Report

of

The Danish Biological Station

to

The Board of Agriculture.

MARINE BIOLOGICAL LABORATORY
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IX.

1899.

By

C. G. Joh. Petersen,
Ph. D.

Kjøbenhavn.
Centraltrykkeriet.
1900.

Smithsonian Institution

From

The Danish Biological Station.

IX.

1899.

Copenhagen.
Centraltrykkeriet.
1900.

Trawlings in the Skager Rack and the Northern Cattegat in 1897 and 98.

With One Map.

By C. G. Joh. Petersen and J. Chr. L. Levinsen.

Contents.

Introduction.

Modern naturalists have, long ago already, clearly understood that the investigation of nature is the first condition of scientific progress; but it must be granted that the way in which the various countries have had their fishes and fisheries investigated, has been anything but satisfactory. A few historical data, fetched from the investigation of the Skager Rack, will afford a characteristic example of this fact:

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When *H. Krøyer* wrote his work of »Danmarks Fiske«, he knew, from personal observation, no more about the fishes of the Skager Rack than what the fishermen had observed; he had no means at all at his disposal for investigations of his own. As the fishermen fished only near the shore, or in the surface of the water, nothing was known then about the fishes of the Skager Rack proper, but the single specimens which on some occasion (in a storm, perhaps) were stranded on the shores; whether they really did belong to the stock of fish of the Skager Rack, or whether they had come from far away, was a thing nobody knew for certain.

When *C. A. Bergh* in the Swedish gunboat »Ingegerd«, in 1870, investigated the Northern Cattegat and Skagbanken off the Skaw, as also Kostergrunden off Stromstad, particularly to learn whether the bottom there was suitable for trawling, consequently just for fishery purposes, such gear was employed that he caught no other fishes than young lump-fish and a few pipefish; the common species he knew only from the fish-market at Frederikshavn or from the fishermen's boats; the crew, however, seems to have enjoyed itself by catching cod in its leisure hours.

When *G. Winther,* in 1879, wrote his »Prodromus ichthyologiæ danicæ marinæ«, no investigations had as yet been made, for the purpose of catching

fish in the Skager Rack. In 1879 a Swedish gunboat, the »Gunhild«, has made some draughts with »a sort of trawl« in the deep part of the Skager Rack and caught *Careproctus Reinhardi* and *Raja lintea,* but I have found no further information of this expedition which, as far as I know, was made on the suggestion of Professor *S. Lovèn,* and with Messrs. *Hj. Theél* and *C. Forsstrand* onboard. At any rate no report has been published in a collected form.

When *C. G. Joh. Petersen,* in 1886, wrote »Nye Bidrag til den danske Hav-Fiskefauna«, he had, with respect to the Skager Rack, only the same source to draw from. As regards the Cattegat, the matter was somewhat different; for though the gear which was used for the investigation, was here especially made to catch the lower animals, it could not be avoided that *a few* fish were caught also. In this way, therefore, som few species of fish were found, which were new for the Cattegat, and others, which were but rarely caught, were proved really to belong to this sea. The thought of a direct investigation of the fish fauna everywhere in our seas had not yet, however, dawned upon him, — indeed, this did not happen till he had for some years been engaged in actual fishery-investigations. Till 1897 the said works have, as far as I know, been the only sources of information respecting the stock of fish in the deeper parts of the Skager Rack, and it will be understood how eager P. was to investigate these parts, even though his investigations for want of suitable vessels, equipped for this special purpose, must be very defective and sporadic.

When you will make such a *direct investigation of the fishes* in a certain sea, the first thing necessary is, of course, that you have *suitable fishing-gear.* As to this question, however, I shall only refer to the report: »From the Danish Biological Station. VIII. 1898«. Here we shall try to set forth the results of the investigation which it became possible to make in the two years 1897 & 98, when the Biological Station was situated at Frederikshavn: In the Skager Rack we employed the gunboat »Guldborgsund« and the inspection-steamer »Havørnen«; in the Cattegat, a hired steam-tug, the »Express«. That the materials are so sporadic is owing, partly to the weather which, even for these parts, was particularly unfavourable in the summer of 1898. — We had hoped to be able to examine the Skager Rack and, at least, the northern part of the Cattegat, at various seasons, in order to see what influence the seasons had on the stock of fish; but we saw soon that we must content ourselves with getting a summary view only of the stock of fish here. Such a view we think we have got, though, with respect to the Skager Rack, it is far from exhaustive. In order to further characterize the fauna of these seas, we have also

gathered a number of lower animals, viz., such as came into the fishing-gear, and seemed to occur in multitudes, or in other ways were supposed to be of greater interest to the fauna of these parts; but the invertebrates have not been our main point, they have only been taken along with the others. —

Though these trawlings have given rich stores of information as to the fishes and their fry in these waters, it has been possible immediately to supplement them in other ways, by the results of the Biological Station's fisheries with stake-nets and seines along the shore, as also by information from the fishermen; and there is no doubt that future investigations, by means of still larger and better gear than our trawls, *will be able to add much.* Thus, by these trawlings, we never caught a *Spinax niger,* an *Acanthias vulgaris,* a *mackerel,* a *garfish,* etc., though they live in these waters, the gear having been to small to catch them.

Of late, 1896—98, German as also English steam-trawlers have commenced fishing in these seas, but they never go out deeper than c. 100 fathoms. *C. G. Joh. Petersen* has been onboard these vessels, and a few times seen their draughts. Their trawls are quite excellent, and it must be hoped that such a one will be placed at the disposal of the naturalists the next time a great expedition is going to explore the depths of the sea. On account of its large meshes, however, they cannot make the other and smaller fishing-gear quite superfluous. —

The sorts of gear we have used by these investigations are chiefly *otter-seines* (cmp. »From the Biol. Station. VIII«), some with small, some with larger meshes; moreover, *plaice-seines* with meshes of various widths, and, further, a so-called *wire-trawl,* which is rather small, and which, in the long run, proved less suitable. By the respective trawlings further information is given as to the gear which has been used. —

When the journal-numbers are not successive, it is, partly, because many trawlings have failed, from some reason or other, and therefore have been quite left out; partly, because several trawlings were made on shallow water near one another, with so similar results that some of them have been omitted in order not to overcrowd the map; and, finally, because the trawlings have afterwards been arranged in another succession (to facilitate the general survey), than that in which they had been made. —

For the orientation of the reader a map has been added, on which the depths in the Skager Rack and the northern part of the Cattegat are stated, as also the journal-numbers of the trawlings.

The Trawlings.

The Skager Rack 300—275 Fathoms.

Nr. 1. The Skager Rack. Tromlingerne in NW $^3/_4$ N. 38 miles 300 fathoms.
Journal-number 16. 21. May, 1897. **Steel-wire trawl.**

Pisces:

Myxine glutinosa.

Pycnogonida:

Chætonymphon spinosum.

Crustacea:

Nyctiphanes norvegica. 5 specimens.
Pasiphaë tarda. 6 specimens.
Pontophilus norvegicus. Many.
Pandalus propinquus. 2 specimens.
Munida tenuimana. 11 specimens.

Vermes:

Sagitta hexaptera. 4 specimens.
Aphrodite sp. 1 specimen.
Leanira tetragona.
Terebellides Strømi.

Gasteropoda:

Dentalium striolatum. Some specimens.
Scaphander sp. 6 specimens.
Natica pallida. 2 specimens.
Admete viridula. 1 specimen.

Lamellibranchia:

Pecten abyssorum. 15 specimens.
Malletia obtusa. 6 specimens.
Axinus flexuosus. A few.

Holothurida:

Synapta sp.
Chirodota levis. 3 specimens.

Stellerida:

Pteraster multipes. 3 specimens.
Poraniomorpha rosea. 5 specimens.
Astropecten Andromeda. 14 specimens.
Ophioscolex glacialis. Many.
Asteronyx Loveni. Some specimens.

Anthozoa:

Bolocera longicornis.
Actinostola callosa.
Kophobelemnon stelliferum. Several.

Nr. 2. The Skager Rack. Under the Norwegian shore 300—275 Fathoms. Lat. 58° 26'.
Journal-number 58. 28. July, 1897. **Otter-seine*).** 3 hauls.

Pisces:

Careproctus Reinhardi. 6 specimens.
Lycodes Sarsii. 5 specimens.
Lycodes gracilis. 2 specimens.
Coryphaenoides rupestris. 8 specimens.
Argentina silus. 1 specimen.
Eggs of Raja sp. A few.
Raja lintea. 1 specimen.
Raja circularis. 1 specimen.
Myxine glutinosa. 8 specimens.

*) By otter-seine is meant the seine with small meshes, represented and described in Report VIII.

Pycnogonida:

Nymphon Strømi var. gracilipes.

Crustacea:

Haploops setosa Boeck. 1 specimen.
Rhachotropis sp. 1 specimen.
Nyctiphanes norvegica. Some few.
Pasiphaë tarda. 3 specimens.
Pontophilus norvegicus. Many.
Pandalus propinquus. Many.
Munida tenuimana. Many.

Chætopoda:

Leanira tetragona.
Letmonice filicornis.
Terebellides Strømi.
Aricia norvegica.

Cephalopoda:

Octopus arcticus. 2 little ones.
Rossia sublevis. 3 specimens.

Gasteropoda:

Scaphander sp. A great number.
Littorina littorea. Fragment.
Sipho Sarsii. 5 specimens.
Egg-capsules of Mollusks.
Neptunea islandica. 1 specimen.
Dentalium striolatum.
Gymnobranchia sp. 1 specimen.

Lamellibranchia:

Pecten abyssorum. 8 specimens.
Portlandia intermedia. 1 empty shell.
Portlandia lucida. 9 specimens.
Malletia obtusa. 1 specimen.

Tunicata:

Botryllus sp. 1 specimen.

Holothurida:

Holothuria tremula. 20 specimen.
Chirodota lævis. Many.
Echinocucumis typica. Many.

Stellerida:

Pteraster multipes.
Poraniomorpha rosea. 14 specimens.
Archaster tenuispina. 1 specimen.
Astropecten Andromeda.
Opioscolex glacialis. 4 specimens.
Asteronyx Loveni on Funiculina.

Anthozoa:

Bolocera longicornis.
Funiculina quadrangularis. Many.
Actinostola callosa.
Kophobelemnon stelliferum. Many.

Spongia:

Polymastia mamillaris. 3 specimens.
Polymastia hemisphaericum. 1 specimen.
Stylocordyla borealis. 1 specimen.
Reniera sp. 1 specimen.

The Skager Rack 210 Fathoms.

Nr. 3. The Skager Rack. The Skaw in SSE. 34 miles c. 210 fathoms.
Journal-number 18. 21. May, 1897. **Steel-wire trawl.**

Pisces:

Pleuronectes cynoglossus. 3 specimens.
Chimæra monstrosa. 1 specimen.
Myxine glutinosa. 2 specimens.

Pycnogonida:

Nymphon Strømi var. gracilipes.

Crustacea:

Nyctiphanes norvegica. 5 specimens.
Pontophilus norvegicus. Many.
Pandalus propinquus. Some few.
Pandalus (borealis?)
Hippolyte securifrons. Some specimens.
Hyas coaretatus. 2 specimens.
Munnopsis typica. 5 specimens.

Chætopoda:

Tubes of Annelida. A great number.

Gasteropda:

Dentalium striolatum.
Dentalium agilis.
Scaphander sp. Many.
Scalaria. 1 specimen.

Lamellibranchia:

Pecten septemradiatus. 1 specimen.
Syndosmya nitida. 5 specimens.
Nucula tenuis. 1 specimen.

Echinida:

Brissopsis lyrifera.

Stellerida:

Astropecten Andromeda. 4 specimens.
Ophioscolex glacialis. 4 specimens.

Anthozoa:

Bolocera longicornis.
Actinostola callosa.
Kophobelemnon stelliferum. 5 specimens.

Nr. 4. **The Skager Rack.** NNW of the Skaw. 210 Fathoms.
Journal-number 59. 28. July, 1897. **Otter-seine.** 2 hauls. 1 a failure.

Pisces:

Sebastes viviparus. 4 specimens.
Coryphaenoides rupestris. 8 specimens.
Pleuronectes cynoglossus. 11 specimens.
Argentina silus. 1 specimen.
Myxine glutinosa. 6—8 specimens.

Crustacea:

Nyctiphanes norvegica. 8 specimens.
Pasiphaë tarda. 2 specimens.
Pontophilus norvegicus. 5 specimens.
Pandalus propinquus. Some specimens.
Pandalus borealis. Some specimens.
Munida tenuimana. 1 specimen.

Chephalopoda:

Octopus arcticus ♂ (= Oct. Bairdii Verr. [Sars]). 2 specimens.

Gasteropoda:

Dentalium sp.
Scaphander sp. Several.

Lamellibranchia:

Syndosmya longicallis. 1 specimen.

Echinida:

Brissopsis lyrifera. Some few.

Stellerida:

Astropecten Andromeda. Many.
Ophioscolex glacialis. 1 specimen.
Asteronyx Loveni. Many.

Anthozoa:

Actinostola callosa.
Funiculina quadrangularis.
Kophobelemnon stelliferum.

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The Skager Rack. 130—70 Fathoms.

Nr. 5. **The Skager Rack.** The Lighthouse of the Skaw, in variation SE by S. 34 miles. 130 fathoms.
Journal-number 17. 21. May, 1897. **Steel-wire trawl.**

Pisces:

Onos cimbrius. 1 specimen.
Lycodes gracilis. 2 specimens.
Pleuronectes cynoglossus. 1 specimen.
Myxine glutinosa. 7 specimens.

Crustacea:

Mysideis insignis. 1 specimen.
Pontophilus norvegicus. Many.
Hippolyte securifrons. Several.
Pandalus borealis. Several.

Gasteropoda:

Scaphander sp. 1 specimen.
Scalaria sp. 1 specimen.
Typhlomangelia nivalis. 2 specimens.

Lamellibranchia:

Syndosmya nitida. A great number.
Cardium minimum. Several.
Venus ovata. A few dead specimens.

Echinida:

Brissopsis lyrifera.

Stellerida:

Astropecten Andromeda. A great number.
Ophioglypha Sarsii.

Anthozoa:

Bolocera longicornis. Many.

Nr. 6. **The Skager Rack.** The Skaw in S by E. 26 miles. 96 fathoms.
Journal-number 60. 29. July, 1897. **Otter-seine.** (1 hour.) The seine was dragged with too great speed.

Pisces:

Gadus æglefinus. 1 specimen.
Gadus Poutassou. 2 specimens.
Gadus Esmarkii. 2 specimens.
Lycodes gracilis. 1 specimen.
Pleuronectes cynoglossus. 3 specimens.
Chimæra monstrosa. 1 specimen.

Crustacea:

Nyctiphanes norvegica. Some few.
Pontophilus norvegicus. Many.
Hippolyte securifrons. Some few.
Pandalus borealis. A number of large spec.
Pandalus propinquus. Some specimens.

Stellerida:

Astropecten Andromeda. 1 specimen.

Nr. 7. **The Skager Rack.** The Lighthouse of the Skaw in SSW ½ W. 20 miles. 130 fathoms.
Journal-number 20. 22. May, 1897. **Steel-wire trawl.**

Pisces:

Lycodes gracilis. 1 specimen.
Onos cimbrius. 1 specimen.
Chimæra monstrosa. 1 specimen.
Myxine glutinosa. A few.

Crustacea:

Munnopsis typica. 1 specimen.
Stegocephalus sp. 1 specimen.
Nyctiphanes norvegica. Several.
Pontophilus norvegicus. 55 specimens.
Hippolyte securifrons. Some specimens.
Pandalus borealis. Several.
Pagurus sp. A few small specimens.

Chætopoda:

Tubes of Annelida. Many.
Leanira tetragona.

Gasteropoda:

Scaphander sp. A few.

