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SYNOPSIS OF BIOLOGICAL DATA ON THE NORWAY POUT

Trisopterus esmarkii (Nilsson, 1855)

Prepared by
D.F.S. Raitt

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 1968

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OT Données océanographiques.

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IT Sinopsis sobre limnologia.

y

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SYNOPSIS OF BIOLOGICAL DATA ON THE NORWAY POUT

Trisopterus esmarkii (Nilsson, 1855)

Prepared by

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, January 1968

PREPARATION OF THIS SYNOPSIS

A revision of the provisional version issued in September 1966 for presentation at the ICES Symposium on The Ecology of Pelagic Fish Species in Arctic Waters, Copenhagen, 30 September - 1 October 1966.

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Taxonomy. Distribution. Life History.
Population structure. Exploitation.
Management.
NE 13-6M047.

C O N T E N T S

* As no information was available to the author, these items are not listed in the text.

1 IDENTITY

1.1 Nomenolature

1.11 Valid name

Trisopterus esmarkii (Nilsson, 1855)

1.12 Objective synonymy

Gadus esmarkii Nilsson, 1855, Scand. fauna IV, p.565.

1.2 Taxonomy

1.21 Affinities

- Suprageneric

Phylum Vertebrata
Series Pisces
Class Teleostomi
Subolass Aotinopterygii
Order Gadiformes
Family Gadidae
Subfamily Gadinae

- Generic

Trisopterus Rafinesque, 1814, Prec.découv. somiologiques, p.16

Genotype: Gadus capelanus Laoépède.

The following generic concept is that given by Svetovidov (1948): "Dorsal fins touching or separated by small space, anal fins touching without a space. First anal fin long, its origin beneath the first dorsal fin. Caudal fin truncate or with a small notch. Lower jaw shorter or slightly longer than upper. A long barbel on the chin. Teeth on pre-maxillary and dentary and in one or two rows along the forward edge of the head of the vomer. Lateral line in the forward half of the body in the shape of a low arch, farther back straight, uninterrupted for its entire length. Pores on the head along the sensory oanal; 12 pores in the preoperculo-mandibular oanal, 8 pores in the infraorbital canal, 2 pores in the supraorbital canal, and one unpaired pore in the supraorbital commissure. Mucous cavity on the skull almost closed. The facial nerve exists through a foramen on the side of the skull."

- Specific

Trisopterus esmarkii (Nilsson, 1855)

Type Gadus esmarkii Nilsson, 1855

ID 14-18; IID 21-29; IIID 23-29; IA 24-32; IIA 24-30; pectoral 19-20; vertebrae 52-55; vertebrae bearing the first haemal aroh 18-19. Lower jaw slightly projects forward. Anal fins touching, dorsals with a small spaoe between. Beginning of first anal almost beneath the rear end of the first dorsal. Barbel not very long, about 10% of head length. Body muoh less deep than in all other species and subspecies of this genus, lateral line less ourved. Dorsum greyish brown, the sides dull silvery, belly pale. At the upper edge of the base of the pectoral fin there is a dark spot, which is sometimes not seen on preserved specimens. Maximum length about 25 cm (Williamson, 1906; Svetovidov, 1948).

- Key to the species and sub-species of Trisopterus (adapted from Svetovidov, 1948).

1. Lower jaw somewhat longer than upper .... T. esmarkii (Nilss.)
2. Lower jaw shorter than upper .... (3) (4)
3. First anal fin long, with 30-34 rays, the length of its base constituting 35.7-37.8% of body length, its insertion anterior to that of the second dorsal. Interorbital space broad 17.9-18.1% of head length .... T. Luscus (L.)
4. First anal fin shorter with 27-30 rays, the length of its base constituting 27.9-31.7% of body length, its insertion vertically in line with that of the second dorsal. Interorbital space narrower 17.0-17.4% of head length .... (5) (6)
5. Gillrakers about 28; Atlantic Ocean .... T. minutus minutus (O.Mull.)
6. Gillrakers about 17-20; Western part of the Mediterranean Sea .... T. minutus oapelanus (Risso)

1.22 Taxonomic status

Morpho-species

1.24 Standard common names, vernaoular names - Table 1

1.3 Morphology

1.31 External morphology (see also seotion 1.21)

Proportional measurements "in % of body length: anteanal distance 34.3-37.5, antedorsal distance 25.3-27.1, length of pectoral fin 16.7-17.6, length of pelvic fin 12.3-14.5, base of first dorsal fin 11.6-12.7, base of second dorsal 22.1-25.1, base of third dorsal 15.4-18.4, base of first anal 20.4-26.6, base of second anal 16.4-18.5, height of first dorsal 12.6-13.6, height of first anal 10.6-11.9, depth of caudal peduncle 3.8-4.0, its length 10.5-12.5, length of head 22.1-22.9.

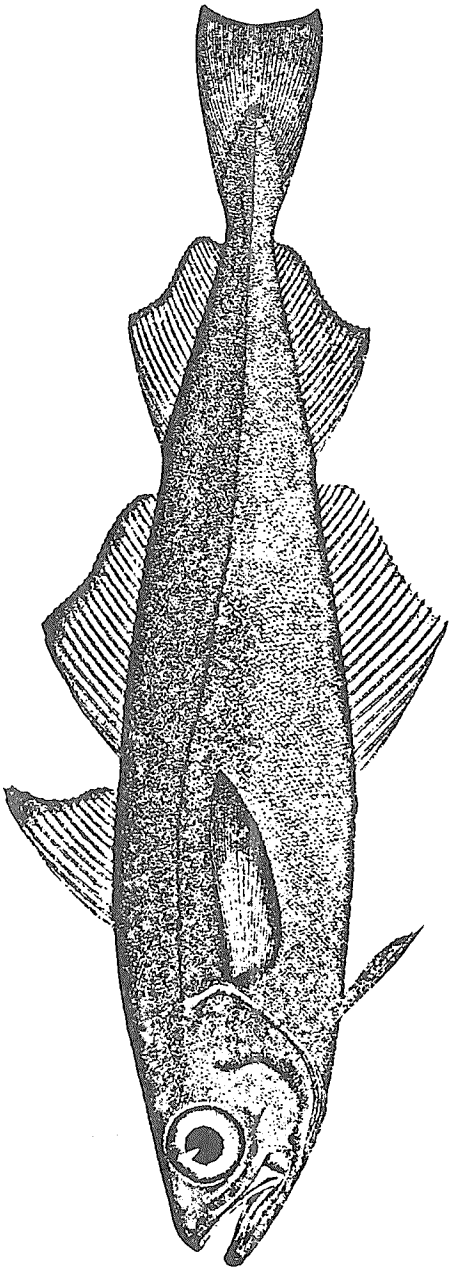

Figure 1. Norway pout (Fries et al., 1895)

