the two wheels and pinions, so long as the telescope is pushed round by hand, yet when the tube is set in position, as it always finally should be, by the button-head *i* on the shaft between the two wheels, the error will be the *difference* and not the *sum* of the "*loss*" in teeth of each pair of wheels and pinions, and this difference can be reduced to such a very small amount as to become practically inappreciable.

Also, with regard to the velocity-ratio, care is taken that when the leaf of one pinion is in any particular phase as regards its wheel, the leaf of the corresponding pinion at the other end of the shaft is in the same phase as regards its wheel; consequently the error due to this cause does not take effect. It is found practically that these circles work with quite sufficient accuracy for all ordinary setting purposes with small instruments. The whole instrument is mounted upon a frame which can be any moment changed from an equatorial to an alt-azimuth, or *vice versa*. When used as an alt-azimuth the circles read altitudes and azimuths instead of ascensions and declinations.

XXXIV.

REPORTS ON THE ZOOLOGICAL COLLECTIONS MADE IN TORRES STRAITS BY PROFESSOR A. C. HADDON, 1888–1889.

NOTES ON A SMALL COLLECTION OF HYDROCORALLINÆ.

By SYDNEY J. HICKSON, M.A., D.Sc., Fellow and Lecturer of Downing College, Cambridge. (Plates XVIII., XIX., XX.)

[Read January 20, 1892.]

The collection consisted of some pieces of *Millepora Murrayi*, both dried and preserved in spirits, some dried and spirit specimens of *Distichopora violacea*, and a small piece of *Stylaster gracilis* preserved in spirit.

In all cases it is difficult to determine satisfactorily specific differences in Hydrocorallines; but the difficulty is considerably increased when there are only small pieces of the coralla at the disposal of the naturalist, for the general form, colour, and mode of branching of the entire colony have always been taken as some of the most important specific characters of these corals, and these features cannot be determined by the examination of small pieces. Whether these characters are satisfactory is another matter. The fact remains that in order to say with any degree of certainty whether a specimen under examination does or does not belong to species already described by Milne-Edwards, Saville Kent, Verrill or Moseley, it is necessary to note in the first place the form, colour and mode of branching. As I shall point out later, it is probable that in some cases the male, female, and immature colonies of one and the same species have been raised to the position of separate species by some naturalists, and the tendency of those who in the future examine the structure of both the hard and soft parts together will be rather to diminish than increase the number of existing species.

The importance of a thorough examination of the soft parts, particularly the male and female organs of reproduction, cannot be too strongly insisted upon, and the thanks of all zoologists are due to travellers who, like Professor Haddon, take the trouble to preserve a few specimens in alcohol for this part of their examination.

Specimens preserved quite roughly by simple immersion in alcohol have their value, and afford an insight into many characters that are quite lost in dried specimens. Specimens that are preserved, as those are that are now in my hands, with considerable care and patience, so that they will bear the most elaborate histological treatment, with excellent results, more than twelve months after their original capture, are indeed precious, as being the only specimens upon which a complete knowledge of the species can be founded.

In writing in this vein I am but repeating the opinions of my late master and respected friend, Professor Moseley, whose lamentable death last November robbed us of one of the most vigorous investigators and brilliant writers in this branch of zoology.

The demonstration of the hydroid affinities of the Hydrocoralline was in itself an achievement of the highest importance to scientific knowledge, but when we regard the enormous amount of detailed work on the soft parts of these corals which was done by Moseley without the assistance of our modern, rapid and precise methods of investigation, we cannot fail to admire his wonderful skill and unflagging perseverance.

Moseley was not only the first but the only naturalist of his time who examined and described the anatomy of the Hydrocorallinæ, and his name will always remain imperishably connected with the investigation of the group.

As an old pupil and friend of Professor Moseley during his unfortunately brief tenure of the Linacre Professorship at Oxford, I fully acknowledge that if there be any merit in the investigations that I have been able to make in the natural history of this group of corals, it is due to the stimulus of his teaching, his encouragement, and extremely original suggestions.

STYLASTER GRACILIS (Edwards and Haime).

Stylaster gracilis: Milne-Edwards and Jules Haime. Ann. des Sci. Nat. 3rd séries. Vol. XIII. p. 98, Plate III., fig. 4.

The specimen sent to me is a small branch 35 mm. in length, with a branchlet springing from it at about 15 mm. from its thickest extremity which branchlet bifurcates at a distance of 3 mm. from its insertion (Pl. XIX. fig. 4). Small branchlets bearing the calyces spring from the sides of the main branch and branchlet irregularly at intervals of 2 or 3 mm. On the faces of the main branch and branchlet may be seen the small round prominences —the female gonads (*gon.*)—each about $\frac{2}{3}$ mm. in diameter. The diameter of the thickest branch is not more than 2 mm.

The description of the species given by Milne-Edwards and Haime is—Polypier flabelliforme. Les rameaux grêles, cylindroides, tous situés dans le même plane vertical, assez serrés, non coalescents, d'un rose orangé, à l'exception des dernières ramifications qui sont blanches. Le tronc principal a sa surface lisse; les rameaux présentent des stries microscopiques, et sont tous couverts de tubercules échinulés. Calyces tous placés sur deux lignes opposées et parallèles, alternant avec ceux de la rangée voisines, à bords en general un peu saillants. Douze à seize cloisons, assez minces, bien débordantes dans les calyces terminaux, plusieurs d'entre elles formées par un repli de la muraille. Les polypiers que nous avons observés ont quelques centimètres de hauteur, les plus gros rameaux n'ayant que 5 millimètres de diamètre; largeur des calyces $\frac{2}{3}$ mm. Habite l'Australie.

So far as the specimen at my disposal goes, it agrees with this description. The colour is white, and I have no evidence of the colour of the rest of the colony. The microscopic striations may be seen, but they are probably obscured by the preservation of the soft parts. The number of "cloisons," that is to say, the partition walls between the dactylopores, varies from twelve to sixteen, but notwithstanding this fact, I have not been able to count more than twelve dactylozooids in any of my sections.

The first reference to *Stylaster* occurs in Pallas' "Elenchus Zoophytorum," where a coral is described under the name *Madrepora rosea*, that must belong to this genus. Ellis described three species, *Madrepora rosea*, *M. purpurascens*, and *M. erubescens*, and it is quite possible that all of these were Stylasters.

The Cœnosteum.

The cœnosteum is probably flabellate in form. All the branchlets in the specimen spring in the same plane right and left from the sides of the main branch. The branch is almost circular in section, but "the sides" can be distinguished from the "surfaces" by the position of the branchlets. The "surfaces" are traversed by very fine longitudinal striations, and exhibit at intervals rounded protuberances of a dark colour. These are female gonads projecting on the surface from the subjacent cœnosarc. The "sides" of the branch are marked by semicircles or fragments of semicircles of cycle systems, indicating the former position of complete cycle-systems that have become partially imbedded in the growing cœnosteum in the manner described by Moseley.[1] No cycle-systems or scattered pores of either kind, dactylopores or gastropores can be seen on the surfaces of the branch. The growing tips of the branchlets are entirely composed of cycle-systems. Each cycle-system springs either from the right side or the left side of the one immediately below it, that is the system from which it has budded (Pl. XIX. fig. 5). In the older basal parts of the branchlets the cycle systems are partially enveloped by the growing cœnosteum. Each cycle system is finely echinulate. The styles are as Moseley described them. In the gastropore, a small brush-like style standing up prominently from the base, in the dactylopores a series of tooth-like projections standing out vertically from the outer wall of the pore cavities (Pl. XX. figs. 1, 2).

The structure of the soft parts agrees very closely with the description given by Moseley of the soft parts of *S. densicaulis*, but I have usually found twelve tentacles on the gastrozooids instead of eight. It is probable that this may be regarded as a specific distinction between *S. gracilis* and *S. densicaulis*.

Each dactylozooid consists of a short blunt teat-like process directed almost at right angles to the direction of the pore towards the centre of the system, and a long muscular slip firmly attached to the teeth of the long serrated style (Pl. XX. fig. 1). The endoderm of the teat-like process is scalariform in appearance, the ectoderm is thick and contains a number of very minute nematocysts. I have not been able to discover any nematocysts on any parts of the colony excepting at the tips of the dactylozooids.

The muscular slip of the dactylozooid consists of a thin sheath of ectoderm covering a bundle of parallel muscular fibres

[1] H. N. Moseley, "Challenger" Reports, vol ii.

(Pl. xx. fig. 2). I have been unable to determine whether these muscles are ectodermic or endodermic in origin, but when we compare them with similar structures in *Distichopora* there is reason to believe that they are ectodermic. If this is the case then the endoderm is entirely obliterated in "the muscular slip," part of the dactylozooid of *Stylaster*.

The only specimen of *Stylaster* I have had an opportunity of examining belonged to a female stock. The ripe eggs are 0·25 mm. in diameter, being considerably smaller than the the eggs of *Distichopora* (0·3 to 0·4 mm.), and *Allopora* (0·5 mm.)[1]

The ovum contains, as in other Hydrocorallines, a large quantity of yolk, and in the process of maturation, fertilization, and the early part of the development, it exhibits similar phenomena to those I have already described elsewhere in *Allopora* and *Distichopora*. The trophodisc does not need any special description. It resembles in all the essential features of its formation and structure that of *Allopora* (Pl. xx. fig. 3).

I have no knowledge of the structure of the male gonophores of this species, but it might be useful to repeat here Moseley's brief reference to the male gonophores of *S. densicaulis*. He says: "Only male specimens of *S. densicaulis* were obtained. Each male ampulla contains two or three ovoid gonophores which are attached to large offsets of the cœnosarcal meshwork at one end of their longer axis. They have an internal spadix, and in finer structure seem to differ very little from those of *Sporadopora*." From the last sentence it seems clear that the male gonophores of *Stylaster densicaulis* are similar in general structure to those of *Allopora*. It should be remembered that I have abandoned the use of the term spadix and adopted the word trophodisc for Moseley's "cup-shaped spadix," and manubrium for the "internal cylindrical spadix."

I have previously pointed out that in the male gonophores of *Distichopora* there is no manubrium, and that in the male gonophores of *Allopora* there is a very prominent manubrium. Both from the text and the figure given of *Sporadopora* it is clear that *Stylaster densicaulis* possesses a well-marked manubrium in the male gonophore.

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[1] In all cases I have taken the longest diameter of the ovum, *i.e.* the diameter parallel with the surface of the corallum.

This similarity in the gonophores of *Allopora* and *Stylaster*, the presence of twelve tentacles (the number attributed by Moseley to the gastrozooids of *Allopora*) in the gastrozooids of *S. gracilis*, and many other points in their anatomy support very strongly the statement that "the separation of the genera *Allopora* and *Stylaster* is difficult."

It is quite possible that *Stylaster* has been derived from a form closely resembling *Allopora* by the terminal branches remaining in their development more delicate, and showing consequently more definitely than in the ancestral type the regular alternate method of gemmation.

DISTICHOPORA.

Several specimens of *Distichopora* were placed in my hands by Professor Haddon, some of them well preserved in spirit, after treatment with corrosive sublimate, the others dried. All the specimens were obtained in shallow water off Murray Island in December, 1888, and January, 1889. The first point that attracted my attention was the great variety of colour exhibited by the specimens. Some of the smaller colonies are bright orange in colour, others vandyke brown, and the larger ones are deep purple with pale yellowish white tips. Many intermediate varieties of colour are to be met with in the collection (Pl. xviii.).

These differences of colour do not mean a difference of species. All the specimens should be referred to Lamarck's *Distichopora violacea*. The differences in colour do mean, I believe, a difference in age and sexual condition. I do not like to speak too confidently on this point, because the number of specimens at my disposal is not sufficiently large, but I think it will be proved when the varieties of *Distichopora* of this region are more fully investigated: 1. That the young colonies of not more than half an inch in height are usually bright orange in colour and are not sexually mature. 2. That the colony turns brown later in life, and male ampullæ are formed; and, 3, that the older colonies reaching on an average an inch and a-half in height and four or five inches across the longest diameter of the flabellum are violet. Local causes, such as the position with regard to other corals on the reef, depth of water or tide eddies may cause some colonies to turn violet sooner than others, or, indeed, to become sexually mature before the colour change I have just referred to has taken place. Whether I am correct in my opinion on this matter or not there can be no doubt that this collection of Professor Haddon's emphasizes most strongly the fact that the colour of *Distichopora* can no longer be regarded as the principal character for the separation of the species. It is quite possible that both *D. coccinea* and *D. rosea* should be considered to be distinct species, but until we have some further information concerning the anatomy of the soft parts these species must be considered to be quite provisional.

The first notice we have of this Hydrocoralline is in the Rariteitkamer of Rumphius, vol. vi., p. 243, where it is described under the name of *Lithodendrum saccharaceum rubrum.*

In Pallas' "Elenchus Zoophytorum," p. 258, there is a description of a *Distichopora* under the name *Millepora violacea.* Ellis adopted the name *Millepora violacea*, and recognized some of the principal characters of the genus referring to the two kinds of pores on the edge of the branches, and to the prominences on the surfaces which he supposed to be the "ovaries." There are two very good figures on Plate 26, which are undoubtedly representations of *Distichopora*, but, unfortunately, the description of this plate was not found among Ellis's papers, and there is no reference to it in the text. Lamarck was the first to introduce the generic name *Distichopora.* He adopted Pallas' specific name, and the species became *Distichopora violacea.*

I have given this brief summary of the early history of our knowledge of the genus to justify the step I am taking in naming the specimens before me *Distichopora violacea.* If it be eventually proved that there are not sufficient reasons for separating into separate species the red, pink, yellow, and white varieties that have been described, *Distichopora violacea* is the specific name that must remain.

There is no need to give an account of the cœnosteum of *Distichopora*, for Moseley's description, p. 95, is very complete and accurate. The only point in which his description does not quite agree with the specimens before me lies in the fact that the occurrence of pores on the flabellar surfaces are not of such rare occurrence as he seems to have considered them to be. The figures on Pl. XVIII. show that in all the specimens there are several rows of pores on the flabellar surfaces. In a small specimen of a violet variety of *Distichopora* that I obtained in North Celebes, this irregularity in the disposition of the pores was even more pronounced than in the specimens from Australia (Pl. XIX. fig. 1). In some spots, indeed, the pores are arranged in circles showing a close resemblance to the arrangement of the pores in *Stylaster* and *Allopora*. There are similar circular arrangements of the pores in young specimens from Australia. A careful examination of the soft parts of these specimens leads me to the conclusion that this irregularity in the arrangement of the pores is not in itself sufficient to justify the creation of a new species for the *Distichopora* from Celebes, and I am inclined to think that Moseley's species *D. irregularis* may, after all, be but a younger stage of *D. violacea* or *D. coccinea*.

In Plate XVIII. I have given four water-colour drawings of spirit specimens of *D. violacea* from Professor Haddon's collection. Fig. 1 represents an adult female colony with ripe ampullæ. The colour is deep violet in the basal and older parts, with a tendency to become reddish in the region of the ampullæ, and fading off into a pale yellowish tint at the free extremities of the branches. The shape of the colony is irregularly flabelliform. This shape does not seem to be produced by the branching of the colony taking place in only one plane, but by the feeble development of the branches that originate in any other plane than that of the flabellum. An examination of young colonies and the extremities of older ones proves most conclusively that the growth in complexity is produced by dichotomy of the terminal branches and the subsequent suppression of those branchlets that are not situated in the plane of the flabellum. The rows of pores situated irregularly on the flabellar surfaces such as may be seen in all the figures given, I consider to represent branches that have been thus suppressed. To return to fig. 1. On both sides of this specimen there are dense clusters of female ampullæ situated on the secondary branches, that is to say, there are no ampullæ on the terminal pale branchlets nor on the thick basal trunks. They are found only on the branches between the two extremities. In old colonies, such as the one I am now describing, ampullæ are found on both sides of the flabellum, in younger ones they occur on one side only. The female ampullæ may be readily distinguished from the male by the fact that they stand out on the surface as rounded prominences, marked at their edges by radially arranged shallow ridges of the cœnosteum which give the whole ampulla a stellate appearance when examined with a simple lens.

The male colonies (fig. 3) I have examined have been usually smaller in size than the female, and of a brownish colour, frequently with a dash of purple in it. The male gonads may be clearly seen from the surface in spirit specimens as small pale oval bodies, sometimes solitary, sometimes arranged in groups of three or four together, the groups and solitary gonads together forming a cluster situated usually on one side only of a secondary branch. In the figure the gonadial area contains about thirty of the groups and solitary gonads. The gonadial area is paler in colour than the rest of the branch, but is not raised above its general surface, so that in dried specimens the male ampullæ cannot be seen from the surface. When the young embryos of *Distichopora* escape they leave a considerable scar on the surface, but this is almost immediately replaced by the growth of a thin layer of cœnosteum to protect the new ovum that is developing in the ampulla vacated by the embryo. In spirit specimens the scars are but rarely seen. In dried specimens, however, the thin layer of cœnosteum readily breaks down, and consequently we find on the old Distichoporas in museums numerous large gaping scars.

The spermatozoa, on the other hand, are discharged by a narrow seminal duct—vas deferens—and consequently no conspicuous scar is formed at any time on the male colonies by the discharge of the contents of the ampulla.

A few very small bright yellow (fig. 4) colonies were found in Professor Haddon's collection. On only one of these were any ampullæ to be seen—a group of four or five female ampullæ—the others were quite immature. No trace of ova or spermcells were to be found in a series of sections.

The position of the gastropores and dactylopores in the colony was correctly given by Moseley, and I cannot do better than quote his words: "Pores very deep, prolonged in curved lines side by side in the plane of the flabellum, inwards and downwards towards the bases of the branches, forming thus throughout the flabellum a thin, continuous tract of fragile tubulate tissue in which the successively developed curved pore-tubes stand out fanwise, separating from one another the compact masses of cœnenchym forming the opposite faces of the branches."

I have only to add a few words concerning the histology of the gastrozooids and dactylozooids. In Pl. XIX. fig. 2, I have drawn an ideal longitudinal section through a gastrozooid (*gz.*) and a pair of dactylozooids (*dz.*). It is, of course, impossible to obtain a section in practice similar to that I have drawn in consequence of the curvature of the pores.

The gastrozooid is provided with a large mouth (*M.*) and four small tentacles (*T.*). The tentacles are frequently very difficult to observe both in sections and whole specimens, as they become tightly adpressed to the body wall; but I have no doubt that Moseley was right in making the general statement that there are four tentacles to the gastrozooids. The ectoderm is thin, finely granular in appearance, and provided with a row of nuclei. I cannot find in my sections any very well marked cell outlines. At the oral extremity of the gastrozooid the endoderm bears a number of clear pyramidal gland-cells, wedged in between the ordinary columnar endoderm-cells. The long lancet-like style stands up in the enteric cavity and is covered by a thin sheath of flattened endoderm-cells.

The dactylozooids have a solid endoderm, with the cells and nuclei arranged in the same manner as is usual with the solid dactylozooids of other Stylasterids and the tentacles of many Hydrozoa, giving an appearance like a ladder with a nucleus at the median point of each rung. An examination with a high power shows that the histology is not so simple as it appears at first (Pl. XIX. fig. 3). Although the general arrangement of the slips of granular protoplasm containing the nuclei is at right angles to the long axis of the dactylozooids, and parallel with one another, yet many of them are branched at their extremities or joined with their neighbours by median communications. The clear spaces between the protoplasmic slips are to be considered intracellular, not intercellular, in position. In fact we have here a nucleated syncytium with large vacuoles containing probably water only, the stiffness of the dactylozooid being produced by turgidity, as in many vegetable tissues. At the base the dactylozooid passes into a muscular slip attached to the side wall of the pore, the scalariform endoderm becomes irregularly parenchymatous, and between it and the ectoderm there is a thick sheath of nucleated muscle-cells. How far the muscle-cells extend towards the free end of the zooid it is difficult to say without the examination of macerated preparations. I have noticed a longitudinal striation of the mesoglœa close to the free end of the dactylozooid, but I cannot prove that this is due to muscle-cells. Moseley says that the dactylozooids are provided with "very long" muscular slips. In my preparations I cannot trace these slips very far down into the pore. There can be no doubt that these muscular slips correspond to similar structures occurring in the dactylozooids of *Stylaster*, supported by the serrated style. Like Moseley, I can find no trace of styles in the dactylopores of *Distichopora*.

At the free extremities of the tentacles of *Distichopora* there is a thickening of the ectoderm, and a number of very small nematocysts may be seen embedded in it. In all the Stylasteridæ I have examined I have been struck with the very small size of the nematocysts, and in nearly all cases by their rare occurrence in other parts of the colony than on the tips of the dactylozooids.

The structure of the cœnosarcal canal system of *Distichopora* will be readily understood by reference to figs. 12 and 22 on Plate xxx. of my last paper.[1] On making a transverse section through a decalcified secondary branch (fig. 12) one notices that the canal extends from the periphery to a distance equal to about one-third of the diameter of the branch towards its centre, leaving a central space filled with the broken-down remnants of former canals. In other words, in *Distichopora* as in *Millepora* (Moseley, *l.c.* p. 24), only the superficial parts of the branch contain living tissue, the centre or-axis being composed of dead coral. The older the branch the smaller the proportion of living tissue. Thus in the young pale tips living canals will extend almost to the axis, whilst in the basal pieces of a colony there will be only a narrow strip of cœnosarc covering a thick axis of dead coral. On making an examination with a one-sixth inch objective of a section (fig. 22), the ectoderm may be seen to be a thin nucleated sheath with fairly well-marked cell outlines covering the surface of the colony and continuous with the ectoderm of the zooids. Between this and the endodermal canals there is a dense tissue containing a few small nuclei—the mesoglœa, and lying in the mesoglœa are numerous and irregular

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[1] Q. J. M. S., Vol. xxxii.

calcareous pieces composing the cœnosteum or hard parts of the colony (calc.). In decalcified preparations the mesoglœa is always very considerably shrunk, so that it is not easy to make out very clearly its histological structure. In sections prepared by Von Koch's method of grinding down together the hard and soft parts in solid Canada balsam rather more satisfactory results can be obtained, but the true nature of this interesting tissue will only be understood when macerated and teased preparations are made from living specimens. As I have not yet done this I can only make a few remarks on the structure of the mesoglœa as it appears in my sections of spirit specimens.

In the first place it must be remarked that we have in *Distichopora* a much more extensive mesoglœa than in *Millepora*. The skeleton, moreover, is not in close contact with the cells of ectoderm in the deep parts of the corallum, but lies embedded in the mesoglœa as is represented in fig. 22 on Plate xxx. (*l.c.*). In *Millepora*, on the other hand, the mesoglœa is represented by a very thin perfectly structureless lamella situated between the ectoderm and endoderm, and the skeleton lies in all cases outside the ectoderm in close contact with its cells. The mesoglœa of *Distichopora* always stains very deeply in borax-carmine, and hæmatoxylin; it contains a few very small scattered nuclei and a number of lines running in all directions through its substance, which are probably the result of the shrinkage produced by treatment in acid and alcohol.

In *Stylaster* the relations of the cœnosteum to the mesoglœa seems to resemble that of *Distichopora*, but it will be necessary to examine more and larger specimens than have been at my disposal before this point can be definitely settled. In *Allopora* there is no doubt that superficially the cœnosteum bears the same relation to the ectoderm that it does in *Millepora*, as I have correctly shown in my paper on the development of this form; but a re-examination of my sections shows that in the deeper parts the ectoderm layer disappears and the cœnosteum lies buried in a mesoglœa similar to that of *Distichopora*.

Millepora Murrayi, Quelch.

Since the publication of my last paper in the Quarterly Journal of Microscopical Science I have received from Professor Haddon some more dried specimens of the *Millepora* from Torres Straits, and

I have carefully compared them with numerous specimens of *M. Murrayi* (Quelch) in the British Museum. The conclusion I have come to is that the specimens must be considered to belong to Quelch's species. The tips of the branches are, it is true, somewhat broader than in most of the type specimens, and the ampullæ are somewhat smaller; but both of these characters may be considered to be local variations, for some of the tips of the branches of the type specimens are quite as broad as the broadest of the tips of Professor Haddon's, and the diameter of the ampullæ varies considerably on the same branches of both. The interest of the spirit specimens forwarded to me by Professor Haddon centred in the examination of the contents of the ampullæ. Quelch very reasonably suggested that the ampullæ were the receptacles for large ova or embryos as in the *Stylasteridæ*, but the first series of sections I made showed that Quelch had been misled. The ampullæ were found to contain very primitive but, nevertheless, complete free swimming medusæ, and the ova are small and alecithal as in *M. plicata.* I found medusæ in all stages of development, and was able to prove that they originate by an actual metamorphosis of the dactylozooids, a condition that it is hardly necessary to state has not been found in any other *Cœlenterates.* This remarkable species of *Millepora* also shows that very rare combination of a free medusa with a migration of the sexual cells from the cœnosarc into the medusa, a condition that is only known, so far as I am aware, in *Monobrachium parasiticum* (Wagner).

These, and many other facts that I was able to bring forward, showed that the medusa of *Millepora* is not reduced or degenerate, but primitive in its simplicity. The condition of the ova in *M. murrayi* engaged my attention for some time, but I was unable to discover any points either in their structure, mode of origin, or development, that showed differences between this species and *M. plicata.*

I was able to make out nearly all the stages in the fragmentation of the germinal vesicle, and the subsequent arrangement of the nuclear fragments that I have described in the other species. In fact I was able to confirm all the statements and conclusions of my previous paper. I have nothing to add to our previous knowledge of the cœnosarcal canals and polyps of *Millepora.* The different species of this genus seem to offer very few variations in the structure of their soft parts from the type that has been described and figured by Moseley. It is possible, however, that when we have more knowledge of the gonophores of the different species, specific differences may be found, but at present the ova and sperm sacks have been seen only in the two species, *M. Murrayi*, and *M. plicata*.