Lamellibranchia:

Pecten septemradiatus. A few, dead spec.
Leda pernula.
Nucula tenuis.
Syndosmya longicallis. Many.
Venus ovata.
Venus gallina.
Cyprina islandica. juv.
Neæra obesa. 1 specimens.
Typhlomangelia nivalis. 4 specimens.

Echinida:

Brissopsis lyrifera.

Stellerida:

Astropecten Andromeda.

Anthozoa:

Large actinias.

Nr. 8. **The Skager Rack.** The Skaw in SW by S. 16 miles. 106 fathoms.
Journal-number 57. 27. July, 1897. **Otter-seine.** 2 hauls.

Pisces:

Lycodes gracilis. 8 specimens.
Gadus Esmarkii. 2 specimens.
Pleuronectes cynoglossus. 4 specimens.
Chimæra monstrosa. 2 specimens.
Myxine glutinosa. 5 specimens.

Crustacea:

Stegocephalus inflatum. 10 specimens.
Nyctiphanes norvegica. Many.
Pontophilus norvegicus. Many.
Hippolyte securifrons. Several.
Hippolyte pusiola.
Pandalus borealis. Many.
Pandalus propinquus. Several.

Chætopoda:

Leanira tetragona.

Gasteropoda:

Scaphander sp. 1 specimen.
Syndosmya longicallis. A few large spec.

Echinida:

Brissopsis lyrifera. Many.
Echinus norvegicus. 2 specimens.

Stellerida:

Luidia Sarsii. Many.
Ophioglypha Sarsii. Many.
Ophioscolex glacialis. Many.
Ophiuridæ. Many, small specimens.

Anthozoa:

Bolocera longicornis. Many.
Actinostola callosa. Many.

Nr. 9. **The Skager Rack.** Hållo Revolving Light in ESE. 15 miles. 95 fathoms.
Journal-number 62. 29. July, 1897. **Otter-seine.** (1 hour.)

Pisces:

Lycodes gracilis. 29 specimens.
Onos cimbrius. 1 specimen.
Gadus æglefinus. 6 specimens.
Gadus merlangus. 2 small specimens.
Gadus callarias. 3 specimens.
Gadiculus argenteus. 1 specimen.
Pleuronectes cynoglossus. 5 specimens; the two smallest 3".
Drepanopsetta platessoides. 3 specimens.

Crustacea:

Pontophilus norvegicus. Many.
Hippolyte securifrons. Many.
Pandalus borealis. Many.
Pandalus propinquus.
Lithodes sp. 1 specimen.
Pagurus sp. 1 specimen.

Chætopoda:

Aphrodite sp.
Letmonice filicornis.
Eumenia crassa.

Cephalopoda:

Rossia Owenii ♀. 1 specimen.

Gasteropoda:

Natica sp.
Buccinum undatum.

Neptunea antiqua.
Neptunea propinqua.

Lamellibranchia:

Pecten septemradiatus.
Leda pernula. A great number.
Modiolaria nigra. 1 specimen.
Astarte sulcata.
Cyprina islandica.
Venus ovata. Dead.

Echinida:

Brissopsis lyrifera. A great number.
Echinus norvegicus.

Stellerida:

Asterias rubens.
Ophioglypha Sarsii.

Anthozoa:

Bolocera longicornis.

Nr. 10. **The Skager Rack.** The Skaw in SE by S ¼ S. 26 miles. 80 fathoms.
Journal-number 19. 22. May, 1897. **Steel-wire trawl.**

Pisces:

Lycodes gracilis. 2 specimens.
Lycodes Sarsii. 1 specimen.
Onos cimbrius. 3 specimens.
Myxine glutinosa. 3 specimens.

Crustacea:

Hippolyte securifrons. Some specimens.
Pandalus borealis. Many.
Pagurus sp. 3 small specimens.
Hyas sp.

Gasteropoda:

Turritella terebra.
Natica sp.
Scalaria sp.
Typhlomangelia nivalis. 5 specimens.
Buccinum undatum. A few.
Buccinum Humphreysianum. 1 spec.

Lamellibranchia:

Pecten septemradiatus. A few.
Leda pernula. Many.
Leda minuta.
Nucula tenuis.
Syndosmya nitida.
Cardium (minimum?)
Cyprina islandica.
Venus ovata.
Venus gallina.

Echinida:

Brissopsis lyrifera.

Stellerida:

Astropecten Andromeda. 1 specimen.
Ophioglypha Sarsii.

Anthoza:

Bolocera longicornis.

Steam-trawler 44 B x Georg x S fishes here, together with 2 other trawlers, haddock *(Gadus æglefinus)* and pole dab *(Pleuronectes cynoglossus)*; otherwise they fish very little.

Nr. 11. **The Skager Rack.** North of the Skaw. 70 fathoms.
Journal-number 53 + 52. 15. July, 1897. **Otter-seine.** 2 hauls.

Pisces:

Lycodes gracilis. 2 specimens.
Gadus callarias. 5 spec., 3 spec. of the fry of the year. } Perhaps under jelly-fish.
Gadus æglefinus. 5 spec., 3 spec. pul. 3—4″. } Perhaps under jelly-fish.
Gadus merlangus. 3 specimens.
Gadus Poutassou. 7 specimens.
Pleuronectes cynoglossus. 11 specimens.
Drepanopsetta platessoides. 4 specimens.
Raja radiata. 3 specimens.
Eggs of raja. Some specimens.

Crustacea:

Nyctiphanes norvegica. A few.
Pontophilus norvegicus. A great number.
Sabinea Sarsii. 1 specimen.
Hippolyte securifrons. A great number.
Pandalus borealis. Many.
Pandalus propinquus. Many.
Hyas sp. 1 specimen.

Gasteropoda:

Natica sp.
Buccinum. Some few.
Neptunea antiqua. Several large spec.

Echinida:

Echinus norvegicus.
Amphidetus flavescens.
Spatangus purpureus. 1 specimen.
Brissopsis lyrifera.

Stellerida:

Luidia Sarsii.
Asterias rubens.
Astropecten Andromeda.
Ophioglypha Sarsii.

Anthozoa:

Bolocera (longicornis?)
Alcyonium digitatum. A few.

Nr. 12. **The Skager Rack.** N of the Lighthouse of the Skaw. 10 miles. 70 fathoms.
Journal-number 91. 9. July, 1898. **Otter-seine.**

Pisces:
Trigla gurnardus. 1 spec. (immature roe).
Lycodes Sarsii. 2 specimens.
Lycodes gracilis. 3 specimens.
Gadus æglefinus. 7 specimens.
Gadus merlangus. 4 specimens (large).
Gadus Esmarkii. 31 spec. (milters).
Gadus Poutassou. 12 spec. (milters).
Gadus minutus. 1 spec. (immature roe).
Gadiculus argenteus. 1 specimen.
Onos cimbrius. 7 spec. (much, but immature roe).
Pleuronectes cynoglossus. 19 spec., among which 3 young fish.
Drepanopsetta platessoides. 6 specimens.
Raja radiata. 2 specimens.
Myxine glutinosa. 1 specimen.

Crustacea:
Pandalus borealis.
Pandalus propinquus.
Hippolyte securifrons.

Gasteropoda:
Buccinum undatum.
Neptunea antiqua.

Echinida:
Brissopsis lyrifera. (2 Danish Tonder.)

Stellerida:
Asterias rubens.
Astropecten Andromeda.
Ophioglypha Sarsii.

Nr. 13. **The Skager Rack.** NE of the Lighthouse of the Skaw. 13 miles. 72 fathoms.
Journal-number 96. 11. July, 1898. **Otter-seine.**

Pisces:
Lycodes gracilis.
Gadus callarias.
Gadus æglefinus.
Gadus Esmarkii.
Gadus Poutassou.
Molva vulgaris (with roe).
Pleuronectes cynoglossus.
Drepanopsetta platessoides.
Raja sp.
Myxine glutinosa.

Cephalopoda:
Rossia sp.

Crustacea:
Pandalus sp.

Echinida:
Brissopsis lyrifera. (5 Danish Tonder.)

Stellerida:
Asterias rubens.
Luidia Sarsii.

NB. The sack burst, in being hauled up, so that a great part of its contents ran out.

The Skager Rack 60—20 Fathoms.

Nr. 14. **The Skager Rack.** North of the Lightship of the Skaw. 3 miles. 55 fathoms.
Journal-number 51. 15. July, 1897. **Steel-wire trawl.**

Pisces:
Lycodes gracilis. 1 specimen.

Crustacea:
Tubes of gammarida. In great numbers.
Nyctiphanes norvegica. 1 specimen.
Pontophilus norvegicus. 1 specimen.
Pandalus propinquus. A few.
Pandalus Montagui. A few.
Pandalus (brevirostris?)
Pandalus borealis. A few.
Eupagurus Bernhardus.

Chætopoda:
Aphrodite aculeata.
Harmothoe nodosa.

Gasteropoda:
Turritella terebra.
Natica pallida.
Natica pulchella.
Buccinum undatum.
Neptunea antiqua.

Lamellibranchia:
Pecten septemradiatus.
Leda pernula.
Leda minuta.
Modiolaria nigra.
Syndosmya nitida.
Cardium fasciatum.
Venus ovata.

Echinida:
Amphidetus ovatus.
Brissopsis lyrifera.
Echinus norvegicus.

Stellerida:
Luidia Sarsii.
Ophioglypha Sarsii.
Ophioglypha albida.

Nr. 15. **The Skager Rack.** Hirtshals in SW by S $^1/_4$ S. $12_{,7}$ miles. 33 fathoms.
Journal-number 49. 13. July, 1897. **Plaice-seines with large meshes**, and from a German steam-trawl which had several hundred lbs. of fish in its haul.

Pisces:
Lophius piscatorius. 1 specimen.
Gadus æglefinus. A great number.
Gadus callarias. 1—4 annual series.
Gadus merlangus. In several sizes.
Merlucius smiridus. Large & of average size.
Molva vulgaris. A few large specimens.
Pleuronectes platessa. A few.
Pleuronectes microcephalus. A few.
Pleuronectes cynoglossus. A great number.
Drepanopsetta platessoides. Several.
Raja batis. A few.
Raja radiata? 1 specimen.

Bryozoa:
Several.

Echinida:
Brissopsis lyrifera.

Anthozoa:
Alcyonium digitatum.

A few loose *Laminariæ* were taken with the rest. Soft deposits.
No common dabs *(Pleuronectes limanda)*.

Nr. 16. **The Skager Rack.** Maarup Church free W of Hirtshals. 19—40 fathoms.
Journal-number 47. 12. July, 1897. **Plaice-seine with large meshes.**

Pisces:
Lophius piscatorius. 1 specimen.
Gadus minutus. 6 specimens.
Pleuronectes limanda. 70 specimens.
Pleuronectes platessa. 26 specimens.
Raja batis. 1 specimen.

Bryozoa:
Colonies of Bryozoa.

Lamellibranchia:
Solen ensis. Dead.
Mactra sp. Dead.

Echinida:
Echinus sp.

Stellerida:
Asterias rubens.
Astropecten Mülleri.

Anthozoa:
Alcyonium digitatum.

Of *Plants*: A very great number of fresh *Laminariæ* (2 species) and other algæ, together with some *Zostera*, came up with the seine; they were most likely all loose.

Nr. 17. **The Skager Rack.** North of the Lightship of the Skaw. 50—60 fathoms.
Journal-number 66. 16. June, 1898. **Otter-seine.**

Pisces:
Gadus callarias. 2 specimens.
Gadus æglefinus. 18 specimens.
Gadus merlangus. 2 specimens.
Gadus minutus. 18 specimens.
Gadus Poutassou. 2 specimens.
Gadus Esmarkii. 14 specimens.
Pleuronectes cynoglossus (large). 2 spec.
Drepanopsetta platessoides. 14 spec.

Echinida:
Amphidetus cordatus.
Echinus norvegicus.

Stellerida:
Luidia Sarsii.

Nr. 18. **The Skager Rack.** North of the Lightship of the Skaw. 40 fathoms.
Journal-number 67. 16. June, 1898. **Otter-seine.**

Pisces:
Gadus æglefinus. 6 specimens.
Gadus merlangus. 1 specimen.
Pleuronectes cynoglossus. 1 specimen.
Drepanopsetta platessoides. 7 specimens.
Raja radiata. 6 specimens.

Echinida:
Spatangus purpureus.

Stellerida:
Asterias rubens (large).

Nr. 19. **The Skager Rack.** North of the Lightship of the Skaw. 30 fathoms.
Journal-number 68. 17. June, 1898. **Otter-seine with large meshes.**

Pisces:
Gadus æglefinus. 2 specimens.
Pleuronectes platessa. 1 specimen.
Pleuronectes cynoglossus. 12 specimens.
Pleuronectes microcephalus. 4 specimens.
Drepanopsetta platessoides. 3 specimens.

Bryozoa:
Flustra foliacea.

Stellerida:
Asterias rubens.

Anthozoa:
Alcyonium digitatum.

Nr. 20. **The Skager Rack.** $^1/_2$ mile north of the Lightship of the Skaw. 30 fathoms.
Journal-number 69. 17. June, 1898. **Otter-seine.**

Pisces:
Gadus æglefinus. 3 specimens.
Gadus merlangus. 20 specimens.
Gadus Esmarkii. 4 specimens.
Gadus minutus. 3 specimens.
Pleuronectes platessa. 1 specimen.
Drepanopsetta platessoides. 1 specimen.

Stellerida:
Asterias rubens.

Anthozoa:
Alcyonium digitatum.

Nr. 21. **The Skager Rack.** North of the Lightship of the Skaw. 25—20 fathoms.
Journal-number 78. 5. July, 1898. **Otter-seine with large meshes.** (22 min.)

Pisces:
Trigla gurnardus. 1 specimen.
Gadus æglefinus. 34 specimens.
Gadus merlangus. 2 specimens.
Pleuronectes platessa. 8 spec. (5 good-sized).
Pleuronectes limanda. 34 specimens.
Pleuronectes microcephalus. 1 specimen.
Drepanopsetta platessoides. 29 specimens.

Chætopoda:
Aonides fulgens. Great masses.

Stellerida:
Asterias rubens.

Nr. 22. **The Skager Rack.** North of the Lightship of the Skaw. 45—50 fathoms.
Journal-number 79. 6. July, 1898. **Otter-seine with large meshes.** (1 hour.)

Pisces:
Gadus æglefinus. 7 specimens.
Gadus merlangus. 1 specimen.
Pleuronectes microcephalus. 2 specimens.
Drepanopsetta platessoides. 5 specimens.
Raja radiata. 17 specimens.

Gasteropoda:
Tritonia Hombergi.

Echinida:
Spatangus purpureus.
Amphidetus cordatus. A few.

Stellerida:
Asterias rubens.
Astropecten Mülleri.
Ophiotrix fragilis.

Anthozoa:
Alcyonium digitatum. Masses.

Nr. 23. **The Skager Rack.** North of the Lightship of the Skaw. 40—50 fathoms.
Journal-number 80. 6. July, 1898. **Otter-seine with large meshes.** (1 hour.)

Pisces:
Trigla gurnardus. 2 specimens.
Gadus æglefinus. 5 specimens.
Gadus merlangus. 5 specimens.
Pleuronectes limanda. 4 specimens.
Pleuronectes cynoglossus. 5 specimens.
Drepanopsetta platessoides. 20 specimens.
Raja radiata. 1 specimen.

Echinida:
Brissopsis lyrifera. Many.

Stellerida:
Asterias rubens. Many.
Astropecten Mülleri.
Luidia Sarsii.
Ophioglypha Sarsii.
Ophiothrix fragilis.

Anthozoa:
Alcyonium digitatum.