TABLE 1

Standard and Vernacular Names

Country	Standard common name	Vernacular names
Belgium	Kever	
Denmark	Spaerling	Calypso
Faroe	Hvitingsbrodir	
Finland	Harmaaturska	
France	Tacaud norvégien	
Germany	Stintdorsch	
Holland	Kever	
Iceland	Spaerlinger	
Norway	Øyepål	Calypso
Poland	Okoniel	
Spain	Faneca noruega	
Sweden	Vitlinglyra	
United Kingdom	Norway pout	
U.S.S.R.	Tresochka esmarka	

In % of head length: length of snout 27.9-31.3, horizontal diameter of eye 31.9-33.5, length of upper jaw 40.7-42.0, length of lower jaw 53.0-55.0, width of forehead 12.4-13.7, length of barbel 10.4" (Svetovidov, 1948).

2 DISTRIBUTION

2.1 Total Area

Norway pout occurs only on the continental shelf on the eastern side of the North Atlantic and its range of distribution is charted in Figure 2. It is generally most abundant in waters 100-200 m in depth. It is very common off the west and north Scottish coasts and in the northern North Sea. It is also found in some numbers in the Skagerrak and Kattegat and the southern Baltic (Petersen and Levinsen, 1900; Ehrenbaum, 1936; Hannerz, 1961). It has been recorded from the Norwegian fjords as far north as Lofoten and also from Bear Island and the western part of the Barents Sea. Svetovidov (1948) relates these northerly records to the recent general warming up along the shores of the Scandinavian peninsula, and Baranenkova (1960) associates the large numbers of Norway pout in the southern Barents Sea in 1959, with the high intensity of the Murmansk Current in that year and the above-normal water temperatures from March onwards. Maslov (1944) found spawning individuals in great numbers at the Lofotens and the young at Bear Island and Boldovsky (1939) identified several specimens from the Barents Sea as did Johannessen (1966).

More recent trawling records of the English research ship "Ernest Holt" (Blacker, 1966) gave the following results:

Norway pout were caught in quite large numbers in the codend cover on the Malangen Bank and Sven's Ground off the north-west Norwegian coast. Catches of ½-1½ baskets per haul were recorded including many mature, ripe females.

Norway pout is abundant at Faroe and on the northwest, west and south coasts of Iceland (Saemundsson, 1949; Kotthaus and Krefft, 1957) although the first author states that it is not found on the colder north and east coasts.

At the southern end of its range its distribution extends into the Irish Sea (Gokhale, 1953) and one specimen has been recorded from the extreme western end of the English Channel (Garstang, 1903). Blacker (1962) in a recent report on rare fishes recorded in catches by exploratory fishing vessels from fishing grounds to the west of the British Isles found Norway pout on the Farm and Porcupine Bank grounds off the west coast of Ireland. Other observations from this area have been made by Holt and Calderwood (1895). Trawling records of the Marine Laboratory, Aberdeen (unpublished) from the other oceanic banks, Rockall, Bill Bailey, George Bligh, etc., off the west coast of Scotland, however, show no instance of this species being caught but it is interesting to note that the closely related and generally more inshore species T. minutus (poor cod), was recorded on several occasions, from Rockall Bank. Schmidt (1909) also noted the presence of the larvae of poor cod at Rockall but not those of the Norway pout.

2.2 Differential distribution

2.21 Spawn, larvae and juveniles

- Spawn

Within the area of its distribution spawning occurs over the coastal banks or over the upper part of the slope towards the deeper water. The eggs are pelagic and there appears to be little spawning in more than 200 or less than 50 metres (Schmidt, 1909). Data on the distribution of the eggs of Norway pout off the Norwegian coast are given by Wiborg (1960, 1961 and 1962) and Dragesund and Wiborg (1963 and 1966) and off north-western Norway and in the Barents Sea by Baranenkova and Khoklina (1966).

- Larvae

Schmidt (loc. cit.) found the larvae of Norway pout in greatest abundance in the northern North Sea, off the north and west coasts of Scotland, at Faroe, and to the west and south of Iceland. Schmidt's results for the North Sea are confirmed by those of Damas (1909).

In the northern North Sea one main centre of larval abundance has been described between Shetland and Norway, although a smaller secondary concentration occurred to the south in the area of the Gut in several of the years investigated (Raitt, 1965). These concentrations of larvae appeared to be quite distinct from a similar one off the north-west coast of Scotland and on only three occasions could the results be interpreted as indicating a slight larval drift through the Orkney-Shetland passage into the North Sea.

Schmidt (1909) states that in his plankton hauls close to the surface very few larvae were caught, most were taken deeper down at about 30 metres. More recently Henderson (1953) found no Norway pout larvae in 6 years of sampling the North Sea with the continuous plankton recorder and concluded that they were not present at the 10 m level of sampling in sufficient numbers to be represented in the catches.

Magnusson et al (1965) give the results of work with the Icelandic high speed sampler in the Irminger Sea and record the highest catches of Norway pout larvae at the 15-18 m level of sampling during the day and the 25-30 m level during the night. Actual numbers of larvae caught, however, were higher by day at both depths. Very few larvae occurred at the 3.5 m level.