In view of the interesting facts that may come to light by the investigation of the anatomy of this interesting form, I may be allowed to repeat my request that all naturalists who have an opportunity of collecting specimens on the coral reefs of any part of the tropical world, will take care to preserve some branches of *Millepora*, in strong alcohol, and send them to me at Cambridge. I am more particularly anxious to obtain specimens from Bermuda and the West Indies, and I may add that the value of the specimens will be greatly increased if careful notes are made, on labels attached to the specimens, of the time of year that they were collected.

EXPLANATION OF PLATES.

PLATE XVIII.

FIG. 1.—Female stock of *Distichopora violacea*, drawn and coloured from a spirit specimen. Natural size.

FIG. 2.—A small portion of the same enlarged to show the female gonophores (*gp.*), arranged in a cluster on the flabellar surface of a secondary branch.

FIG. 3.—A portion of a male stock (× 2), showing the male gonophores lying in a cluster on the flabellar surface of a secondary branch. The male gonophores are not so large nor so prominent as the female gonophores, and in dried specimens are scarcely visible.

FIG. 4.—A portion of a small sterile stock of a bright yellow colour. (× 2).

Plate XIX.

Fig. 1.—A branch of a stock of coral from Limbé Island, North Celebes, showing a very irregular arrangement of the pore system, and a few systems at * that are circular as in other Hydrocorallines.

Fig. 2.—An ideal longitudinal section through a gastrozooid (*gz.*) and two dactylozooids (*dz.*) of *Distichopora violacea.* The calcareous cœnosteum (*cœn.*) is shaded. The long style in the gastrozooid may be seen to be covered by a thin flattened layer of cells. M., mouth.

Fig. 3.—Longitudinal section through a small portion of one of the dactylozooids showing the scalariform arrangement of the endoderm (*end.*).

Fig. 4.—The fragment of *Stylaster gracilis* I received from Professor Haddon, showing the disposition of the gonophores (*gon.*) on the flabellar surface of the stock.

Fig. 5.—The termination of one of the branches of the same stock, showing the manner in which the terminal cycle system is budded from the one immediately preceding it.

Plate XX.

Fig 1.—Longitudinal section through one of the cycle systems of *Stylaster gracilis* showing the centrally placed gastrozooid (*gz.*) and one dactylozooid (*dz.*). The brush-like style of the gastrozooid may be seen standing up in the centre of its cavity. The cœnosteum in this figure is shaded.

Fig. 2.—A longitudinal section through a dactylozooid of *Stylaster gracilis* more highly magnified. The cœnosteum in this figure is left unshaded. The dactylozooid consists of two parts: a teat-like process (A) with solid scalariform endoderm, and (B) a muscular slip attached to the teeth of the serrated style.

Fig. 3.—A transverse section through a secondary branch showing the female gonophores (*gon.*) on the cœnosarcal canals (*c.c.*), and a gastrozooid (*gz.*) in transverse section. The cœnosteum in this section is shaded.

XXXV.

THE VARIOLITE OF ANNALONG, CO. DOWN. BY PROFESSOR GRENVILLE A. J. COLE, F.G.S. (PLATE XXI.)

[Read FEBRUARY 17, 1892.]

AMONG the specimens of igneous rocks from Ireland arranged by the officers of the Geological Survey in the Museum of the Department of Science and Art, Dublin, is one which attracted my attention from its resemblance to the historic variolite of Mont Genévre[1]. The old label affixed to the specimen reads, "Variolite from a dyke. Kilkeel, E. Coast of Mourne. Co. Down." I am informed that the rock was collected when the Survey was under the direction of Major-General J. E. Portlock; and a reference to the paper by Major S. Patrickson on the "Dykes appearing on the shore which skirts the Mourne Mountains"[2] shows that in former years the term variolite was familiar to workers on the dyke-rocks of this country. Whether the variolites mentioned by Major Patrickson are literally such, or in some cases merely amygdaloids, as is suggested by his dyke numbered 39, must be left to future examination of the coast; the more so as, curiously enough, he omitted to notice the rock now under consideration, which was probably covered by high water at the time. It comes very near his number 51, "Analory" in his Paper being clearly Annalong.

Nor is this rock included among the "Spherulitic Rocks from Co. Down" described by Dr. J. S. Hyland.[3] Hence it became of interest to rediscover the dyke from which Portlock's specimen was derived, and to examine this rare rock in detail, the discovery of

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[1] For references to this Alpine type, see Cole and Gregory, "The Variolitic Rocks of Mont Genèvre," Quart. Journ. Geol. Soc., vol. xlvi. (1890), p. 295.

[2] Journ. Geol. Soc. Dublin, vol. i., p. 182 (1835).

[3] Proc. Roy. Dublin Soc., vol. vi. (N.S.), p. 420.

variolite in Anglesey[1] in 1888 having been regarded as the first occurrence recorded from the British Isles.

Through the kindness of Sir Archibald Geikie, F.R.S., I have been able to examine the type-specimen from the Museum, and also a section which has been prepared from it. In November of last year, with the advantage of the company of Mr. C. G. F. Chute, B.A., I examined the dykes north-east of Kilkeel as far as Glasdrumman Port.

We found at length, five and a half miles from Kilkeel, a remarkable mass agreeing well with the characters of the specimen in the Museum. On the Ordnance Survey six-inch map, Co. Down, sheet 56, a cottage is shown on the coast 900 feet north of the mouth of the Annalong river. Opposite this cottage a group of dykes may be found at low water, having a general south-easterly trend, and perpendicular to the strike of the altered shales and sandstones. It is possible that boulders may have been heaped upon these at the time that the officers of the Geological Survey visited the spot; for the structure of the variolite is so remarkable among a host of ordinary basalts as to have merited notice in the published memoirs.[2] The local absence of dykes on the higher part of the shore may also deceive observers in unfavourable conditions of the tide.

The variolitic dyke appears nearest the land as an elliptical mass some 3·5 metres long, its longer axis approximating towards the strike of the strata, which have become compressed against it on its east side through movement subsequent to the intrusion. A small rock-pool divides this portion from the next, which runs mainly SE. for 5·2 metres, with a width of 1·2 metres (about 4 feet). The dyke then ends abruptly, and reappears 60 cm. to the south, this lateral displacement probably representing a small fault in the strike of the surrounding strata. This third mass runs in the same general direction out to sea, curving at one or two points, and measuring 17 metres. The total length of the masses observed is thus more than 25 metres (82 feet), and the material is pure variolite from end to end.

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[1] J. F. Blake, "Report of Comm. to investigate Rocks of Anglesey," Brit. Assoc. Report for 1888, Pl. v. fig. 22. G. A. J. Cole, Proc. Roy. Dublin Soc., vol. vii. (N.S.), p. 112.

[2] Explanatory Memoir to Sheets 60, 61, and 71 (1881).

I owe several of the above measures to Mr. Chute. Close against the variolite on the north-east there crops up a dyke of ordinary dark basalt, structureless to the eye, and branching into a number of thin grey-green veins at the landward end. Microscopic examination shows this to be a typical basalt rich in olivine, with a thin selvage of translucent brown tachylyte. Traces of glass remain on the contact-surfaces of many of the dykes of Mourne; and the suggestion occurs that in the variolite dyke of Annalong we may have the very crown, or upward termination, of the intruded rock, a portion that would be more free from crystals and would cool far more rapidly than the lower mass. This portion is lost to us in hundreds of other dykes, owing to the extensive denudation of the coast since their intrusion. The arrangement of the bands of spherulites ("varioles"), and the appearance of the most landward mass of the dyke like a dome from beneath the surrounding strata, certainly favour the view that we are near the crest of the dyke.

The Annalong variolite exhibits the structures of a once vitreous mass in a more admirable degree than any other example that I have examined. The coarse spheroidal pillow-like structure, characteristic of the vast masses at Mont Genèvre and of the highly altered rock of Ceryg Gwladys, is not present in this comparatively thin dyke; nor does the glass appear to be anywhere perlitic. But the spherulites are remarkably beautiful and distinct, increasing in size and closeness towards the centre, and also towards the seaward end of the mass. In the latter part they are sometimes 1 cm. in diameter, and the oxidized iron has coloured them a warm brown-red, the outermost zone of each being a pale greenish-white. The interstitial altered glass is dark green, and has now a hardness of about 3·5, the spherulites being from 5 to 6. A polished surface of this rock would be distinctly handsomer, for ornamental purposes, than corresponding specimens from the Durance.

In the centre of the greater part of the dyke the rock is purple-black, and the closely-set spherulites are barely distinguishable without the microscope. As one proceeds outwards, the increasing proportion of devitrified glass gives a dark green tinge in places, against which the spherulites appear greenish-white with purplish centres. Banded structure, formed by coalescing spherulites, is beautifully seen, and at length, some 7 cm. from the selvage, the glass clearly predominates. The spherulites are here far more scattered, though often arranged in delicate bands by flow parallel to the walls of the dyke; and their average diameter is only 1·25 mm. wide. Finally, the spherulites become reduced to about ·2 mm. in diameter, and there is a selvage, 5 mm. wide, minutely jointed like that of the Basalt-glass of Portree,[1] almost free from products of crystallization, and even retaining its original vitreous lustre. If any link was yet wanting between variolite and tachylyte, the dyke of Annalong completely fills the gap.

The delicately banded rock, about 10 cm. from the selvage, has a specific gravity of 2·68 to 2·72. The central mass probably differs little from this at any point, a large specimen selected giving 2·70. A good deal of carbonate of lime has been formed during alteration, as is shown by the ready effervescence of the rock-surface when touched with acid. The variolite of Anglesey has a specific gravity of 2·71; and that of Mont-Genèvre, very possibly through the development of a larger quantity of epidote, is as high as 2·91.[2]

Microscopic examination of the rock of Annalong shows that it contains porphyritic crystals of plagioclase, which are too rare in the sections examined to allow of specific determination. They have clearly been formed during an earlier period of consolidation, and are greatly corroded by the matrix. Their outer layers have been penetrated to such an extent by filaments of glass as to resemble the tubulated walls of foraminifera. One large decomposed pyroxene has also been observed. There is every reason to believe that olivine also may be found, as at Anglesey, in some portion of the dyke. The neighbouring dykes consist of olivine-basalt, and the three that have been examined in section show glassy selvages, one being truly variolitic for a distance of 15 mm. from each margin.

The actual edge of the Annalong variolite, in contact with the sedimentary rocks, shows under the microscope as a brown

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[1] Judd and Cole, "Basalt-Glass of Western Isles of Scotland," Quart. Journ. Geol. Soc., vol. xxxix., p. 451.

[2] Delesse similarly records 2·896 for the variolite of the Durance (Comptes Rendus, t. xxx., p. 741).

tachylyte, scarcely altered, and crowded with "cumulites"[1] and other minute products of the primary devitrification (Pl. xxi. fig. 1). A delicate banded structure, parallel to the wall of the dyke, is noticeable on the very edge, and becomes rapidly more marked as one proceeds inwards. Darker bands, formed of imperfect spherulites, traverse the glass precisely as in the more familiar rhyolites, and often wrap around the corroded felspars. Then abundant minute spherulites, ·05 mm. in diameter, replace the cumulites in the ground itself; and these aggregate into spheroidal masses, brown by transmitted light, in a residual glass of somewhat lighter brown. This glass alters irregularly to vivid green decomposition products. Greatly elongated steam-vesicles, now filled by zeolites and calcite, also occur freely.

At 1 cm. from the edge, a somewhat abrupt transition occurs from these patches of aggregated and minute spherulites to the region in which the individual spherulites are distinctly visible to the naked eye. Indeed, a plane of division exists between the two regions, as if consolidation of the rock took place through rapid chilling along the wall, while the main mass remained fluid until an appreciable time had elapsed. Thus the larger spherulites may be seen imperfectly developed, starting from the zone of minute spherulites as from a base of attachment that was already practically solid at the time of their formation. They have, in fact, begun to grow from this surface, as from the wall itself in the case of the tachylyte of Ardtun.[2] Proceeding inwards, we find the normal type of the variolite (Pl. xxi. fig. 2). Rod-like crystallites, straight or curved, abound in the pale brown groundmass, from which slow secondary action has removed much of the original glass. The spherulites, and the cloudy matter round them, have developed from this groundmass, as in the more highly silicated rocks, without disturbance or obliteration of the first-formed crystallites. Rifts and cracks occur through the rock; but it is far less injured in this way than is the case at Ceryg Gwladys, Anglesey.

In the handsomely developed mass already referred to as forming the S.E. end of the exposure, the once glassy ground has become converted into a bright green chlorite. A few large

[1] Vogelsang, "Die Krystalliten."

[2] Quart. Journ. Geol. Soc., vol. xliv., pl. xi., fig. 1.

granules of magnetite occur in addition to the plagioclase. The groundmass and the dusky spherulites are full of skeleton-crystals resembling those in slags, the long axes of which are often curved; they are arranged here and there in sheaves, but without relation to the subsequent spherulitic crystallization, except that small ones are thickly massed upon the margins of the spherulites (Pl. XXI. fig. 3). While the spherulites show patches of low colours of the first order between crossed nicols, radial structure is barely traceable.

With a power magnifying 400 diameters, the dark skeleton-crystals are seen to have long spindle-shaped axial bodies, which are built up of globulites, so that they remind one of the spicules of Alcyonidæ. Cross-bars are set on many of these, apparently at right angles, and often in two series perpendicular to one another and to the axis. When very thin, their colour is a warm brown; but suspicious stainings around some of them make one believe that they were originally skeletons of magnetite, as in many tachylytes,[1] and that they have become coloured by further oxidation. A few felspathic microlites occur, with forked terminations to the prism;[2] but the other prevailing individualized constituents consist of long and often pale-green rods, which have developed quite independently of the magnetite, traversing the skeleton crystals at all angles. They are sometimes very long (·5 mm.) in comparison with the axes of the magnetite; I regard the coloured ones as microlites of pyroxene. These coloured rods are often gathered together in long groups, which are without visible axes, the individual microlites lying parallel to one another and perpendicular to the long axis of the group; it is as if one were to cut the string of a bundle of firewood, spread out the sticks in a parallel series, retaining their original orientation, and then remove the string. For convenience we may term this arrangement the "palisade-structure" (Pl. XXI. fig. 4).

The central mass of the dyke yields the most slag-like section of a natural product that I know. The crosses of magnetite, more or less developed, have the same orientation over areas 2 mm.

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[1] *E.g.* the rocks of Screpidale and Sorne Point, Quart. Journ. Geol. Soc., vol. xxxix., pl. XIV., figs. 3 and 4.

[2] "Crenulites" of Rutley; Min. Mag., vol. ix., p. 267.

across, as if they held one another like so many freely suspended magnets. The axes of these crystals are seldom curved. Among their rays the almost colourless rods have developed; and, while many lie quite irregularly, others have grouped themselves into fan-shaped bunches, probably sections of irregular cones, radiating from local centres, and so forming the spherulitic structure traceable in the mass. Very little matrix remains anywhere between these close-set spherulites, the radial structure of which can only be fully appreciated between crossed nicols. The pyroxene in this central part of the rock is in the form of shorter needles, small granules (like those of common basalts on a very minute scale), and also of tiny patches micropegmatitically intergrown with felspar. The two minerals seem here to have developed simultaneously; while in the porphyritic products of a previous consolidation we find the pyroxene including the plagioclase, as in normal doleritic rocks (Pl. XXI. fig. 2). In the sections taken nearer the edges of the dyke, the green rods seem to have originated before the colourless ones, judging by their free and superior development; but the small diameters of the microlites of either substance (about ·002 of a millimetre) would enable groups of the one to penetrate among groups of the other, and both to pass in among the magnetite skeletons, without sensible interference or displacement. As exemplifying possible local differences in the order of succession, owing to fluctuations of pressure and temperature in the viscid oozing mass, I may record one solitary case where the magnetite skeleton has formed around a colourless rod, presumably of felspar.

As already mentioned, translucent brown glass forms a thin selvage to many of the olivine-basalts of the coast of Mourne. A remarkably well-preserved edging to a fissile altered dyke, immediately south of Annalong harbour, will serve as an example; in this the plagioclase crystals remain brilliantly fresh. A spherulitic tachylyte has been described from the opposite side of the Mourne Mountains, near Bryansford.[1] A more interesting case in connexion with the variolite is a dyke, 1·5 metres across, appearing somewhat conspicuously just north of Arthur's Port, and shown even on the one-inch Geological Survey Map. Both its selvages have given

[1] Quart. Journ. Geol. Soc., vol. xliv., p. 305.

rise to spherulitic tachylyte some 15 mm. thick, and alteration has produced a variolite on a miniature scale. The largest spherulites, as seen in section, are 1 mm. in diameter; clear yellow-green glass remains between them in places, but for the most part it has become devitrified by alteration. Towards the interior, the spherulites are smaller, but in contact; they are built up of curving fibres like their representatives at Mont Genèvre, and the usual poorly-defined dark cross is seen with polarized light.

From the above considerations, and from the Anglesey example, it is clear that variolite may be the product of an olivine-basalt. I have also recently noticed pseudomorphs after olivine in a specimen of variolite picked up near Cesana Torinese, on the Italian side of Mont Genèvre. The basic character of the rock of Annalong has been shown by a partial analysis, which has been kindly made for me by Mr. Basil L. Dunne, A.R.C.S.I., A.I.C. The results were obtained through the kindness of Professor W. N. Hartley, F.R.S., in the chemical laboratory of the Royal College of Science for Ireland. But the considerable alteration of the rock renders the figures unsatisfactory for purposes of comparison, the carbonic anhydride being as much as 6·3 per cent. The ferric oxide is 13·02, and the silica 46·89 per cent., that of the variolite of the Durance, determined by Delesse,[1] being 52·79. Analyses of other basic dykes of the Mourne district have been published by Dr. Samuel Haughton.[2]

Incidentally, during the observation of a special feature among the dykes of Mourne, a general question is brought before us. The condition of the selvages of many of these dykes, exposed as they are to all manner of natural attacks, is such as to suggest that they are not of very remote geological age. Although cut off by the great granite intrusion, or traversed by its offshoots of eurite, they may not be so far anterior in origin to these as has sometimes been supposed. May they not represent the first fissuring and "starring" of this locality in earliest Eocene times, followed by the granite of the Mourne Mountains, which in its turn yielded to those

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[1] "Sur la Variolite de la Durance," Bull. Soc. Geol. de France, 2me série, t. vii., p. 430.

[2] "On the trap dykes of the district of Mourne," Journ. Roy. Geol. Soc. Ireland, vol. iv., pp. 95 *et seq.*

basic dykes which are probably contemporaneous with the plateau-basalts of Co. Antrim?

In addition to the friends already named, I have to thank Mr. W. W. Watts, M.A., for kind help given with regard to the Survey specimen. Much of the detailed work has been carried on in the Geological Laboratory of the Royal College of Science for Ireland. The credit for the discovery and just appreciation of the variolite of Mourne rests with the officers of the Geological Branch of the Survey of Ireland some fifty years ago.

EXPLANATION OF PLATE XXI.

Fig. 1.—Edge of the variolitic dyke of Annalong, in contact with the sedimentary rocks. Banded and fluidal structures in brown tachylyte, with porphyritic felspar and elongated vesicles. × 11.

Fig. 2.—Variolite of Annalong, showing ordinary spherulites, and spherulitic matter aggregated round a porphyritic group of pyroxene and plagioclase felspar. × 11.

Fig. 3.—Variolite from the S.E. end of the dyke of Annalong, showing abundant and often curving skeleton-crystals. × 11.

Fig. 4.—Part of the same section enlarged, showing dark microlites (magnetite), which under a lower power are seen to form parts of skeleton-crystals; colourless ones (probably felspar); and pale green longer rods (pyroxene?). The last-named often show "palisade-structure." A curving row of pyroxene granules, in contact with one another, is also seen. × 200.

XXXVI.

ON THE ECHINODERMS COLLECTED BY THE SS. "FINGAL" IN 1890, AND BY THE SS. "HARLEQUIN" IN 1891, OFF THE WEST COAST OF IRELAND. By F. JEFFREY BELL, M.A., Sec. R.M.S. (Plates XXIII., XXIV., XXV.)

[COMMUNICATED BY PROFESSOR HADDON.]

[Read March 16, 1892.]

I have been greatly interested by the fine collection of Echinoderms, chiefly from deep water, which, made in 1890 and 1891 under the auspices of the Royal Dublin Society, has, by Professor Haddon's kindness, been submitted to me for examination.

It has long been, with me, a matter for regret that a complete survey has not been made of an area which promises to be full of instruction and lies as close to our shores as the 500 fathom line off the West of Ireland. The collection here reported on, and especially that part of it which was dredged at St. 201 (45 miles, N.N.W. of Black Rock, Blacksod Bay, Co. Mayo), where the depth was 500 fathoms, shows how much material of interest we can obtain within a few miles of our own shores.

Only one species unknown to science is here described, but I cannot pretend that I look upon that with any regret. The anxieties of zoologists[1] as to the total number of species with which they expect to become acquainted are, I believe, groundless. The progress of our knowledge and the enlightenment of our ideas will, I am sure, reveal to us great and wide variations, and will lead at last to a diminution rather than an increase in the number of species recognized as distinct. The so-called new species in the present collection shows quite unexpected powers of variation, and the large collection of specimens of *Asthenosoma hystrix* shows that

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[1] See especially the annual addresses of the present and two preceding Presidents of the Entomological Society of London.

there, too, the range of variation is not limited to colour,[1] or to the characters of the spines.

The experience of recent deep-sea dredgers that species which are said to be inhabitants of shallow water are to be found some way beyond the 100 fathom line is repeated here; so that not only is there extension of knowledge as to range of variation in structure, but as to distribution also. To those who, like myself, are desirous to learn more about so-called known forms than to produce new species from the vasty deep, such a collection as the present offers many attractions.

Since the appearance of my two earlier contributions[2] to our knowledge of the fauna of the deep water off the Irish Coast, Mr. W. Percy Sladen has published[3] a report on a collection, which is regarded as very rich in new species, made in 1888 by a Committee appointed by the Royal Irish Academy; these new species were all from 750 fathoms, and some are to be found in the collection entrusted to me. These earlier papers will allow me to pass rapidly over most of the species now to be enumerated.

I.—HOLOTHURIOIDEA.

Synapta digitata, Mont.

Roundstone Bay, Connemara, 5 fms. (St. 28); Killybegs, Co. Donegal (St. 51) shallow water.

Psolus, sp. juv.

From 500 fms. 45 miles N.N.W. of Black Rock, mouth of Blacksod Bay, Co. Mayo (St. 201).

This is, I think, the first time this genus has been recorded off the west coast of Ireland, but it has been found in Shetland and on the east coast. Canon Norman would, I think, name them the young of *P. phantapus*; their resemblance to *P. Fabricii* is, however, too striking for me to commit myself altogether to his view without further knowledge than I at present possess.

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[1] The variation in colour was first noticed by Prof. Alex. Agassiz, "varying from a dark claret to a grayish pink colour."—Bull. Mus. Comp. Zool. Cambridge, Mass. VIII., p. 74.

[2] Ann. and Mag. Nat. Hist. IV. 1889, p. 432; and Jour. Marine Biol. Assoc. 1890, p. 324.

[3] Proc. Roy. Irish Acad. I. 1891, p. 687.

Thyone raphanus, Düb. and Kor.

Dingle Bay, Co. Kerry, 7 fms. (St. 103).

Holothuria nigra, Auct.

W. of St. John's Point, Donegal Bay, 30 fms. (St. 212); Killybegs Harbour, Co. Donegal, 14–26 fms. (St. 207); Davalaun Sound, Co. Galway, 13–16 fms. (St. 196); Dingle Bay, Co. Kerry, 4 fms. (St. 103); Casheen Bay, Connemara, 7 fms. (St. 137).

Holothuria intestinalis, A. and R.

Probably from 40 miles off Achill Head, 220 fms. (St. 63).

Holothuria tremula, Gunn.

From the same locality as *H. intestinalis* (St. 63); 45 miles off Black Rock, Co. Mayo, 500 fms. (St. 201).

II.—CRINOIDEA.

Antedon bifida, Penn. (*A. rosacea*, Auct.).

Cleggan Bay, Co. Galway, 8–11 fms. (St. 75).

III.—ASTEROIDEA.

Astropecten irregularis, Penn.

500 fms.; 115 fms., 40 miles off Bolus Head, Co. Kerry (St. 125); Galway Bay, 15 fms.

Astropecten sphenoplax (Pl. xxii.).

I am unable to find that a starfish from 500 fms. 45 miles off Blacksod Bay, Co. Mayo (St. 201) has as yet been described. It is noticeable from the fact that the infero-marginal plates are sharply cut off into a wedge-shape on their outer side. The extent of the gap made by this cut varies somewhat, but the gap is always to be seen. What is much more remarkable is the great variation in the extent to which spines are developed on the supero-marginals. The commonly accepted view is, of course, that the presence or absence of spines on these plates is not only a good specific character, but one by which species may be arranged in groups. When, therefore, I had in my hands a specimen in which no spines were developed on the supero-marginals, and another in which a well-marked spine was present on nearly every plate, I felt that it would be difficult to convince any one of their specific identity, and that notwithstanding the fact that they came up from the same spot and had the same characteristic wedge-shaped infero-marginal.

Fortunately, however, there were other specimens, and I found that of the seven two had the supero-marginals quite spineless, two had a few spines, 2 mm. long, scattered irregularly on the plates near the base of the arm; in a fifth similar spines extended some way along some but not all of the arms; the same was the case with the sixth specimen, while in the seventh spines were developed with considerable regularity at the bases of the arms, and were replaced on the distal supero-marginals by spiniform tubercles.

The more one works at Echinoderms the more one sees how species vary, but I do not think that a more unexpected example than this has ever yet been put on record.

It conveys two clear lessons—the first is that, when we think we have got a "new species" we should examine with care an extensive collection to see if we cannot link on our new form to some known species whose variations we only imperfectly know;[1] the other is that in the description of a species we cannot be too careful in eliminating what is individual, and be watchful to remember that we have to define not a specimen but a species.[2] It is the habit of systematic zoologists to talk about describing a new species; it would be well to speak always of diagnosing it. Description without diagnosis is nothing worth.