Nr. 24. **The Skager Rack.** NE of the Lightship of the Skaw. 45 fathoms.
Journal-number 81. 6. July, 1898. **Otter-seine.**

Pisces:
Gadus callarias (large). 1 spec., besides young fish from this year. 10 spec.
Gadus æglefinus. Young fish from this year. 5 specimens.
Gadus merlangus. 4 specimens.
Pleuronectes platessa. 2 specimens.
Pleuronectes cynoglossus. 7 specimens.
Pleuronectes microcephalus. 1 specimen.
Drepanopsetta platessoides. 9 specimens.
Myxine glutinosa. 3 specimens.

Echinida:
Brissopsis lyrifera.

Stellerida:
Asterias rubens. A few.

Anthozoa:
Alcyonium digitatum.

Nr. 25. **The Skager Rack.** NE of the Lightship of the Skaw. 40 fathoms.
Journal-number 82. 6. July, 1898. **Otter-seine.**

Pisces:
Trigla gurnardus. 4 specimens.
Anarrhichas lupus. 1 spec. Roe of 3mm, but far from mature.
Gadus callarias. 1 specimen.
Gadus æglefinus. 12 specimens.
Gadus merlangus. 47 specimens.
Gadus minutus. 3 specimens.
Pleuronectes limanda. 3 specimens.
Pleuronectes cynoglossus. 5 specimens.
Drepanopsetta platessoides. 30 specimens.
Raja clavata. 1 specimen.
Myxine glutinosa. 3 specimens.

Cephalopoda:
Sepiola scandica. 1 specimen.

Echinida:
Brissopsis lyrifera. Masses.

Stellerida:
Asterias rubens.

Nr. 26. **The Skager Rack.** NE of the Lightship of the Skaw, c. 10 miles. 39—45 fathoms.
Journal-number 95. 11. July, 1898. **Otter-seine.**

Pisces:
Trigla gurnardus. 2 spec. (1 mature ♁ and 1 ♂.)
Gadus callarias. 1 specimen.
Gadus æglefinus. 10 spec.; among which 7 young fish.
Gadus merlangus. 10 specimens.
Gadus Esmarkii. 2 specimens.
Gadus minutus. 1 specimen.
Pleuronectes cynoglossus. 1 specimen.
Drepanopsetta platessoides. 12 specimens.

Crustacea:
Crangon sp.

Lamellibranchia:
Pecten septemradiatus.

Echinida:
Brissopsis lyrifera.

Stellerida:
Asterias rubens.

The neighbourhood of the Skaw. 20—12 Fathoms.

Nr. 27. **The Cattegat.** East of the Lighthouse of the Skaw. 11—12 fathoms.
Journal-number 70. 17. June, 1898. **Otter-seine.**

Pisces:
Gadus æglefinus. 11 specimens.
Gadus merlangus. 14 specimens.
Pleuronectes platessa. 1 specimen.
Pleuronectes limanda. 31 specimens.
Pleuronectes microcephalus. 2 specimens.
Arnoglossus laterna ♂. 1 specimen.

Nr. 28. **The Cattegat.** The Lighthouse of the Skaw in NW. 3 miles. 12 fathoms.
Journal-number 71. 17. June, 1898. **Otter-seine.** ($^1/_2$ hour.)

Pisces:
Gadus callarias. 1 specimen.
Gadus æglefinus. 11 specimens.
Gadus merlangus. 18 specimens.
Pleuronectes platessa. 11 specimens.
Pleuronectes limanda. 28 specimens.
Drepanopsetta platessoides. 3 specimens.

Nr. 29. **The Cattegat.** SSE of the Lighthouse of the Skaw. 12 fathoms.
Journal-number 72. 17. June, 1898. **Otter-seine.**

Pisces:
Gadus callarias. 1 specimen.
Gadus merlangus. 6 specimens.
Pleuronectes limanda. 2 specimens.
Clupea sprattus. 3 specimens.

Nr. 30. **The Cattegat.** The Lighthouse of the Skaw in W by N. 18—19 fathoms.
Journal-number 83. 6. July, 1898. **Otter-seine with large meshes.** ($^3/_4$ hour.)

Pisces:
Trigla gurnardus. 4 specimens.
Gadus æglefinus. 4 specimens.
Gadus merlangus. 4 specimens.
Pleuronectes platessa. 34 specimens.
Pleuronectes limanda. 40 specimens.
Pleuronectes microcephalus. 1 specimen.
Drepanopsetta platessoides. 4 specimens.

Crustacea:
Paguri in shells of Neptunea.

Gasteropoda:
Neptunea antiqua.

Echinida:
Brissopsis lyrifera.

Stellerida:
Asterias rubens.
Asterias glacialis.
Astropecten Mülleri.

Nr. 31. **The Cattegat.** 3 miles SE of the Lightship of the Skaw. 17 fathoms.
Journal-number 84. 6. July, 1898. **Otter-seine with large meshes.** ($^3/_4$ hour.)

Pisces:
Trigla gurnardus. 1 specimen.
Gadus æglefinus. 14 specimens.
Gadus merlangus. 1 specimen.
Merlucius smiridus. 1 spec. Mature milt.
Pleuronectes platessa. 22 specimens, 16 of which over 10 inches.
Pleuronectes limanda. 52 specimens.
Pleuronectes microcephalus. 3 specimens.
Drepanopsetta platessoides. 7 specimens.
Raja batis. 1 specimen.

Gasteropoda:
Buccinum undatum.
Neptunea antiqua.

Stellerida:
Asterias rubens.
Asterias glacialis.

Anthozoa:
Alcyonium digitatum. A few.

Nr. 32. **The Cattegat.** SE by E of the Lighthouse of the Skaw. 12 miles. 17 fathoms.
Journal-number 92. 11. July, 1898. **Otter-seine.** ($^1/_4$ hour.)

Pisces:
Trigla gurnardus ♂. 1 specimen.
Callionymus maculatus ♂. 2 specimens.
Gadus æglefinus. 9 spec., of which 1 young fish.
Gadus merlangus. 29 specimens.
Pleuronectes platessa. 9 specimens.
Pleuronectes limanda. 14 specimens.

Drepanopsetta platessoides. 1 specimen.
Arnoglossus laterna. 2 specimens (small ♂, large ♀).

Echinida:
Brissopsis lyrifera.

Stellerida:
Asterias rubens.

Anthozoa:
Pennatula phosphorea.

Nr. 33. **The Catlegat.** SE by E of the Lighthouse of the Skaw. 12 miles. 17 fathoms.
Journal-number 93. 11. July, 1898. **Otter-seine.** (1/4 hour.)

Pisces:
Trigla gurnardus. 1 specimen.
Callionymus maculatus. 2 specimens.
Gadus æglefinus. 5 specimens.
Gadus merlangus. 25 specimens.
Pleuronectes platessa. 11 specimens.
Pleuronectes limanda. 34 specimens.
Drepanopsetta platessoides. 4 specimens.
Arnoglossus laterna. 5 specimens ♀.
Bothus rhombus. 1 spec. Mature roe.

Crustacea:
Nephrops norvegicus. 1 specimen.

Chætopoda:
Aphrodite sp.

Echinida:
Brissopsis lyrifera.

Stellerida:
Asterias rubens.

Anthozoa:
Pennatula phosphorea.

Nr. 34. **The Cattegat.** The Lighthouse of the Skaw in N. 7 miles. 12 fathoms.
Journal-number 102—103. 12. July, 1898. **Otter-seine.** 2 hauls.

Pisces:
Callionymus maculatus. 1 specimen.
Gadus æglefinus. 2 specimens.
Gadus merlangus. 7 specimens.
Gadus callarias. 1 specimen.
Merlucius smiridus. 1 specimen.
Pleuronectes platessa. 15 specimens.
Pleuronectes limanda. 29 specimens.
Pleuronectes microcephalus. 2 specimens.
Arnoglossus laterna. 2 specimens.

Stellerida:
Asterias rubens.

Anthozoa:
Pennatula phosphorea.
Alcyonium digitatum.

From the Skaw to Anholt, east of Læsø.

(Mainly on rather deep water.)

Nr. 35. **The Cattegat.** The Lighthouse of the Skaw in W by N 1/2 N. 16 miles. 21 fathoms.
Journal-number 94. 11. July, 1898. **Otter-seine.**

Pisces:
Trigla gurnardus. 6 specimens.
Callionymus maculatus ♂. 1 specimen.
Gadus æglefinus. 4 specimens.
Gadus merlangus. 205 specimens.
Merlucius smiridus. 4 spec., among which 1 of 39 inches in length, 17 1/2 lbs.; much immature roe.
Onos cimbrius. 1 specimen.
Pleuronectes platessa. 11 specimens.
Pleuronectes limanda. 67 specimens.
Pleuronectes microcephalus. 1 specimen.
Pleuronectes cynoglossus. 1 specimen.
Drepanopsetta platessoides. 10 specimens.

Crustacea:
Nephrops norvegicus. 8 specimens.

Echinida:
Brissopsis lyrifera.

Stellerida:
Asterias rubens.

Anthozoa:
Pennatula phosphorea.

Nr. 36. **The Cattegat.** NW of Vinga. $14^1/_2$ miles. 27–25 fathoms.
Journal-number 90. 8. July, 1898. **Otter-seine.**

Pisces:

Trigla gurnardus. 4 spec. Mature roe.
Callionymus maculatus. 34 spec. Roe near maturity.
Lumpenus lampetriformis. 1 specimen.
Gadus æglefinus (large). 1 spec.; moreover young fish from this year.
Gadus merlangus. 140 spec.; moreover 2 young fish from this year.
Gadus minutus. 6 specimens.
Merlucius smiridus. 1 specimen.
Onos cimbrius. 6 specimens.
Pleuronectes platessa. 1 specimen.
Pleuronectes limanda. 12 specimens.
Drepanopsetta platessoides. 49 specimens.

Crustacea:

Nephrops norvegicus. 77 specimens.

Lamellibranchia:

Isocardia cor.
Solen pellucidus.

Echinida.

Brissopsis lyrifera. Many.
Amphidetus cordatus.

Stellerida:

Asterias rubens. Large.
Astropecten Mülleri.

Anthozoa:

Pennatula phosphorea.

Nr. 37. **The Cattegat.** Vinga Lighthouse in SE by E. 8 miles. 40–55 fathoms.
Journal-number 86. 8. July, 1898. **Otter-seine.**

Pisces:

Lycodes gracilis. 7 specimens.
Gadus minutus. 1 specimen.
Onos cimbrius. 3 specimens.
Pleuronectes microcephalus. 1 specimen.
Myxine glutinosa. 1 specimen.

Crustacea:

Portunus sp.
Pandalus Montagui.
Pandalus borealis.
Crangon Allmanni.

Lamellibranchia:

Leda pernula.
Nucula sulcata.

Echinida:

Brissopsis lyrifera. Masses.

Stellerida:

Goniaster phrygianus.
Amphiura sp.
Ophioglypha Sarsii.

Nr. 38. **The Cattegat.** NW of Vinga. 9 miles. 50 fathoms.
Journal-number 87. 8. July, 1898. **Otter-seine with large meshes.**

Pisces:

Gadus callarias (large). 1 specimen.
Pleuronectes microcephalus. 1 specimen.
Drepanopsetta platessoides. 4 specimens.
Raja radiata. 2 specimens.

Crustacea:

Lithodes Maja.
Cancer pagurus.

Echinida:

Echinus esculentus.
Brissopsis lyrifera. 2 Danish Tønder.

Stellerida:

Goniaster phrygianus.
Ophioglypha Sarsii.

Anthozoa:

Aktiniæ.

NB. The bottom consisted of soft clay deposits; nevertheless the trawl took up half a score of stones (as large as 5 inches in diam.) along with the fish.

Nr. 39. **The Cattegat.** WNW of Vinga Lighthouse. 13 miles. 21 fathoms.
Journal-number 85. 8. July, 1898. **Otter-seine.**

Pisces:

Trigla gurnardus. 9 spec. Mature roe.
Callionymus maculatus. 3 specimens.
Gadus callarias. 1 spec.; moreover 1 young fish from this year.
Gadus æglefinus. 3 specimens.
Gadus merlangus. 276 specimens.
Pleuronectes platessa (large). 6 specimens.
Pleuronectes limanda. 33 specimens.
Pleuronectes microcephalus. 1 specimen.
Drepanopsetta platessoides. 7 specimens.
Raja sp., pull. 1 specimen.

Crustacea:
Nephrops norvegicus. 2 specimens.

Echinida:
Brissopsis lyrifera. Many.

Stellerida:
Asterias rubens.
Astropecten Mülleri.

Anthozoa:
Pennatula phosphorea. Masses.

Nr. 40. **The Cattegat.** NW of Vinga Lighthouse. 12 miles. 30 fathoms.
Journal-number 88. 8. July, 1898. **Otter-seine with large meshes.**

Pisces:
Pleuronectes cynoglossus. 2 specimens.
Drepanopsetta platessoides. 2 specimens.

Crustacea:
Nephrops norvegicus. 13 specimens.
[Of these: 10 ♂ Average size 7½ inch., 3 ♀ (one with roe); the largest 6 inches].
Lithodes Maja.

Lamellibranchia:
Isocardia cor. 2 specimens.
(NB. 1 empty shell with eggs of gobii, probably of Aphya.)

Echinida:
Brissopsis lyrifera.

Stellerida:
Goniaster phrygianus (half a score.)

Anthozoa:
Pennatula phosphorea.

Clay deposits, but less soft than out in the channel.

Nr. 41. **The Cattegat.** NW of Vinga. 14 miles. 26 fathoms.
Journal-number 89. 8. July, 1898. **Otter-seine with large meshes.**
Clay deposits.

Pisces:
Trigla gurnardus. 1 spec. Mature roe.
Gadus æglefinus. 3 specimens.
Gadus merlangus. 4 specimens.
Merlucius smiridus. 1 specimen.
Pleuronectes platessa. 2 specimens.
Pleuronectes limanda. 8 specimens.
Drepanopsetta platessoides. 4 specimens.
Raja batis. 1 specimen.

Crustacea:
Nephrops norvegicus. 35 specimens.

Lamellibranchia:
Isocardia cor.

Echinida:
Brissopsis lyrifera. Many.

Stellerida:
Asterias rubens (large).
Goniaster phrygianus.

Anthozoa:
Pennatula phosphorea.

NB. The contents of the stomachs of the haddocks:
Ophiuridæ, Chætopoda (especially Pectinaria), small bivalves (especially Cardium), but chiefly Ophiuridæ (Amphiura).

The contents of the stomachs of the whitings:
Spratts.

Nr. 42. **The Cattegat.** Between the Lightship of Trindelen and Trekosten. 15—20 fathoms.
Journal-number 108—109. 22. August, 1898. **Otter-seine** with coir-rope 2¼ inch. 2 hauls (½ hour each.)

Pisces:
Trigla gurnardus. 1 specimen.
Gadus callarias. 3 spec., moreover 1 young fish from this year.
Gadus æglefinus. 1 specimen.
Gadus merlangus. 1 specimen.
Pleuronectes platessa. 16 spec. The largest 16 inches.
Pleuronectes limanda. 23 specimens.
Pleuronectes microcephalus. 2 specimens.
Drepanopsetta platessoides. 4 specimens.
Arnoglossus laterna. 14 specimens.
Bothus rhombus. 3 specimens.

Echinida:
Amphidetus cordatus. Small.

Stellerida:
Solaster papposus. 2 specimens.
Asterias rubens. Many.
Asterias glacialis. 2 specimens.
Astropecten Mülleri.

Several Laminariæ.

Nr. 43. **The Cattegat.** The Buoy of Knallen. 9 fathoms.
Journal-number 40. 3. July, 1897. **Plaice-seines of 3 inches.** 2 hauls.