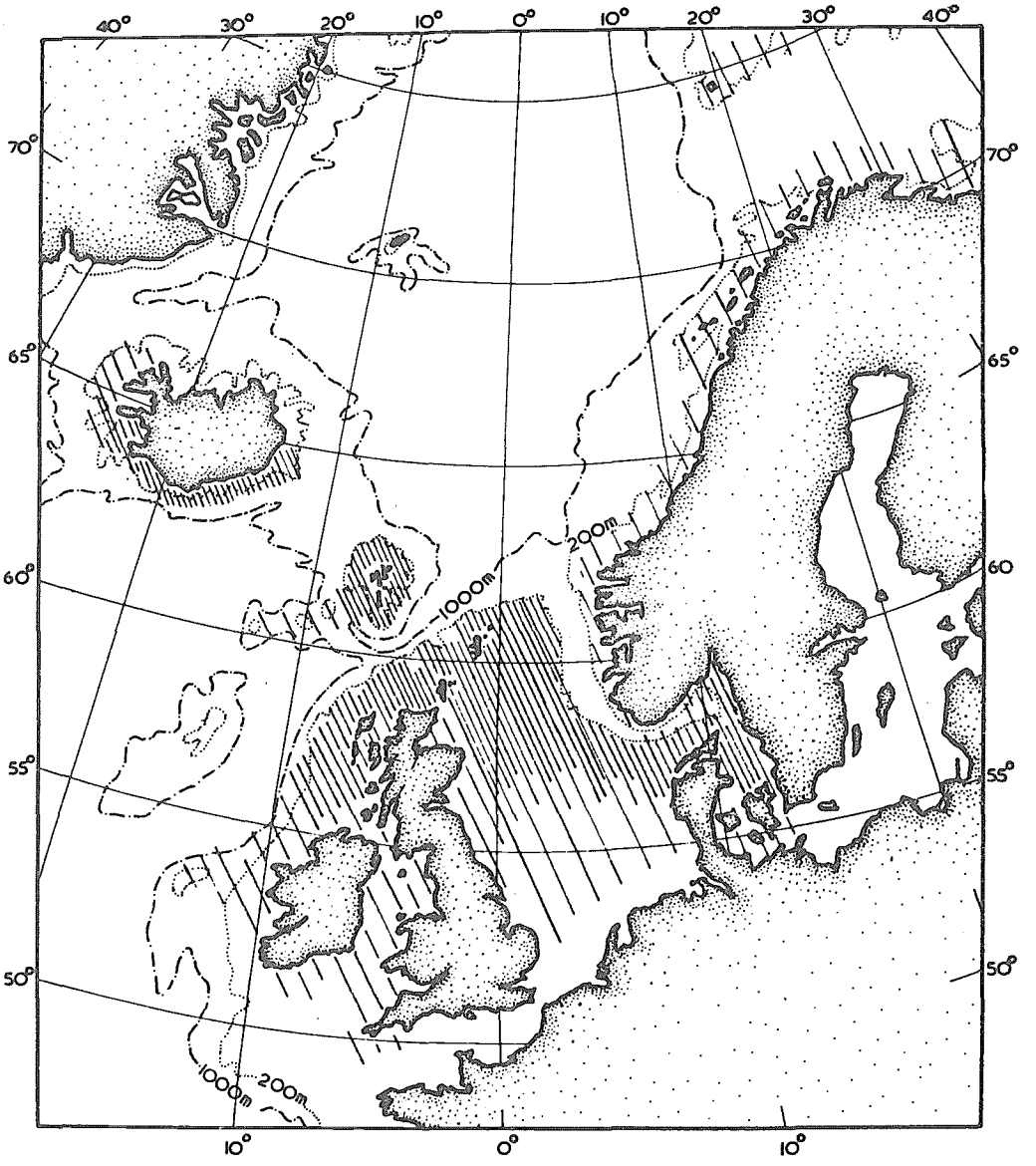

Figure 2: Overall distribution of Norway pout (Raitt, in press)

- Juveniles

Mason (1960) found juvenile Norway pout especially abundant in the late summer and early autumn in the northern North Sea as a result of the new brood spawned in the previous spring. At Faroe, juveniles first appeared in catches rather later than in Scottish waters. The population on the Faroe plateau is probably self contained, the eggs and larvae normally being retained by a cyclonic eddy system (Tait, 1934). See Figure 2 for comparison of distribution of juveniles and adults in the North Sea.

2.22 Adults
(see also section 2.1)

Within the northern North Sea, where the bulk of the research on Norway pout has been done so far, adults are most abundant off the Shetlands and south towards the Fladen and Gut areas. A secondary concentration appears to exist in the Egersund area along the Norwegian Deeps (Sahrhage, 1964; Raitt, in press). There is some evidence to suggest a slight northerly migration for spawning to an area between Shetland and Norway (Mason, 1960) and this coincides with the area where the largest concentrations of Norway pout larvae are found in the spring (Raitt, 1965).

In the Skagerrak there is a large scale spawning migration out into the North Sea and the subsequent larvae and juveniles drift back into the Skagerrak and Kattegat (Poulsen, 1964 and, 1966).

2.3 Determinants of distribution changes

Schmidt (1909) gives the following boundaries for the spawning of Norway pout:

northern limit; off N.W. and S.E. Iceland;
southern limit; the waters south of Ireland (including these);
minimum temperature; about 6°;
maximum temperature; about 9-10°C.

Raitt (in press) found that adult Norway pout in the northern North Sea showed no major changes in distribution associated with the changing temperatures and salinities in the years he investigated. The most consistent environmental relationship was with depth, highest catches being obtained in water over 100 m in depth and less than 200 m. In the spring samples these were associated with bottom temperatures of 6°-8°C and in the autumn with bottom temperatures of 7°-9°C.

Mason (1960) has also noted the relationship with depth and states that Norway pout are only occasionally found at depths of less than 80-90 m in the North Sea. Sahrhage (1964) observed that the conditions prevailing at the bottom may play a part in that these fish are found with particular frequency on a muddy bottom. Tambs-Lyche (1954) found them typical inhabitants of the muddy bottoms occurring in the fjords of western Norway. Sahrhage (1964) concludes that the stock in the North Sea lives in "mixed" water with a salt content of over 35°/oo and temperatures mainly between 6-9°C.

3 BIONOMICS AND LIFE HISTORY

3.1 Reproduction

3.11 Sexuality

Norway pout are heterosexual, but no known external characteristics distinguish males from females.

3.12 Maturity

Amongst workers who have recorded the smallest mature specimens of Norway pout Holt (1891) found two ripe females at a length of 11.5 cm in April and Fulton (1901a and 1904) found fish of 12 and 13 cm with maturing gonads in October, although all the ripe specimens he examined were over 15 cm long. Collett (1875; 1903) found specimens spawning in the Oslofjord in February-March. Raitt (1961) found that the mean size at first maturity in the main body of the northern North Sea in March was about 14 and 15 cm for males and females respectively and the smallest mature individual of either sex was 13 cm. In the Moray Firth and inshore at Shetland, however, ripe females of 11 cm were found. From age determinations using otoliths it was possible to show that the majority of the Norway pout stock in the North Sea spawn for the first time at age 2, but that a small proportion also spawn at 1 year old. This has also been shown for Norway pout in the Irish Sea by Gokhale (1953).