The following appear to be the characteristics of this un-

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[1] An instructive example of this has lately happened to myself. Professor Herdman was good enough to send a specimen of an Echinoderm from Norway, which was remarkable for having seven pairs of pores in an arc; *Strongylocentrotus drobachiensis* is ordinarily said to have five or six pairs, and a survey of the extensive series in the British Museum showed that this statement was quite correct. Satisfied, however, that I had nothing but an example of the first-mentioned species before me, I continued the monotonous business of counting till I came on a specimen in which a plate bearing eight pairs of pores was intercalated between two bearing six pairs; the corresponding plates in the other half of the ambulacrum bore seven each.

[2] The history of the species of *Cycethra* is very instructive: cf. Perrier in Miss. Sci. du Cap Horn, vi., Echinodermes (Paris, 1891), pp. 122–5 and 170–188.

described species, the specific name of which will remind the student of the form of the infero-marginal plates :—

R, nearly equal to 5 *r*; breadth of arm at base equal to *r*. Marginal plates about 30; the infero-marginals sharply cut off at their free edge so as to be wedge-shaped and to leave a gap between each plate. Spinulation of the supero-marginals *nil*, or there are a few scattered spines, or prominent spines are pretty regularly developed from the angle to the middle of the arm, one on each plate, and more distally there are distinct spinous tubercles. The arms taper rather rapidly, and near the tip the whole of the dorsal surface is occupied by the supero-marginals. The adambulacral plates are rather closely covered by fine spines, arranged in two or more definite rows, or in two definite rows and the remainder more irregular. About ten spines at the sides of the infero-marginals, some of which are so long as to extend beyond the hinder edge of the plate next in front, and some of which are quite short. Madreporite quite close to a supero-marginal. Colour in spirit, straw to brown.

Taken at 500 fms. off Black Rock, an islet off the mouth off Blacksod Bay, Co. Mayo (St. 201.)

R.	r.
52.	11. 5.
51.	11.
49.	11. 5.

Psilaster andromeda, M. Tr.

Forty-five miles off Blacksod Bay, Co. Mayo; 500 fms. (St. 201).

The specimen noted by Mr. Sladen (*op. cit.* p. 688), has no recorded locality; Mr. G. C. Bourne, while on H.M.S. "Research," dredged a specimen from 400 fms. at 50° 29′ 26″ N. 11° 4′ W.

It is to be pointed out that the "superambulacral plate," which is a characteristic of Mr. Sladen's family, Astropectinidae, is absent or at least non-apparent in well-grown examples of this species. I do not feel called upon to arbitrate between the naturalist just named and Prof. Perrier, who has placed this old species in his own genus *Goniopecten* (see Miss. Sci. Cap Horn; Echinodermes, p. 189).

Luidia Sarsi, D. and K.

Outside Valentia, Co. Kerry; Donegal Bay, 33–37 fms.

Luidia ciliaris, Phil.

Dingle Bay, Co. Kerry, 31 fms.

Porania pulvillus, O. F. Müll.

Killybegs Harbour, Co. Donegal, 14–16 fms.; Davalaun, Co. Galway, 30 fms.; off Ballycotton, Co. Cork (30 fms.) (?).

Asterina gibbosa, Penn.

Limerick Harbour; Co. Kerry.

Cribrella sanguinolenta, O. F. Müll.

Blacksod Bay, Co. Mayo, 5–6 fms.; Roundstone Bay, Connemara.

Stichaster roseus, O. F. Müll.

30 miles off Achill Head, 144 fms. (St. 64). This is an increase of 90 fms. on any previously recorded depth, except that of Mr. Bourne, who took it at 200 fathoms.

Asterias rubens, Linn.

Kilkieran Bay, Connemara; Roundstone Bay, 4 fms. Connemara; Galway Bay, 15 fms.; outside Valentia, Co. Kerry.

Asterias Murrayi, Bell.

When I described this species (Ann. and Mag. Nat. Hist. vii. 1891, p. 478) I remarked that it had not been obtained off the Irish coast; since then it has been taken in the 1891 expedition. Unfortunately, I have no information as to station or depth.

IV.—OPHIUROIDEA.

Ophiura ciliaris, Linn.

Blacksod Bay, Co. Mayo, 3–4 fms.

Ophiura albida, Forbes.

35 miles off Achill Head, 175 fms. (St. 71); Donegal Bay, 30 fms.; Blacksod Bay, Co Mayo.

Amphiura filiformis, O. F. Müll.

Killary Bay, Co. Galway, 9–15 fms.; Kenmare River, Co. Kerry, 21 fms.

Ophiocoma nigra, O. F. Müll.

Off Malin Head (Ireland's North Point) 22–23 fms.; Kilkeiran Bay, Connemara, 4–10 fms.

Ophiothrix fragilis, Linn.

Two specimens from 220 fms., 40 miles off Achill Head, Co. Mayo (St. 63); 127 fms., 20 miles off Achill Head (St. 72); Blacksod Bay, Co. Mayo, 5–6 fms.

Ophiothrix Luetkeni, Wyv. Th.

I am glad to say that the view I expressed last year (Ann. and Mag. Nat. Hist. viii. 1891, p. 338) as to the distinctness of this species is confirmed by specimens taken 50 miles (220 fms.) and 40 miles (115 fms.) off Bolus Head (Sts. 124, 125).

Ophiobyrsa hystricis, Lym.

A young form, which may, perhaps, be referred to this species, was dredged in 220 fms., 40 miles off Achill Head (St. 63). This must be a very fine species when adult; unfortunately the original "Porcupine" specimen has been dried.

V.—ECHINOIDEA.

Cidaris papillata, Leske.

45 miles N.N.W. off Black Rock, Blacksod Bay, Co. Mayo, 500 fms. (St. 201); 35 miles N.N.W. off Black Rock, Blacksod Bay, Co. Mayo, 250 fms. (St. 203); 40 miles N.N.W. off Achill Head, 220 fms. (St. 63); 30 miles N.N.W. off Achill Head, 144 fms. (St. 64).

Phormosoma placenta, Wyv. Th.

54 miles off Achill Head, 500 fms. (St. 70).

Asthenosoma hystrix, Wyv. Th.

(Pls. XXIV. and XXV.).

This species is, fortunately, represented by a large number of specimens; fortunately, for had it been otherwise it would have been difficult, perhaps impossible, to have escaped from the error of believing that more than one species of the genus had been taken. The specimens differ so much from one another that it is quite easy to find two which might be made "types" of distinct species. The differences in structure are apparent to a careful collector and during life, for I see by two pictures with which Mr. E. W. L. Holt has been so obliging as to favour me, that in life one is coloured above a bright-red, five patches of which are deeper than the rest, while the other is greyish, with five reddish-brown patches of varying degrees of intensity; the former the collectors describe as having small plates and small spine-bases; the latter as having "large plates or large spine-bases."

It will be remembered that Sir Wyville Thomson described two species of "Calveria" from the "Porcupine" dredgings, and, from the description that he gives of the colouration it might be thought that Mr. Green got the same two forms, for of one Thompson writes:[1] "The colour of the perisom is a brilliant deep rose, inclining to claret-colour; twenty bands of deeper shade run in pairs, alternately closer, and more remote from one another, along the ambulacral and interambulacral spaces. The ends of the spines are pale pink, and the tube feet are nearly white."

Of the second species he remarks:[2] "The colour of the test generally is greyish, but ten bands of purplish brown radiate from the apical pole, shading off into the grey of the test, and giving a rich effect of colour to the upper surface. The spines are whitish, and the ambulacral part grey tinged with purple."

The colouration of tests, however, does not often go far in helping in the discrimination of species of Echinoids; and in the large series (preserved, indeed, in spirit) which has passed through my hands, I have found a considerable degree of variation in the extent and intensity of the bands or patches of colour; and this may go so far that some specimens are quite pale. When such a specimen is set side by side with one that is a brilliant pink all over, it is of course impossible to believe that they are examples of one and the same species.

Another point in which there is great variation is the extent of

[1] Phil. Trans. 169 (1874), p. 740. [2] *Loc. cit.*, p. 743.

the uncalcified membrane between the plates of the test; this may be quite conspicuous or calcification may have gone so far that it is difficult to detect the membranous interspace (cf. Pl. xxv.).

It will be remembered that in the "Porcupine" deep-sea dredgings, Professor Wyville Thomson described two species of *Calveria* (= *Asthenosoma*, Grube); one he called *C. hystrix* and the other *C. fenestrata*; the specific name of the latter was given because there were wide membranous fenestrae between the plates of the corona. From the specimens before me I am compelled to conclude that this is not a specific character, and that the amount of calcification of the plates is a point in which individuals living together may differ among themselves. Mr. Edgar Smith tells me that the conchologist experiences the same variability in the texture of shells.

Thomson insisted on the large size of the orifices of what he called the ovarial plates in both *Calveria hystrix* and *C. fenestrata*. I observe that the size of the orifices varies within rather wide limits, but I attribute this to a difference in sex.

I have been unable to find in any specimen, and I have most closely examined a large number, any of the remarkable, large four-branched pedicellariae which Thomson found in *C. fenestrata*; and I am of opinion that the form figured by him is abnormal.

I see no escape from the conclusion that only one species is at present known from the eastern side of the Atlantic, and I venture to propose that *A. fenestratum* be regarded as a synonym of *A. hystrix*.

Echinus acutus, Lamk.

Taken from 126 fms. 20 miles N.W. off Achill Head (St. 72); a very conical specimen; several examples from Galway Bay.

Echinus esculentus, Linn.

The variations in the form of the test of this species are very remarkable.

Echinus elegans, Düb. and Kor.

Eight specimens from 500 fms. (St. 70) of various sizes, and with a test sometimes conical, sometimes rather depressed; 35 miles off Blacksod Bay, 250 fms. (St. 203). Another set of specimens of

Echini from 500 fms. appeared to be made up of *E. acutus* and *E. elegans.*

Echinus microstoma, Wyv. Th.

35 miles off Black Rock, Co. Mayo, 250 fms. (St. 203.)

Spatangus purpureus, O. F. Müll.

One small specimen from 220 fms., 40 miles off Achill Head (St. 63).

Spatangus Raschi, Loven.

One specimen from 144 fms., 30 miles of Achill Head (St. 64) and a larger one from 500 fms., 54 miles off Achill Head (St. 70); 45 miles off Black Rock, 500 fm. (St. 201) and 50 miles off Bolus Head, 220 fms. (St. 124).

DESCRIPTION OF THE PLATES.

Plate XXIII.

Astropecten Sphenoplax.

Figure A, 1–3 show three stages in the extent of the gap between the infero-marginals, due to the more or less wedge-shaped form of the plates.

Figure B, 1–3 show three stages in the spinulation of the supero-marginals; in B 1 there are no spines, in B 2 some of the plates bear spines, in B 3 many bear spines.

Plate XXIV.

Figures of *Asthenosoma hystrix*, after drawings by Mr. E. W. L. Holt of fresh specimens; the details from preserved specimens. The differences in colour and the size of the plates are very marked in these two.

Plate XXV.

Figures to show the variations in the calcification of the plates of the corona of *A. hystrix*, × 2.

1. From a specimen in which calcification is extensive, and the coronal plates touch one another.
2. From a specimen in which calcification has been complete in part only of the plates of the corona so that there is distinct fenestration.
3. From a specimen in which calcification is much less complete over the whole area of the plates of the corona.

XXXVII.

ON THE APPRECIATION OF ULTRA-VISIBLE QUANTITIES, AND ON A GAUGE TO HELP US TO APPRECIATE THEM. By G. JOHNSTONE STONEY, M.A., D.Sc., F.R.S., Vice-President, Royal Dublin Society.

[Read March 16, 1892.]

I.—Description of the Gauge.

Imagine a quadrant of the earth's meridian to be straightened out, and used as the base line of a wedge-shaped gauge. Set a metre upright at one end of this base, and from the top of it draw the inclined plane to the other end. This completes the gauge. It is, in fact, a wedge with a slope of one in 10,000,000. We shall only require the last ten metres of this gauge, next its apex; and it is this portion which I propose as a standard for the measurement of small quantities. Small quantities are to be measured by the ordinates of the gauge, that is by the little perpendicular distances from its base line up to its sloping top.

Another and perhaps a better way of conceiving the gauge is to take a base line that is only ten metres long, to erect a micron[1] at one end, and from the top of this to draw the incline to the other end. This will give the same slope as before—a gradient of one in 10,000,000.

II.—Illustrations of the very Acute Angle of this Gauge.

1. A wedge with an angle of $1''$ would furnish a slope of one in 206,265. Ours has a slope of only one in 10,000,000. It is, accordingly, between 48 and 49 times more acute: in other words, its angle is less than the forty-eighth of $1''$, which is a much smaller angle than can be measured by any astronomical instrument.

[1] The micron is a measure that has come of late years into general use among microscopists. It is the thousandth of a millimetre, which is the same as 1/25400th of an inch. The micron is between the seventh and the eighth part of the diameters of the little red corpuscles in human blood, which are tolerably uniform in size and are familiar objects to all workers with the microscope.

2. Prolong the gauge beyond the ten metres. Then the slightly differing diameters of the red corpuscles in human blood are equal to the ordinates of the gauge at from 70 to 80 metres from its apex—about as far as street lamps are from one another.

3. At ten kilometres distance (over six miles), the ordinate is exactly one millimetre.

4. And to reach an ordinate which is as long as an inch, we should have to go to a distance of 254 kilometres from the apex—about 158 miles, or across Ireland.

However, in the study of molecular physics, we are dealing with measures that are fractions of a micron; so that the ten metres of our gauge that are next its apex are enough for us to retain.

III.—Relation of the Gauge to Ångström's Map.

The wave-lengths of light are the longest of the small quantities with which we need concern ourselves; and the gradient of the gauge has been specially chosen to be convenient in measuring them. For this purpose, lay the gauge on Ångström's map of the "Spectre normal du Soleil," making the points on the base line at 4, 5, and 6 metres from the apex of the gauge coincide with the positions 4000, 5000, and 6000 on his map. This can be done, since Ångström's scale is a scale of millimetres.

Then the actual length of λ (the wave-length-in-air) for each ray represented in his map is the ordinate of the gauge (*i. e.* the vertical distance from the horizontal base of the gauge up to its sloping top) immediately over the line of the map representing the ray.[1]

IV.—The "Minimum visibile."

The *minimum visibile* (*i. e.* the smallest separation at which two points must stand to admit of their being seen as two, by the help

[1] Rowland's great photograph of the solar spectrum is on a scale which is about three times larger than that of Ångström's map; and, from the exigencies of the case, the lengths of the degrees upon it differ slightly from strip to strip. To adapt a gauge to it, begin by extending both ways the scale of the strip under examination till it reaches zero in one direction and 10,000 in the other. Over the 10,000 mark erect a micron, and from the top of it draw the inclined plane to the zero mark. This is the gauge whose ordinates will be the wave-lengths of the rays represented in that strip of the map. Each strip will require its own gauge; but none of them will be far from 30 metres long, so that they are about three times more acute than the proposed *standard* gauge.

of such coarse waves as the waves of light) is about half the wave-length of the light admitted to our microscope, that is, it is the ordinate of our standard gauge at some point between two and three metres from its apex. All smaller magnitudes are ultra-visible.

V.—The Larger Ultra-visible Magnitudes.

1. Ponderable matter is in the gaseous state when its molecules are so little crowded that they have room to dart to a certain distance along a free path, in the intervals between their encounters with one another; and information as to the average length of these little journeys can be deduced from experiments on the viscosity of gases. If the gas is a tolerably "perfect" one, at the ordinary temperature, and exposed to the pressure of one atmosphere, the average length of the "free path" of the molecules is small. In fact the observed amount of the viscosity assigns to it in air a length equal to the ordinate of our gauge at a distance of something like *three quarters of a metre* (30 inches) from its apex; and although the mean length of the free path differs from one gas to another, it is in all a magnitude of this order.[1] Note that this is a good deal smaller than what we have found to be the "minimum visibile."

Within the receiver of an air-pump the free path becomes longer, until at the excessive attenuations that Mr. Crookes obtains by working his compound Sprengel pump for a long time, its average length may even reach to several centimetres, which would be the ordinate of our gauge at a distance from its apex of some hundreds of miles. Ponderable matter is then in what Mr. Crookes calls the *radiant* state.

2. The average *spacing* of the molecules in a gas (*i. e.* their average distance asunder at any one instant of time) may be obtained in various ways,[2] *e. g.* it may be deduced from the last

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[1] See *Philosophical Magazine* for August, 1868, p. 138.

[2] Calling the average length of the free path λ, the average interval between the molecules σ, and the average 'diameter of a molecule' δ; we can obtain λ from experiments on viscosity, we get δ/σ from observing the condensation which the gas undergoes when liquefied, and one other equation between λ, σ, and δ would enable us to obtain all three.

Now it is evident that λ (the average length of the journeys of the molecules) will, *cœteris paribus*, increase if σ (the space between the molecules) is increased, which may measure by taking into account the degree in which the gas falls short of being "perfect," *i. e.* of accurately fulfilling the law

$$\frac{pv}{p'v'} = \frac{T}{T'}$$

where p is pressure, v volume, and T absolute temperature. Judged in this and other ways, it appears that the average interval between the molecules of any of the more perfect gases, when at atmospheric pressures and temperatures, is something like the ordinate of our gauge at the distance of *one centimetre* from its apex. [1] If the vacuum in a Sprengel pump be carried so far as to

be effected by expanding the gas, and will decrease if δ (the distance within which the molecules sensibly act on one another) is increased, which may be effected by exchanging one gas for another. It is, in fact, a function of these two quantities and of others, viz. of the velocities of the molecules (the mean of the squares of which is known from the pressure and density of the gas), of the events that occur in the struggle of two molecules with one another during their brief encounters, and of the time occupied by these struggles.

The events that occur during the encounters and the time they last are not sufficiently known for the actual equation to be set down: but hypotheses can be framed in regard to them—as for instance that the molecules when they encounter simply rebound like hard elastic globes—which enable us to ascertain what function σ/λ would be of δ/σ if the hypothesis were true, and thus enable us to judge what *kind* of magnitudes δ and σ are.

The quantities λ and δ vary within wide limits from gas to gas; but it is one of the elementary propositions in the kinetic theory of gases that σ (which may be called the average spacing of the molecules) is nearly the same in all nearly "perfect" gases when compared at the same pressure and temperature. This is, in fact, the truth that underlies and gives its value to Avogadro's erroneous hypothesis that at the same temperature and pressure the size of the gaseous molecules of all substances is the same. In the present state of science it is desirable that every practicable effort should be made to determine with more exactness the value of this important physical quantity.

[1] *Philosophical Magazine*, August, 1868, p. 140. If we assume, as in the text, that the molecules of a gas at, say, 21° C. and 760 mm. pressure, are as numerous within a given space as would be a number of points cubically disposed at intervals of a ninthet-metre asunder (this being the ordinate of our gauge at the distance of one centimetre from its apex); then the number of molecules of the gas in every cubic millimetre of its volume is a uno-eighteen—the number represented by 1 with eighteen 0's after it. Hence, in a litre of the gas there will be a million times more, i.e. a uno-twentyfour of molecules. Now at the above-mentioned temperature and pressure a litre of hydrogen weighs just one-twelfth of a gramme (·083'). Hence the mass of each molecule is the twenty-fourthet of this (i.e. the fraction represented by 1 in the numerator, and 1 followed by twenty-four 0's in the denominator), i.e. it is = 8·3' xxviets of a gramme; and according to this computation the chemical atom of hydrogen, being the semi-molecule, has as its mass 4·16' xxviets of a gramme. This is probably somewhere in the neighbourhood of the true value; so that we may regard the mass of a chemical atom of hydrogen

reduce the pressure to one millionth of an atmosphere (which is not very far from the greatest exhaustion that can be attained) the average spacing of the molecules will have increased up to being equal to the ordinate of our gauge at a distance of about a metre from the apex. It is instructive to observe that even this enlarged interval is ultra-visible, and that in this so-called extreme vacuum there remain something like a million millions of molecules of the gas in every cubic millimetre of the space within the receiver—*i. e.* about a thousand in every cubic micron.

3. The magnitude to be next considered is the diameter of a molecule. By this is to be understood the distance within which the centres of two molecules must come, if they are sensibly to deflect each other's path. This *size of the gaseous molecule* as it may be called, is intimately related to the ratio of the last two measures to one another, and may be deduced from that ratio. Or it may be obtained by observing the condensation which a gas or vapour undergoes when passing into the state of a liquid or solid. Estimated in either of these ways, it appears to be usually about the 8th, 10th, or 12th of the last measure—that is, it is something like the ordinate of our gauge at a distance of *one millimetre* from its apex.

VI.—Smaller Magnitudes.

The diameter of a gaseous molecule, as above defined, is the smallest measurement for which the present gauge is suggested as convenient, as it is also the smallest magnitude of the actual size of which any approximate estimate has been made. But we have through the spectroscope, indications of important events in nature that are perpetually going on *within* each gaseous molecule, and probably on a *very* much smaller scale. For example, an easy

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as a mass probably not more than a few times more or a few times less than the twenty-fifthet or twenty-sixthet of a gramme. This seems the best approach that can at present be made to estimating the mass of a chemical atom.

The determination depends upon the average spacing of the centres of the molecules of a gas at standard temperature and pressure (see last footnote); and if this very important physical magnitude, which is common to all perfect gases, can be ascertained with more accuracy, we shall get a proportionally better estimate of the mass of a chemical atom. Of course if the mass of the atom of any one element, e. g. hydrogen, be determined, the masses of all the others become known by the chemical tables of atomic weights.

calculation will show that the motion within the molecules of sodium to which the principal double line in its spectrum is due—a motion which is repeated 508,911,000,000,000 (*i. e.* more than five hundred millions of millions) of times every second within each molecule—would need to have a velocity several times greater than that of the earth in its orbit (which is a velocity of 30 kilometres, 19 miles, per second) if the range of these motions is the whole diameter we have attributed to the molecule.[1] This consideration, though not decisive, is nevertheless quite sufficient foundation on which to base the *expectation* that, if ever we are able to ascertain the actual range of this motion and others of a like kind, they will turn out to be much smaller than the ordinate of our gauge at a distance of a millimetre from its apex; so that if ever we discover any way of quantitatively estimating such events, we shall require another and more acute-angled gauge to aid us in appreciating them.

VII.—Of the Borderland of the Visible.

Meanwhile the gauge now proposed will, it is hoped, help the scientific student to obtain a more connected view of nature, by placing before him in somewhat clear evidence the relation in which some of the larger molecular events stand to the dimensions of the smallest objects he can see with his microscope.

He should never forget that even the most minute of these microscopic objects is an immense army of molecules,[2] or semi-molecules, crowded together, more numerous indeed than all the inhabitants of Europe. The individuals that constitute the battalions are not seen, nor is there the least glimpse of the active motions that are without intermission going on among or within the individuals: nay more, waves of light are too coarse to supply our microscopes with information about the evolutions of the companies, regiments, and brigades of this great army. It is only when the *entire* army shifts its position that anything can be *seen;*

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1 See Stoney "On Double Lines," Scientific Proceedings, R. D. S., vol. iv., p. 603.

2 That is, of molecules such as are present in the gaseous state of the ultimate chemical constituents of the speck of matter under examination. These in a highly organized substance like protoplasm are associated into much larger organic groups, that may be called mega-molecules, and may be likened to the companies or regiments of the brigades and corps that make up an army.

and my object will be attained if the contrivance I have proposed helps in any degree to bring about a better balance of thought relatively to the cosmos in which we find ourselves: it is so difficult to avoid making the small range of our senses a universal scale with which to measure all nature. Where, for instance, is the justification for our alleging that any *visible* speck of protoplasm is undifferentiated? And, in fact, are not subsequent events perpetually rebuking this rashness?

A convenient object to help in connecting visible with ultra-visible magnitudes is the marking on the frustule of the *Pleurosigma angulatum* (or, *Gyrosigma angulatum*), one of the commonest of test objects. The little brown specks are easily seen with the higher powers of a microscope if a good condenser and the proper stop be used, and their distance asunder from centre to centre is somewhere between ·64 and ·65 of a micron according to the best determinations I can make. This is a trifle more than the spacing deduced from Professor Smith's measurement of the interval between the rows. It is the ordinate of our gauge at about six and a-half metres from its end, and is the wave-length of a ray of *red* light not far from the α hydrogen line, the line C of the solar spectrum; so that the brown dots succeeding one another in a row mark off in the field of the microscope the successive waves of this particular ray of red light.

The dots are arranged in rows parallel to the sides of an equilateral triangle, and with oblique light coming at right angles to any one of these sets of rows, the dots will elongate and almost run into one another in a way that makes the rows look like a ruling of parallel lines. These parallel lines are at shorter distances asunder than the dots in the ratio of $\sqrt{3}$ to 2, and accordingly present to the eye intervals equal to the wave-length of a *green* ray less refrangible than the line E of the solar spectrum. The interval in this case is the ordinate of our gauge at a distance of about five metres and a third from its apex.

Furthermore what we have found above to be the *minimum visibile* is a little more than one-third of the interval from centre to centre of the dots, or a little less than half the interval of the rows. It is well illustrated by the Pleurosigma markings. In fact, judging from similar markings on other scales, the round dots would be seen as rings were it not for their small size, which prevents the opposite sides of the ring from being seen as two objects. They accordingly look like disks.[1]

VIII.—Of the Nomenclature of Small Measures.

It will often be found convenient to connect the proposed standard gauge with another useful way of describing small magnitudes. Let us understand by a sixthet a unit in the sixth place of decimals, *i. e.* the fraction $1/10^6$, and let us use the phrase sixthet-metre, or metre-sixthet, to mean the sixthet of a metre, in the same sense in which we say half-inch or quarter-inch to mean the half or quarter of an inch.

We can then conveniently express the following table of equivalents.