Pisces:
Trigla gurnardus. 2 specimens.
Lophius piscatorius. 2 specimens.
Anarrhichas lupus. 3 specimens.
Gadus callarias. 9 specimens.
Gadus æglefinus. 1 specimen.
Pleuronectes platessa. 473 spec., of which 188 spec. over 10 inches.
Pleuronectus flesus. 1 specimen.
Pleuronectes limanda. 885 specimens.
Pleuronectes microcephalus. 3 specimens.
Drepanopsetta platessoides. 1 specimen.
Hippoglossus vulgaris. 8 spec. 1—2 feet.
Bothus maximus. 1 specimen.
Bothus rhombus. 3 specimens.
Solea vulgaris. 1 specimen.
Raja clavata. 2 specimens.
Raja batis (small). 2 specimens.

Nr. 44. **The Kattegat.** The Buoy of Knallen. 14 fathoms.
Journal-number 41. 5. July, 1897. **Plaice-seines of 3 inches.** 2 hauls.

Pisces:
Trigla gurnardus. 1 specimen.
Lophius piscatorius. 2 specimens.
Anarrhichas lupus. 3 specimens.
Gadus callarias. 3 specimens.
Pleuronectes platessa. 318 spec., of which 122 spec. over 10 inches.
Pleuronectes limanda. 540 specimens.
Pleuronectes microcephalus. 9 specimens.
Hippoglossus vulgaris. 3 spec. 1—2 feet.
Bothus maximus. 1 specimen.
Bothus rhombus. 6 specimens.
Solea vulgaris. 5 specimens.
Raja sp. 3 specimens.

Nr. 45. **The Cattegat.** East of Trekosten. (NE of Læso). 20 fathoms.
Journal-number 111. 23. August, 1898. **Otter-seine.** (55 minutes.)

Pisces:
Gadus callarias. 2 specimen.
Gadus æglefinus. 8 specimens.
Gadus merlangus. 15 specimens.
Pleuronectes platessa (large). 3 specimens.
Pleuronectes limanda. 13 specimens.
Pleuronectes microcephalus. 2 specimens.
Drepanopsetta platessoides. 9 specimens.
Solea vulgaris (large). 1 specimen.
Arnoglossus laterna. 33 specimens.

Crustacea:
Nephrops norvegicus. 1 specimen.

Stellerida:
Asterias rubens. Many.
Asterias glacialis.

Several Laminariæ, etc.

Nr. 46. **The Cattegat.** Trindelen in S by E $^1/_2$ E. 20—15 fathoms.
Journal-number 62 a. 15. October, 1897. **Otter-seine.** 2 hauls. (1 hour & $^1/_2$ hour.)

Pisces:
Trigla gurnardus. 2 specimens.
Ctenolabrus rupestris. 2 specimens.
Caranx trachurus. 3 specimens.
Gobius minutus. A few.
Aphya pellucida. 1 specimen.
Centronotus gunellus. 3 specimens.
Gadus callarias. 2 spec. and a number of young fish from this year.
Gadus merlangus. 897 spec., of which 57 spec. large.
Gadus æglefinus. 9 specimens.
Gadus Esmarkii. 2 specimens.
Pleuronectes platessa (large). 5 specimens.
Pleuronectes limanda. 28 specimens.
Pleuronectes microcephalus. 2 specimens.
Drepanopsetta platessoides. 6 specimens.
Bothus maximus (large). 1 specimen.
Bothus rhombus. 2 specimens.
Zeugopterus sp., pull. 2 specimens.
Arnoglossus laterna. 5 specimens.
Solea vulgaris. 2 specimens.
Clupea sprattus. 1 specimen.

Crustacea:
Pandalus Montagui.

Cephalopoda:
Loligo media. Several.

Echinida:
Echinus esculentus.

Stellerida:
Asterias rubens.
Astropecten Mülleri.

Several Laminariæ.

Nr. 47. **The Cattegat.** North of the Lightship of Kobbergrunden. 1 mile. 10—17 fathoms.

Journal-number 114. 26. August, 1898. **Otter-seine.** ($^3/_4$ hour.)

Pisces:
Gadus æglefinus. 2 specimens.
Gadus merlangus. 1 specimen.
Pleuronectes limanda. 4 specimens.
Drepanopsetta platessoides. 1 specimen.
Arnoglossus laterna. 3 specimens.

Echinida:
Amphidetus cordatus.

Stellerida:
Asterias rubens. Small.
Asterias glacialis. Small.

Masses of rotten Zostera.

Nr. 48. **The Cattegat.** The Lightship of Kobbergrunden in NW by W. $3^1/_2$ miles. 25—16 fathoms.

Journal-number 115. 26. August, 1898. **Otter-seine**, with a coir-rope under it, $2^1/_4$ inches thick.

Pisces:
Gadus callarias. 1 specimen.
Bothus rhombus. 1 specimen.
Arnoglossus laterna. 2 specimens.

Lamellibranchia:
Pecten maximus. Empty shell.

Bryozoa:
Alcyonidium gelatinosum.

Tunicata:
Corella parallelogramma.
Phallusia mentula.

Stellerida:
Asterias rubens.
Asterias glacialis.
Astropecten Mülleri.

Anthozoa:
Alcyonium digitatum.

Spongiæ:
Suberites.

Masses of Laminariæ.

Nr. 49. **The Cattegat.** North of the Lightship of Kobbergrunden. 4 miles. 40—25 fathoms.

Journal-number 113. 26. August, 1898. **Otter-seine.** (1 hour.)

Pisces:
Callionymus maculatus. 3 specimens.
Lycodes gracilis. 1 specimen.
Gadus callarias. 7 specimens.
Gadus æglefinus. 1 specimen.
Gadus merlangus. 90 specimens. None over 10 inches.
Gadus minutus. 4 specimens.
Gadus Esmarkii. 18 specimens.
Pleuronectes platessa. 2 specimens. 18 inch.
Pleuronectes limanda. 7 specimens.
Drepanopsetta platessoides. 43 specimens. (1 quite small, 2 inches. Most likely 3 annual series.)
Bothus rhombus. 1 specimen.
Raja batis. 1 specimen.
Myxine glutinosa. c. 10 specimens.

Crustacea:
Galathea sp.
Portunus sp.
Calocaris Macandreæ. 1 specimen.
Pandalus Montagui. 3 specimens.
Pandalus borealis. 125 specimens.
Hippolyte sp.
(Thysanopus in the stomachs of the fishes.)

Echinida:
Brissopsis lyrifera.

Stellerida:
Solaster endeca. 1 specimen.
Luidia Sarsii.
Amphiura filiformis.

Ophioglypha Sarsii.
Ophiothrix fragilis.

Anthozoa:
Alcyonium digitatum.

Nr. 50. **The Cattegat.** Anholt Lighthouse in SW ½ S. 7 miles. 23 fathoms.
Journal-number 27. 26. May, 1897. **Plaice-seines with small and large meshes.**

Pisces:
Callionymus maculatus. C. 50 specimens.
Gobius minutus. 2 specimens.
Gadus æglefinus. 5 specimens.
Pleuronectes cynoglossus. 24 specimens.
Pleuronectes limanda. 16 specimens.
Solea vulgaris. 1 specimen.
Drepanopsetta platessoides. C. 80. spec.
Raja sp. 1 specimen.

Crustacea:
Crangon Allmanni.
Hippolyte securifrons.
Pandalus Montagui.
Eupagurus Bernhardus.

Gasteropoda:
Turritella sp. A great number.
Buccinum undatum.
Neptunea antiqua.
Neptunea propinqua.

Lamellibranchia:
Nucula sulcata. A great number.
Leda sp.

Echinida:
Brissopsis lyrifera. A great number.

Stellerida:
Asterias rubens.
Goniaster phrygianus. 11 specimens.
Astropecten Mülleri. 1 specimen.
Luidia Sarsii. A few.
Ophioglypha albida.

Anthozoa:
Bolocera longicornis. 4 specimens.

Nr. 51. **The Cattegat.** The Lightship of Fladen in NW by N. 4 miles. 30 fathoms.
Journal-number 28. 26. May, 1897. **Plaice-seine with small meshes.**

Pisces:
Callionymus maculatus. 3 specimens.
Lycodes gracilis. 1 specimen.
Pleuronectes limanda. 1 specimen.
Pleuronectes microcephalus. 1 specimen.
Drepanopsetta platessoides. 2 specimens.

Crustacea:
Crangon sp.
Hippolyte sp. 1 specimen.

Chætopoda:
Large tubes of Annelida.

Echinida:
Brissopsis lyrifera. A great number.

Stellerida:
Amphiura sp.

Frederikshavn and north of Læsø. C. 20-10 Fathoms.

Nr. 52. **The Cattegat.** North of Nordre Rønner. 18—20 fathoms.
Journal-number 54—55. 16. July, 1897. **Otter-seine.** 2 hauls.

Pisces:
Callionymus maculatus. 13 specimens.
Lumpenus lampetriformis. 1 specimen.
Trigla gurnardus. 6 specimens.
Gadus æglefinus. 1 spec., together with fry of c. 3 inches.
Gadus callarias. 1 spec., together with fry of c. 2 inches.
Gadus merlangus. C. 50 spec., of sizes c. 6½ inches and 10 inches, together with fry of 2—3 inches.
Gadus Esmarkii. 3 specimens.
Pleuronectes platessa. 3 specimens.
Pleuronectes cynoglossus. 2 specimens.
Pleuronectes limanda. 32 specimens.
Drepanopsetta platessoides. C. 70 spec.
Zeugopterus norvegicus. 1 specimen.
Arnoglossus laterna. 1 specimen.
Raja batis. 1 specimen.
Myxine glutinosa. 1 specimen.

Crustacea:
Pandalus Montagui. Several.
Hippolyte Gaimardi. Some specimens.

Echinida:
Brissopsis lyrifera. Many.

Stellerida:
Astropecten Mülleri.
Asterias rubens.

Anthozoa:
Pennatula phosphorea. Many.

Nr. 53. **The Cattegat.** North of Læsø. c. 11 fathoms.
Journal-number 63 a. 15. October, 1897. **Otter-seine.** (1/2 hour.)

Pisces:
Trigla gurnardus. 2 specimens.
Gobius minutus. A few.
Gadus merlangus. Some specimens.
Merlucius smiridus. 1 specimen.
Pleuronectes platessa. 2 specimens.
Pleuronectes microcephalus. 1 specimen.
Drepanopsetta platessoides. 1 specimen.
Arnoglossus laterna. 2 specimens.
Solea vulgaris. 3 specimens.
Solea lutea. 3 specimens.
Clupea harengus (small). Some specimens.

Crustacea:
Cancer pagurus (large). 4 specimens.

Cephalopoda:
Loligo media.

Nr. 54. **The Cattegat.** East of Sæby. 20 fathoms.
Journal-number 63 and 64. 27. April, 1898. **Otter-seine.** 2 hauls.

Pisces:
Trigla gurnardus. 1 specimen.
Gobius minutus. 1 specimen.
Lumpenus lampetriformis. 2 specimens.
Gadus callarias. 10 specimens.
Gadus æglefinus (large). 13 specimens.
Gadus merlangus (small). 549 specimens.
Onos cimbrius. 1 specimen.
Pleuronectes platessa. 1 specimen.
Pleuronectes flesus. 1 specimen.
Pleuronectes limanda. 16 specimens.
Drepanopsetta platessoides. 40 specimens.
Raja clavata. 1 specimen.

Nr. 55. **The Cattegat.** East of Sæby. 18 fathoms.
Journal-number 65. 27. April, 1898. **Otter-seine with large meshes.** (1 hour.)

Pisces:
Gadus callarias. 3 specimens.
Gadus æglefinus. 10 specimens.
Gadus merlangus. 5 specimens.
Pleuronectes platessa. 1 specimen.
Pleuronectes limanda. 16 specimens.
Drepanopsetta platessoides. 12 specimens.
Solea vulgaris. 1 specimen.

Nr. 56. **The Cattegat.** NW of Nordre Ronner. 20 fathoms.
Journal-number 76. 18. June, 1898. **Otter-seine.**

Pisces:
Gadus callarias. 2 spec., one of which 2 inches, from Cyanea?
Gadus Esmarkii. 1 specimen.
Gadus æglefinus. 13 specimens.
Gadus merlangus. 29 specimens.
Pleuronectes limanda. 20 specimens.
Drepanopsetta platessoides. 87 specimens.

Echinida:
Brissopsis lyrifera. Many.

Anthozoa:
Pennatula phosphorea. A few.

Nr. 57. **The Cattegat.** NW of Nordre Rønner. 20 fathoms.
Journal-number 77. 18. June, 1898. **Otter-seine.** (1/2 hour.)

Pisces:
Gadus æglefinus. 14 specimens.
Gadus merlangus. 30 specimens.
Pleuronectes platessa. 3 specimens.
Pleuronectes limanda. 28 specimens.
Drepanopsetta platessoides. 82 specimens.
Callionymus maculatus. 4 specimens.
Clupea sprattus. 1 specimen.

Echinida:
Brissopsis lyrifera. Many.

Nr. 58. The Cattegat. NE of Hirtsholmene. 6 miles. 11 fathoms.
Journal-number 101. 12. July, 1898. Otter-seine.

Pisces:
Aphya pellucida. 1 specimen.
Pleuronectes platessa. 3 specimens.
Pleuronectes limanda. 2 specimens.
Arnoglossus laterna. 1 specimen.

Crustacea:
Galathea sp.

Stellerida:
Asterias rubens. Small.

Anthozoa:
Pennatula phosphorea.

Nr. 59. The Cattegat. SE of the harbour of Frederikshavn. 6 miles. 11 fathoms.
Journal-number 104. 13. July, 1898. Otter-seine.

Pisces:
Gadus callarias (2 years old). 1 spec.
Gadus merlangus. 6 specimens.
Pleuronectes platessa. 28 specimens.
Pleuronectes limanda. 39 specimens.
Arnoglossus laterna ♀. 1 specimen.

Echinida:
Amphidetus cordatus.

Stellerida:
Asterias rubens.

Nr. 60. The Cattegat. NW of Nordre Rønner. 5 miles. 23—16 fathoms.
Journal-number 105—106. 13. July, 1898. Otter-seine. (2 hauls.)

Pisces:
Anarrhichas lupus ♀. 1 spec. A little roe.
Gadus callarias. 4 spec., 2 of which from this year.
Gadus æglefinus. 64 specimens.
Gadus merlangus. 153 specimens.
Pleuronectes platessa. 20 specimens.
Pleuronectes limanda. 32 specimens.
Drepanopsetta platessoides. 82 specimens.
Raja batis. 1 specimen.

Crustacea:
Pandalus Montagui.

Echinida:
Brissopsis lyrifera.

Stellerida:
Asterias rubens.

Nr. 61. The Cattegat. NW by W of Nordre Rønner. 15 fathoms
Journal-number 107. 13. July, 1898. Otter-seine. (50 minutes.)

Pisces:
Trigla gurnardus. 7 specimens.
Gadus callarias. 1 specimen.
Gadus æglefinus. 20 specimens.
Gadus merlangus. 138 specimens.
Pleuronectes platessa. 16 specimens.
Pleuronectes limanda. 38 spec., moreover 1 young fish, $^3/_4$ inch.
Drepanopsetta platessoides. 1 specimen.
Bothus rhombus. 1 specimen.
Clupea harengus. 1 specimen.

Turbellaria:
Nemerteans, large, broad. 2 specimens.

Echinida:
Brissopsis lyrifera.
Amphidetus cordatus.

Stellerida:
Asterias rubens. Many.

Nr. 62. The Cattegat. Læsø Channel. 21 fathoms.
Journal-number 116. 29. August, 1898. Otter-seine. (15 minutes.)

Pisces:
Callionymus maculatus. 2 specimens.
Gadus merlangus. 4 spec. Small.
Pleuronectes limanda. 1 young fish from last year.
Drepanopsetta platessoides. 4 spec., among which 3 young fish from last year.

Lamellibranchia:
Leda pernula.

Echinida:
Brissopsis lyrifera.

Stellerida:
Asterias rubens.
Astropecten Mülleri.
Amphiura filiformis.