Gonad stages are similar to those recorded for whiting by Bowers (1954) and have been described for Norway pout by Gokhale (1957).

3.13 Mating

Nothing is known of the spawning behaviour of Norway pout.

3.14 Fertilization

Ova and sperm probably shed freely into the water.

3.15 Gonads

Fulton (1904) records some data on ovary weights of fish from the Moray Firth in January (Table 2).

Histologically the gonad development in Norway pout is most active during late winter and early spring. Since this is the period of least body growth the germ cells develop fastest while the body is growing most slowly (Gokhale 1957).

- Fecundity

Preliminary estimates (Raitt, 1966b) on a sample of 2 year old fish (the age group which normally accounts for the bulk of the spawning stock each year) showed that the mean fecundities for fish of 15, 17 and 19 cm in length were 27,000, 38,000 and 51,200 respectively. On this basis, for a change in length of 2 cm the fecundity is increased by a factor of about 1.4. The range of mean lengths of two-year-old fish from 1960-65 was 16.0 - 19.0 cm. Growth then must have a considerable influence on the total spawning potential each year.

TABLE 2

Ovary weights and diameter of largest eggs, January 1904. (Fulton, 1904)

Length (mm) of fish	Weight of fish (g)	Weight of ovary (g)	Diameter of largest eggs (mm)
153	24.7	0.5	0.44
155	26.5	0.7	0.46
155	28.6	1.3	0.57
155	28.4	1.1	-
155	26.7	0.8	-
158	31.0	1.8	-
161	31.7	1.2	0.57 - 0.63
180	41.0	1.3	0.50
202	67.1	3.4	0.59 - 0.63

3.17 Spawn

Small round egg of 1.0-1.33 mm in diameter, without oil globule, egg capsule smooth, without large perivitelline space, yolk of egg homogeneous. Pigment, black only, not extending on to the yolk. Gadoid anus. (Hoek and Ehrenbaum, 1911). See Figure 3.

3.2 Pre-adult phase

3.22 Larvae phase (see Figure 3)

Fraser (1961) found the larvae of Norway pout to be more abundant in "mixed" water conditions in the North Sea as indicated by the presence of Sagitta elegans, and suggested that a more abundant food supply was the possible cause (see section 3.41).

3.23 Adolescent phase

This phase may be defined as the stage from metamorphosis to first maturity. The young fish may be regarded as a juvenile when the first sizes are taken when trawling on the bottom. This, according to Mason (1960), is at a length of 2 cm in May in the Moray Firth but more typically 5-6 cm in August. (See also section 3.12).

3.3 Adult phase

3.31 Longevity

Fish up to 4 years of age have been taken in the North Sea although the numbers of fish over 3 years of age were few (Raitt, in press). At Faroe, however, 4 and 5 year olds are not too uncommon and several 6 year olds have been recorded from Iceland. Saemundsson (1929), however, examined the otoliths of Norway pout at Iceland and concluded that the maximum age of the fish was usually 4 years but occasionally 5. Hannerz (1961) states 3 year olds were rare in his samples from the Skagerrak.

3.33 Competitors

Information on the way in which competition may arise in the Norway pout stocks is obscure. When found in large numbers together, e.g., as in the commercial fishery, Norway pout usually constitute almost the whole of the catch (Johannessen et al, 1964). In circumstances such as this there is more likelihood of intraspecific rather than interspecific competition. Indeed there is some evidence of growth being markedly density dependent (Raitt, 1966b). Raitt and Adams (1965), however, showed that 0 group whiting caught in the same trawl as Norway pout were frequently feeding on the same food species.

3.34 Predators

Jones (1954) shows that in the North Sea Norway pout is by far the most important food item in the diet of whiting over 21 cm long. Nagabhushanam (1964) also records Norway pout as an important food item of adult whiting in the deeper water west of the Isle of Man.

Rae (1963) states that it is also the principal food type of the larger megrim in the North Sea. Norway pout has been recorded from the stomachs of cod at certain times of the year in the North Sea (Graham, 1923), but Rae (personal communication) has found it to be, in general, not of first importance as a food type in Scottish waters. Saemundsson (1949) states that at Iceland it is "of great importance as food for many fishes, particularly cod and ling."

Feeding on Norway pout has been recorded to a lesser extent in a number of other species. Hickling (1935) working on the food of hake states that he found hake in the Minches between the outer and inner Hebrides "feeding heavily on the pollack whiting (Gadus esmarkii)", and Dunn and Holt (1899) found specimens in the stomach of a pollack /Pollachius pollachius (L.)/ off south-west England. Holt (1892), Scott (1910), McIntyre (1953) and Rae (1958) recorded it in the stomachs of halibut from the North Sea, North Atlantic, Faroe and Iceland.

Ritchie (1937) found haddock feeding on Norway pout only in the autumn off the Shiant Isles and from St. Kilda to North Rona. Jones (1954), however, shows the relative insignificance of fish generally in the diet of haddock.

It can be concluded, therefore, that Norway pout is one of the chief prey species in the North Sea and is an important link in the food cycles of that area.

3.35 Parasites, diseases, injuries and abnormalities

The infection of the eye of Norway pout by the cranial protozoan parasite Myxobolus aeglefini Auerbach has been noted by several authors (Günther, 1888; Fulton, 1901b; Johnstone, 1906; Kabata 1957). Raitt (1965) was able to use the incidence of infection as a biological indicator of stock in helping to establish the independence of the stocks of Norway pout in the North Sea and off the North-west Scottish coast.

A recent examination of 20 adult Norway pout from the west coast of Scotland and 20 from Faroe by Dr. Z. Kabata of the Marine Laboratory, Aberdeen, Scotland (unpublished) gave the results shown in Table 4.