The ordinate of the standard gauge, at a distance

Of ten metres from the apex,	=	a sixthet-metre.
Of one metre, ...	=	a seventhet-metre.
Of one decimeter, ...	=	an eighthet-metre.
Of one centimetre, ...	=	a ninthet-metre.
Of one millimetre, ...	=	a tenthet-metre.

The sixthet-metre is identical with the micron spoken of above. Many writers represent it by the symbol μ.

The ninthet-metre is the thousandth part of a micron. It has sometimes been called the micro-millimetre, and is by some writers represented by the symbol $\mu\mu$.

The tenthet-metre is the same measure as is usually called the tenth-metre. It has also sometimes been called the tenth-metret.

IX.—Of the smallest magnitudes that have been measured.

The most minute magnitudes that have been actually measured are differences of wave-length. These can be determined with truly astonishing precision by observations with the diffraction grating spectroscope, so much so that they carry us down to magnitudes that are fractions of the diameter of a gaseous molecule. The observation is most easily made in the case of close double lines. In these the interval between the two constituents is due

[1] The white pearl-like specks which take the place of the dots when they are a little out of focus, must not be mistaken for their being seen as rings. They are an optical effect, and of larger size.

to the difference of their wave-lengths, and by measuring the former the latter can be ascertained. Thus, an interval of one degree on Ångström's or Rowland's map indicates a difference of wave-length amounting to a tenthet-metre, which, as we know, is the ordinate of our standard gauge at a distance of a millimetre from its end. But lines have been seen to be double with Prof. Rowland's gratings, in which the separation of the two constituents is not more than from 1/30$^{\text{th}}$ to 1/100$^{\text{th}}$ part of a degree. In the latter case the difference of wave-length is only one twelfthet-metre. This is the ordinate of our gauge at a distance from its apex which is little more than the diameter of a single blood corpuscle, and may be taken to be the smallest measurement that can as yet be directly effected with certainty.

The following is a list of close double lines which I have myself seen in the solar spectrum with a small Rowland's grating[1]:

The solar line b_3, and a multitude of other close doubles, shown as such on Rowland's map (2nd Series, 1888).
The less refrangible of the two E lines.
The line in the E group at $\lambda = 5264{\cdot}4$ of Rowland's scale.
The nickel line which is nearly midway between the two D lines.
The least refrangible constituent of the triple lines at $\lambda = 5328{\cdot}7$.

This last is about the closest double that my spectroscope will resolve. There is no micrometer on my instrument, so that I cannot give measures, but I estimate the coarsest of these, those first mentioned, to have a difference of wave-length under two eleventhet-metres—and in the closest, that last mentioned, it cannot be more than a very few twelfthet-metres. Most of them could be measured with a good micrometer.

This can be accomplished with one of the smaller of Professor Rowland's splendid gratings; and he himself and other observers have carried matters further, by taking photographs with the best of his great six-inch concave gratings. This may give some idea

[1] The grating is flat, nearly an inch and three-quarters long, contains about 25,000 lines, and the observations were made in the fifth spectrum. In this spectrum the image is formed by bringing together every fifth wave of light out of a series of 125,000 consecutive waves, and the ruling must be sufficiently accurate to effect this.

of the marvellous precision of this, the latest and most searching appliance for exploring nature. By it a brilliant series of discoveries have already been made in stellar astronomy; and we may anticipate still greater achievements from the distance to which it can throw its plumb-line into the obscure depths of molecular events.

X.—TIME RELATIONS.

The fragments of time that can be appreciated with accuracy in this way are even more wonderful in their minuteness than are the differences of length. Time relations, however, lie somewhat outside the scope of the present essay; but they, too, should be carefully pondered by anyone who wants to know what Nature really is. And after thus taking the best survey that he can, he should bear in mind that all he can do is to gauge the little that man has been fortunate enough to detect; and that far more may lie beyond the ken of any human being than the immense range which now lies within it. He should also reflect that the few molecular events that are already known succeed one another with such astonishing rapidity that the swiftest visible motions are, in relation to them, as sluggish and as gradual in their progress as are the changes in the configurations of the constellations owing to the proper motions of the fixed stars, in their relation to us and to the events we can see occurring about us on the earth. In fact, the thousandth of one second of time is, in relation to them, comparable with some such period as twenty or thirty thousand years in its relation to man's slow thoughts, or the driftings about of those accumulations of molecules which are the only kind of objects he can perceive even with the highest powers of his microscope. These *visible* objects, these *armies* of molecules massed together, seem to him sometimes at rest and sometimes in motion; but in either case strenuous activity within and between the molecules themselves never ceases, nor the perpetual response between them and the æther through which they keep up a communication with one another at a distance. The magnitude of the consequences throughout all nature of this unflagging intercourse between molecules cannot be approached by the utmost thought we can give to it. It is quite impossible for us to appreciate it adequately. The human eye placed anywhere intercepts a small fragment of the messages in their transit, and is thus a detector of their presence. But it does so roughly. It jumbles up the immense detail which even our spectroscopes can show to be included within this fragment. Yet even so, how much our eyes show us wherever we turn them, and with what seems to us such marvellous promptness! The spectroscope in some respects penetrates farther as a detector. Even it, however, fails to reach much detail that we know to be present, *e. g.* it cannot tell us the innumerable interruptions or the various orientations or the phases of the actual motions. And, at the best, both these detectors together can give us but a very slender notion of the real activity that is going on, and of the precision and fulness with which the molecules everywhere about us are energetically exchanging many millions of different messages with one another every second. Such is Nature as it really is.

XI.—On the bearing of these Determinations on other branches of Study.

1. Determinations such as those dealt with in this Paper have a bearing upon almost every study that is occupied either in the interpretation of material nature, or in investigating the relation between the thoughts of animals and the operations that go on in their brains; inasmuch as the whole of material Nature is found, on careful analysis, to rest on molecules—on their mutual relations and motions, on the events going on within the molecules, and on those which they excite in the medium in which they move. One example of this influence upon other studies is the general limitation which molecular determinations impose upon the methods employed in dynamical inquiries, as pointed out in a Paper by the present author on "Texture in Media." [These Scientific Proceedings, vol. vi., p. 392; Phil. Mag. for June, 1890, p. 467.]

2. The direct bearing of the inquiry upon chemistry is obvious. It is briefly referred to in the Scientific Transactions of this Society, vol. iv., p. 608. In fact the record of the chemist is not unlike what one often sees upon a tombstone—"Born in such a year; Died in such another";—while the intervening *life* is passed over in silence. So the chemist submits two or more substances to their mutual influence, and finds that such and such

substances emerge; but he takes little note of the eventful time during which all the protracted contests of the reaction have taken place, which if it has lasted for only the five-hundred-thousandth of one second has been as long in reference to the activities of the molecules as a long life of 60 years would be in reference to all the thoughts and actions of a man.

3. The *minimum visibile*, as defined above, is between the fourth and fifth of a micron, and a speck whose volume is the cube of this may be regarded as the smallest organic speck that the biologist can distinguish from other specks by the highest powers of his microscope. Its volume is accordingly about one-hundredth of a cubic micron—about the 1/7000th part of the volume of one blood corpuscle. Now, liquid or solid material, if resolved into its chemical elements, and if these be brought into the gaseous state, will, at the temperature and pressure of the atmosphere, expand about 1000 times. Hence the foregoing speck, if thus resolved into gas, would occupy about ten cubic microns. But this volume of gas at that temperature and pressure contains about a uno-ten (10,000,000,000) of molecules, which for the most part will consist each of two chemical atoms. Hence the number of chemical atoms in our speck may be taken to be about two uno-tens. Our speck, perhaps, consists of very complex organic molecules; but however complex each of these may be their number must nevertheless be very great. For, let us make the liberal allowance of 2000 chemical atoms for each organic molecule, and the number of these very complex molecules will be about ten millions. This is an army quite large enough to admit of an immense amount of differentiation within its ranks—of very active operations within and among the complex molecules or between brigades of them—all of which are ultra-visible events. These are facts which every biologist should keep constantly before his mind when carrying out his investigations and interpreting them, and especially when he is tempted either to speak or think of 'undifferentiated protoplasm.'

4. A still more striking instance is presented when we consider the operations of the human mind. Here I will make the usual assumption, that every perception or other thought in the mind is accompanied by a physical event occurring in the brain, which is connected with it in such a way that neither presents itself without

the other. Of this event we know that it is of a kind that arises only in living brains and in them only while the man is either awake or dreaming. We also know that it is of a kind that lasts for a considerable time when it does occur, viz. throughout the duration of the perception or other thought in the mind.

This last consideration is very significant. The event in the brain with which human perception or any other human thought is associated must be one which can last while the thought lasts, *i. e.* for a time immensely long when compared with the original molecular events that are going on. The event may, for example, be such an event as a strain consequent on a stress, whether dynamical or electro-magnetic, acting on some part of the brain; or it may be of the nature of a forced vibration or current. These are events which would continue in existence so long as the stress is applied, and will cease when the stress is removed: they fulfil the requisite time conditions. Another event which would fulfil the time conditions is an undulation—dynamical, electro-magnetic, or of any other kind. The waves that make up an undulation may continue in it but a short time, some passing off while others come on, and the motions or stresses of which each wave consists may be such as succeed each other with extreme rapidity, while all the time the undulation viewed as a whole continues as much unchanged as a human thought does while it lasts. Hence an event of this kind may, so far as its relation to time is concerned, be that event in the brain which is intimately associated with human thought. Possibly the event we are in search of may be found among the processes of metabolism whereby nutrient matter brought by the blood becomes part of the brain; or more probably among those processes in which matter that had formed part of the brain separates and is swept away either by the blood or lymphatic vessels. Events of this kind, including every interference with those here specified, and the many other events which like them may be described as *stream* effects, are marked by the peculiarity that a vast number of molecules are concerned in them in such a way that different molecules successively take up the running. All such events fulfil the necessary condition of continuing temporarily in existence, as each of our thoughts does, for a time which may be immensely long compared with the *fundamental* events within or between the molecules, or in the interfused æther. It must, however, be borne in mind that it is upon these fundamental events that the whole superstructure rests; and that stream effects are in relation to them of the nature of very small outstanding residual events which remain over, when the rest—the great bulk of the events that are actually happening—are such as balance one another.[1]

It is evident that it is among protracted events such as those spoken of in the last paragraph that we must search for the physical event in the brain with which human thought is associated. It is also evident that it is with but a very small selection out of the vast number of such events occurring in the brain during life, that the thoughts of which man is conscious can be directly associated. All the rest of the innumerable stream events, and all the underlying fundamental events within and between the individual molecules, go on besides.

Now, what happens in the brain is an index to us of what is going on in that portion of the Autic Universe[2] which is most closely connected with human thought. For what goes on in the phenomenal world (to which the brain belongs) is an index to us of what is going on in the Autic Universe (to which our thoughts belong), in the same sense in which a weather-cock is an index to us of the direction of the wind; since what occurs in the phenomenal world is dependent upon and determined by what occurs in the Autic Universe [see *passim* a paper by the Author, "On the relation between Natural Science and Ontology," Scientific Proceedings of the Royal Dublin Society, vol. vi., p. 475]. Hence in the Autic Universe there are events as closely related to the thoughts which exist in my mind at any time, as are the other physical events going on in my brain at that time to those few which are directly associated with my thoughts. The autic events here spoken of probably more or less distantly resemble the events within my own mind of which I am conscious, inasmuch as all the physical events in the brain in a certain degree resemble one

[1] Wind is such a residual event. It arises whenever there is a small preponderance in one direction of the very much swifter velocities with which the individual molecules of air are at all times darting about in all directions. So also the current in a river is a similar residual event.

[2] Auta, actual existences (of which the thoughts that are in my mind are a sample *directly* known to me). The Autic Universe, the totality of all really existing things, of all auta.

another; and, in particular, the time relations between them and between them and my thoughts are the same as the time relations of the physical events that, as a consequence, go on in my brain. This body of events in the Autic Universe, and the thoughts or other auta between which they occur, may suitably be spoken of as a *synergos* (συνεργός, a fellow-worker) which is ever on the alert to work along with my mind, and on which the thoughts that are my mind as much depend (in the autic sense of that word), as do those few physical events in my brain which are associated with my thoughts depend (in the physical sense of the word) upon the vast multitude of other physical events also going on in my brain. The one cannot even exist without the other.

The lesson to be learned from all this is that psychology and the other branches of metaphysics as presented by the ablest men who were unaware of the existence of this synergos and of the large degree in which it intervenes in all that happens in the mind, will now have to be rewritten. In memory; in the association of ideas; and in the other miscalled "faculties and operations of the human mind," it is little we do: it is much that is done for us.[1]

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[1] Take, for example, some particular instance of memory. I remember where I sat at breakfast this morning, where my companions sat, also several particulars of what was said during breakfast, of the gestures of my companions, of my own motions, of what I ate, of the equipage on the table, and so on. None of these things have occupied my thoughts since breakfast, till I sat down to write these lines; since when they have all come into my mind.

Now what does all this mean? It means that the group of thoughts which I call myself, my mind—and which at each instant is a group the several parts of which are connected and interacting in that way that we call being within one consciousness—is a group of thoughts that has undergone change; that one instance of this change has been the discontinuance of the above-recited perceptions that formed part of the group at breakfast-time, and that another instance has been the occurrence now within the group of thoughts of what are more or less an imperfect and modified repetition of some of those perceptions, accompanied by the additional thought which we call being aware that they had at breakfast-time occupied a place within the group in the fuller form of complete perceptions. During the intervening hours none of these occupied any place in the group either in their fuller or in their modified form: nevertheless, there must have been, somewhere in the autic universe, a chain of causation connecting the original perceptions and the memory of them. Of this chain the first link *was* a part of my mind, the last link *is* a part of my mind, but the connecting links have been in the synergos.

This becomes clearer when we turn to the objective or phenomenal world, which is a kind of shadow thrown in a special way by the succession of events that occur in the autic universe (see Stoney, "On the Relation between Science and Ontology," Scientific

Man's mind—the little changeful group of interwoven thoughts that is himself—is a *very* small part of the great Autic Universe. We must shift our centre, and exchange the metaphysician's narrow Ptolemaic for a broad Copernican view of existence.

Proceedings of the Royal Dublin Society, vol. vi. pp. 502, 503, 504). My thoughts, which are a part of the autic universe, are shadowed by certain objective changes in my brain; and the term synergos means that other portion of the autic universe which is shadowed *by all the other events* that happen objectively in my brain. It appears from physical considerations that the particular stream effects or other changes in the brain that were the shadows of the perceptions I had at breakfast-time, cannot have occurred alone, but were accompanied by more subtile motions or changes in the brain which were the shadow of, and thus betokened, certain closely associated events then going on in my synergos. These again were succeeded by motions, changes, or states of strain in the brain during the intervening hours, all of which were a part of the varying shadow of the synergos as it underwent whatever changes took place in it during that interval. Moreover, these intervening events in the brain were of such a kind, as the result has proved, that they have been now followed up by motions or changes in the brain which resemble those that were the shadow of my thoughts at breakfast-time, and which are a part of the group of events now going on in my brain that is the shadow of the group of thoughts that constitute my mind as it exists at present.

Softening of the brain is the shadow cast within the objective world when very unfortunate events have happened in the autic universe—events which have included a weakening of the power which the synergos and the mind previously had of mutually acting on one another, or else which have prevented the full formation within the synergos of some of the intermediate links of causation spoken of above. Either of these would involve a partial loss of memory.

XXXVIII.

WHY THERE IS NO ATMOSPHERE ON THE MOON.

By G. JOHNSTONE STONEY, F.R.S.

(*Abstract of a Paper read April* 20, 1892, *and published in extenso in the* Scientific Transactions of the Royal Dublin Society, *Vol. IV.*, Part xiv., *p.* 703.)

In this communication reference is made to the conditions that limit the height of an atmosphere upon any celestial body. These had been announced by the author in a Paper "On the Physical Constitution of the Sun and Stars," printed in the Proceedings of the Royal Society for 1868; and in the present Paper it is pointed out that the same method of investigation shows that under certain circumstances some of the constituents of an atmosphere may molecule by molecule wander off into space. This event occurs with more readiness—1st, the lower the mass of the molecules of the gas; 2nd, the higher the temperature at the boundary of the atmosphere; 3rd, the feebler the potential of gravity at the boundary of the atmosphere.

By investigating the conditions that prevail on the earth and moon, it is shown that free hydrogen could not remain a constituent of the earth's atmosphere; and that no free oxygen, nitrogen, or the vapour of water could remain on the moon. Hence, even if there were no oxygen present, the earth's atmosphere could not retain free hydrogen; and on the moon there is now neither atmosphere such as we know it, nor water nor ice.

It follows from the investigation that space must be peopled with vast numbers of wandering gaseous molecules, especially of the lighter gases; and that these tend ultimately to settle down upon such of the more massive bodies of the universe as are sufficiently dense to exert a powerful potential at their surface.

Finally, the investigation indicates conditions which must be fulfilled by any "nebular hypothesis" in order that it may be admissible.

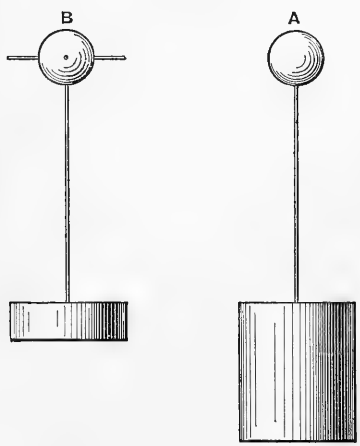
XXXIX.

ON A MERCURY-GLYCERINE BAROMETER.

By J. JOLY, M.A., D.Sc., F.R.S.

[Read April 20, 1892.]

A column of mercury may be suspended unbroken in a wide tube—it appears immaterial how wide—by a device which occurred to me some seven or eight years ago, and which was then brought by me before the Dublin University Experimental Science Association. I have heard lately that the arrangement is not new, but when or by whom else invented seems unknown. The arrangement is as follows:—A cylinder of ivory or ebonite, having a diameter a *little* less than that of the tube, has a projecting "float" extending from its centre at one side (see fig. A). The



shank of the float may be a steel pin, and the float a sphere or cylinder of wood or ivory. Now, if the float enter the bottom of a column of mercury, contained in a wide tube, it will tend to rise through the mercury and will pull the cylinder up against the base of the column with a force equal to the difference in weight of the float and the mercury displaced by it. But if the float has a proper bulk, this force will not be adequate to cause the cylinder to break the surface of the mercury and squeeze the latter downwards between the edge of the disk and the glass. Thus the mercury column is preserved from falling out of the tube, the free surface at the base being reduced to the small annular space around the top of the cylinder, which annular space may be as narrow as we please so long as contact between disk and tube is avoided. Such a tube may be considerably shaken without the outflow of the mercury occurring, and if some air be let pass up (by inclining the tube) the elasticity of this permits of the column being oscillated vertically with considerable violence, without air passing up or the mercury leaking downwards. I may mention here that, in conjunction with Professor Fitzgerald, I have adopted this arrangement to the demonstration at lectures of the thermal expansion of air. For if such a tube, with air above the mercury, be jacketed first with ice and then with steam, the sinking of the column will amount to a length of the tube (supposed uniform in bore) which will be represented by 100 units, the length of the column at 0° being 273 such units. Thus a simple demonstration of the absolute zero of the air thermometer is provided. To keep the air dry in this arrangement it is sufficient to let a piece of calcium chloride permanently float upon the surface of the mercury. A convenient length for such a tube will be one metre, and the bore one centimetre. This is visible to a large class.

Returning to the application of this contrivance to the construction of a mercury-glycerine barometer, it is apparent at once that we might have the space in the tube below the disk filled with glycerine, and preserve the open end of the tube dipping below a bath of glycerine. We may thus have a column of glycerine in the tube loaded with a column of mercury. Suppose we make the mercury column 27″ in length, and that a vacuum exists above the mercury, the mercury column will stand at such a height in the tube that the pressure at the base of the tube, due to the length of the column of glycerine plus that due to the length of the column of mercury, is equal to that exerted by the atmosphere. Thus, if the mercury barometer stand at 29 inches, then a column of glycerine equivalent to two inches of mercury must stand in the tube. If the barometer rise another tenth inch, such a further height of glycerine as will exert a pressure equal to the tenth of an inch of mercury must be added to the column already in the tube. If the barometer fall, the glycerine, on the other hand, must flow out into the bath; so that the sensitiveness of the instrument is exactly that of the Jordan's Glycerine Barometer, but presumably with the advantage of being more rapid in its indications, the viscous friction of the glycerine moving through the length of some 28 feet of tubing, causing probably considerable sluggishness in response to any sudden variation of pressure. There is, however, this practical objection to the mercury-glycerine barometer that a want of uniformity in the bore of the tube may be a serious evil, disturbing the truth of the scale; for if the column of mercury moves into a place of narrower bore, it of course lengthens, and the whole sinks proportionately. Now, this evil might be remedied by empirical graduation of the scale if it was not for the fact that there is a secular creeping of the glycerine past the column of mercury. It is a very slow motion (I observed one millimetre in about a month's observations); but while in uniform tubes this would be no source of error (only necessitating the re-setting of the mercury column once every four or five years), it interferes with the permanency of empirical graduation. There is no remedy but to select tubes as uniform in bore as possible. I say the passage of a little of the glycerine to the upper surface of the mercury is no source of error in itself. This is because it is difficult to set up the barometer without permitting a little glycerine passing up in the first instance, so that, in any case, in reading the instrument, it is not the mercury meniscus we observe, but a surface of the glycerine above the mercury, so that we are not concerned (in the case of a uniform tube) with the position of the mercury column in the glycerine.

Of course, the great advantage this form of glycerine barometer has over the ordinary form is its compact size. It may stand with its bath resting on the floor of the room in which we read it—the mean height being a convenient height to observe when standing in front of the instrument. The total length of the tube is about 8 feet. I use one about $\frac{3}{4}$ inch in diameter—but of course any bore may be chosen. The appearance of the instrument with the bright column of mercury hanging in the clear glycerine is very handsome. I mount the tube and a light scale some three inches away from the back-board. The bath is a circular glass dish about 4 inches deep and of 8 inches diameter, covered with a wooden cover pierced to receive the tube. A little oil (pure sperm oil seems to answer the purpose well) is floated on the surface of the glycerine in the bath to preserve the latter from taking moisture from the atmosphere.

The mode of setting up the barometer is as follows:—The mercury ($26\frac{1}{2}''$) is first poured into the tube. If *all* air is to be got out a rubber stopper with a tube leading to an air-pump is inserted in the open end and the pump worked. While the vacuum is maintained the tube is cautiously inclined so that the column becomes detached all down the upper surface, and this is done several times, rotating the tube axially a little each time till all bubbles are got out. The cylinder is then dropped in, float downwards, and sufficient mercury is poured in after it to sink by its weight the float up to the disk. The glycerine is now slowly poured down the tube. The glycerine used should be pure, and must previously have been warmed and let stand under the exhausted receiver of an air-pump for some hours to extract dissolved air from it as recommended by Mr. Jordan. When quite full a cork is inserted, squeezing out some of the glycerine and leaving no air bubble beneath it. The tube is now inverted and fixed in its place upon its board; the corked end of the tube dipping below the glycerine in the bath. The cork is now withdrawn slowly, so as not to let the column descend too rapidly. The small quantity of mercury used in sinking the float of course falls out into the glycerine bath. The mercury column descending leaves a vacuum above it. Some glycerine will finally descend upon the upper surface of the mercury column from the wet walls of the tube. The proportion of the float to the area and weight of the disk is important. Ebonite and ivory are almost of the density of glycerine, so that these substances exert but little downward pull upon the float. On the other hand, a certain force is required to preserve the surface of the cylinder pressing against the mercury column, while too much force may lead to mercury being pressed down past the cylinder. With a three-quarter inch diameter ebonite cylinder, having a length equal to its diameter, about, I found a cylindrical float half an inch long and about one-fifth inch diameter suitable, or a spherical float may be used as in the figure. In the air-thermometer alluded to previously an adjustment was provided in that the cylinder was made in the form of a hollow ivory box into which, by inserting little tinfoil weights, the upward pressure was regulated. It is important that the upper edge of the cylinder be sharp and rectangular, not rounded, as will surely be the case if glass paper be used in finishing it. An alternative and better form of the float is shown in fig. B. There will be less drag upon this in its motion through the glycerine. The cylinder is reduced to the dimensions of a disk. It is kept from jamming in the tube by the four guiding pins projecting from the float, or these pins may be placed below the disk attached to a downward prolongation of the shank of the float. By shaping a conical cavity in the bottom of the disk or cylinder a chance air bubble rising through the glycerine will be retained beneath the float, where, except it be of considerable size, it can do no harm.

I have found that distilled water, boiled and cooled in a closed vessel to deprive it of air, serves in place of glycerine except very accurate readings are required. A correction for the vapour tension is of course applied. I have thought of floating a small thermometer upon the surface of the mercury within the tube. The readings of this would be clearly visible through the walls of the tube, and would afford accurately the temperature of the vapour above the mercury, and of the mercury and water, enabling corrections to be applied. In the case of water I have not as yet detected any creeping of the water past the column of mercury.

The use of creosote has also suggested itself. It is at present under trial. It appears to possess all the requisite qualities. Low vapour tension; specific gravity 1·07′, about; and does not adhere to the glass as does glycerine, the latter property being that most objectionable in the case of glycerine. Again creosote appears unaffected by exposure to the atmosphere, and has no corrosive properties rendering it difficult to handle. It is a clear liquid, colourless or yellowish, possessing an odour of tar.

XL.

REPORTS ON THE ZOOLOGICAL COLLECTIONS MADE IN TORRES STRAITS BY PROFESSOR A. C. HADDON, 1888–1889.

PYCNOGONIDA. By GEORGE H. CARPENTER, B. Sc., Lond., Assistant Naturalist in the Science and Art Museum, Dublin. (Plate XXII.)

[COMMUNICATED BY PROFESSOR HADDON.]

[Read May 18, 1892.]