Anthozoa:
Pennatula phosphorea.

Nr. 63. **The Cattegat.** NW of Nordre Rønner. $4^1/_2$ miles. 17 fathoms.
Journal-number 117. 29. August, 1898. **Otter-seine.**

Pisces:
Gadus æglefinus. 1 specimen.
Gadus merlangus. 96 spec. Small.
Merlucius smiridus. 1 specimen.
Pleuronectes platessa. 1 specimen.
Pleuronectes limanda. 4 specimens.
Drepanopsetta platessoides. 7 specimens.
Clupea sprattus. 6 specimens.

Echinida:
Brissopsis lyrifera.

Stellerida:
Asterias rubens.
Astropecten Mülleri.
Amphiura filiformis.

Nr. 64. **The Cattegat.** NW of Nordre Rønner. 4 miles. 16—18 fathoms.
Journal-number 118. 29. August, 1898. **Otter-seine.** ($^1/_2$ hour.)
Soft clay deposits.

Pisces:
Trigla gurnardus. 2 specimens.
Callionymus maculatus. 5 specimens.
Gobius minutus. 1 specimen.
Gadus æglefinus. 4 specimens.
Gadus merlangus. 95 specimens.
Pleuronectes platessa. 1 specimen.
Pleuronectes limanda. 18 spec., among which 5 young fish from last year.
Drepanopsetta platessoides. 17 specimens.

Crustacea:
Cancer pagurus.
Portunus sp.

Lamellibranchia:
Pecten opercularis.

Echinida:
Brissopsis lyrifera.

Stellerida:
Asterias rubens.

Nr. 65. **The Cattegat.** Nordre Rønner in East. 4 miles. 16 fathoms.
Journal-number 119. 29. August, 1898. **Otter-seine.** ($^1/_2$ hour.)

Pisces:
Trigla gurnardus. 4 spec. Mature, running roe.
Callionymus lyra. 1 spec. ♂ & 3 spec. ♀. No roe.
Gobius minutus. Some few.
Gadus æglefinus. 5 specimens.
Gadus merlangus. 51 spec. Small.
Pleuronectes platessa. 4 specimens.
Pleuronectes limanda. 19 spec., among which 3 young fish from last year.
Pleuronectes microcephalus. 2 specimens.
Drepanopsetta platessoides. 12 spec., among which 1 young fish from last year.
Solea lutea. 2 specimens.

Echinida:
Brissopsis lyrifera.

Stellerida:
Asterias rubens.
Astropecten Mülleri.

The Northern Cattegat. C. 9—3 Fathoms.

Nr. 66. **The Cattegat.** Muldbjergene in WNW. Jyske Aas in NNW. $6^1/_2$ fathoms.
Journal-number 64 a. 27. June, 1897. **Plaice-seine of 3 inches.** 2 hauls.
Light-coloured sand deposits.

Pisces:
Cottus scorpius. 3 specimens.
Trigla gurnardus. 2 specimens.
Gasterosteus aculeatus. 1 specimen.
Gobius sp.
Zoarces viviparus. 4 specimens.
Gadus callarias. 6 specimens.
Gadus merlangus. 3 specimens.
Pleuronectes platessa. 6 specimens.
Pleuronectes limanda. 100 specimens.

Nr. 67. **The Cattegat.** Hals Church in W by S. Jyske Aas in NW $^1/_2$ N. 5—7 fathoms.
Journal-number 65 a. 28. June, 1897. **Plaice-seine of 3 inches.** 2 hauls.
Brown sand, mixed with clay.

Pisces:
Cottus scorpius. 5 specimens.
Gadus callarias. 3 specimens.
Gadus æglefinus. 1 specimen.
Pleuronectes platessa. 41 specimens.
Pleuronectes limanda. 47 specimens.

Nr. 68. **The Cattegat.** S of the harbour of Frederikshavn. 5 fathoms.
Journal-number 73. 18. June, 1898. **Otter-seine.** (15 minutes.)

Pisces:
Zoarces viviparus. 63 specimens.
Aphya pellucida. 1 specimen.
Gadus callarias. 4 specimens.
Gadus merlangus. 11 specimens.
Pleuronectes platessa. 60 specimens.
Pleuronectes limanda. 26 specimens.
Solea vulgaris. 1 specimen.
Gasterosteus aculeatus. Many.
Anguilla vulgaris. 1 specimen.

Crustacea:
Crangon vulgaris.

Echinida:
Amphidetus cordatus.

Stellerida:
Asterias rubens.
Ophiuridæ.

Nr. 69. **The Cattegat.** S of the harbour of Frederikshavn. 8 fathoms.
Journal-number 74. 18. June, 1898. **Otter-seine.** (20 minutes.)
Fine sand deposits.

Pisces:
Ctenolabrus rupestris. 1 specimen.
Cottus scorpius. 1 specimen.
Gadus merlangus. 8 specimens.
Pleuronectes platessa. 45 specimens.
Pleuronectes limanda. 59 specimens.
Arnoglossus laterna. 2 specimens.
Clupea sprattus. 1 specimen.
Clupea harengus (young fish, 4—5 inches). 4 spec.

Echinida:
Amphidetus cordatus.

Nr. 70. **The Cattegat.** Sæby Church in SW by W. $9^1/_2$ fathoms.
Journal-number 75. 18. June, 1898. **Otter-seine.** ($^1/_2$ hour.)

Pisces:
Trigla gurnardus. 1 spec. Small.
Gadus æglefinus. 1 specimen.
Gadus merlangus. 26 specimens.
Pleuronectes platessa. 16 specimens.
Pleuronectes limanda. 124 specimens.
Bothus rhombus. 1 specimen.

Echinida:
Amphidetus cordatus.

Nr. 71. **The Cattegat.** East of the Sandmiler. 7 fathoms.
Journal-number 97—98. 12. Juli, 1898. **Otter-seine.** 2 hauls.

Pisces:
Gadus merlangus. 14 specimens.
Pleuronectes platessa. 16 specimens.
Pleuronectes limanda. 4 specimens.
Bothus rhombus. 1 specimen.

Cephalopoda:
Loligo media.

Stellerida:
Asterias rubens. Small.
Astropecten Mülleri.

Nr. 72. **The Cattegat.** Aalbæksbugten. 8—9 fathoms.
Journal-number 99—100. 12. July, 1898. **Otter-seine.** 2 hauls.

Pisces:
Pleuronectes platessa. 6 specimens.
Pleuronectes limanda. 6 specimens.

Stellerida:
Asterias rubens. Small.

Nr. 73. **The Cattegat.** Trekosten. NE of Læso. 3 fathoms.
Journal-number 110. 22. August, 1898. **Otter-seine.** (10 minutes.)

Pisces:
Pleuronectes platessa. 5 specimens.

Lamellibranchia:
Mactra subtruncata. In numbers.

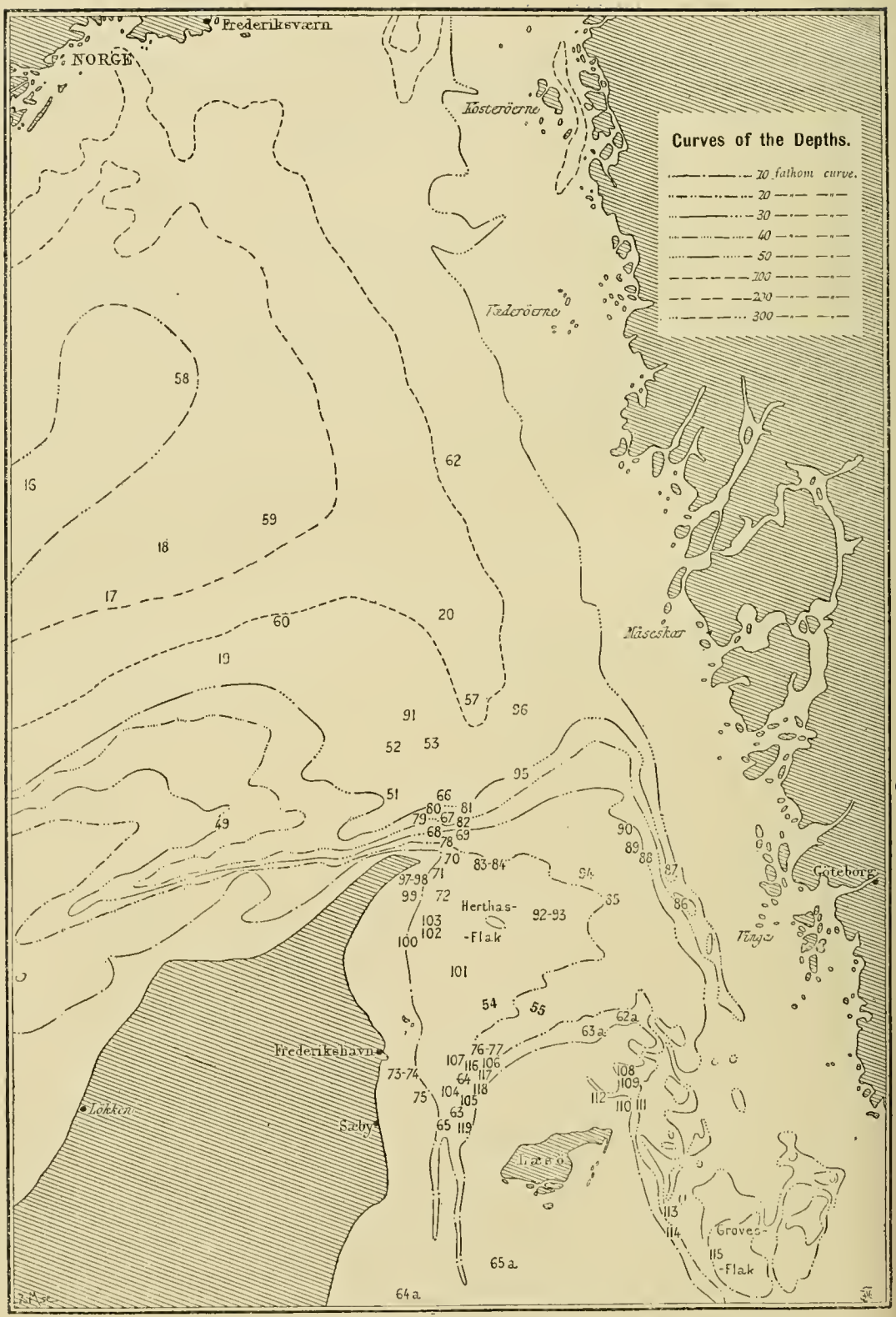
Stellerida:
Asterias rubens.

Nr. 74. **The Cattegat.** 2 miles W of Trekosten. (NE of Læso.)
10—6 fathoms.
Journal-number 112. 23. August, 1898. **Otter-seine.**

Pisces:
Trachinus draco. 1 specimen.
Liparis Montagui. 1 specimen.
Gadus merlangus. 2 specimens. Small.
Pleuronectes platessa. 2 specimens.
Raja clavata. 1 specimen.

Stellerida:
Asterias rubens. Small.

Several Laminariæ, etc.



The figures on the map refer to the journal-numbers un the preceding Travlings.

Part I:

The Northern Cattegat.

The investigations which the Biological Station made into the fish-fauna of the Cattegat, in the years 1897 and 98, were mainly limited to the northmost part of this sea, from the Skager Rack to a line a little south of Læsø. Considered as a whole, the Cattegat is by no means a deep sea; but in the part here described, we find depths of 50—60 fathoms (at one particular spot east of Læso even 75 fathoms), consequently considerably greater than in our other seas within the Skaw.

It is evident that a sea whose depths vary from 0—60 fathoms, must present very different conditions of life to the animals living in it. That this holds good of the lower animals in the Cattegat had already been proved by the extensive dredgings undertaken by C. G. Joh. Petersen*). The trawlings which the Biological Station, of late years, has made in the northern Cattegat, show, that it holds good of the fishes also, that these by no means are equally distributed over the whole sea, but that most species of fishes live within certain belts (see later on), which thus get their peculiar stock of fishes.

This is not the place to enter more closely into the causes of this fact, but it must be emphasised that there are many concurrent factors, each of which being of some importance, which together produce the said result.

We must say a few words, however, of one of these factors — *the condition of the bottom* — as this, to a certain degree, must be said to be the basis

*) C. G. Joh. Petersen: Det videnskabelige Udbytte af Kanonbaaden »Hauch«s Togter i de danske Have indenfor Skagen i Aarene 1883—86. Copenhagen 1893.

of our apprehension of the distribution of the fishes, and as, from this very reason, it underlies the arrangement of the various sections of this treatise.

The condition of the bottom is, in part, decisive of the lower animal life on the bottom of the sea, and through this also of the stock of fishes, as most fishes are more or less attached to the bottom, i. e. stay near it, and seek their food among the lower forms of animals living in or on the same.

In an open sea like the northern Cattegat it seems, particularly, to be the depths which are decisive of the occurrence of the various bottom-species*); that the same holds good also of the distribution of the vegetation is likewise a well-known thing. The plants must have light in order to assimilate; but as the light, in a great measure, is absorbed by the water, less and less light will reach the bottom as the depths become greater. Some sea-plants demand more light than others, from which reason their depth-limits do not agree; but already on proportionally low water every trace of attached plants disappears.

The various species of deposits, and the appearance and disappearance of the vegetation as the depth increases, may, in its main features, be described as follows:

On quite shallow water, along the open shores, where the surf is strong and the whole sea in almost incessant motion, the bottom generally consists of unmixed sand, gravel, or stone. The motion of the water is too strong to permit plants as the zostera, which grows in the loose sand, to get a footing, and only where there are stones we find a few bushes of bladder-wrack attached to these. The *sand-banks* are therefore, generally, a locality**), barren of vegetation and rather destitute of nourishment. — Already on a depth of c. 1 fathom the zostera begins to get a footing, and most frequently we find this plant covering the bottom within a belt which reaches out on 6—7 fathoms, where the want of light prevents its going farther. The bottom where the zostera grows consits also, chiefly, of sand, although as light formation of mud may take place on particularly protected spots, in hollows and in shelter of the stones. This locality, consequently, yields food and hiding-places for a multitude of herbivorous, lower animals; its biological conditions are, on the whole, widely different from those of the sand-banks nearer the shore. — Outside the zostera belt, where the water is getting deeper, we still meet almost unmixed

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*) C. G. Joh. Petersen: Loc. cit. pp. 433—35.

**) *Locality* is used here in the sense in which it is often used by botanists, to indicate places of the same physical conditions, such as species of deposits, depth, vegetation, etc. A locality may therefore very well be extended over several square miles, or its various parts may be situated near to or far from one another.

sand deposits; but as the depth is increasing, they become more and more mixed with clay, as the deeper strata of the water are calm and suffer particles of clay and dead rests of plants to precipitate.

This »clay-mixed sand« belt which, as a rule, goes out as far as 18—20 fathoms depth, now and then a little farther, has still a hard, firm bottom, with thinly scattered and small plants, exclusively brown and red algæ attached to stones, shells, etc., while on the other hand the fauna is rather richly represented out here.

On depths of more than 20 fathoms, however, the bottom is generally getting softer; the precipitated clay becomes more and more dominating, and gradually we get out on unmixed clay deposits, which occupy the deeper and deepest parts of the Cattegat. This unmixed clay bottom is without any vegetation whatever, and the fauna seems to be rather poor also, particularly in the deepest channels, from 30—60 fathoms, where the conditions are such that many species of animals cannot exist. This is the case, first of all, with the herbivores and the species which are not particularly adapted for moving on or in such a bottom, but sink down and perish in the soft clay; many forms cannot bear the constant darkness down here, or the low temperature, which does not change much from season to season, etc.