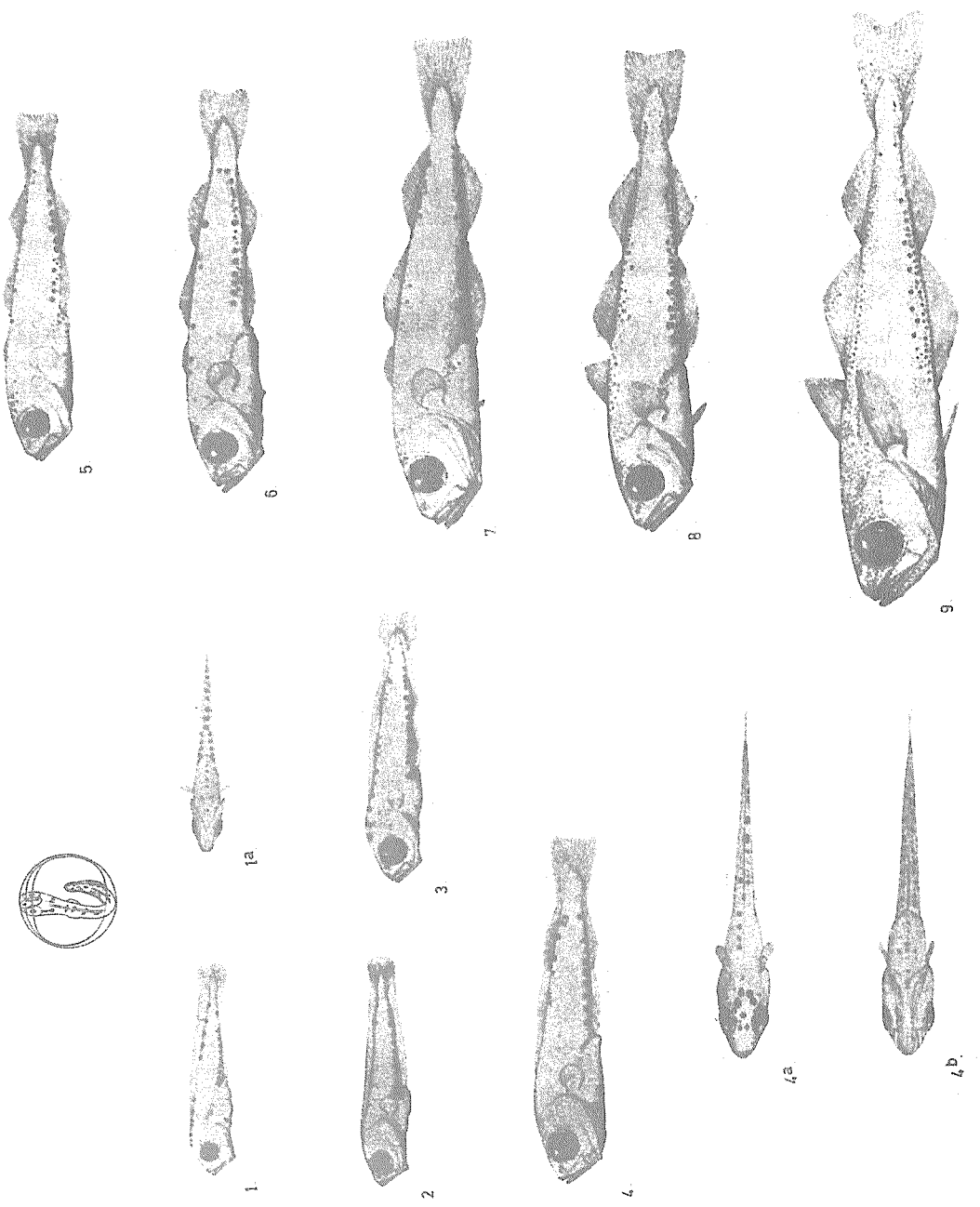

Figure 3. Egg and larvae of Norway pout (Schmidt, 1905)

TABLE 3

Development of larval characteristics with growth, after Schmidt (1905)
(See Figure 3)

Length	Characteristics
6 mm	Notochord straight. Pectorals fan shaped folds of skin, ventrals lacking. Eyes relatively small. Occipital pigment of four stellate chromatophores. Preanal pigment - 8 large chromatophores. Abdominal pigment weak, sides free of pigment. Ventral pigment - about 20 large chromatophores. Dorsal - 15 which are smaller and have greater interspaces.
8½ mm	End of notochord almost quite straight. Distinct indication of rays in caudal fin and of interspinous regions in dorsal and ventral fins. Occipital pigment - 2 large round well-separated chromatophores. Bifurcation of the ventral pigment is characteristic. 7 postero-ventral and 6 pairs of antero-ventral chromatophores.
10¼ mm	End of notochord bent slightly upwards. Rays of caudal clear. IID 10; IIID 14; IA 12; IIA 17 can be detected. Ventrals are tiny knobs. Ventral pigment no longer bifurcated now a double row. Dorsal pigment weaker than ventral.
13 mm	End of notochord strongly bent upwards. ID 4; IID 15; IIID 19; IA 18; IIA 20. Ventrals still wart-like. Ventral pigment - about 10 large stellate chromatophores on each side of median fins.
16 mm	End of notochord now almost entirely reduced. No pigment on fins.
19¾ mm	Caudal fin is conoave posteriorly. Body decreases from before backwards. Eyes relatively small. ID 10; IA 24; IIA 27.
23 mm	Caudal fin deeply concave. Unpaired fins quite separated. Underjaw now forward of snout. No pigment on fins.
28½ mm	Relatively small eye. Slenderform. IA 28; IIA 26. Single black chromatophore on most of the rays of IID and IIA.
54 mm	ID 14; IID 25; IIID 26; IA 30; IIA 27. Unpaired fins show faint pigment. Almost whole of ventrolateral region is still pigmentless.

3.4 Nutrition and growth

3.41 Feeding

Norway pout is a streamlined fish, has a terminally placed mouth and sharp teeth. The sensitive barbel is reduced and it is typical of the active predator fish; it is a pelagic feeder.

Data on seasonal variations in feeding, although inconclusive, suggested that in the adult fish there may be three periods of low feeding intensity, in January, March-April (the main spawning period) and August. Apart from a slight drop in March, juvenile fish sampled from September to April showed no marked variations in feeding intensity. Both juveniles and adults appeared to have a higher

TABLE 4

Parasites of Norway pout (Kabata, unpublished).