The collection of "sea-spiders" obtained by Professor Haddon is very small, numbering only seven individuals referable to three species. Of these, however, two appear to be new to science. Almost all our knowledge of exotic Pycnogonids is derived from the work of deep-sea dredging expeditions, and the present small contribution shows how much might be learned from a study of the shallow-water species in the tropics.

Professor Haddon's specimens were dredged from a depth of about fifteen fathoms, between the reefs off Murray Island.

In a recent Paper on the Pycnogonida of the Australian Seas, Haswell (4) enumerates eighteen species, of which only one (*Phoxichilidium Hoekii*, Miers) is from Torres Straits.

Of the species taken by Professor Haddon, two belong to the Pallenidæ and the other to the Eurycydidæ. In the nomenclature of the families I have followed Sars in his recent monograph of the North Atlantic species (6). I have also adopted his terms for the different parts of the body and its appendages. He calls the three pairs of appendages in front of the ambulatory legs "chelifori," "palpi," and "false legs," and has introduced the names "cephalic segment" and "caudal segment" for the foremost and hindmost divisions of the body respectively, instead of "cephalothoracic segment" and "abdomen" hitherto in general use.

Family.—PALLENIDÆ.

Genus.—PARAPALLENE, gen. nov.

I suggest this genus to receive *Pallene australiensis*, Hoek, and a new species, both of which were collected by Professor Haddon. Sars (6) points out that the genus *Pallene* in its present restricted sense cannot be made to include Hoek's three "Challenger" species, each of which will probably become the type of a distinct genus. *Parapallene*, of which *Pallene australiensis*, Hoek, may be taken as the type, is distinguished by the following characters:—

Body slender and elongated; posterior trunk segments separate; proboscis short and blunt, swollen at anterior end; lateral processes well separated; false legs, with spines slightly or not denticulate; tarsi of legs without auxiliary claws.

The genus seems to come nearest to *Pallene*, from which the absence of auxiliary claws on the walking-legs and the independence of the two last trunk-segments from each other distinguish it. The body is much more slender than in *Pseudopallene* and *Cordylochele*. The simple nature of the spines on the false legs also distinguish it from other genera of the Pallenidæ.

Parapallene australiensis (Hoek).

Pallene australiensis, Hoek, "Challenger," Zoology III., p. 76, pl. xi., ff. 1–7.

A single female was obtained by Professor Haddon.

Only three specimens were dredged by the "Challenger," and I am not aware that the species has been recorded since. The two stations where the "Challenger" specimens were found are off the south coast of Australia—one in Bass's Straits, the other off Twofold Bay, and the depths were 40 and 120 fathoms respectively. The discovery of the species between reefs in Torres Straits, at the northern extremity of the Australian continent, proves, therefore, that it has a considerable geographical and bathymetric range.

Parapallene Haddonii, sp. nov.

Pl. XXII., figs. 1–6.

Body moderately slender; neck fused with cephalic segment; oculiferous tubercle with rounded apex; proboscis bluntly conical at extremity, two-thirds the length of the cephalic segment; false legs with long claws and non-denticulate spines; ambulatory legs with the second coxal joint slightly longer than the two others taken together; femora and tibiæ, in male, with strong conical projections at their extremities; legs with numerous long hairs and smooth spines.

Length of the proboscis, 1·5 mm.; of the cephalic segment and trunk, 5 mm.; of the abdomen, 1·5 mm.; of a false leg (male), 5 mm.; of a false leg (female), 4 mm.; of an ambulatory leg of the second pair, 18 mm.

One male and one female specimen were taken by Professor Haddon.

The body of this species is smooth, slender, and elongated, but not so extremely attenuated as that of *P. australiensis.* The cephalic segment is about twice as long as a trunk segment; the neck is short, rapidly widening into the broad frontal part (figs. 1–2). The oculiferous tubercle (fig. 3) is low, with an evenly rounded apex (in *P. australiensis* it is more prominent, with a pointed apex). The lateral processes are about as long as the width of the body. The caudal segment is as long as a trunk segment, erect and bifid at its extremity. The proboscis is swollen at its base, constricted in the middle, and again swollen at its extremity, which is bluntly conical (Pl. xxii., fig. 2.) The chelifori are well-developed, with scape reaching beyond the end of the proboscis, stout rounded palm, and short strong fingers; all joints armed with spines. The false legs (fig. 4) are very similar in the two sexes; the fourth joint about once and a half as long as the three first together, it is stout in both sexes and has a central protuberance in the male; the fifth joint two-thirds as long as the fourth; the sixth two-thirds as long as the fifth; the seventh three-fourths as long as the sixth; the eighth, ninth, and tenth, each slightly shorter than the sixth; the tenth joint bears a slender claw longer than the joint, with a few very slight serrations on its inner edge; the last four joints bear stout, smooth spines (fig. 5) (in *P. australiensis* the spines are denticulate on one edge). The ambulatory legs are long, but not so long relatively as in *P. australiensis.* The second coxal joint is rather more than twice as long as the first or third (in *P. australiensis* it is three times as long); it is armed with a few spines, and swollen distally where the genital aperture is situated; the femur is once and two-thirds as long as the coxal joints taken together, somewhat swollen centrally in the female (containing eggs in the specimen examined), cylindrical in the male, in which sex (fig 2) it has a distal conical process bearing spines; there are also distal spines in the female, and a few long hairs in both sexes. The first tibial joint is somewhat shorter than the femur, it bears numerous hairs and spines, and, like the femur, has a distal conical process in the male; the second tibial joint is somewhat longer than the femur (shorter relatively than in *P. australiensis*), slender, cylindrical, and very hairy, bearing a few stout spines at its distal end (fig. 6). The tarsus is very short, armed with a few strong spines; the propodus (fig. 6) is about six times as long as the tarsus, moderately arched with three strong spines beneath its base, and numerous smaller ones beneath the rest of its extent; it bears a strong claw about three-fifths its length. (None of the spines on the legs are toothed like those of *P. australiensis.*) The four pairs of ambulatory legs are of about equal length.

The smooth spines on the false legs in this species are, I believe, peculiar among the Pallenidæ, and seem to indicate a transition to the Phoxichiliidæ.

Family.—EURYCYDIDÆ.

Genus.—ASCORHYNCHUS, Sars.

In a recent list of the genera of the Pycnogonida (7), Schimkewitsch states his opinion that this genus should be sunk in *Eurycyde*, Schiödte (*Zetes*, Kr.). Sars (6), however, points out that the absence of a distinct scape to the proboscis in *Ascorhynchus* and other structural characters require their separation.

Ascorhynchus tenuirostris, sp. nov.

(Pl. XXII. figs. 7–14).

Proboscis narrowly flask-shaped, two-thirds as long as the rest of the body, and reaching when folded beneath beyond the hinder edge of the second trunk segment. Oculiferous tubercle prominent, conical, and pointed. A dorsal spinous process at the junctions of the segments, and a prominent spine at the hinder end of the last trunk segment. A dorsal spine at the extremity of each lateral process. False legs with rows of denticulate spines (in male); ambulatory legs with a conical process at the extremity of the femur.

Length of the proboscis, 4 mm.; of the cephalic segment and trunk, 5 mm.; of the abdomen, 1 mm.; of a false leg, 6 mm.; of an ambulatory leg of the second pair 12·5 mm. One adult and three immature males of this species were taken by Professor Haddon.

This species differs from all the known species of the genus in the narrow shape of the proboscis which, after swelling out from its base, narrows for the distal half of its extent. The cephalic segment is more than one and a half times as long as a trunk-segment. It has distinct processes at the front end for the insertion of the chelifori, giving a bifid appearance. There are processes for the palpi below and in front of the oculiferous tubercle, directed outwards and forwards. The oculiferous tubercle carries well-developed eyes; it has a few fine spines at its extremity. The lateral processes are rather longer than the breadth of the body; there is a prominent spine on the extremity of each. The trunk segments are raised into sharp spinous processes at their junctions whence a few minute spines arise; there is a very prominent spine as high as the oculiferous tubercle at the hinder end of the trunk; a few minute spines also spring from it. The caudal segment is as long as a trunk segment, very slender, slightly enlarged at its rounded hinder end. The chelifori (Pl. xxii. fig. 10) are much reduced, the hand being a mere remnant without movable finger. The palpi are of the form usual in the genus; the third joint is slightly longer and slenderer than the fifth, which has a very long hair situated about the middle of its length; the sixth, eighth, ninth, and tenth joints are of about equal length, the seventh a little longer; all these five are furnished with fine spines and strong bristles. The false legs have the fourth and fifth joints of equal length, as long as the first three together; the fourth joint is thickened at its proximal, the fifth at its distal end; the sixth joint is three-fifths as long as the fourth, thickened, and armed with spines the seventh joint is two-thirds as long as the sixth; the eighth, ninth and tenth, rather more than half as long as the seventh (Pl. xxii. fig. 12); the last four joints are armed with denticulate spines (Pl. xxii. fig. 13) those on the seventh and eight joints in three irregular rows, those on the ninth and tenth in two rows, the spines in the two rows being in the same plane, and pointing away from each other; there is a small claw at the end of the tenth joint. The second pair of ambulatory legs is rather the longest. The second coxal joint is once and a half as long as the first or third, the femur is once and two-thirds as long as the coxal joints together; it is thickened, and has a conical distal process; the first tibial joint is thickened distally and nearly as long as the femur; the second tibial joint is slightly arched, slender, and as long as the femur, it has a short, stout, distal spine; the tarsus is about a fourth the length of the propodus, and has a short stout distal spine; the propodus is slender (fig. 44) slightly arched, bearing a small claw, and furnished beneath, with small spines, and above with hairs. The joints of the legs are sparingly furnished with fine spines, those on and around the conical process of the femur being the strongest.

This is the eighth species described as an *Ascorhynchus*, the type being *A. abyssi*, Sars, from the depths of the Arctic Ocean. Hoek described three species from the "Challenger": *A. glaber* from between the Cape of Good Hope and Kerguelen, *A. minutus* from the southern coast of Australia, and *A. orthorhynchus* from near the Admiralty Islands. Lately, Ortmann (5) has described *A. crytopygius*, *A. glabroides*, and *A. bicornis* from Japan. Hoek includes *Gnamptorhynchus ramipes*, Bohm, from Japan in this genus, and is inclined to think that *Barana Castelli*, Dohrn, from the Mediterranean should also belong to it. This last species agrees with *A. tenuirostris* in having conical processes on the femora, but its proboscis is much thicker than in our species, and the dorsal spines on the trunk-segments are between, not at, the junctions.

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EXPLANATION OF PLATE.

Fig. 1. *Parapallene Haddonii*, dorsal view of female, × 6.
Fig. 2. ,, ,, ventral view of cephalic segment of male, × 6.
Fig. 3. ,, ,, profile of oculiferous tubercle × 6.
Fig. 4. ,, ,, last joints of false leg of female (1 in. obj.).
Fig. 5. ,, ,, spines of false leg ($\frac{1}{6}$ in. obj.).
Fig. 6. ,, ,, tarsus and propodus of ambulatory leg (1 in. obj.).
Fig. 7. *Ascorhynchus tenuirostris*, dorsal view of male, × 8.
Fig. 8. ,, ,, profile of male, × 8.
Fig. 9. ,, ,, ventral view of hinder part of cephalic segment of male, showing false leg, × 8.
Fig. 10. ,, ,, cheliforus (1 in. obj.).
Fig. 11. ,, ,, palp, portion of fifth, and last five joints (1 in. obj.).
Fig. 12. ,, ,, false leg of male, last four joints (1 in. obj.).
Fig. 13. ,, ,, a denticulate spine ($\frac{1}{2}$ in. obj.).
Fig. 14. ,, ,, tarsus and propodus of ambulatory leg (1 in. obj.).

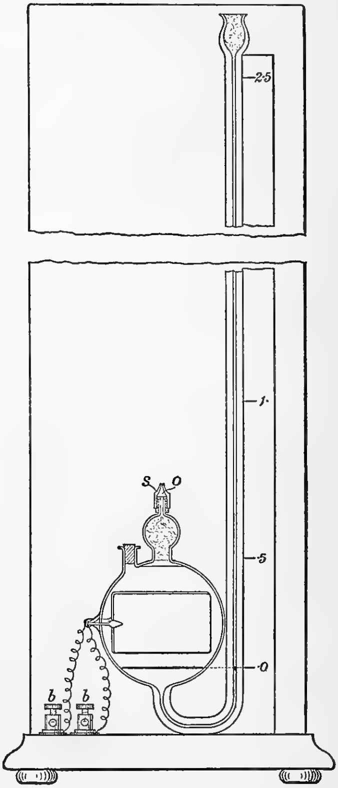
XLI.

ON A DIRECT READING ELECTROLYTIC AMPÈRE METER.

By J. JOLY, M.A., D.Sc., F.R.S.

[Read May 18, 1892.]

In the ordinary instruments for measuring current strength by means of chemical actions, the element of *time* constitutes necessarily one of the quantities observed. For the general method is to estimate from the mass or volume of the products of electrolysis the number of culombs which have traversed the circuit in an observed time, and from these data to calculate the mean current in ampères prevailing in the interval.



For many purposes this method is inconvenient, and has essentially remained a laboratory method, both on account of the time necessarily consumed in effecting a measurement, as well as from the care and pains necessary in order to obtain a correct estimation of the mass or volume of the liberated products of electrolysis. The method, too, affords a *mean* reading only of the current over a certain interval, and cannot follow and exhibit brief variations of current strength.

The instrument described in this note was devised by me several years ago in the hope of meeting those objections. Pressure of other work has, till the present, hindered me from trying it. It consists (see fig.) of a spherical glass bulb, as made, about

6 cms. in diameter. This communicates below with a tube, bent twice at right angles, and brought up to a height of about 50 cm. above the level of the bulb. This tube is open at top—only loosely plugged with cotton wool to keep out dust. In the bulb are two platinum electrodes of large area (each $2\frac{1}{2} \times 4$ cms.), and set with their plane surfaces vertical and about 2 millimetres apart. These communicate with the binding screw *b*, *b* by platinum leads fused in the glass. At the upper surface of the bulb are two openings. The one a small tubulure stoppered by a sound tight-fitting cork (a ground-stopper would probably be preferable), the other a tubulure, over which is sealed by strong turner's-cement a metal cap having a plane surface above, and perforated by an orifice about 2 mms. in diam.) at *o*. Below this metal cap there is a widening in the glass tubulure which is filled with cotton wool before the cap is cemented in position. Over the ground surface of the cap a second cap *s* can be screwed. This is open at top. A small disk of platinum foil, rather less in diameter than the ground surface of the cap, is perforated by a very small puncture, and then cemented down over the orifice *o*. To effect the puncture a very fine steel needle is used, the platinum disk being placed upon a smooth sheet of ebonite or even glass. As will be seen, the size of the perforation regulates the degree of sensitiveness of the instrument. When the disk is cemented above the orifice *o*, the cover *s* is screwed on, a little loose wool being inserted in its opening, to protect the perforated plate from dust.

The second tubulure now serves to admit some clean mercury which is poured in till it rises well into the bulb. On top of this, water, mixed with about 15 per cent. by volume of sulphuric acid, is poured till the bulb is almost filled. The cork is then tightly inserted, and the instrument is ready for calibration.

What will be the effect of passing a current of given strength through the instrument? Suppose a current of one ampère. The volume of gas given off per second by this current is 0·1734 cubic cms. if measured at 0° C. and 760 mms. pressure. But this quantity of gas cannot escape through the orifice in the platinum plate in one second, except the pressure upon the gas is increased. It therefore rapidly accumulates in the bulb, increasing in pressure, and driving the mercury up the vertical index-tube communicating with the bulb. This goes on till the increase of the gas has generated such a pressure in the bulb that the quantity escaping through the orifice is 0·1734 c. cs. per second. The column of mercury then comes to rest. In the case of the instrument upon the table, it takes 20 or 30 seconds for this state of rest to be attained. And the mercury column now stands at some 14 cms. above the zero, where the reading on the vertical scale is 1·0 ampère. When reading as high as 2 ampères, a somewhat longer time is needed before the final reading is attained. This appears to be due to temperature changes going on in the bulb, and suggests that heavy currents should not be run through so small an instrument. Of course, if the current is now varied, the mercury column takes up a new level. Thus when a resistance in the circuit is diminished the column rises quickly; when it is increased, it falls quickly, and takes its stand at a new level. The reason is obvious. The rate of evolution of the mixed gases is different with each current, and the position of the mercury column is peculiar to each rate of evolution, being such that in each case the pressure produced by it is just able to drive the evolved gas through the orifice at the same rate at which it is being evolved.

To construct the scale of the galvanometer it is only necessary to place it in circuit with a galvanometer reading ampères reliably, and passing a number of different currents, c_1, c_2, c_3, . . . through the circuit, to mark upon the scale the points to which the mercury rises in the tube. Subsequently we measure the height of these points above the normal level of the mercury, and plot these upon divided paper against the currents. The result is a curve upon which readings of level for any intermediate current strengths may be interpolated. The scale is thus marked out in ampères and tenths of ampères, or closer. It will be found that the scale opens out in its upper readings, the equation $\frac{c^2}{h} = k$, approximately describing the curve. As c is proportional to the velocity of efflux of the gas at any reading of h centimetres of mercury upon the scale, this approximates to the usual law of the efflux of liquid from an orifice under the head or pressure h.

The instrument upon the table was constructed for purposes of trial and experiment. It has, however, worked very satisfactorily. So little gas is used in obtaining a reading that the consumption of the electrolyte is very slow. It is made good by the addition of a little water now and again.

If heavy currents are to be run through the instrument, it will be essential to make the electrodes large. Otherwise there is considerable evolution of ozone. In this connexion the use of phosphoric acid in place of sulphuric acid might be worth trying. The evolution of ozone is objectionable, in that it diminishes the volume of the issuing gas.

It is very essential that water-dust be kept from clogging up the orifice. The chamber beneath the orifice filled with cotton wool should not be too small. It might be well to place the orifice at the extremity of a long fine tube twisted into a spiral of several turns, or other means devised to trap water-dust; for observation shows that if the orifice gets wet the readings become too high, falling again when the orifice is touched with bibulous paper.

None of these points which I have noticed in my experience of the instruments need, I think, stand in the way of its application to many purposes. It possesses the merit of not depending upon the constancy of magnets. It might be cheaply and strongly constructed, and may, of course, be protected from the risks of currents too heavy for it by a fusible cut-out. By lessening the size of the orifice great sensitiveness may be imparted to the instrument, or the same end attained by replacing the mercury by a liquid of less density. Again we are not confined to the use of a single orifice. Two or more may be provided communicating by taps or screw-valves with the interior of the bulb. Each of these orifices may correspond to separate values upon the scale so as to extend it to any desirable degree. Promptness is attained by using an index-tube of fine bore, and leaving but little free space above the electrolyte.

Experiments upon possible variations of the readings with temperature are desirable. Atmospheric changes of temperature will probably entail only small errors in the scale readings.

I regret that I am unable to give results bearing upon these points here; but perhaps some reader of these remarks may consider the invention to be of sufficient promise to induce him to go more fully into its merits and demerits, and assign more definitely its value as a means of measurement.

XLII.

ON A SPECULATION AS TO A PRE-MATERIAL CONDITION OF THE UNIVERSE. By J. JOLY, M.A., D.Sc., F.R.S.

[Read February 17, 1892.]

> "For lack of power to solve the question troubles the mind with doubts, whether there was ever a birth-time of the world and whether likewise there is to be any end."—Lucretius, *De Rerum Natura.*

> "Then the angel threw up his glorious hands to the heaven of heavens, saying, 'End is there none to the Universe of God? Lo! also there is no beginning.'"—Richter, *The Dream of the Universe.*

In the material universe we find presented to our senses a physical development continually progressing, extending to all, even the most minute, material configurations. Some fundamental distinctions existing between this development as apparent in the organic and the inorganic systems of the present day I have already ventured to point out.[1] In the present note, these systems as having a common origin and common ending, are merged in the same consideration as to the nature of the origin of material systems in general. In short this present note is occupied by the consideration of the necessity of limiting material interactions in past time; the speculation originating in the difficulty of ascribing to these interactions infinite duration in the past. These difficulties first claim our consideration.

Accepting the Kantian hypothesis in its widest extension, we are referred to a primitive condition of wide material diffusion, and necessarily too of material instability. The hypothesis is, in fact, based upon material instability. We may pursue the sequence of events assumed in this hypothesis into the future, and into the past.

In the future we find finality to progress clearly indicated.

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[1] *The Abundance of Life.* These Proceedings.

The hypothesis points to a time when there will be no more progressive change but a mere sequence of unfruitful events, such as the eternal uniform motion in reference to the ether around it of a mass of matter no longer gaining or losing heat: to an ether possessed of a uniform distribution of energy in all its parts; a uniform distribution, of unceasing but unfruitful interactions, wherein the material aggregations, if not all one, yet in perfect equilibrium or sundered by infinity, move as unceasing and unchanging waves of unfruitful energy. Or, again, if the ether absorb the energy of material motion, these vast and dark aggregations eternally poised and at rest within it. This is, physically, a thinkable future. Our minds suggest no change, and demand none. More than this, change is unthinkable according to our present ideas of energy.

This finality *a parte post* is instructive. Abstract considerations, based on geometrical or analytical illustrations, question the finiteness of some physical developments. Thus our sun may require eternal time to attain the temperature of the ether around it, the approach to this condition being assumed to be asymptotic in character. But consider the legitimate *reductio ad absurdum* of an ember raked from a fire 1000 years ago. Is it not yet cooled down to the constant temperature of its surroundings? But we may evidently increase the time a million-fold if we please. It appears to me that we must regard eternity as outliving every progressive change. For there is no convergence or enfeeblement of time. The ever-flowing present moves no differently for the occurrence of the mightiest or the most insignificant events. And even if we say that time is only the attendant upon events, yet this attendant waits patiently for the end, however long deferred.

Does the essentially material hypothesis of Kant and Laplace account for an infinite past as thinkably as it accounts for the infinite future? As this hypothesis is based upon material instability the question resolves itself into this:—Is the assumption of an infinitely prolonged past instability a probable or possible account of the past? There are, it appears to me, great difficulties involved in accepting the hypothesis of infinitely prolonged material instability. I will refer here to three principal objections. The first may be called a metaphysical objection; the second is partly metaphysical and partly physical, the third may be considered a physical objection, as it is involved directly in the phenomena presented by our universe.

The metaphysical objection must have presented itself to everyone who has considered the question. It may be put thus:—If present events are merely one stage in an infinite progress, why is not the present stage long ago passed over? We are evidently at liberty to push back any stage of progress to as remote a period as we like by putting back first the one before this and next the stage preceding this, and so on, for, by hypothesis, there is no beginning to the progress.

Thus, the sum of passing events constituting the present universe should long ago have been accomplished and passed away. If we consider alternative hypotheses not involving this difficulty, we are at once struck by the fact that the future of material development is free of the objection. For the eternity of unprogressive events involved in the future of Kant's hypothesis, is not only thinkable, but any change is, as observed, irreconcilable with our ideas of energy. As in the future so in the past we look to a cessation to progress. But as we believe the activity of the present universe must in some form have existed all along, the only refuge in the past is to imagine an active but unprogressive eternity, the unprogressive activity at some period becoming a progressive activity—that progressive activity of which we are spectators. To the unprogressive activity there was no beginning; in fact, beginning is as unthinkable and uncalled for to the unprogressive activity of the past as ending is to the unprogressive activity of the future, when all developmental actions shall have ceased. There is no beginning or ending to the activity of the universe. There is beginning and ending to present progressive activity. Looking through the realm of nature we seek beginning and ending, but "passing through nature to eternity" we find neither. Both are justified; the materialistic question of the ancient poet, the transcendental answer of the modern quoted at the head of this Paper.

The next objection, which is in part metaphysical, is founded on the difficulty of ascribing any ultimate reality or potency to forces diminishing through eternal time. Thus, against the assumption that our universe is the result of aggregations progressing over eternal time, which involves the primitive infinite separation of the particles, we may ask, what force can have acted between particles sundered by infinite distance? The gravitational force falling off as the square of the distance, must vanish at infinity if we mean what we say when we ascribe infinite separation to them. Their condition is then one of neutral stability, a finite movement of the particles neither increasing nor diminishing interaction. They had then remained eternally in their separated condition, there being no cause to render such condition finite. The difficulty involved here appears to me of the same nature as the difficulty of ascribing any residual heat to the sun after eternal time has elapsed. In both cases we are bound to prolong the time, from our very idea of time, till progress is no more, when in the one case we can imagine no mutual approximation of the particles, in the other no further cooling of the body. However, I will not dwell further upon this objection, as it does not, I believe, present itself with equal force to every mind. A reason less open to dispute, as being less subjective, against the aggregation of infinitely remote particles as the origin of our universe, is contained in the "physical" objection.

In this objection we consider that the appearance presented by our universe negatives the hypothesis of infinitely prolonged aggregation. We base this negation upon the appearance of simultaneity presented by our universe, contending that this simultaneity is contrary to what we would expect to find in the case of particles gathered from infinitely remote distances. Whether these particles were endowed with relative motions or not is unimportant to the consideration. In what respects do the phenomena of our universe present the appearance of simultaneous phenomena? We must remember that the suns in space are as fires which brighten only for a moment and are then extinguished. It is in this sense we must regard the longest burning of the stars. Whether just lit or just expiring counts little in eternity. The light and heat of the star is being absorbed by the ether of space as effectually and rapidly as the ocean swallows the ripple from the wings of an expiring insect. Sir William Herschel says of the galaxy of the milky way:—"We do not know the rate of progress of this mysterious chronometer, but it is nevertheless certain that it cannot last for ever, and its past duration cannot be infinite." We do not know, indeed, the rate of progress of the chronometer, but if the dial be one divided into eternal durations the consummation of any finite physical change represents such a movement of the hand as is accomplished in a single vibration of the balance wheel.