We may still mention another locality which, in contradistinction to the above-mentioned ones, does not belong to the open sea, but is characteristic of our long, narrow fjords, where the undulation and the currents of the sea are shut out, or at any rate made less strong by the surrounding land. In such calm waters fine particles of clay are precipitated, and as the depth is generally inconsiderable there is a luxuriant vegetation: the rich zostera goes in almost to the shores, in these fertile deposits, and contributes towards making the waters calm; it is overgrown with diatomaceæ and bluish-green and brown algæ, so that its leaves get a hairy appearance. Most of the latter die when the summer is over, and sink to the bottom, where they become transformed into dark, stinking *mud*, which is the characteristic species of deposits in the fjords. —

While, as above mentioned, most species of fish are more or less closely attached to the various species of deposits, and therefore may be referred to certain localities, there are also some which appear to be less dependent on the deposits and their animal forms, and which seek their food in all strata of the water, occurring, therefore, now at one locality now at another.

To these *migratory fishes* belong, for instance, the *common cod* (*Gadus*

callarias), the *green cod* (*Gadus virens*), and on the whole, more or less, the other *codfishes, mackerels, sharks,* etc.

We see also that many stationary fishes, which are attached to the bottom, as young fish belong to one locality, as grown-up fish to another; this applies, for instance, to the plaice and other flatfishes.*)

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1. The Closed Waters (Fjords etc.).

By looking at a map of the northern part of the Cattegat**) — within the limits here laid down — it will be seen that the coasts have scarcely any natural inlets.

The conditions of the fjords are therefore rarely found here, and a closer investigation shows that they are more developed at places where man has assisted nature and, for instance by the building of harbours, just aimed at producing conditions similar to those which, in the fjords, we find made by nature: calm waters, made calm by shutting out the sea to some extent.

We find thus an artificial fjord-locality at Frederikshavn, in the inmost basin, which is shut out from the inner harbour, properly so called, by means of a provisional dam with one single narrow opening; in here the water is quite calm with dense zostera-vegetation on mud deposits.

Similar conditions, though less highly developed, we find also in the inmost corners of the harbour at Hirtsholmene.

Produced without the aid of man, we find them also on quite shallow water, between some of the banks of Læsø, south of this island.

The fish-fauna in the basin at Frederikshavn consists of the following forms:

The black Goby (*Gobius niger*), large, mature specimens as well as smaller

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*) The above trawlings are arranged topographically, so that those which have been made in the same part of the sea, are put together. The text, on the other hand, has been arranged according to the belts (localities), but by each of these it has been stated, which trawlings (journal-numbers) fall within the belt in question.

For some of the localities, viz. the fjords and the sand-banks, the results of the several investigations have not been stated among the trawlings, in some measure because they have been produced in another way, by ammodytes-seines, stake-nets, shrimp-nets, etc.

Something like this is the case also with the zostera-belt, only very few of the numerous hauls at this locality being stated in the annexed trawlings.

**) See »Hauchs« Togter.

ones. Quite young fry, however, is not known here; so it is possible it breeds outside and immigrates later on.

The freckled Goby (*Gobius minutus*) which, on the other hand, is known for certain to breed in there, but then again is not so characteristic of the fjord-fauna, as it, just as well, lives and breeds on the open shores (cmp. The Sand-Banks).

The three-spined Stickleback (*Gasterosteus aculeatus*), which also breeds here and whose young live among the zostera.

The fifteen-spined Stickleback (*Spinachia vulgaris*), which is one of the few annual fishes in our fauna. The generation of the past year dies away shortly after the egg-laying, in the end of June; but in the end of August, already, the young fish are about 4 inches long.

The broad-nosed Pipe-fish (*Siphonostoma typhle*), which also breeds in here, and which moreover, like the preceeding forms, is characterised by its taking care of eggs and fry, actually nursing them; a thing rather uncommon among the fishes.

The Eel-pout (*Zoarces viviparus*), which is found in all sizes, so that it must be supposed to breed in there.

The following forms, on the other hand, never breed in this locality, and occur, on the whole, far less constantly in the basin.

The Eel (*Anguilla vulgaris*), in various sizes, but rarely in very large specimens.

The Jago's Goldsinny (*Ctenolabrus rupestris*), whose proper home is out by the stone moles of the outer harbour, or by the stone reefs outside the harbour.

The Plaice and the Flounder (*Pleuronectes platessa & flesus*), but never the fry of the year and rarely grown-up specimens; this is absolutely not the place where they breed, and are reared from small. Pleuronectes flesus of middle size is found, however, in rather concidereble numbers in here.

Cod appear now and then in small specimens, but they belong to the rarer forms in this locality.

The short-spined Sea-scorpion (*Cottus scorpius*) occurs; but it is also rare, and the young fish are never found here.

Young Herrings immigrate in large shoals, now and then, in the course of summer; but as a rule they do not stay long in here at a time.

As to the lower animal life in this locality, I shall mention here only that the prawn (*Palæmon Fabricii*) lives and breeds in the basin in great numbers, while it is not found at all along the shores outside the harbour. This is one example showing how quickly an animal will make its appearance, when the conditions of its existence are forthcoming.

I shall add that it was not known at all that the prawn was living here in numbers, till the Biological Station arrived at Frederikshavn.

Of other species of prawns we find here also, though in much smaller numbers, *Palæmon squilla* and the shrimp (*Crangon vulgaris*).

The common Crab (*Carcinus mænas*) is found here in great numbers.

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2. The open Cattegat.

a. The Sand-Banks.

The low water on the above-mentioned sand-banks, along the open shores, is a favourite dwelling-place of the tender fry of several species of fish. As the scanty vegetation (a few bushes of bladder-kelp) affords only few places of refuge for these animals, it is of great importance to their safety when they have, in their capability of changing colour, a means of accommodating themselves to the appearance of the bottom. This is the case with the fry of several of our flat-fishes which, when they have come out of the pelagic eggs that are floating in the water, seek refuge on the sand-banks.

To these flat-fishes belong:

The Plaice (*Pleuronectes platessa*). The eggs are met with already in February, March, and April, in the sea; and in the first days of May the little newly hatched young ones (the O-group) are first appearing on the very lowest water on the shores; but they do not occur more commonly in here till the end of the month or the beginning of June. As they grow larger, they go out a little farther, but in August the c. 5 months old fish are still met with on 1—3 feet of water; they are then about 2 inches long.

Besides the fry of the year, some of the young fish from the preceding year (I-group) are generally living on the deepest places of this locality.

The Flounder (*Pleuronectes flesus*), the O-group as well as the I-group, and sometimes a few still older specimens. The fry of the year is in Au-

gust, on an average, only 1 inch long; but it is also a couple of months younger than the plaice of the 0-group, which have been caught at the same time.

The Brill (*Bothus rhombus*) and the Turbot (*Bothus maximus*). On the sand-banks we meet only the 0-group, which in August is nearly 2 inches long.

The Sole (*Solea vulgaris*), the fry of the year as well as the grown-up fish, at any rate in the summer.

As above mentioned, *Gobius minutus* is properly at home in this locality. Its breeding-time is the month of June, at which time we may find fine furrows in the sand, where there is an empty shell of the sand-gaper (*Mya arenaria*). These furrows are produced by the male gobius, which watches the eggs, deposited on the underside of the shell, and which constantly, with its fins, wafts a fresh stream of water in to the eggs.

The fry of this little fish, however, does not live constantly on these naked sand-banks, where it finds too little food and protection, but emigrates to the bottom where there is a vegetation (See The Zostera Belt).

As migratory fish, large shoals of young herrings come in pretty often in the course of summer, on quite shallow water, where they are pursued by the sand-eels (*Ammodytes lanceolatus*). We see the shoals constantly being spread, and the young herrings flying to all sides, when these greedy fish quick as lightning pursue them.

Also the pipe-fish (*Siphonostoma typhle*) is often seen in here; but it is not particularly at home here, as little as the eel, which now and then comes in from the zostera belt.

Of lower animals living on the sand-banks we find chiefly lug worms (*Arenicola*) and various crustacea, especially large masses of opossum-shrimps (*Mysis*), shrimps (*Crangon vulgaris*), and the common crabs (*Carcinus mænas*).

b. The Zostera Belt.

The Journal-numbers: 64a, 65a, 72, 73, and partly 112.

The zostera-vegetation in the northern part of the Cattegat is not by far so rich as in our more closed seas. At the Skaw the zostera-belt is very narrow; it spreads a little more in the Aalbæksbugt, and reaches at Frederikshavn about a Danish mile in width, extending as far as Hirtsholmene. Towards south, in the Læsø Rende, it becomes still wider. The expansive

shallows north and south of Læsø are also, in part, densely overgrown with zostera. This plant never goes deeper down than to c. 7 fathoms of water. —

But even where the zostera is developed at its best, we often find the growth interrupted by, smaller or larger, naked spots of sand, or by stone-banks with a rich algæ-vegetation.

The bottom, which as a rule consists of sand, may in a few particularly protected places become a little mixed with mud; here we find then many of the species of fish which are mentioned above (under the fjord-region). South of the harbour at Frederikshavn, which place, with most winds, is rather sheltered, there live for instance great numbers of Gasterosteus aculeatus, Spinachia vulgaris, Zoarces viviparus, and Pl. flesus, which scarcely ever occur north of the harbour or at such more exposed places.

The stationary fishes in the zostera-belt are:

The Plaice, but generally only those of one or two years; never the fry of the year, and very rarely the older groups. They are found more particularly on the naked spots of sand between the zostera.

The Flounder. All ages, except the fry of the year. This fish, however, is not very common in the north of the Cattegat; as above mentionend it is found only at the more protected places.

The common Dab (*Pleuronectes limanda*). Never the fry of the year, and rarely those one year of age. In contradistinction to the hitherto mentioned flat-fishes, the tender fry of this fish lives on deeper water. The dab is very common in the northern part of the Cattegat.

The species of Pipe-fish: *Siphonostoma typhle*, *Syngnatus acus*, *Nerophis aequoreus* and *Nerophis ophidion*.

The Sea-scorpions (*Cottus scorpius* and *Cottus bubalis*). Strange to tell, the young fish of these forms are scarcely ever seen under two inches in length.

The armed Bull-head (*Agonus cataphractus*). Small fish of this species, on the other hand, are caught now and then; both quite small, pelagic ones ($^1/_4$ inch), and larger ones (c. 1 inch), living on the bottom.

The double-spotted Goby (*Gobius Ruthensparri*), which is very common, and whose tender fry in the summer is swarming in numberless shoals among the zostera, together with the tender fry of the above mentioned *Gobius minutus*.

The Eel (*Anguilla vulgaris*) lives here in great numbers, in all sizes, both as yellow eel and as silver eel. It prefers particularly the places where the bottom is somewhat mixed with mud.

Strange to tell, we do not know for certain, as yet, where in our seas this very common fish is breeding; but it is supposed that it must be on deep water, and the migration of silver eels towards the north, which we see on all our shores in the autumn, and which at Frederikshavn and other northern points of Jutland is proved also to go in the same direction, seems to indicate that it must be in the Skager Rack we must expect to find its breeding-place, its eggs, and its tender fry.

Young Wrasses, of which in August 1898 a great number were caught in the ammodytes-seine, particularly on depths from 3—6 fathoms.

Now and then also the grown-up wrasses are caught, but they seem chiefly to live on the stone-banks (see later on).

Young Lump-suckers are also common on these depths (3—6 fathoms), throughout the whole summer. (As to the grown-up fish see later on).

Two rather rare fishes must, most likely, also be classed among the stationary fishes in the zostera belt, viz:

The five bearded Rockling (*Onos mustela*) and the Paddock (*Raniceps raninus*); both species are caught here, now and then, in weels.

Fishes which, in the breeding-season only, stay in the Zostera-belt:

The Herring (*Clupea harengus*) comes in here both in spring and autumn. The fry early proves to be strongly marked migratory fish, which in large shoals occur everywhere in the surface of the sea on somewhat low water (see The Sand-banks and Fjords).

The Lump-sucker (*Cyclopterus lumpus*) also appears here in early spring. The eggs are deposited in large lumps among the zostera where, later on, also the fry lives. Shortly after the breeding the grown-up fish, however, disappears completely from the zostera-belt.

The Garfish (*Belone acus*), in April and May, goes in on the lowest part of the zostera belt to lay its eggs, and is then — particularly on the Læsø banks — much fished for. The large eggs, which are surrounded by long threads, are attached to the zostera. The fry, which has not at first the characteristic long beak of the grown-up fish, swims about in the surface of the sea like the young herrings.

Migratory fish in the Zostera belt.

While some of these occur constantly almost at this locality, there are others which are seen only now and then.

To the commonest belong:

The Whiting (*Gadus merlangus*), but only smaller specimens, never above 10 inch. long.

The Cod (*Gadus callarias*), in various sizes, but rarely the very large ones; the fry of the year as well as the one year old fish also seem to appear in much smaller numbers than the intermediate ages (10—20 inch.).

Much more rarely occur:

The green Cod (*Gadus virens*); most frequently only young specimens, but never the fry of the year. *Trigla gurnardus*, *Callionymus maculatus*, *Aphya pellucida*, and *Labrax lupus*. The latter is a very rare migratory fish, which in our seas has been caught only in this locality. In 1897 it was caught a few times in ell-weels at Frederikshavn: October the 11th, 12th, and 28th.

In autumn we often see the trout (*Salmo trutta*) in the rough wathers about the stone-banks. After its stay in the sea, it goes towards the shores at this time to enter the water courses.

Quite a large number of sharks are also seen now and then in this locality. These proportionally large and quick fish are scarcely ever caught in the seines, but most frequently on hooks or in pound-nets.

The picked Dogfish (*Acanthias vulgaris*) is by far the most frequent of them, but now and then also other forms are seen; in September 1898, for instance, two rather large specimens of *Galeus vulgaris* were caught in pound-nets at Frederikshavn.

As above mentioned, we meet in the zostera belt a considerable number of larger and smaller stone-banks, with a rich algæ vegetation. Besides the natural banks, Busserev, Brunerev, etc., we may class among these also the long stone moles at Frederikshavn, where the same algæ and lower animals are living: chitons, snails, bryozoa, various hydroids, etc.

The locality, however, is too limited to develop a rich fauna, and, more particularly, very few fishes may be said to be at home here.

The otter-seines are not well calculated for the exploration of the fish-fauna on this bottom; generally we must have recourse to weels, as the small dredges, though they may be used here, are but badly adapted for the catching of fish.

Now and then, however, a fish which is particularly attached to the

stones, the Montagu's Sucker (*Liparis Montagui*), has been caught in a dredge, and one single time it has been taken also in an otter-seine, near Læsø, on less pronounced stone bottom.

Of other fishes belonging to this locality must be mentioned *Centronotus gunellus* and the wrasses (which occur also on the zostera bottom), of which particularly *Ctenolabrus rupestris* and *Labrus melops* are very frequently caught in the cod-weels. The larger, magnificent *Labrus berggylta* is found also, for instance at Frederikshavn, but it seems to be much rarer. *Labrus mixtus* has not been caught at all in 1897—98.

Also other fishes belonging to the zostera belt are, of course, often found on the stone-banks; more particularly codfish and other migratory fishes are frequently met with.

c. The Mixed Deposits.

The Journal-numbers: 70, 71, 72, 83, 84, 92, 93, 102—103, 108—109, 40, 41, 62a, 114, 63a, 63—64, 65, 77, 101, 104, 107, 117, 118, 119, 74, 75, 99—100, and in part 115, 112, and 55.

The hitherto mentioned belts on shallow water are here in the northern part of the Cattegat of less importance to our fisheries; the proper fishing-grounds are to be found on deeper water, on the so-called mixed deposits, which everywhere as a broader or narrower belt separates the unmixed sand from the clay deposits.

This belt is of a considerable width at the Skaw and in the Aalbæksbugt, where it goes quite round about Herthas Flak, extends like a broad tongue through Læsø Rende, and is continued from this place in north-easterly direction round about the shallows north of Læsø as far as Trindelen, whence it goes southwards.