Parasite	Organ infected	W. Coast of Scotland		Faroe	
		% of fish infected	Incidence per fish	% of fish infected	Incidence per fish
Eimeria sp.	Liver, swimbladder	95	mod.	70	mod.
Leptotheca informis	Gall bladder	55	mod.	10	mod.
Zschokkella hildae	Urinary ducts	20	mod.	-	-
Myxobolus aeglefini	Cranial bones, eyes	10	mod.	-	-
Sphaerospora sp.	Urinary ducts	-	-	20	mod.
Trichodina sp.	Inside nostrils	-	-	15	mod.
Octodactylus minor	Gills	-	-	15	1-2
Diclidophora denticulata	Gills	45	1-5	-	-
Bucephalopsis gracilescens; metacercaria	Cranial cavity	100	1-46	100	2-38
Hemiurus communis	Stomach	-	-	10	1-2
Hemiurus levinseni?	Stomach	-	-	15	1-2
Lecithaster gibbosus	Fore and midgut	-	-	60	1-7
Derogenes varicus	Mouth, gills, stomach, foregut	5	1	85	1-8
Contracaecum aduncum; larva	Abdominal wall, Mesenteries, liver Stomach, pyloric caeca, hindgut	10	9	10	1-6
Contracaecum sp.; larvae	Coelom, liver mesenteries gonads, caeca	100	3-139	100	1-87
Anisakis sp.; larvae	Mesenteries, Gonads	10	1	25	1-2
Ascarophis morrhuae	Stomach	10	1	15	1
Capillaria sp.	Hindgut	-	-	10	1-2
Capillaria sp.	Hindgut	-	-	20	1-2
Cucullanus cirratus	Foregut	-	-	5	1
Unidentified larval nematodes	Hindgut	5	1	-	-
Trypanorhynch larvae	Surface of gut and Pyloric caeca	15	1-8	5	1
Tetraphyllidean larvae	In pyloric caeca	5	7	-	-
Plerocercoid larvae	Pyloric caeca fore, mid, hindgut	95	1-13	50	1-6
Chalimus larvae	Fins	20	1-2	5	1

average volume per stomach during the hours of daylight.

A comparison of the stomach contents of Norway pout with the zooplankton in the northern North Sea, as sampled by the Gulf III, showed that the most abundant of the smaller planktonic species were also most frequently represented in the stomachs. An increase in the numbers of Calanus finmarchicus and Pseudo/Paracalanus in the zooplankton was reflected in an increase in the numbers of these species in the stomachs (Raitt and Adams, 1965).

3.42 Food

Planktonic crustaceans formed the bulk of the diet, copepods and euphausiids being of prime importance. There is evidence to show that the juvenile fish tended to have more copepods in the stomachs than the adults. Other food types occurring included Sagitta sp., appendicularians, and natant decapods (Raitt and Adams, 1965).

3.43 Growth rate

Raitt (1960) gives data on growth rates from the results of two North Sea trawling surveys carried out in the spring of 1960 and both covering the same general area in the northern North Sea. Preliminary estimates of the parameters of the Von Bertalanffy growth equation calculated from these results were

1) $L_\infty = 18.52$ $K = 0.44$ 2) $L_\infty = 19.32$ $K = 0.37$

Ursin (1963) followed the growth of two year classes of young Norway pout in the Skagerrak. Multiple regression analyses showed that the growth rate depends particularly upon day length and less upon temperature. Application of the Von Bertalanffy growth equation $[dl/dt = E - Kl]$ to monthly means of increment and size revealed considerable seasonal variation of the growth parameters. Except when quite young, the actual weights recorded for individual fishes were, during a large part of the year, often higher than the calculated asymptotic weight, W_∞. He finally concluded that the discrepancies between the length and weight curves (because length increase is not completely reversible) suggested a possible cause of natural mortality (see Figure 4), due presumably to physiological stress.

3.5 Behaviour

3.51 Migrations and local movements

As already noted (section 2.22) there is some evidence that adults in the North Sea migrate to spawn in an area between Shetland and Norway and also migrate out of the Skagerrak. Meek (1916) used the size and ages of Norway pout from different areas to demonstrate some movement within the North Sea.

3.52 Schooling

From information from the fishery (see section 5) it is clear that Norway pout tend either to be found in dense concentrations consisting almost entirely of the one species or in low concentrations mixed with a number of other species (Johannesen, 1964). Raitt (in press) noted that catches of Norway pout fell from several baskets per hour to less than half a basket as soon as the research ship "Scotia" moved out of the area of abundance which, in this case, was on the Fladen in 1961.

There is no evidence to suggest that Norway pout form "organized" schools in the way in which herring do.

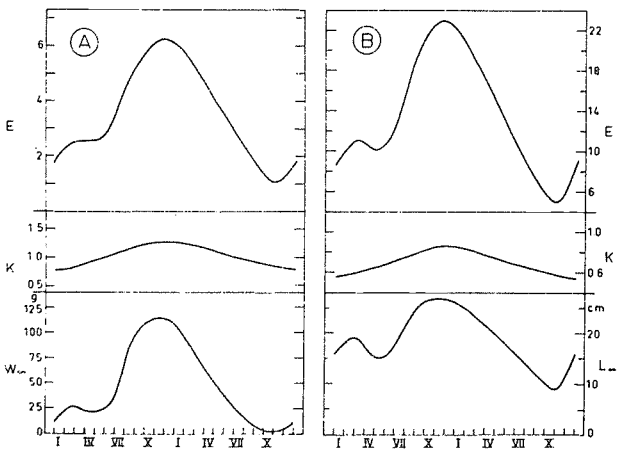

Figure 4. Growth parameters of Norway pout (Ursin, 1963)

4 POPULATION

4.1 Structure

4.11 Sex ratio

TABLE 5

Sex ratios of Norway pout samples

Region	% Male	% Female	No. in Sample	Authority
S.W. Iceland	37.8	62.2	172	Saemundsson (1929)
S.W. Iceland	57.5	43.5	421	Saemundsson (1929)
Moray Firth and Shetlands	34.3	65.7	572	Raitt (1961)
North Sea	43.0	57.0	1636	Raitt (1961)

4.12 Age composition

The data of Saemundsson (1929), Hannerz (1961) and Raitt (1963) are from research ship sampling and those of Poulsen (1964) and Christensen (1964) are from the commercial fishery.

The maximum age recorded from the North Sea is 4 years (Section 3.31) but it is clear that the majority of this population are usually 1 year olds.