Hence we must regard the hosts of glittering stars as a conflagration that has been simultaneously lighted up in the heavens. The enormous (to our ideas) thermal energy of the stars resembles the scintillation of iron dust in a jar of oxygen when a pinch of the dust is thrown in. Although some particles be burnt up before others become alight, and some linger yet a little longer than the others, in our day's work the scintillation of the iron dust is the work of a single instant, and so in the long night of eternity the scintillation of the mightiest suns of space is over in a moment. A little longer, indeed, in duration than the life which stirs a moment in response to the diffusion of the energy, but only very little. So must an Eternal Being regard the scintillation of the stars and the periodic vibration of life in our geological time and the most enduring efforts of thought. The latter indeed no more lasting than

> "——the labour of ants
> In the light of a million million of suns."

But the myriad suns themselves, with their generations, as the momentary gleam of a light for ever after extinguished.

Again, science suggests that the present process of aggregation is not finished, and possibly will only be when it is become universal. Hence the very distribution of the stars, as we observe them, as isolated aggregations, indicates a development which in the infinite duration must be regarded as equally advanced in all parts of stellar space and essentially a simultaneous phenomenon. For were we spectators of a system in which any very great difference of age prevailed, this very great difference would be attended by some such appearance as the following:—

The appearance of but one star, other generations being long extinct or no others yet come into being; or, perhaps, a faint nebulous wreath of aggregating matter somewhere solitary in the heavens; or no sign of matter beyond our system, either because ungathered or long passed away into darkness.

Some such appearances were to be expected had the aggregation of matter depended solely on chance encounters of particles scattered through infinite space. For as, by hypothesis, the aggregation occupies an infinite time in consummation it is nearly a certainty that each particle encountered after immeasureable time, and then for the first time endowed with actual gravitational potential energy, would have long expended this energy before another particle was gathered. But the fact that so many fires which we know to be of brief duration are scattered through a region of space, and the fact of a configuration which we believe to be a transitory one, suggest their simultaneous aggregation here and there. And in the nebulous wreaths situated amidst the stars there is evidence that these actually originated where they now are, for in such no relative motion, I believe, has as yet been detected by the spectroscope. All this, too, is in keeping with the nebular hypothesis of Kant and Laplace so long as this does not assume a primitive infinite dispersion of matter, but the gathering of matter from finite distances first into nebulous patches which aggregating with each other have given rise to our system of stars. But if we extend this hypothesis throughout an infinite past by the supposition of aggregation of infinitely remote particles we replace the simultaneous approach needed to account for the simultaneous phenomena visible in the heavens, by a succession of aggregative events, by hypothesis at intervals of nearly infinite duration, when the events of the universe had consisted of fitful gleams lighted after eternities of time and extinguished for yet other eternities.

Finally, if we seek to replace the eternal instability involved in Kant's hypothesis when extended over an infinite past, by any hypothesis of material stability, we at once find ourselves in the difficulty that from the known properties of matter such stability must have been permanent if ever existent, which is contrary to fact. Thus the kinetic inertia expressed in Newton's first law of motion might well be supposed to secure equilibrium with material attraction, but if primevally diffused matter had ever thus been held in equilibrium it must have remained so, or it was maintained so imperfectly, which brings us back to endless evolution. Again, a primitive infinite and stable diffusion had either remained so, or supposing chance to have led to its dissolution, the subsequent gradual evolution had been at variance with the simultaneity of our universe.

On these grounds I contend that the present gravitational properties of matter cannot be supposed as having acted for all past duration. Universal equilibrium of gravitating particles had been indestructible by internal causes. This our knowledge of matter surely tells us. Perpetual instability or evolution is alike unthinkable and contrary to the phenomena of the universe of which we are cognisant. We therefore turn from gravitating matter as affording no rational account of the past. We do so of necessity, however much we feel our ignorance of the nature of the unknown actions to which we have recourse.

A prematerial condition of the universe was, we assume, a condition in which uniformity as regards the average distribution of energy in space prevailed, but heterogeneity and instability were *possible*. The realization of that possibility was the beginning we seek, and we to-day are witnesses of the train of events involved in the breakdown of an eternal past equilibrium. We are witnesses on this hypothesis, of a catastrophe possibly confined to certain regions of space, but which is, to the motions and configurations concerned, absolutely unique, reversible to its former condition of potential by no process of which we can have any conception.

We may illustrate such a hypothesis of prematerial equilibrium and its breakdown by the phenomena of suffusion, or supersaturation. We observe that many salts, such as acetate of soda, melted and allowed to cool may preserve their fluidity indefinitely long. But unexpectedly, on the other hand, seemingly from no external cause, a change occurs at some point within the liquid. Once this change begins a very brief period suffices to carry the change throughout the mass, and in a few moments the liquid is a crystalline solid. We put our hand now on the containing vessel, and find that the whole has grown hot.

Now we know that all this heat energy, and a great deal more, was contained all along in the clear liquid, and this involves molecular agitation. In the clear liquid, therefore, there was all along unceasing motion, but yet no change. Our days may lengthen into thousands of years, and these again into infinite time, and yet there may be no change. But we may suppose the particular configuration at one moment in eternity is attained, and then all is change, accelerated progress, conflagrations of molecular motions, radiation growing feebler each moment, and finally a lower kinetic condition, and another cycle of equilibrium. We may, indeed, affirm that higher equilibrium than the liquid (a state of gaseous supersaturation) is possible, or a metamorphic change possible yet to the solid. We may even go further and push the equilibrium of the gas back to that of the prematerial motions we are considering, or carry the equilibrium of the solid through descending stages till an absolute deprivation of heat renders further change impossible, or determines yet another departure of matter from its present laws. We may picture any such series of changes, but at each stage of equilibrium we find that pause which need not be finite in duration, and between the stages the hurrying change of evolution.

Our speculation is that we, as spectators of evolution, are witnessing the interaction of forces which have not always been acting. A prematerial state of the universe was one of unfruitful motions, that is, motions unattended by progressing changes, in our region of the ether. How extended we cannot say; the nature of the motions we know not; but they differed from matter in the one important particular of not possessing gravitational attraction. Such kinetic configurations we cannot consider to be matter. It was *possible* to construct matter by their summation or linkage as the configuration of the crystal is possible in the clear supersaturated liquid.

Duration in an ether filled with such motions would pass in a succession of mere unfruitful events; as duration, we may imagine, even now passes in parts of the ether similar to our own. An endless (it may be) succession of unprogressive, fruitless events. But at one moment in the infinite duration the requisite configuration of the elementary motions is attained; solely by the one chance disposition the stability of all must go, spreading from the fateful point, as the crystal advances, building its chambers from the irregular configurations of the liquid.

Possibly the material segregation was confined to one part of space, the elementary motions condensing upon transformation, and so impoverishing the ether around till the action ceased. Again in the same sense as the stars are simultaneous, so also they may be regarded as uniform in size, for the difference in magnitude might have been anything we please to imagine; if at the same time we ascribe sufficient distance sundering great and small. So, too, will the highly dilute acetate of soda build a crystal at one point, and the impoverishment of the medium checking the growth in this region, another centre will begin at the furthest extremities of the first crystal till the liquid is filled with loose feathery aggregations comparable in size with one another. In a similar way the crystallizing out of matter may have given rise, not to a uniform nebula in space, but to detached nebulæ, approximately of equal mass, from which ultimately were formed the stars.

That an all-knowing Being might have foretold the ultimate event at any preceding period by observing the motions of the parts then occurring, and reasoning as to the train of consequences arising from these motions, is supposable. But considerations arising from this involve no difficulty in ascribing to this pre-material train of events infinite duration. For progress there is none, and we can quite as easily conceive of some part of space where the same Infinite Intelligence, contemplating a similar train of unfruitful motions, finds that at *no* time in the future will the equilibrium be disturbed. But where evolution is progressing this is no longer conceivable, as being contradictory to the very idea of progressive development. In this case Infinite Intelligence necessarily finds, as the result of his contemplation, the aggregation of matter, and the consequences arising therefrom.

The negation of so primary a material property as gravitation to these primitive motions of (or in) the ether, probably involves the negation of many properties we find associated with matter. Possibly the quality of inertia, equally primary, is involved with that of gravitation, and we may suppose that these two properties so intimately associated in determining the motions of bodies in space were conferred upon the primitive motions as crystallographic attraction and rigidity appear to our observation as first conferred upon the solid growing from the supersaturated liquid. But in some degree less speculative is the supposition that the new order of motions involved the transformation of much energy into the form of heat vibrations; so that the newly generated matter, like the newly formed crystal, began its existence with a large supply of thermal energy. We may consider that we here supply the want of the chemist, who has sought a high primitive temperature to account for a primitive disassociation of the elements, and compelled to refer to a nebular stage of the solar system before the vast stores of heat involved in the gravitational condensation of matter were liberated, finds himself in the difficulty of not being able to imagine any source whence the vast stores of heat originated. And, again, we recall how the physicist finds his estimate of the energy involved in mere gravitational aggregation inadequate to afford explanation of past solar heat. It is supposable, on such a hypothesis as we have been dwelling on, that the entire subsequent gravitational condensation and conversion of material potential energy, dating from the first formation of matter to the stage of star formation, may be insignificant in amount compared with the conversion of etherial energy attending the crystallizing out of matter from the primitive motions. And thus possibly the conditions then obtaining involved a progressively increasing complexity of material structure, the genesis of the elements, from an infra-hydrogen possessing the simplest material configuration, resulting ultimately in such self-luminous nebulæ as we yet see in the heavens.

The late Mr. James Croll, in his *Stellar Evolution*, finds objections to an eternal evolution, one of which is similar to the "metaphysical" objection urged in this paper. His way out of the difficulty is in the speculation that our stellar system originated by the collision of two masses endowed with relative motion, eternal in past duration, their meeting ushering in the dawn of evolution. I am not sure if the state of aggregation assumed here, although possibly quite stable, does not, from the known laws of matter and from analogy, call for explanation as probably the result of prior diffusion, when, of course, the difficulty is only put back, not set at rest. Nor do I think the primitive collision in harmony with the number of relatively stationary nebulæ visible in space.

The metaphysical objection is, I find, also urged by the Rev. Dr. Salmon, Provost of Trinity College, in favour of the creation of the universe.—(*Sermons on Agnosticism.*)

The faith of Professor Winchell, quoted by Mr. Croll, must be added as in many respects similar to the (independent) speculations contained in the foregoing:—" We have not the slightest scientific grounds for assuming that matter existed in a certain condition from all eternity. The essential activity of the powers ascribed to it forbids the thought; for all that we know, and, indeed, as the *conclusion* from all that we know, primal matter began its progressive changes on the morning of its existence."

Finally, in reference to the hypothesis of a unique determination of matter after eternal duration in the past, it may not be out of place to remind the reader of the extreme complexity which modern research ascribes to the simplest chemical atoms.

XLIII.

PRELIMINARY NOTE ON THE WALKING OF SOME OF THE ARTHROPODA. By H. H. DIXON.

[COMMUNICATED BY J. JOLY, M.A., D.SC., F.R.S.]

[Read MAY 18, 1892.]

SOME two years ago I commenced observing the walk of some insects by means of instantaneous photography; since then I have observed several flies, an earwig, a pond-skater, a cockroach, various beetles, an aphis, *Thysanura*, caterpillars, a larva of a beetle, several spiders and scorpions. In these observations I used a quarter-plate camera with instantaneous shutter, set looking vertically down on the animal, which walked on a horizontal white ground. I found it necessary to take these photographs in sunlight in order that the shadows cast by the legs might show if these were in contact with the ground or not. In some cases where the animal experimented on showed a tendency to run into the corners of the box which was used to confine it, I found it a good plan to place the creature on a sheet of white paper floating in a shallow dish of water, thus confining it without casting any shadow on the space in which it moved.

In all the adult Arthropoda which I have examined (except the *Thysanura*), I find that almost simultaneous motion of the "diagonals" is the rule; that is, the Hexapods move the first and third leg on one side with the second leg on the other, while the Arachnida move the first and third on one side with the second and fourth on the other.

However, this apparently simultaneous motion is shown by instantaneous photography not to be absolutely synchronous; thus in the blow-flies photographed the most posterior leg of the set of diagonals, which seems to move together, really is raised from the ground before the front leg of the set. This progression of the motion forwards to the anterior end of the body was also found in one spider (*Tegenaria Derhamii*), though in this case the motion on some occasions appears to commence with one of the middle legs, and one photograph of another specimen showed the two extreme legs moved first. In another spider (*Tarantula pulverulenta*), the house fly, and cockroach, the wave of motion started in the front and travelled back along the diagonals. This wave did not in any case pass continuously from one set of diagonals to the other; but there was always a much longer interval between the moments of raising the first leg of one set of diagonals and the putting down the last leg of the other set, than there was between the moments of raising two successive legs in one set of diagonals, which is the same as saying that there is a short pause between the completion of the motion of each diagonal wave before commencing the next. It is worth observing that the rule of the diagonals seems also to apply to the antennæ and maxillary palps of the cockroach and earwig, for the antenna is twitched simultaneously with the front leg of the same side. I have not yet determined how the palps of the spider move when it runs. In some cases, certainly, both when moving and standing, it uses them as legs; for example, when struggling up a steep place and when it comes to a sudden stop after a quick run. In this last case it often raises its anterior legs aloft and waves them in the air in a manner reminding one of a beetle's antennæ, while it seems to support the weight of the forepart of its body on its palps.

In *Phrynus reniformis* we find that the two anterior legs are structurally modified so as to have almost completely the form of antennæ. Thus we may assume, as Professor Haddon has suggested to me, that the legs from first being used as tactile organs (as in *Tegenaria*) have gradually come to have the form of almost typical antennæ as we find them in *Phrynus*. In some midges, a similar use is made of the first pair of legs, which, when the animal is at rest, are held high in the air while it stands on the two posterior pair of walking legs. Similarly when walking it barely taps the ground in front of the body with the first pair of legs, while it uses the remaining two pairs in the usual diagonal manner. And when tapping the ground the front legs are moved according to the rule of the diagonals. The aphis and several small flies exhibited besides the diagonal walk several irregular walks, sometimes moving all the legs on one side, beginning with the first or third before moving those of the other side.

The diagonal walk, Mr. Muybridge has shown to apply, with but a single exception, to all mammalia; it is observable too in newts, lizards, and tortoises, and, as stated above, it is the general rule in the case of the *Arachnida* and *Insecta.* It does not, however, appear to hold universally; thus in the case of the single representative of the group *Thysanura* (*Tomocerus longicornus*) which I have examined, the opposite legs are often moved simultaneously, in pairs, especially when the sucker placed on the abdomen is brought into play. This mode of locomotion is also found as the rule in caterpillars, and less often in a coleopterous larva which I have observed. It is peculiarly interesting that these larval forms present the same method of progression as the *Thysanura*, which are regarded as having preserved most completely the primitive character of the oldest insects.

In the caterpillars the wave begins with the two most posterior false legs and proceeds forwards. This wave when it reaches the middle of the body gives rise to the characteristic attitude of the "Loopers."

Besides the photographs looking vertically down on the animals, I have also taken a few side views or profiles, which, though not so useful for making out the walk, show some interesting attitudes, *e. g.* when lifting the back legs the spider first raises the most distal part of the leg which touches the ground and then the more proximal part; and similarly in putting down the legs it is the extremity of the leg which reaches the ground first.

Often, when the *Tarantula* was put on the floating paper, after some hesitation it took to the water, and succeeded admirably in making way on its surface. When in this position, the tips of its legs, and sometimes its palps and lower surface of abdomen, made capillary depressions in the surface of the water. These conical depressions converted the water into a diffusing lens, and consequently produced a dark spot on the bottom of the dish, surrounded with a bright ring, which corresponded in size to the depressions on the surface. As the diameter of the depressions depends upon the weight on the point which causes them, and as the shadows are a measure of the depressions, it follows that the ratio of the diameters of the shadows will give us the relative weights on the legs, &c.; and then by weighing the spider we can get the absolute weight on each leg. The diameters of the shadows are easily measured on several of my photographs. In many cases, however, it is to be observed that the spider does not walk normally on the water.

The photographs of the *Tegenaria Derhamii* were taken with an exposure of $\frac{1}{80}$th of a second; therefore we may conclude—

(1). That the wave takes longer than the $\frac{1}{80}$th of a second to traverse one set of diagonals; for within the time of exposure seldom more than two legs, and never more than three, have been raised.

(2). The motion of one leg is not completed within the $\frac{1}{80}$th of a second, for the complete stroke is never shown in a photograph.

In these observations the mean rate of advance of the body, which was found by measuring the blur in the photograph, was 3 inches per second or somewhat less.

Further, by measuring on the photographs of running spiders the width of the blur at the extremity of the leg, its linear velocity at the extremity is found to be about 6 inches per second.

In the case of the cockroach the exposure was $\frac{1}{40}$th of a second, therefore—

1. There was usually more than $\frac{1}{40}$th of a second's lag between the raising of the last leg and first leg of one set of diagonals; for we often find the first and second legs coming to the end of their stroke before the third leg of that set of diagonals is raised.

2. The stroke of one leg is sometimes nearly accomplished in $\frac{1}{40}$th of a second.

The mean rate of advance of the cockroach measured on photographs was 2·2 inches per second, and the mean linear velocity of the extremity of the waving antennæ 7 inches per second. The mean linear velocity of the extremities of the middle legs was 2·7 inches per second. To deduce the angular velocity from the absolute velocity of the extremity of the leg we must take into account, of course, the velocity of body and length of the leg.

In addition to Professor Haddon and Dr. Wright, I am also indebted to Mr. Carpenter, who has kindly named specimens for me.

I intend extending these observations, with improved photographic apparatus, to as many of the groups of the Arthropoda as I can obtain living specimens of. I am in hopes of obtaining more accurate and interesting results by means of a photographic apparatus which will give several successive pictures of the same individual, with a very short interval of time between each.

SCIENTIFIC PUBLICATIONS

OF THE

ROYAL DUBLIN SOCIETY.

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CONTENTS OF VOLUME II. (NEW SERIES).

CONTENTS OF VOLUME III. (New Series).

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4.—A New Determination of the Latitude of Dunsink Observatory. By Arthur A. Rambaut. (March, 1889.)

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13.—Reports on the Zoological Collections made in Torres Straits by Prof. A. C. Haddon, 1888–1889. Actiniæ: I. Zoantheæ. By Professor Alfred C. Haddon, M.A. (Cantab.), M.R.I.A., Professor of Zoology, Royal College of Science, Dublin; and Miss Alice M. Shackleton, B.A. Plates LXI., LXII., LXIII., LXIV. (January, 1892.)

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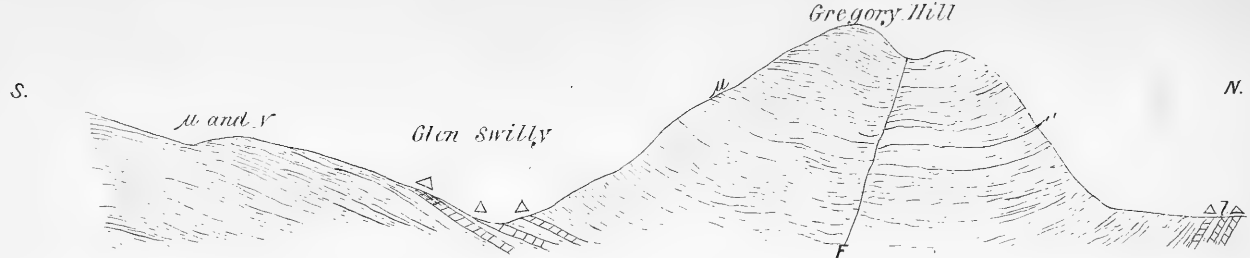
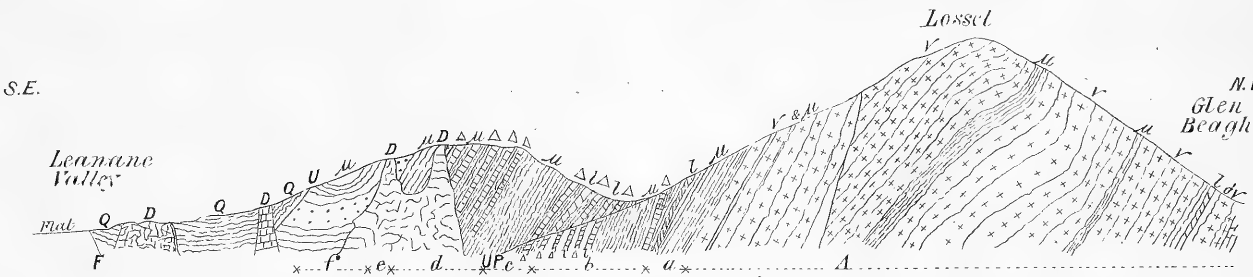
Part 3.—Pages 127 to 220. (March, 1892.)
Part 4.—Pages 221 to 483. (June, 1892.)
Part 5.—Pages 484 to 587. (October, 1892.) [*With title-page and Contents to Volume VII.*]



Gregory Hill Series.



Later Period Rocks × Gartan Schist Series × Gneiss and Foliated Granite.

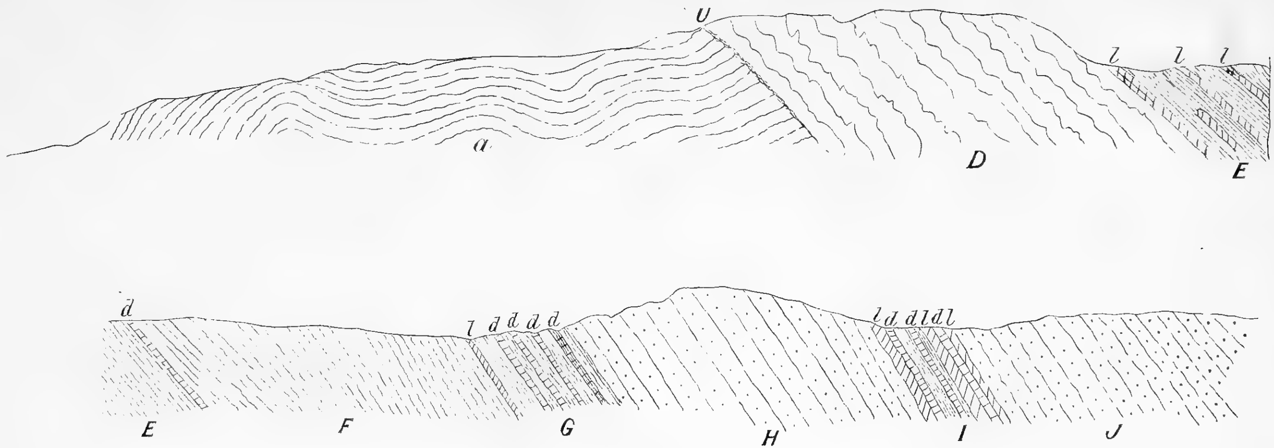
SECTION FROM GLEN SWILLY, TO GLEN BEAGH.

ν. Gneiss. μ. Schist. l. Limestone. Δ. Hornblendite. D. Whinstone. Q. Quartzite
δ. Gneissose-Quartzite. U. Unconformability. F. Fault. U.P. Upthrust.

Vertical Scale 6 Miles to 1 Inch. Horizontal Scale 1 Inch to 1 Mile.

GENERAL SECTION OF THE DONEGAL SCHISTOSE AND GNEISSOSE ROCKS.

Forster & Co. Lith. Dublin.



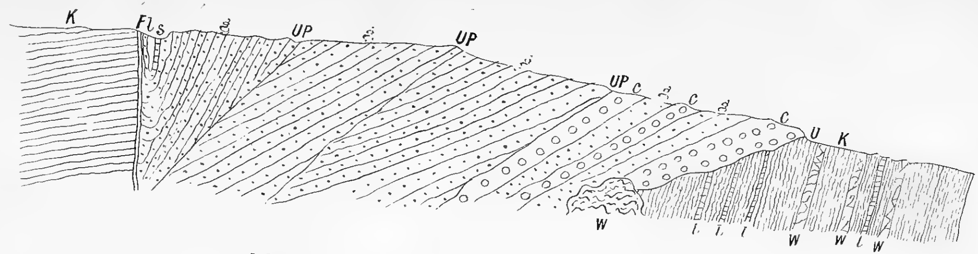
DIAGRAMMATIC SECTION (INISHOWEN) OF THE LATER PERIOD ROCKS.
SHOWING THE GROUPS AND THEIR RELATIONS TO THE OLDER PERIOD ROCKS.

Reference
Older Period Rocks. a. (Kilmacrenans.)
Later Period Rocks. D Great Quartzite. E. Cranford Series.
Sericites and Limestones) F. Schist Series. G. Killygarvan
Volcanic Series. H. Killygarvan Grit Series. I Lubber Volcanic.
Limestone Series. J Barnhill Series. U Unconformability.
d. Whinstone. l. Limestone.

Forster & Co. Lith. Dublin

S.E.   N.W.

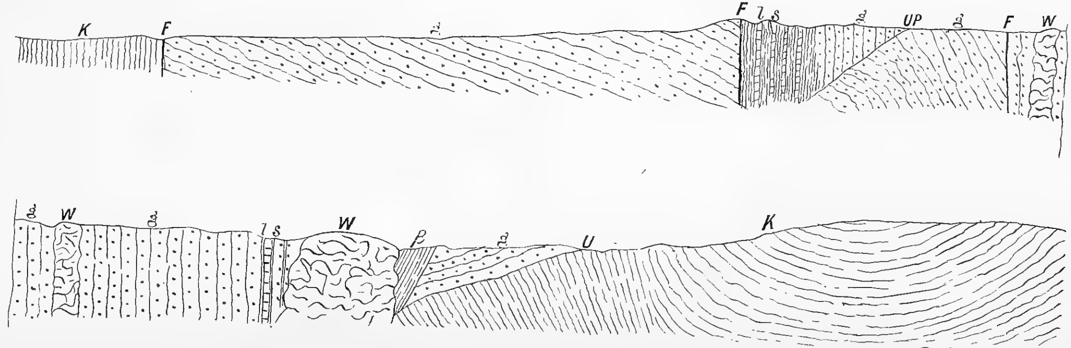
FIG. I.



KNOCKANTEENBEG SECTION.

S.E.

FIG. 2.