The depths go from 7 to about 18—20 fathoms; as above mentioned, the vegetation, which consists only of algæ, is not very richly developed, while, on the other hand, the fauna is rather rich.

Of lower animals may be mentioned particularly large numbers of sea-urchins (*Echinus* and *Amphidetus*), sea-stars (*Asterias rubens* and *A. glacialis*), serpent-stars (*Ophiopholis aculeata*), mussels (e. g. *Cardium* and *Cyprina*), snails (e. g. *Buccinum, Neptunea, Aporrhais*), hermit-crabs, and chætopoda, besides numerous attached species of various classes of animals (bryozoa, tubicoles, and actiniæ).

The number of fish is large also, both with respect to the number of species and to the number of specimens. Several of the most valuable fish live

here. This belt is particularly characterized by the great number of various flat-fishes, particularly their higher ages, from which reason also the cutters from Frederikshavn and the Skaw carry on their plaice-seine fishery chiefly at this place.

Of the above-mentioned flat-fishes we find here:

The Plaice, the two years old as well as the mature three and four years old fish; the number of the latter has decreased so much of late years that it is quite a rarity to catch it.

The common Dab (*Pleuronectes limanda*). All ages. As above mentioned, the tender and the one year old fry (in contradistinction to that of the other flat-fishes of which we have spoken) lives on deep water. The 0-group, however, is but rarely caught*).

The Brill, the Turbot and the Sole, but of these species the older age-groups only.

Of forms which were not found in the belts described above, we may further mention:

The Halibut (*Hippoglossus vulgaris*), which has been caught only a few times in 1897 and not at all in 1898, and only where plaice-seines have been employed (cmp. for instance journal-numbers 40 & 41, 3. & 5. July 1897, at Knallens Vager, on 9 and 14 fathoms). It seems therefore that the otter-seine is not so well adapted for the fishing of this species (which is the case also with several other species of flat-fishes, e. g. the plaice and the turbot).

The Norwegian Topknot (*Zeugopterus norvegicus*), which was not caught either in 1898, but was taken, for instance, 15. Oct. 1897 with otter-seine. Journal-number 62a, on 15—20 fathoms.

The little Sole (*Solea lutea*), which is not among the commonest species either, but is taken now and then.

In the deeper parts of this belt the following flat-fishes also occur:

The long rough Dab (*Drepanopsetta platessoides*), in various ages, particularly one and two years old. The smallest specimens which have been caught in the Cattegat, have been a little more than 2 inches long; it is possible that the 0-group does not occur at all in this sea, which is the case also with others of our flat-fishes, viz. the following species and the pole dab**).

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*) Cmp. Report of the Biological Station 1893.

**) According to earlier investigations (Report of the Danish Biological Station, 1893, p. 39—40) the I-group of this species is c. 3—4 inch. long in the spring (April). Specimens 2—2¼ inches long have been caught once or twice in the Cattegat, e. g. 29. August 1898,

The lemon Dab (*Pleuronectes microcephalus*), which is known as a grown-up fish only, and in three specimens of $4^1/_1$—$4^1/_2$ inch. *).

The Megrim (*Arnoglossus laterna*), a little flat-fish, which in mature state is only 5—6 inches long. It is very characteristic of the clay-mixed sand. It seems to occur particularly frequently on 15—20 fathoms N. and E. of Læso.

Next to the flat-fishes the cod-fishes are strongly represented, and occur so commonly that several of them, in a certain way, may be classed among the stationary fishes of this region:

The common Cod, the various age-groups; but, as in the zostera-belt, there seem to be no places here either, where the fry of the year and the one year old fish occur in great numbers.

The Whiting, most frequently young specimens, not over 10—12 inches long. The fry (the 0-group) is caught pretty commonly, particularly in plankton-bags, as the young fish ($^1/_2$—$1^1/_2$ inch) seek refuge under jelly-fish (*Cyanea capillata*).

The Haddock (*Gadus æglefinus*) is also commonly met with, but particularly in the deeper parts of the belt. It seems more than the whiting to be attached to the bottom; its food consists almost exclusively of animals that live on the bottom, chiefly serpent-stars (e. g. *Amphiura filiformis*), while the whiting particularly feeds on various small fish (small herrings and sprats) which, partly at any rate, live in other strata of the water.

The Hake (*Merlucius smiridus*). Young specimens live here, possibly, at all times of the year, while the large ones seem to enter this proportionally low water in some of the summer months only (May, June, and July), probably in order to breed. In July-August its eggs, strongly pigmented with yellow, are very common in the surface-water of the sea. That the large hakes (of 20—30 lbs. or more) get in here only at the said time of the year agrees with the statements of the steam-trawlers.

Gadus Esmarkii and *Gadus minutus*, which are seen here now and then, must, on the other hand, be looked upon as quite accidental visitors, occasionally getting in here from the Skager Rack. It seems, as if only a single age-group occurs; probably, therefore, they do not breed here.

Of other forms of fishes which almost constantly occur here, we may still mention:

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on 16 fathoms, cmp. journal-number 119; but their number has been so small that it is scarcely possible to decide, whether they have formed a particular age-group (the 0-group) or been specimens only of the I-group which have been stunted in their growth.

*) Report of the Biological Station, 1893, p. 37.

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The grey Gurnard (*Trigla gurnardus*), in various sizes, but not the quite young ones.

The Dragonet *(Callionymus maculatus)*; both the male and the female of this species are very common, and are often caught in considerable numbers in the haul, while the gemmeous Dragonet (*Callionymus lyra*), which is found here now and then, is emphatically a migratory fish. The female is very rarely caught; in August 1898, however, 1 male and 3 females were caught in one single haul with the otter seine.

Further may be mentioned some fishes which are caught occasionally in this belt, though they occur so rarely in these parts that it is difficult to say where their proper home is:

The Weever (*Trachinus draco*); has been taken only a few times with the otter-seine, e. g. 23. August 1898, near Læsø, on 6—10 fathoms (Journal-number 112).

The sharp-tailed Lumpenus (*Lumpenus lampetriformis*), which is taken now and then on this bottom, but is caught also on deep water with soft clay bottom; see for instance journal number 90, 8. July 1898.

The Gunnel (*Centronotus gunellus*), which more particularly belongs to the zostera belt, but has been taken also at this locality.

The Angler or Frog-fish (*Lophius piscatorius*), which has not been taken at all in 1898, but a few times in 1897; see journal-numbers 40 & 41.

The Sea-wolf or Cat-fish (*Anarrhichas lupus*), which occurs somewhat more commonly, particularly in the deeper regions of the belt. It is taken sometimes with ripe roe, but most likely it does not breed here; at any rate we never see the fry — on the contrary, all the specimens that are taken are large.

Of cartilaginous fishes a couple of rays are pretty often taken, viz.:

The Thornback (*Raja clavata*) and the Skate (*Raja batis*). In the parts where the clay is most predominant lives the blind, pale red Hag (*Myxine glutinosa*).

Of migratory fishes properly so called may still be mentioned, besides the above mentioned *Callionymus lyra, Gadus minutus* and *Gadus Esmarkii*: the herring and the sprat (*Clupea sprattus*); the mackerel (*Scomber scomber*), which at times, in the summer, is very common and is taken, particularly, with hook; and the much rarer horse-mackerel (*Caranx trachurus*) which is taken now and then in the autumn, e. g. the 8., 14., 15. & 28. Oct. 1897*).

*) *Aphya pellucida* has also been taken, now and then, at this locality; but it is as yet impossible to tell to which place it belongs (cmp. the following region: The Clay Plains.)

The picked Dogfish is common here, but it is taken with hooks only.

Besides Caranx trachurus also other fishes not belonging to our fauna get into the Cattegat in autumn, e. g. the bass (*Labrax lupus*), which was caught a few times, in 1897, in weels (cmp. above: The Zostera Belt), the mullet (*Mullus surmuletus*), which was taken 10. Oct. 1897, and *Zeus faber* two specimens of which were caught in plaice-seine at Rusmandsbanke and on Herthas Flak in November and December 1898.

In October—December, 1897, we caught also pretty often a small ten-armed cuttlefish (*Loligo media*), in great numbers, throughout the whole of the northern Cattegat, as far down as the isle of Anholt, particularly on depths of 15—20 fathoms. At other seasons this pretty little cephalopod is but rarely taken in the Cattegat. Its occurrence in great numbers in the autumn must probably, like the occurrence of the above mentioned rare fishes, be ascribed to the »warm bank-water« (the Jutland Current), which at this season, as it seems regularly, pours in from the southern part of the German Sea. In 1898 this cuttlefish has been taken only once (12. July 98, in the Skagebugt, on 7 fathoms, journal-number 97); but the Biological Station's investigations of the northern Cattegat ceased already in September, when the Station was removed to Nyborg, and it may possibly have occurred up here later on, as in the preceding year.

On the 1. of August 1898 a fisherman brought a large eeg-mass, probably of another and larger species of Loligo (*Loligo Forbesii?*); it had been taken north of the Læsø banks on 12 fathoms of water.

d. The Clay Deposits.

In the northern Cattegat the clay deposits cover considerably larger areas than the other bottom-materials, and the vertical extension of the clay is likewise proportionally great, as it is found nearly everywhere between 20 and 60 fathoms. The natural conditions of the ground of this large area vary, however, and it may be divided into two essentially different parts. While the bottom in the broader western part, to a depth of 30 fathoms, is a gradually sloping plain, which forms a direct continuation of the mixed deposits, the much narrower eastern part is a channel, where the ground falls from 30 fathoms to 50—60 fathoms, to rise again towards the Swedish sea-territory.

A corresponding difference is seen in the development of the fauna on the western and the eastern part, from which reason we must divide the fauna

of the clay deposits into two subdivisions: the fauna of the clay plains and that of the clay channels.

Common to both, however, is among other things, the complete want of vegetation, as also the huge multitudes in which *Brissopsis lyrifera* occurs. The latter, which is seen pretty frequently on c. 15 fathoms, increases very much in numbers, as the bottom becomes softer on account of the increasing depth. In the deep clay channel it is so common, that it sometimes makes it very difficult to investigate these depths. The otter-seine may be filled with the soft clay and with Brissopsis by the barrel, to the destruction of the rest of the contents — or, as it sometimes happens, the seine bursts while it is hauled up, on account of the huge weight.

By attaching a coir rope, 2—3 inches thick, to the foot-rope of the seines, we can prevent, however, that it cuts deeply down into the soft bottom, by which means the destruction by clay and Brissopsis is diminished.

a. The Clay Plains. (20—30 Fathoms).

The Journal-numbers: 94, 90, 85, 89, 27, 54, 76, and partly: 113, 116 & 105—106.

As the natural condition of the ground in this region in many respects agrees with that of the mixed deposits, so the fauna shows a great similarity to that of the latter, with respect to the species that occur here; on the other hand, the number of specimens is considerably changed. Several species which were common on the mixed deposits, become rare here, and vice versa. Some forms seem to be quite missing, while a few ones have been added.

Of the flat-fishes, for instance, the plaice, the brill, and the common dab become rare, and disappear quite before 30 fathoms.

The halibut and the turbot are, on the whole, so rare in the northern Cattegat that nothing can be said about them for certain.

On the other hand, the lemon dab and, particularly, the long rough dab occur in greater numbers than on the mixed deposits; and, finally, a new species of flat-fish makes its appearance on these depths:

The pole dab (*Pleuronectes cynoglossus*), which, however, does not breed in the Cattegat, but on still deeper water (see the chapter on the Skager Rack).

Of the codfishes we find here nearly the same species and numbers as on the deepest parts of the mixed deposits; but the specimens are often large, particularly the haddocks.

On the softest parts of the clay plains occurs the four-bearded rockling (*Onos cimbrius*).

As our plaice-seine fishermen chiefly fish for the plaice, it does not pay

for them to lie out here, where, on the other hand, the German steam-trawlers often come to fish for haddocks and hakes.

Of other fishes which were found on the mixed deposits, we meet pretty often:

The cat-fish, the dragonets (*Callionymus maculatus*), the gurnard, the skate, and the hag, which latter is very common, like the sharks which are roaming about everywhere.

Once also *Lumpenus lampetriformis* has been found here.

Gobies have not been found out here, to be sure, but on the empty shells of the large *Isocardia cor*, which is also found here alive, their eggs are pretty often seen, originating most likely from the above mentioned *Aphya pellucida*.

Among the lower animals we must especially mention the great numbers of Brissopsis and Sea-feathers (*Pennatula phosphorea*); also the Serpent-star (*Amphiura filiformis*) and large specimens of *Asterias rubens* are vere common. *Nephrops norvegicus* which is rather common out here, may perhaps get some pecuniary value; it is very tasty, but there is the drawback that it dies immediately after it is caught. The largest spawners are rarely more than $6^1/_2$ inches long, while the milters most frequently are 6—8 inches, sometimes nearly 9 inches long.

β. The Clay Channels. (30—60 Fathoms).

The Journal-numbers 86, 87, and partly 113, and the stations 88 & 27 near the boundary-line.

On these, the deepest soft clay-deposits, whose horizontal extension is very limited, we find rather a poor fauna; particularly, we meet but few fishes of any pecuniary value.

Our fishermen go out here very rarely, and it is not often either that the steam-trawlers visit the deepest regions, where they will get a much poorer catch than on the clay plains. The Swedish fishermen, nevertheless, lie here pretty often, setting their hooks, with which they catch large cod, haddocks, and, it is said, lings (*Molva*).

On this locality there live but few species of flat-fishes, and among them none of the valuable ones.

The pole dab (*Pl. cynoglossus*) certainly occurs, but it is by no means common.

The lemon dab and, especially, the long rough dab are the only flat-fishes that occur more frequently.

The common cod, however, is pretty often met with, especially the large specimens; this is the case also with the haddock. Whitings and hakes, on the other hand, go out here more rarely, while now and then we meet with the small forms *Gadus Esmarkii* and *Gadus minutus*. *Onos cimbrius* is common, and we find *Lycodes* here in great numbers, though represented only by one species: *Lycodes gracilis*. At several places one of the rays, *Raja radiata*, is common, and the hag also occurs in great multitudes.

Among the lower animals *Brissopsis lyrifera* is prominent on account of the huge masses in which it occurs. Of other echinoderms occurs, for instance the serpent-star (*Ophioglypha Sarsii*).

Of the crustacea we find the large red deep-sea prawn *Pandalus borealis*, and other species, as also *Hippolyte securifrons* in great numbers; but these fragile animals are generally quite crushed or in other ways destroyed during the seining, by being rolled about among *Brissopsis* and clay. *Lithodes maja* is seen now and then.

The bivalves *Leda pernula* and *Nucula sulcata* occur frequently on this locality.

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Part II:

The Skager Rack.

To set up various belts (regions) with different faunas is not by far so easy in the Skager Rack as in the Cattegat, partly because the Skager Rack has not as yet been so fully explored, partly because there do not exist so sharply distinguished belts in the deeper regions of the Skager Rack. The bottom is thus everywhere in the Skager Rack on deep water, where I have been fishing, soft clay, mixed with a little sand where the depth approaches 50 fathoms; the bottom slopes very gradually from the shores down to 3—400 fathoms; finally, the deep Skager Rack offers, with respect to hydrography, no such sharp transitions as the Cattegat. Though thus one belt passes into the other out here, by almost imperceptible degrees, it must be said that the differences between the faunas on the different depths, e. g. on 275—300 fathoms and on 20—40 fathoms, are very considerable. I shall therefore, as far as it is possible for me at this moment, try to give some of the most characteristic features in the distribution of the animals, more particularly the fishes, in the various parts of the Skager Rack.