Variations in the porportions of 1 and 2 year old fish in research catches have been shown by Raitt (1963 and in press). Whereas from 1960-1962 the samples were characterized by a higher percentage of 1 year olds, in 1963 these were outnumbered by the 2 year olds.

The data of Christensen (1964) for September-December 1961 show that Norway pout can first occur in the commercial catches from the age of 6 months.

4.13 Size composition

Length compositions are available from most of the sources quoted in Section 4.12. Table 7 shows the length ranges and modes of several of these samples.

- Maximum size

Saemundsson (1929) gives the maximum length at Iceland as 25 cm while in the North Sea it appears to be nearer 20-21 cm, although Johannessen et al, (1964) show that sizes above 20-21 cm are sometimes present in the commercial landings at Egersund. Collett (1875) records a specimen of 24 cm from the Oslofjord, Baranenkova and Khoklina (1966) record single fish at 31, 34 and 35 cm from the Barents Sea but state that these lengths were only found exceptionally.

- Maximum weight

Fulton (1904) records a gross weight of 67 gm from a 202 mm fish. Raitt (unpublished has found 20 cm fish from the North Sea at 58 gm and from the West Coast of Scotland at 62 gm.

- Length-weight relationship

These have been calculated by Ursin (1963) from the formula

$$\text{Condition factor } q = \frac{W}{L3}$$

The mean value for the year was approximately 0.0683. Fish were shown to be losing in condition during the winter but seemed to gain rapidly in condition in the spring.

4.2 Abundance and density

4.22 Changes in abundance

Raitt (1963 and in press) describes changes in annual abundance as indicated by the catch per 10 hours fishing during routine research ship trawling surveys in the North Sea. No possible causes of changes in abundance have been suggested apart from those attributable to fluctuations in year class strengths.

T A B L E 6

Age composition of Norway pout in percentage

Region	Time of samples	0	I	II	III	IV	V	Authority
S.W. Iceland	Mar. 1923-4	-	-	31	65	4	+	Saemundsson (1929)
S.W. Iceland	Apr.-May 1924	-	-	62	26	12	-	Saemundsson (1929)
Skagerrak	No information	-	86	14 (II and over)				Poulsen (1964)
Skagerrak	Mar. 1961	-	74	23	3	-	-	Hannerz (1961)
North Sea	Feb. 1961	-	94	5	1	-	-	Hannerz (1961)
North Sea	Mar. 1960-63	-	73	25	1	+	-	Raitt (1963)
North Sea	Mar.-Apr. 1961	-	42	57	1	-	-	Christensen (1964)
North Sea	March 1962	-	100	-	-	-	-	Christensen (1964)
North Sea	June 1960-63	-	72	27	1	-	-	Raitt (1963)
North Sea	Sept.-Dec. 1961	46	40	14	+	-	-	Christensen (1964)

T A B L E 7

Size composition of Norway pout

Area	Time of sample	Length range (cm)	Modes (cm)	Authority
S.W. Iceland	Mar.-May 1923-24	14-24	16/19/21	Saemundsson (1929)
Skagerrak	Feb. 1961	8-18	12/15	Hannerz (1961)
North Sea	Mar. 1961	9-20	12/16/19	Hannerz (1961)
North Sea	Mar. 1961	10-19	12/1[illegible]	Christensen (1964
North Sea	April 1960	8-21	12/17	Raitt (1960)
Barents Sea and N.W. Norway	Feb.-April 1934-65	7-35	11/17	Baranenkova and Khoklina (1966)

4.23 Average density

Catching rates with the bottom trawl are quoted by Raitt (in press) but what relation these bear to actual stock density is not known. Average values for different seasons and years show considerable fluctuations.

4.24 Changes in density

See section 3.52 for information on regional variations in density.

4.4 Mortality and morbidity

4.41 Mortality rates

No information on the value of the natural mortality rate is available. Since the fishing rate on this species has changed considerably in the last 20 years it can safely be assumed that the fishing mortality F has increased.

Raitt (1961 and 1963) has made provisional estimates of the instantaneous total mortality rate Z in the North Sea from research ship catches from 1935 to 1955 and from 1960 to 1963. The results suggested that while in the period up to 1955 the estimated mortality rate was 1.6 and in 1960/61 it was 0.7, in the two years 1961/62 and 1962/63 it had increased to 3.1 and 3.4 respectively.

The high overall total mortality rate and short life span have been attributed mainly to a high predation mortality (Fulton, 1901a; Raitt, 1960; Christensen, 1964) since Norway pout is a very important food type of several larger commercial species (see also Section 3.34).

4.42 Factors causing or affecting mortality

The role of predators has been referred to in section 4.41 and 3.34. In addition, Ursin (1963) has suggested that the discrepancy between the seasonal length and weight growth calculations may be contributory to the high mortality rate (3.34), presumably through physiological stress.

4.43 Factors affecting morbidity

For parasites see section 3.35, although none have been demonstrated to be fatal.

4.5 Dynamics of population (as a whole)

See Sections 3.43, 4.1, 4.2 and 4.3.

4.6 The population in the community and the ecosystem

The normal conditions for spawning have been described by Schmidt (1909). The distribution of Norway pout in the North Sea appears, from the information available, to be related only to depth (see Section 2.3).

Raitt and Adams (1965) stress the importance of Norway pout in the food cycles of the Northern North Sea as follows: "Norway pout, in common with several other species formerly of no commercial value, particularly sandeels, is now the basis of very important industrial fisheries at certain times of the year by certain countries. Rae (1963) has already commented on the fact that man is now a serious competitor for these species, which are also preyed upon for food by many larger commercial fish species. In addition, an analysis of the stomach contents of 0-group whiting has shown that they are often found feeding on the same planktonic species as Norway pout. Thus the relationship between whiting and Norway pout may be very complex but the possible effect on the whiting or other stocks of a decrease in the size of the population of Norway pout resulting from fishing or natural causes would be very difficult to assess."

5 EXPLOITATION

5.1 Fishing equipment

5.11 Gears

At present only two European countries, Norway and Denmark, land Norway pout in significant quantities.

The Norwegian fishery employs small-meshed bottom trawls and sometimes pair trawls. The cod-end mesh size is mainly 22 to 35 mm (Johannessen et al, 1964). The gear used by the Danish boats is very similar. (See also section 5.24).