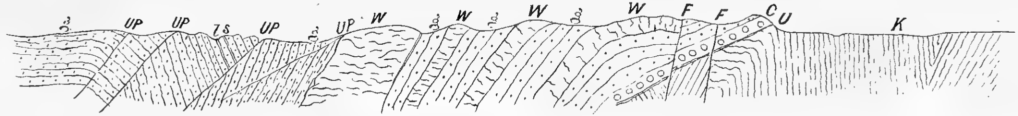
TREANTAGH SECTION.

Scale 6 Inches to 1 Mile.

Forster & Co. Lith. Dublin.

S.E. N.W.

FIG. 1



DOON ROCK SECTION.

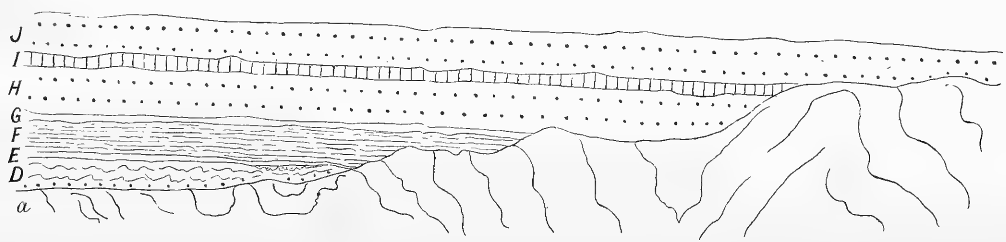
FIG. 2.

Scale 6 Inches to 1 Mile

KILMACRENAN SECTION.

N S

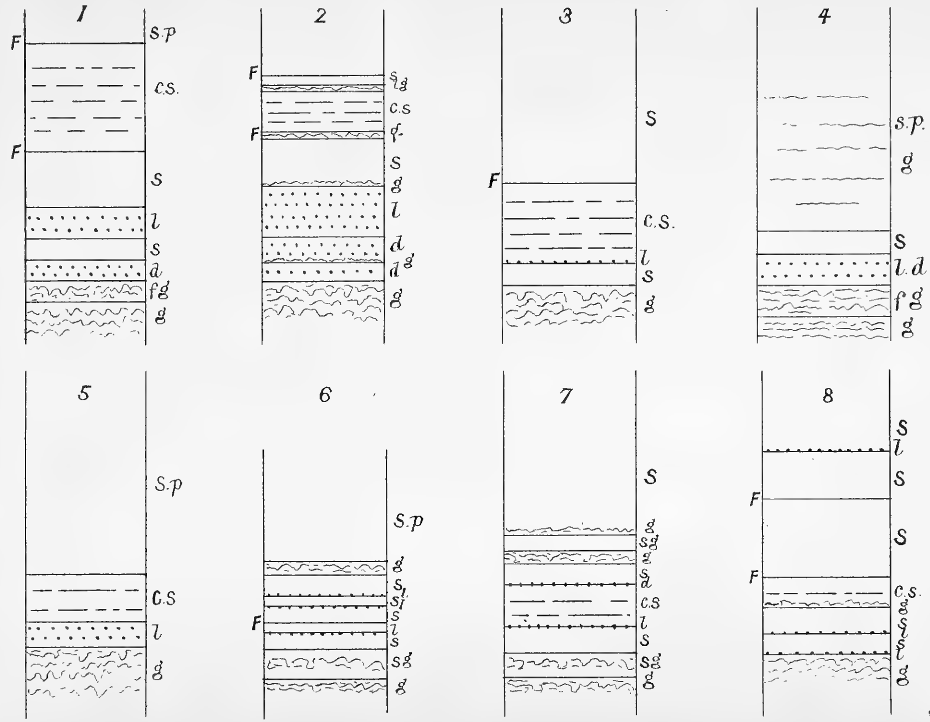
FIG. 3.



DIAGRAMMATIC SECTION.

Forster & Co. Lith. Dublin

Vertical Sections — Cranford Sericyte Series.



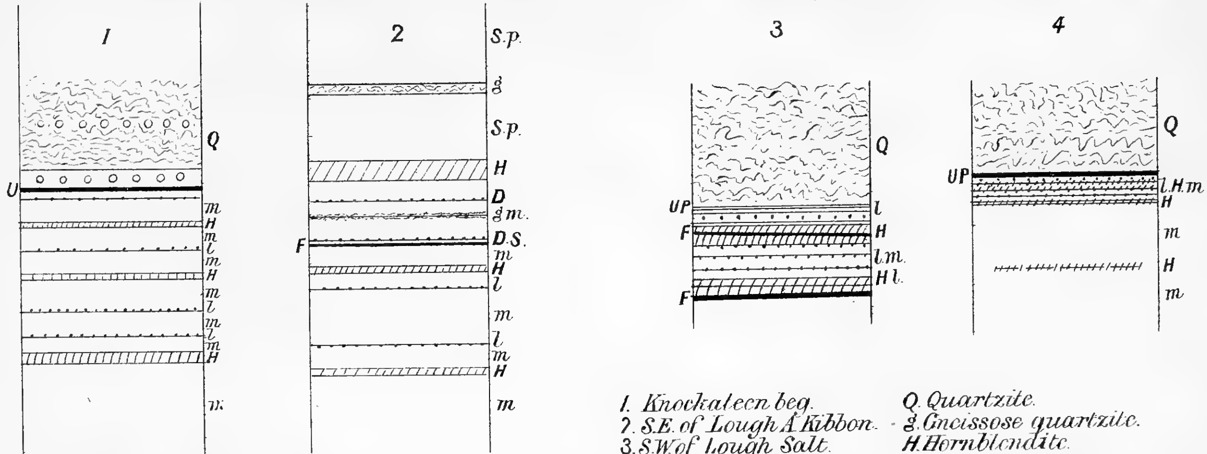
1. Cranford.
2. 1 Mile S.W. of No. 1.
3. Crallagh S.W. of No. 2.
4. Golam S.W. of No. 3.
5. Cashbeenan S.W. of No. 4.
6. Ranny W. of Mulroy B.
7. Hamiltons Hill. do.
8. Rossgarrow. do.

S. Sericites.
p. Phyllites.
c.S. Limestone layer in Sericite.
l. Limestone.
d. Dolomite.
g. Quartzite.
gl ,, friable
gS. ,, Shaly
F. Faults.

Scale 800 Feet to 1 Mile.

Vertical Sections — Hornblendite Series.

Gartan District. Lough Salt District.



1. Knockateen beg.
2. S.E. of Lough A Kibbon.
3. S.W. of Lough Salt.
4. N.E. of Lough Salt.

F. Fault.
UP. Upthrow.
U. Unconformability.

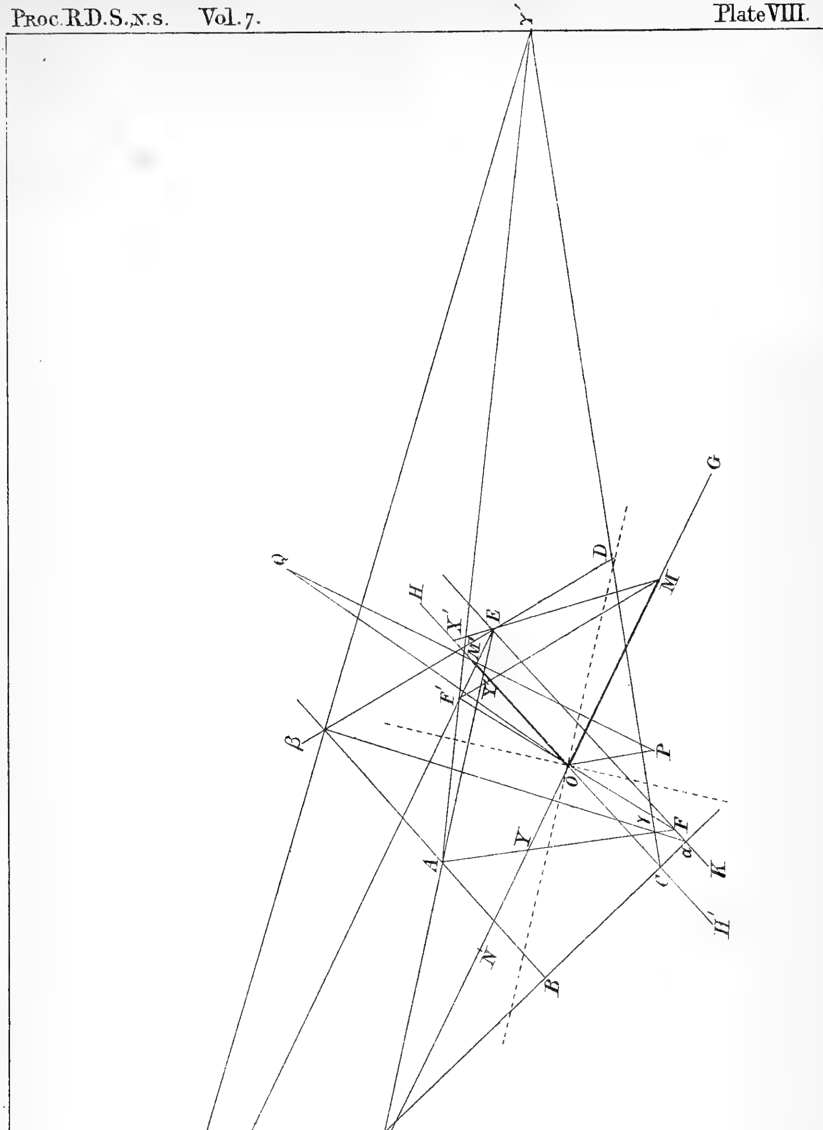
Q. Quartzite.
g. Gneissose quartzite.
H. Hornblendite.
l. Limestone.
d. Dolomite.
m. Micatite.
S. Steatite.
p. Phyllite.

Scale 800 Feet to 1 Mile.

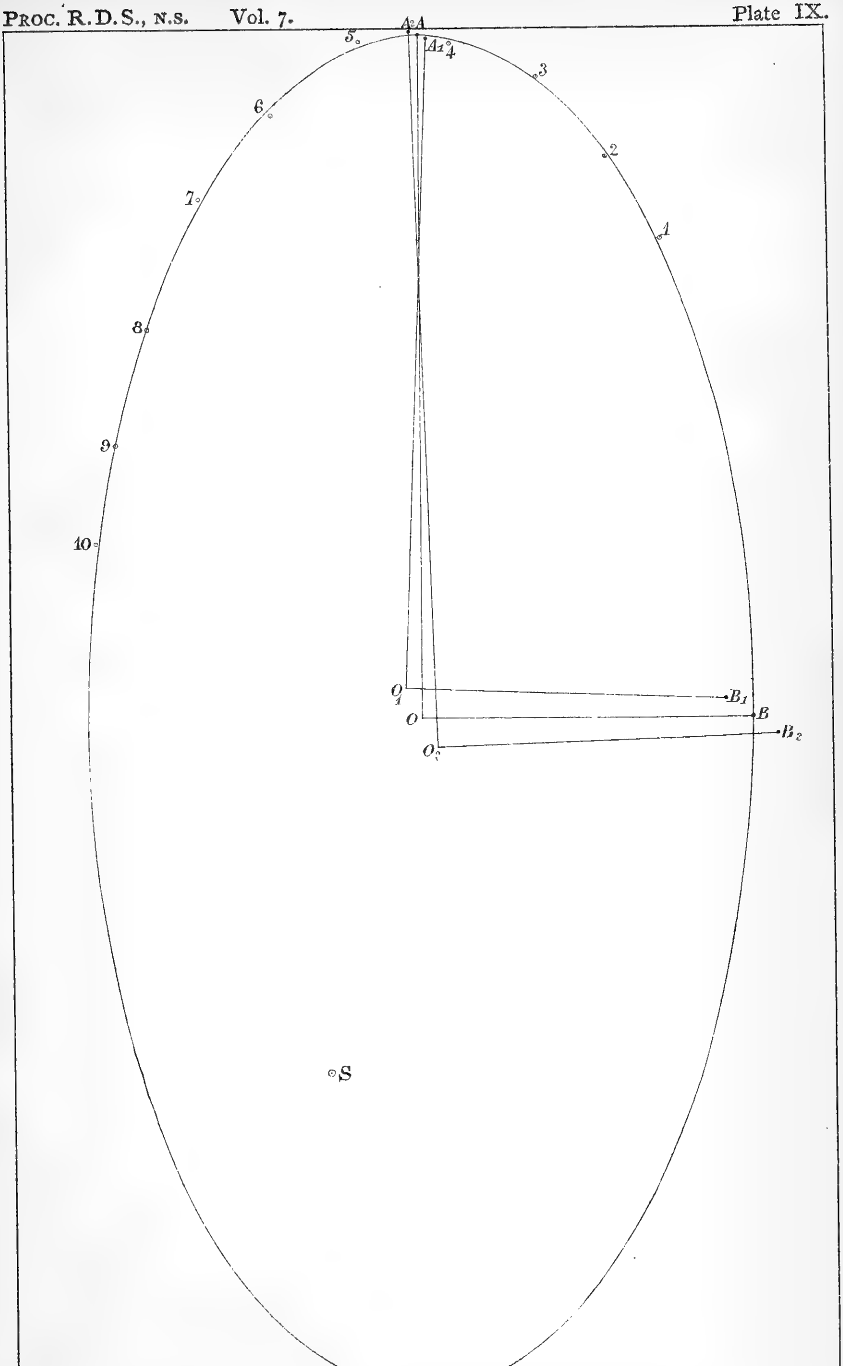
Forster & Co Lith. Dublin

Geo. H. Carpenter del. West, Newman chromo.

Tortrix donelana.



Forster & C^o Dublin.



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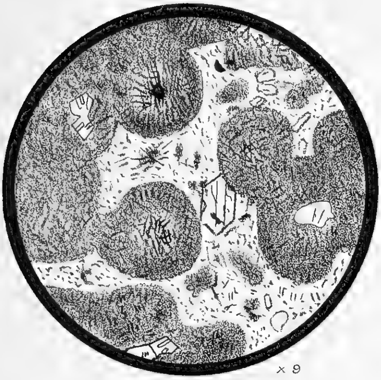
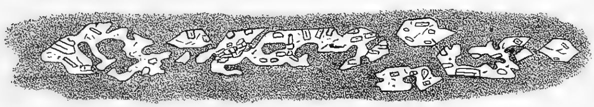


× 9

1

× 30

2



× 25

3

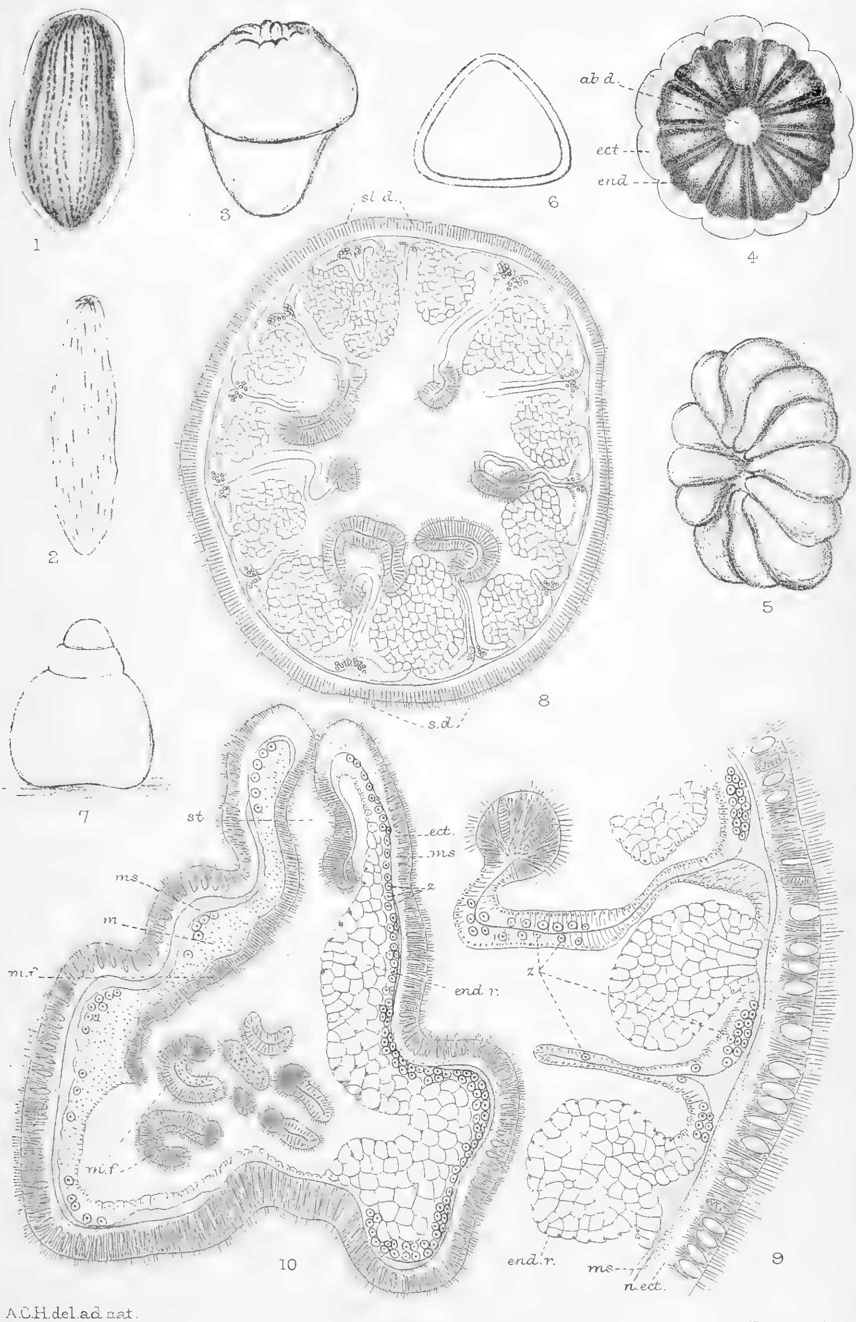
× 30

4

× 9

5

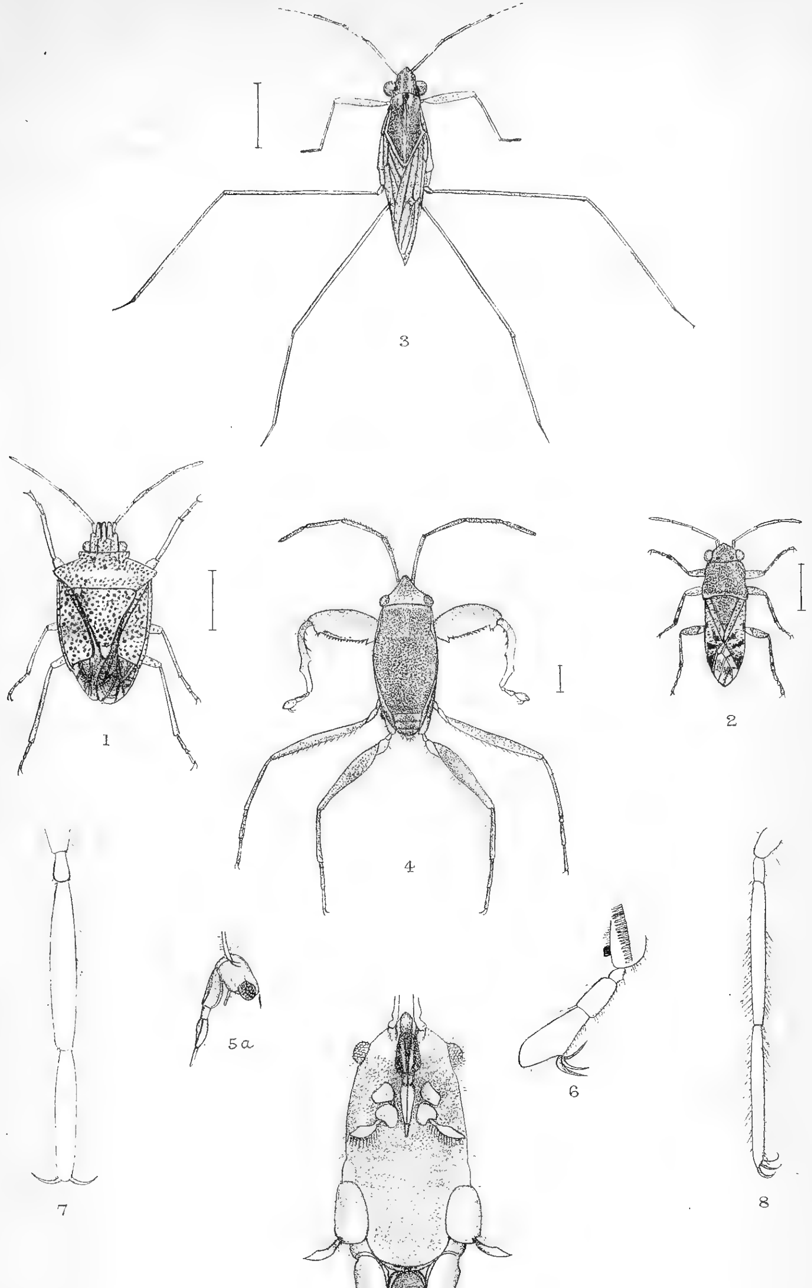
G.C. West, Newman lith.



A.C.H. del. ad nat.
M.P. Parker chromo lith.

West, Newman imp.

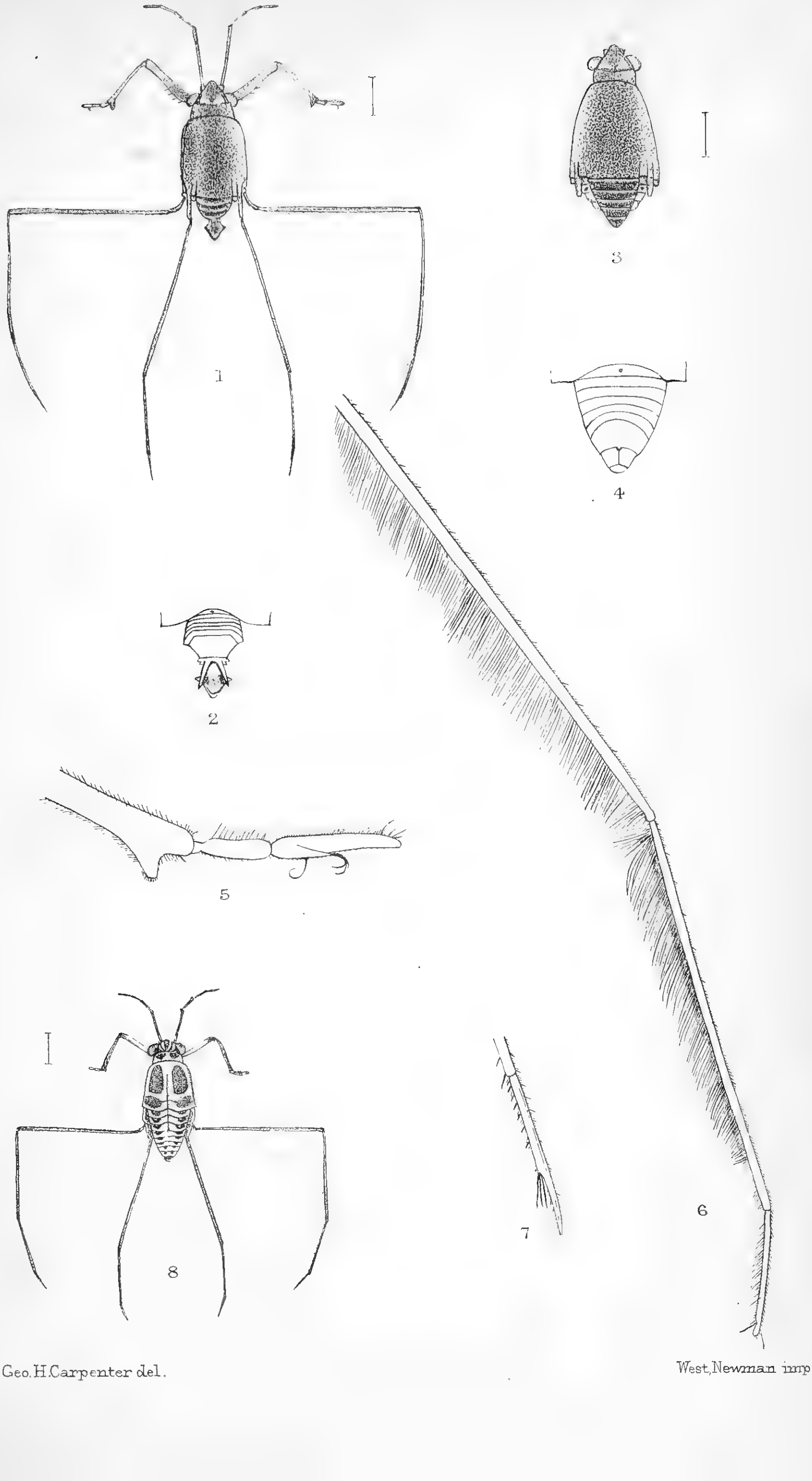
Plate XII.



Geo. H. Carpenter del.

West, Newman imp.

Plate XIII.



Geo. H. Carpenter del.

West, Newman imp.

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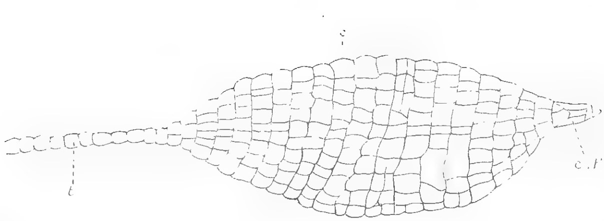

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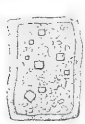

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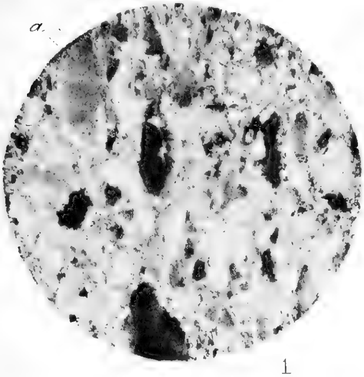
T. Johnson del. West, Newman lith.