On the lower water, c. 20—35 fathoms, we have made but few proper hauls with otter-seine, Nr. 15, 19, 20, 21*). The fauna, evidently, agrees very closely here with that of the Cattegat on the corresponding depths. As, however, the sand-mixed clay deposits, go out on greater depths in the Skager Rack (most likely because the influence of the

*) The numbers in this part refer to the numbers of the trawlings in the text. (See *ante*).

lashing of the waves here reaches deeper down), we do not meet the characteristic »clay animals«, e. g. *Brissopsis*, constantly, till deeper down, on more than 30 fathoms, while we find them in the Cattegat already on 15. The fauna is very rich on 20—30 fathoms, both in fishes and in lower animals. The former are represented by the same species of *cod-fishes* and *flat-fishes* as are found in the deeper parts of the Cattegat. Loose *Laminariæ* are found, at times, and at certain places, in masses, probably carried hither by the current from stones on the western shores of Jutland.

These regions are especially characterized by their rich plaice-fishery, which is carried on by the Danish fishing-cutters with plaice-seines. But also the foreign trawlers are working here, particularly to catch *haddocks* (*Gadus æglefinus*), *cod* (*Gadus callarias*), *hakes* (*Merlucius smiridus*), and the *pole dab* (*Pleuronectes cynoglossus*).

Between 40 and 60 fathoms *Brissopsis lyrifera* is never missing, except when replaced by *Amphidetus* or *Spatangus*. Nr. 14, 16—18, 22—26. The fish-fauna, nevertheless, still agrees very closely with that of the former region, but the codfishes are more dominating than the flat-fishes. The *plaice is missing, or is rare,* and of the codfishes *Gadus Poutassou,* which does not live in the Cattegat, has been added. *Gadus Esmarkii* is common and *Lycodes* begin to appear.

The Danish fishing-smacks scarcely ever fish here, but the trawlers take great numbers of *cod, haddock, the pole dab*, and other fishes.

On 70—80 fathoms, Nr. 10—13, *Brissopsis* is never missing. *Astropecten Andromeda* is added here; it never goes into the Cattegat. A great number of other invertebrates occur here, which are not found in the Cattegat.

Of flat-fishes we find only the *pole dab* (*Pleuronectes cynoglossus*) in great numbers, and moreover the *long rough dab* (*Drepanopsetta platessoides*). 2 species of *Lycodes* are common, besides the *haddock* and other species of *gadus*, and *ling* (*Molva vulgaris*). A small species of codfish (*Gadiculus argenteus*) has been found. The *hag* (*Myxine glotinosa*) occurs, evidently in great numbers, but singly only in the fishing-apparatus. The steam-trawlers are fishing here for *haddock* and *the pole dab.*

The young ones of the latter are found out here; they have never been observed in the Cattegat, and, as it is the opinion of English investigators also, they are at home, evidently, on deep water only.

As above mentioned we find a great number of lower animals, particularly *echinodermata* and *crustacea decapodea* in great masses. **This fauna goes**

down to at least 130 fathoms with scarcely any variations, Nr. 5—9; *the rabbit fish* (*Chimæra monstrosa*) is added, but nothing else of importance.

The following depths have not been explored, till we reach **c. 210 fathoms,** Nr. 3—4. Out here the fish-fauna is quite changed; we find, however, also here the *pole dab* (*Pleuronectes cynoglossus*), the *rabbit fish* (*Chimæra monstrosa*), and the *hag* (*Myxine glutinosa*). Out here live the *Norway haddock* (*Sebastes viviparus*), *Coryphænoides rupestris,* and *Argentina silus;* but *all gadidæ have disappeared.*

I am sorry to say, we have made only one successful haul with the otter-seine here. It is possible, therefore, that other fishes may be found. No doubt there is a very peculiar fauna. This will be found also with respect to the invertebrates. I shall mention only *Octopus arcticus*, *Ophioscolex, Asteronyx*, *Funiculina,* and *Kophobelemnon. Brissopsis* still comes along with the rest.

On the whole there is a rich animal life, of lower animals, particularly crustacea; it is scarcely so rich, however, as it is on less deep water.

On depths between 275 and 300 fathoms we have made one dredging with steel-wire trawl, Nr. 1., by which we caught only *Myxine*, and three hauls with otter-seine, Nr. 2, at one place. The fish-fauna of this place certainly resembles that on 210 fathoms very much, yet it gives three new fishes: to species of *rays,* (*Raja lintea* and *circularis*), and *Careproctus Reinhardi.* As now also the *invertebrates,* especially the *Echinodermata,* agree very little with those on 210 fathoms (*Brissopsis* is quite missing, as on the whole the *Echinida;* 3 new *Stellerida* and 3 new *Holothurida* are added here), I must suppose that we *here again meet an essentially different fauna.*

General Observations. There is no doubt then that the *Skager Rack, on various depths, from 20—300 fathoms, is inhabited by essentially different faunas*, distributed mainly according to the depth of the gradually sloping bottom of the sea.

We cannot imagine, however, such a distribution of faunas in this sea without assuming also that there must be essentially different conditions of life at the various places. For the faunas could not permanently remain separated, if not powerful, nay destructive natural conditions kept the particular species within their fixed locality. As regards *space* and *time* there is evidently nothing that prevents these animals from spreading in all directions. Most of the animals have here pelagic or, at any rate, very mobile young ones, and

the species can therefore very easily spread; but as it is a fact that they do not do so, we must look for *special causes* that limit their distribution, regulate it, and arrange the animals as they have evidently been arranged from times immemorial — It is often said that the animals are to be found where *their food* is. But as the food consists in other animals or plants, or in parts of such, the occurrence of the food, sure enough, may furnish an explanation with respect to certain animals; but then we stop again by the question: what then regulates the distribution of the food-animals (plants)? It is consequently a provisional solution only, this reference to the food. The distribution of the food is scarcely of any great importance to the animals on the bottom of the Skager Rack; for it is evidently the mud of the bottom which affords the means of subsistence to most of the invertebrates, and the rest of the animals live on this invertebrate-fauna. The nourishing ingredients of the bottom-materials, certainly, might occur in different quantities on the various depths — it would be of interest to get this investigated — but however the distribution might prove to be, it will never be able to explain, why some species live on great depths only and not on less deep water, while others do just the contrary.

Besides *time* and *space*, and the *occurrence of the food*, there is still another condition, which is often said to be of great moment when we want to understand the distribution of the organisms, i. e. *the competition between the species*, partly between those which are nearly allied to one another, partly between the species less nearly related. And, certainly, there can be no doubt that in many cases the mutual relation between the various species has a great influence on their distribution; many parasites are bound to *a certain host* and, consequently, can occur only within the province of distribution of the said host. Certain animals may pursue others, which they want for their food, or with which they compete in other ways, so vehemently that they drive them away from districts, where they would otherwise have been able to live. But I can scarcely believe that this circumstance is of any moment to the greater part of the inhabitants of the sea. At any rate we must not forget that there are many other factors which influence the distribution. Among these I shall mention *the light in the various depths, the temperature, the salinity, the gas-contents of the water* (carbonic acid and oxygen), *the specific gravity of the water, the pressure*, etc.

There can be no doubt that the changing *light* must have a powerful influence on the distribution of the organisms (animals as well as plants), on a slope extending from the shores as far as out on 300 fathoms' depth. Many

organisms, evidently, cannot thrive, or find their food, without a certain minimum of light, while others seem to thrive better in almost total darkness. On less deep water, 0—30—40 fathoms, we meet with a *temperature* changing from 0—19° C., on the greater depths c. 4—8° C. — Many animals will not be able, in certain periods of their lives (for instance in their breeding-time) to obtain the sufficiently high or low temperatures which are necessary for them, except on lower water; others cannot bear the changing temperatures of the latter, but are killed by it; they must remain on the greater depths. The *salinity* is, near the surface, very changing; in the deepest regions exceedingly constant. The *specific gravity*, which is chiefly dependent on the salinity of the water, seems also to be of some moment, as certain eggs of fishes cannot float in the lighter water, and are therefore carried into the more saline, deep water.

We must presume that also *the pressure of the water* in the various depths, and its *contents of oxygen and carbonic acid*, must be of essential importance for the life of the animals; but it cannot be denied, it is very strange that it is just between 200 and 300 fathoms the difference between the faunas is so great, for down here most of the said natural conditions (the pressure and the light excepted) are, no doubt, pretty nearly the samme. — It is my conviction that the causes of the distribution in our seas of the various species as a rule can be found in these and similar purely chemico-physical conditions. A closer study of this matter, supported by experiments, would throw light on many questions of merely theoretical as also of great practical importance. —

When we except the Norwegian fjords, which at certain places are very deep (as deep as 700 fathoms), we shall look in vain in northern Europe for a place as easily accessible as the Skager Rack for de study of *the dark regions of the sea;* moreover the bottom is exceptionally convenient for fishing and trawling. From the Skaw we have only 5—6 hours sailing to get out on a depth of 3—400 fathoms. The Norwegian fjords, of course, are more conveniently situated; but the bottom is not so favourable, perhaps, at all places, and their stagnant waters, shut in sometimes for many years, do not offer such oceanic conditions as the Skager Rack, whose waters, acording to *O. Pettersson's* investigations, are frequently renewed.

As to the **frequency of the fishes** in the seas investigated, we get by the investigations of the Biological Station, as a rule, only information with respect to the smaller ones. As to the larger forms, however, the trawlers, especially the German trawlers, can give much information. It is stated every

week in the »Deutsche Fischerei-Zeitung« what German trawlers (having visited, among other places, the Skager Rack) bring to land at Geestemünde and Bremerhafen. We do not get any closer information, certainly, as to the fishing-grounds, but from my personal knowledge of the matter I may presume that Skager Rack in this case means the Skager Rack near the Skaw.

From this source it may be stated that a steam-trawler after a single voyage to the Skager Rack, of c. 8—10 days, can bring home 100—200—400 cwt. of fish of the following species:

Of *haddock*	(*Gadus æglefinus*)*	often	70—120 cwt.
- *cod*	(— *callarias*)*	-	30 —
- *green cod*	(— *virens*)	-	11—30—100 —
- *hake*	(*Merlucius smiridus*)*	-	12—20—40—50—160 —
- *ling*	(*Molva vulgaris*)	-	8 —
- *the pole dab*	(*Pleuronectes cynoglossus*)*	-	15—20—30—70—80 —
- *plaice*	(— *platessa*)*	-	18—65—80 —
- *brill*	(*Bothus rhombus*)	-	8—10 —
- *turbot*	(— *maximus*)	-	4—10 —
- *sole*	(*Solea vulgaris*)	-	$^3/_4$ —

Moreover the following fishes are sometimes caught by the hundredweight: *Raja sp.* (12 cwt.), *Argentina silus* (14 cwt.), *Clupea finta* (16 cwt.), *sharks, halibut* (*Hippoglossus*), *cat-fish* (*Anarrhichas*), *gurnard* (*Trigla sp. sp.*), *Norway haddock* (*Sebastes*); besides a few *salmon* (*Salmo sp.*) at 10 lbs. the piece.

The five species marked * form by far the greater part of every trawler's catch in these regions. Of these 5 again the *haddock* and the *pole dab* are the commonest. — It is a matter of course that a number of other smaller species of fish are caught in the trawl, which are not named in the said periodical; they have no pecuniary value, and do not occur either in greater numbers.

The following **7 species of fish are here for the first time introduced into the Danish fauna:** *Careproctus Reinhardi* Kroyer, *Gadus Esmarkii, Gadiculus argenteus* Guichenot, *Lycodes gracilis* Sars, *Lycodes Sarsii* Collett, *Raja circularis, Raja lintea.*

The *Lycodes* of 1897 have been determined by Professor *R. Collett.* By *Petersen's* investigations in former years in the Cattegat a single *Lycodes* had already been found, but not till now the species has been determined.

Professor *Collett* has in »Videnskabernes Selskabs Skrifter 1898« rendered an account of his determination of *L. Sarsii.*

When *Petersen* in the summer 1897 assisted *Dr. Johan Hjort* in a series

of fishery-investigations in the Christiania Fjord a little *Gadoid* of quite a peculiar appearance was often caught in the otter-seine, which had been brought along from Denmark, a *Gadoid* which was not mentioned in the Scandinavian ichthyological literature; but according to later information from *R. Collett,* it proved to be *Gadiculus argenteus* Guichenot, a small codfish, very nearly related to the genus *Gadus,* and described by *Guichenot* in »Exploration Scientifique de l'Algerie, Poissous. 1851«. It has afterwards been found in the Bay of *Biscay* by the »*Travailleur*«, and the »*Talisman*« found it at *Morocco* and *Sudan;* finally the »*Porcupine*« has taken it west of *Ireland* on 183 fathoms' depth. On the whole it seems to prefer depths of 2—300 fathoms in the Mediterranean and along the western shores of Europe; but now it appears to be common also in the Christiania Fjord, and a small specimen of it has been found (at station 9) in the Skager Rack, towards the Swedish coast, on 95 fathoms' depth, while another, and better, is preserved at Station 12. In the southern European seas the fish occurs in great numbers; and it will surely also be found to be common at certain places in the Skager Rack, when once this sea is properly investigated. As to *Careproctus Reinhardi,* from Greenland, which has been described by *Reinhard* and *Krøyer*, I shall mention only that it was taken, in 1879, by the Swedish gun-boat »*Gunhild*«, at about the same place where it was now again found; this is the case also with *Raja circularis.*

It has further been shown that *Sebastes, Gadus Poutassou, Coryphænoides rupestris, Argentina silus,* and *Chimæra monstrosa,* fishes which otherwise are rare with us, are found more or less commonly distributed in the deep part of the Skager Rack, which is evidently to be looked upon as their proper home. How many others of our rare fishes may be at home out here, we do not know.

Of Crustacea decapoda are new to the fauna: *Munida tenuimana* Sars, *Sabinea Sarsii* Smith, and *Pandalus propinquus* Sars; and of the Mysidæ: *Mysideis insignis* Sars.

Of Gammaridæ there are 3 new specimens: *Stegocephalus inflatum* (Kr.), *Haploops setosa* Boeck, *Rhachotropis* sp.

Of Bivalves there are *Pecten abyssorum, Portlandia intermedia, Malletia obtusa, Syndosmya longicallis.*

Of Gasteropoda: *Dentalium agilis, Admete viridula, Typhlomangelia nivalis, Buccinum Humphreysianum, Sipho Sarsii, Scaphander* sp.

Of Cuttlefishes: *Octopus arcticus* and *Rossia sublevis.*

Of Echinodermata the following species are new: *Pteraster multipes* Sars, *Archaster* Düb. & Kor., *Poraniomorpha rosea* Dan. & Kor., *Ophiosholex glacialis* M. Tr., *Asteronyx Loveni* M. Tr., *Chirodota lævis* Fabr., *Echinocucumis typica* Sars, *Holothuria tremula* Gunn.

Of Spongozoa: *Pylymastia mamillaris* O. F. Müller, *P. hemisphæricum* Sars and *Stylocordyla borealis* Lovèn.

Of Anthozoa, finally, an *Actinia* and *Funiculina quadrangularis* Pall are new; and *Kophobelemnon stelliferum* O. F. Müller, can now with certainty be said to belong to the Danish part of the Skager Rack.

In all about 40 new species have thus been added to the Danish fauna, all from the Skager Rack. For we do not hesitate to class the animals in nearly the whole of the Skager Rack among the Danish fauna, being of the same opinion as *G. Winther* in his »Prodromus Ichthyologiæ Danica Marinæ«, 1879, that it is the deepest part of this sea which forms the natural boundary between the faunas of the countries; and if we draw the boundary-line in the middle of the very deepest part, all the above-mentioned stations, with the exception of Nr. 9, will fall within the Danish part. After all, however, this question of the boundaries is not a very essential one. The main point is, *to get acquainted with the fauna of the open Skager Rack.* To this the above may contribute a little, but, certainly, only a little; for it is but occasionally we have got the large as well as the smallest animals, and the places we have investigated are, as yet, too few in number.