Nitophyllum versicolor, *Harv.*



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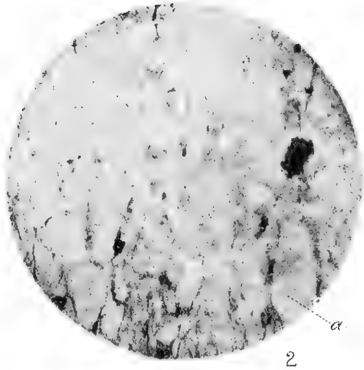

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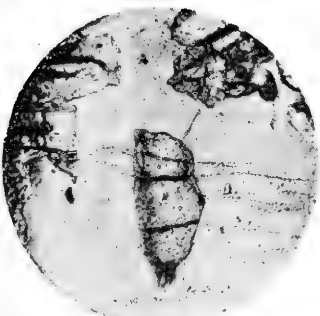

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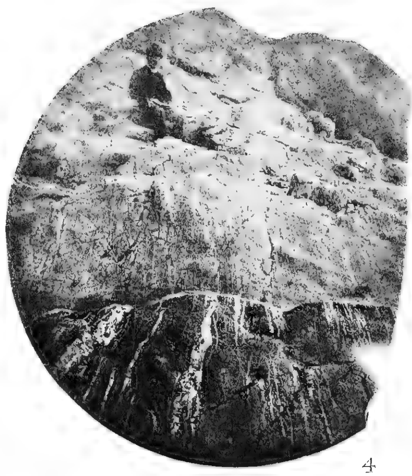

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AUTOTYPE.

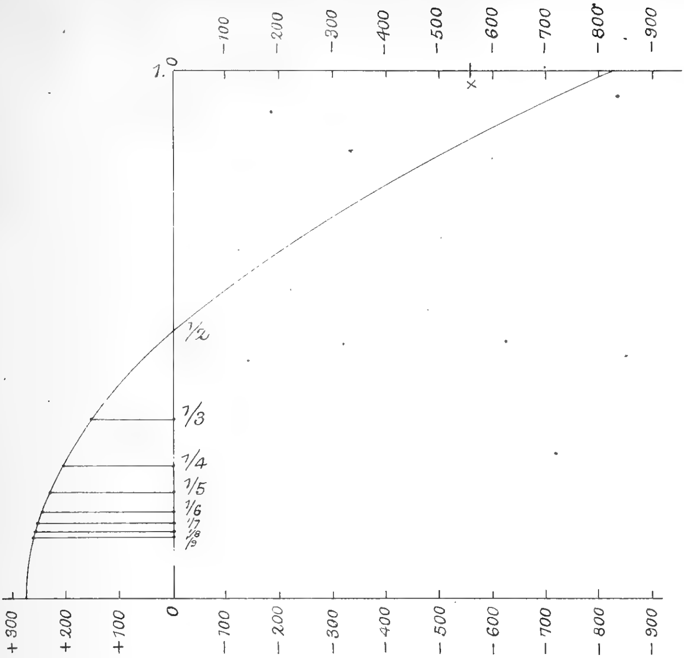


Fig. 1. *Primary curve of the Hydrogen Spectrum.*

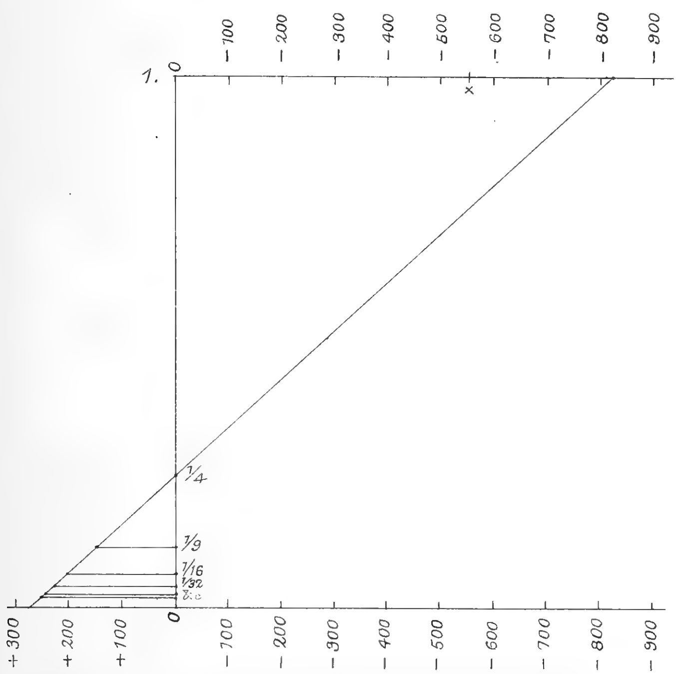


Fig. 2. *Secondary curve of the Hydrogen Spectrum.*

West, Newman lith.

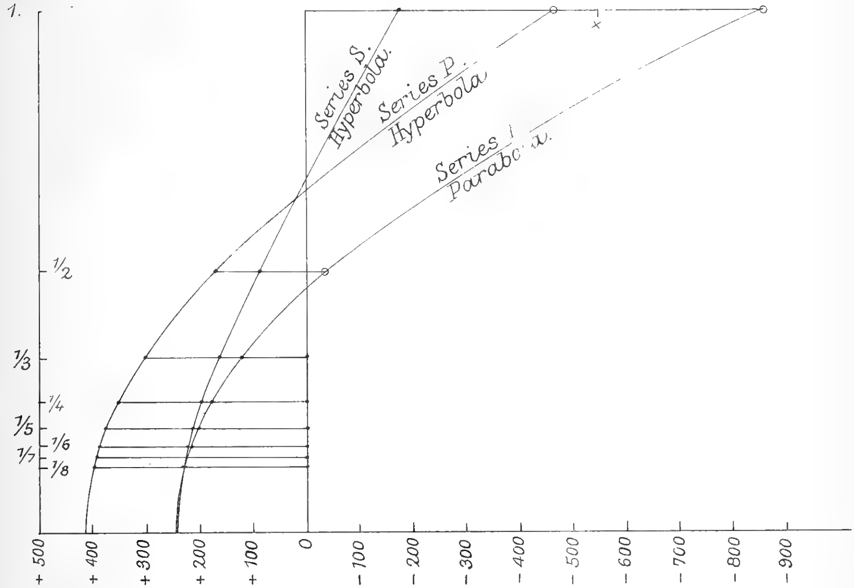


Fig. 4. *The three Primary curves of the Spectrum of Sodium.*

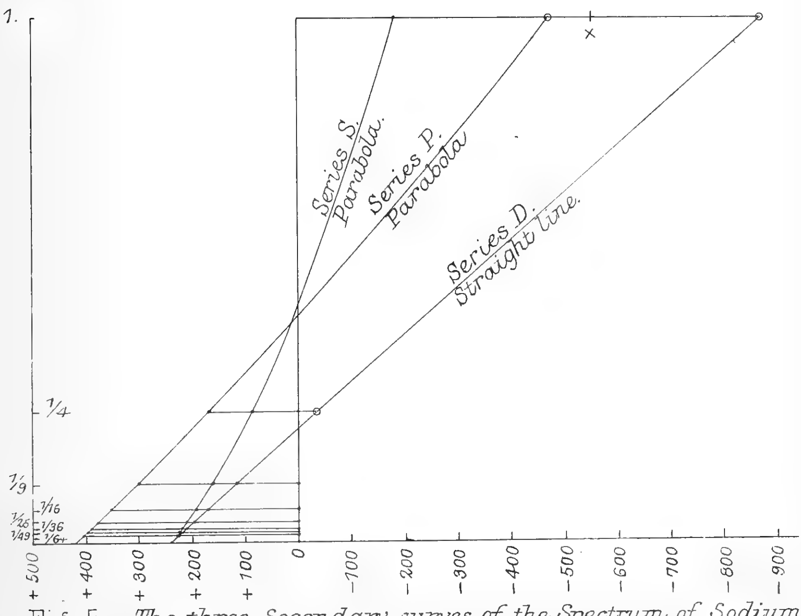
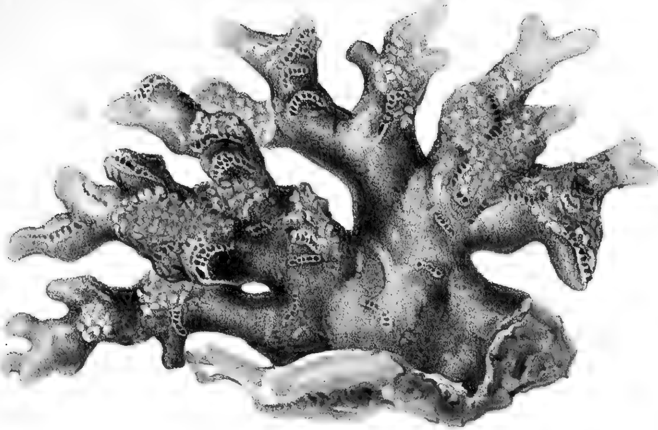


Fig. 5. *The three Secondary curves of the Spectrum of Sodium.*

West. Newman lith.



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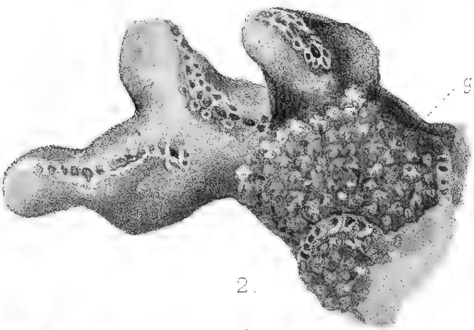

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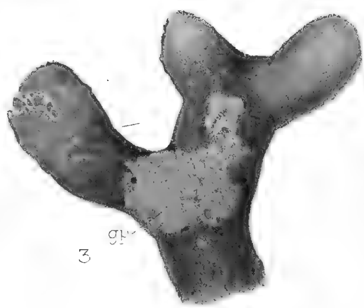


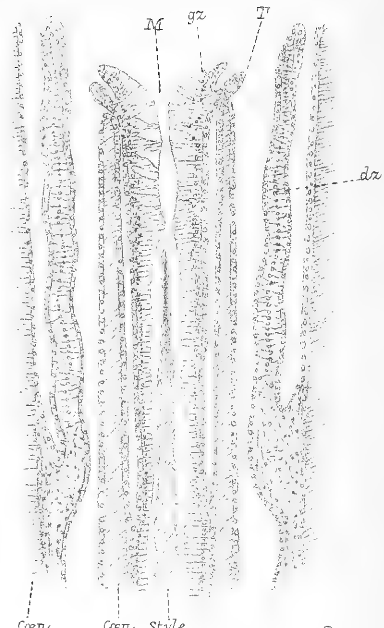
3

A.W Hickson, pinx

Lith Werner & Winter, Frankfurt a/M.

Distichopora violacea

1



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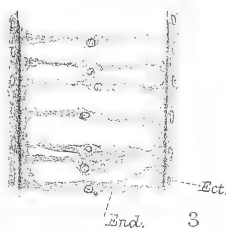

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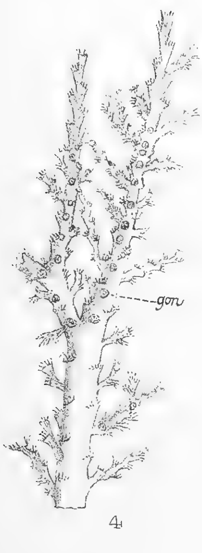
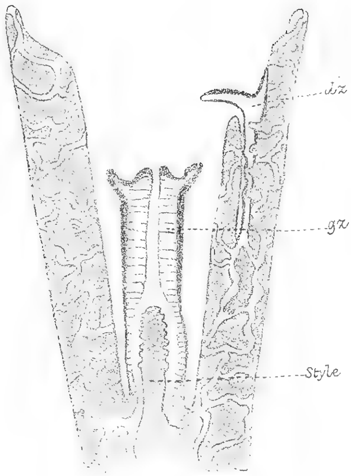


4

5

S. J. Hickson del. West, Newman lith.

Figs. 1. 2. 3. Distichopora. Figs. 4. 5. Stylaster.



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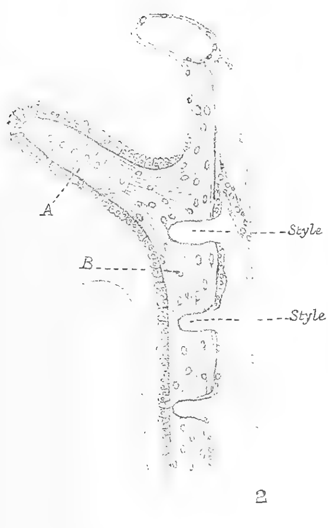

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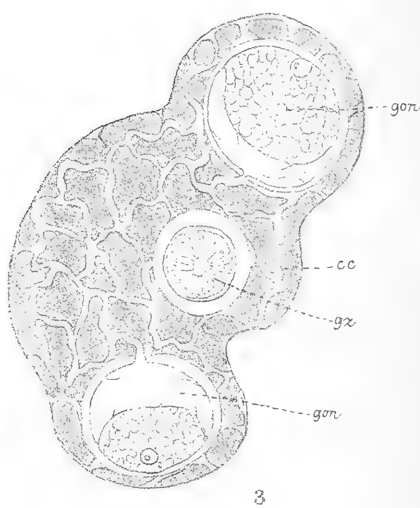

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S. J. Hickson del. West, Newman lith.

Stylaster.

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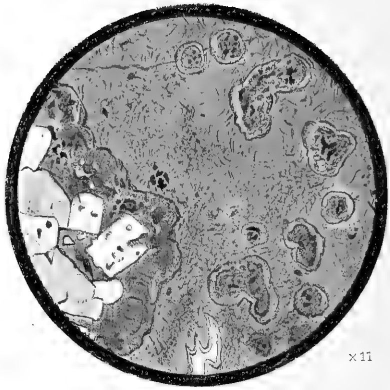
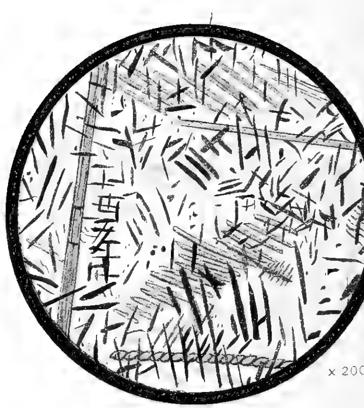


2.

3

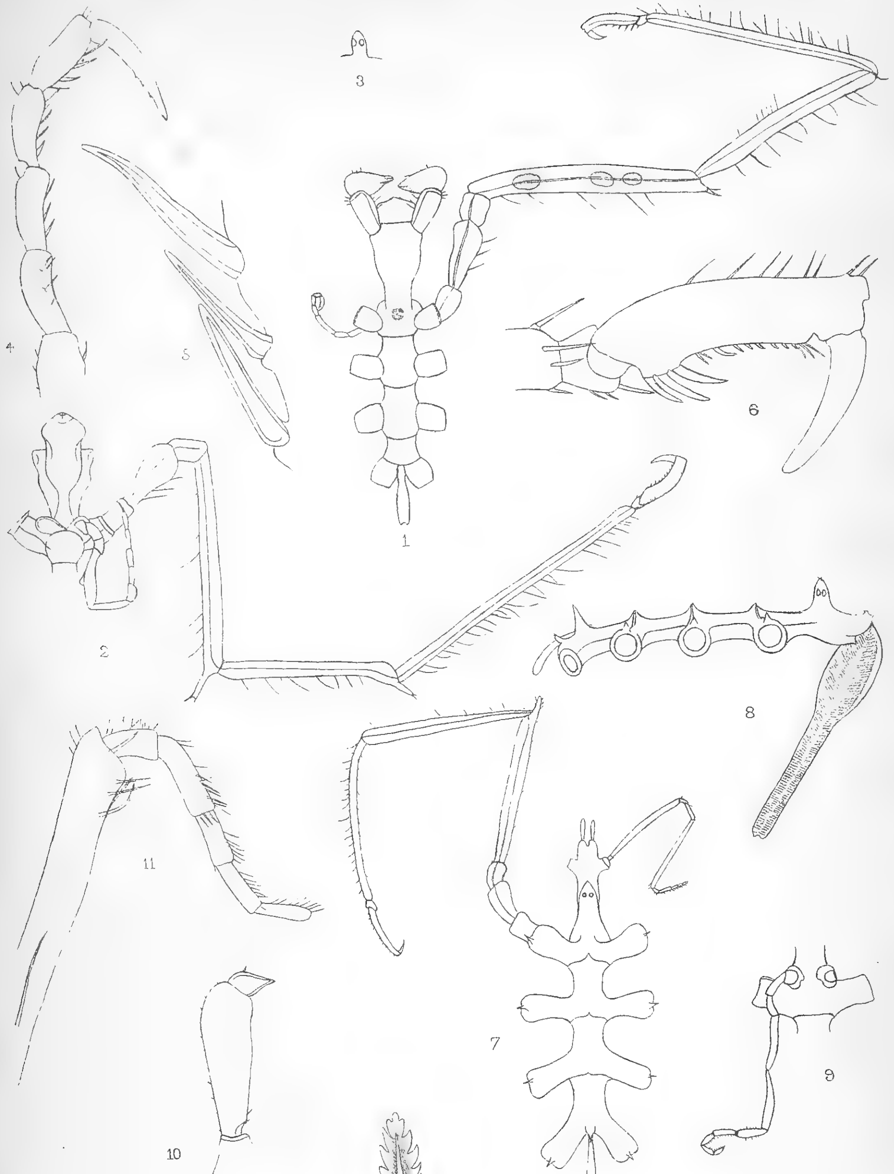


4.

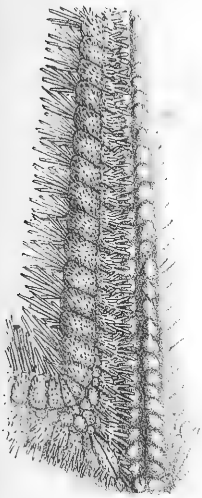
G.C. del.

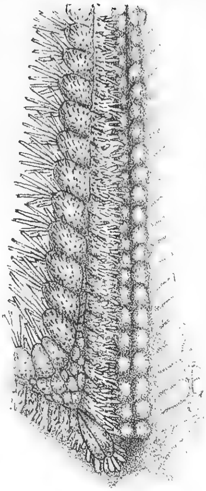
Lith Werner & Winter, Frankfort ᵃ/M

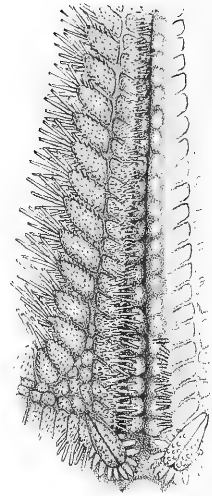
Variolite of Annalong



Geo. H. Carpenter del. West, Newman lith.

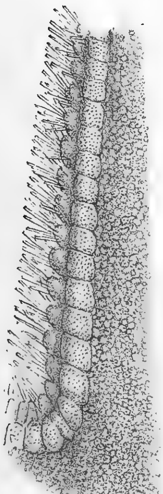


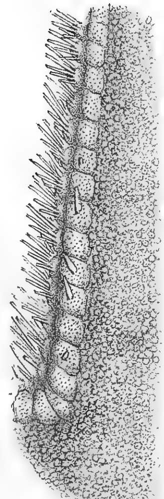


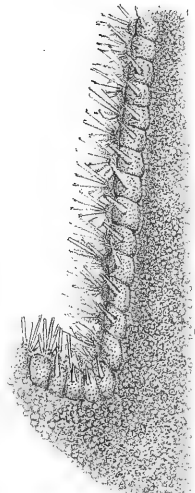


A. 1 2 3

B. 1 2 3

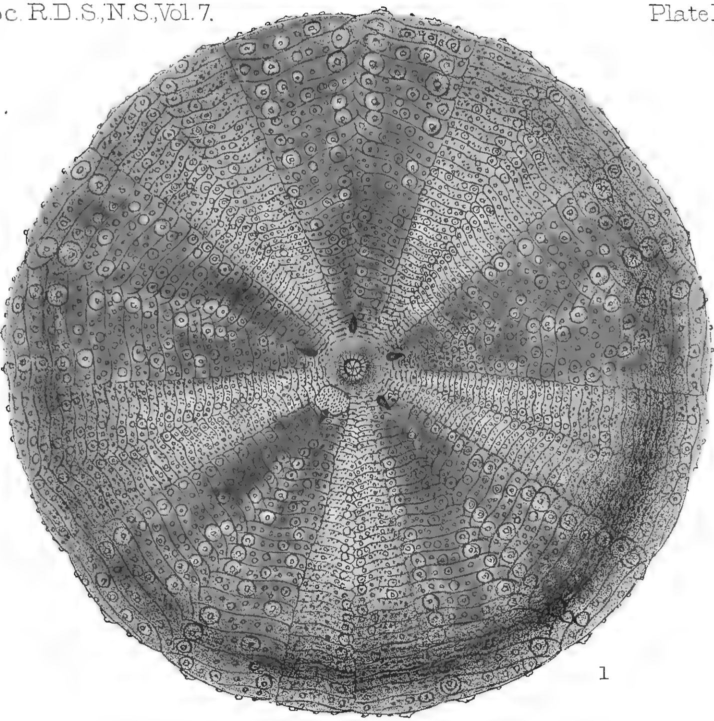






Berjeau & Highley del. et lith. West Newman imp.

Astropecten sphenoplax.



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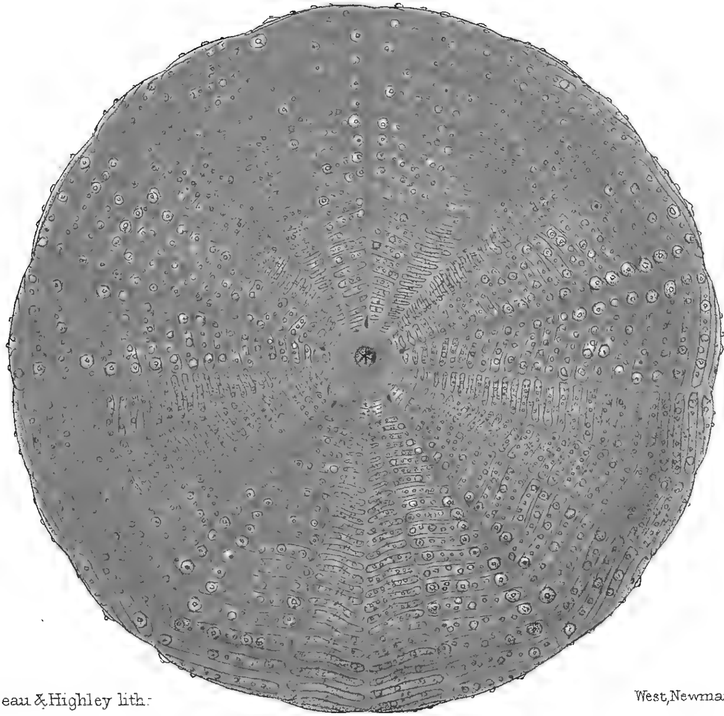
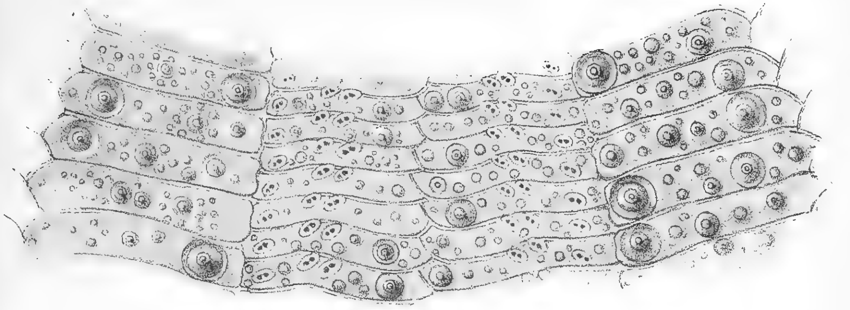


2

Berjeau & Highley lith. West, Newman imp.

Asthenosoma hystrix.



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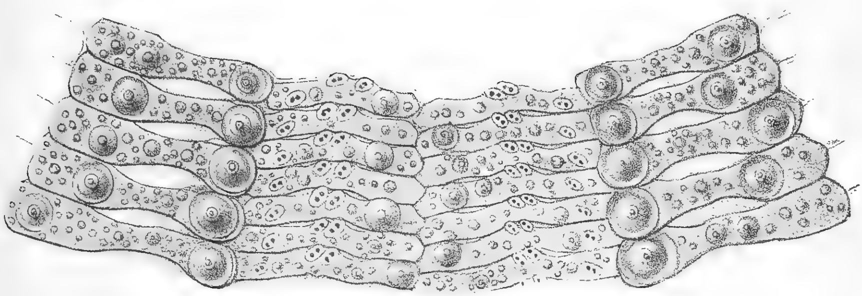

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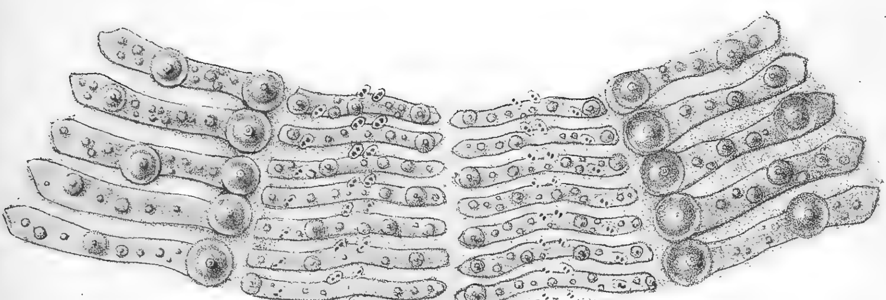

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