5.12 Boats

The Norwegian and Danish fisheries for T. esmarkii are carried out from relatively small vessels mostly between 60 and 90 feet in length (Johannessen et al, 1964). A few, however, are steel vessels of up to 110 ft. These boats, in fact, are the same ones which take part in the industrial fisheries for small herring and sandeels.

5.2 Fishing areas

5.21 General geographic distribution

At the moment the fishery is confined to the Northern North Sea and Skagerrak, and to a lesser extent the Norwegian Møre coast (62°N-64°N).

5.22 Geographic ranges

By far the largest part of the industrial catches are made in the northern part of the North Sea, i.e., the ICES sub-division IVa, and the location of the main fishing areas is shown in Figure 6.

5.23 Depth ranges

The fishery is generally conducted in waters over 100 m and less than 250 m in depth. Some results quoted by Poulsen (1964) and shown in Figure 5 demonstrate the depth distribution by weight as a percentage of the total quantity of industrial fish in catches from the Skagerrak.

5.24 Conditions of the grounds

In general the grounds fished, particularly those in the North Sea such as the Fladen, have a smooth sand-mud bottom and light trawl gear is used with a very light foot-rope (Raitt, 1966a).

5.3 Fishing seasons

5.31 General pattern of seasons

Initially the two countries involved in the industrial fishery for Norway pout started exploiting this species in the winter months to bridge the gap between the autumn and spring industrial herring fisheries; when the sandeel fishery in the summer months was a poor one, effort was diverted to Norway pout. However, with the increase in catches and importance of this species the main Norwegian fishery is now from April/May to October whereas the winter fishery is of lesser importance.

5.32 Dates of beginning, peak and end of season

Since the fishery is at present carried on all the year round it is only possible to give details of when the largest landings are made. Data for Danish North Sea landings taken from the ICES Bulletin Statistique, and from Johannessen et al, (1964) for Norwegian landings, show (Figure 7) that the highest Norwegian landings in 1962 and 1963 were made in May, September, October in 1962 and from June to December in 1963. The Danish statistics show the best months were March and October in 1962 and January and October in 1963.

5.4 Fishing operations and results

5.41 Effort and intensity

It should be noted that these fisheries are industrial fisheries for many different species and that the changes in catch and effort for Norway pout are to a very great extent interrelated with the success or failure of the fisheries for other species, notably herring or sandeel.

At present very few details are available on the effort and intensity of this fishery but the Norwegians have data for the landings at one of their fish meal factories and the corresponding number of trips (see Table 8 reproduced from the proceedings of the North East Atlantic Fisheries Commission, May 1965).

5.42 Selectivity

The following figures are quoted by Poulsen (1964) for the catch of Norway pout from trawls with small meshes (11-13 mm between knots) and from trawls with slightly larger meshes (15-20 mm).

	Small mesh	Large mesh
Average length	11.4 cm	12.5 cm
Smallest and largest specimens	5-18 cm	7-21 cm
Number measured	3,390	5,102

Raitt (in press) demonstrates that the Fladen ground in August 1961 duplicate hauls by day and night gave twice as big a catch by day

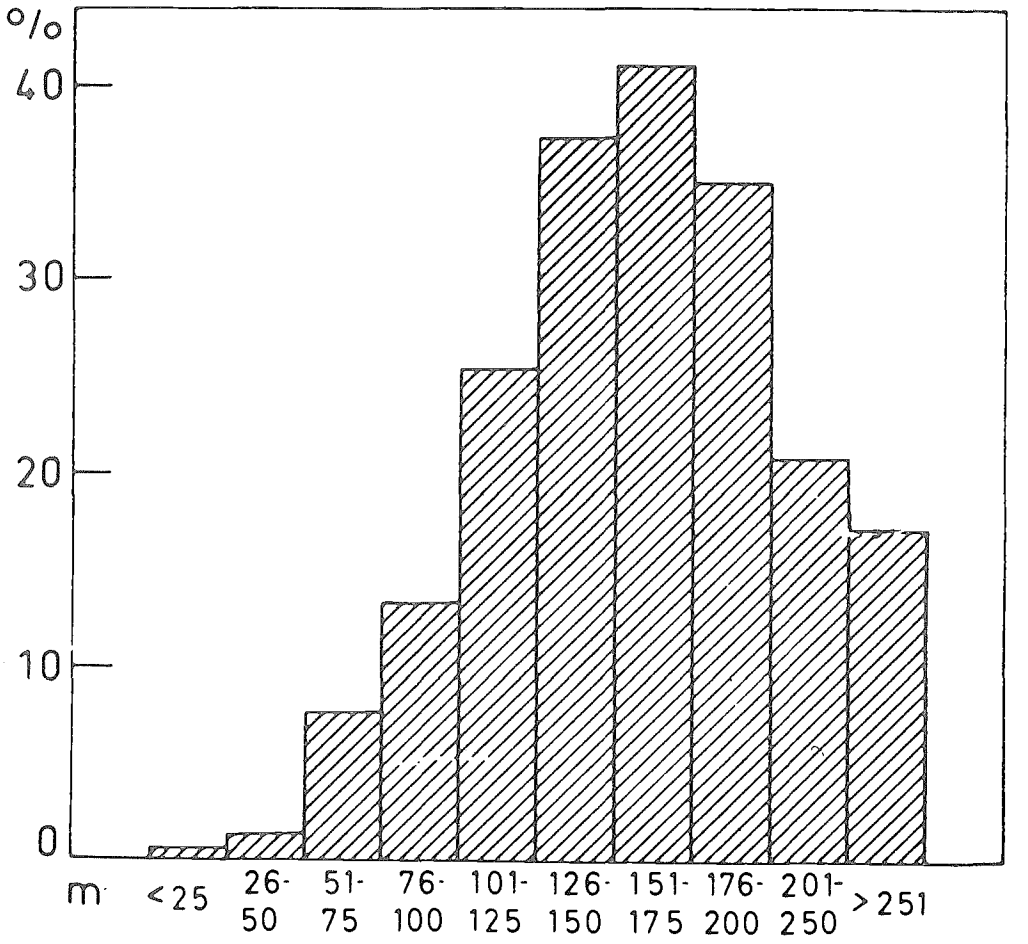

Figure 5. Depth distribution of catches (Poulsen, 1964)

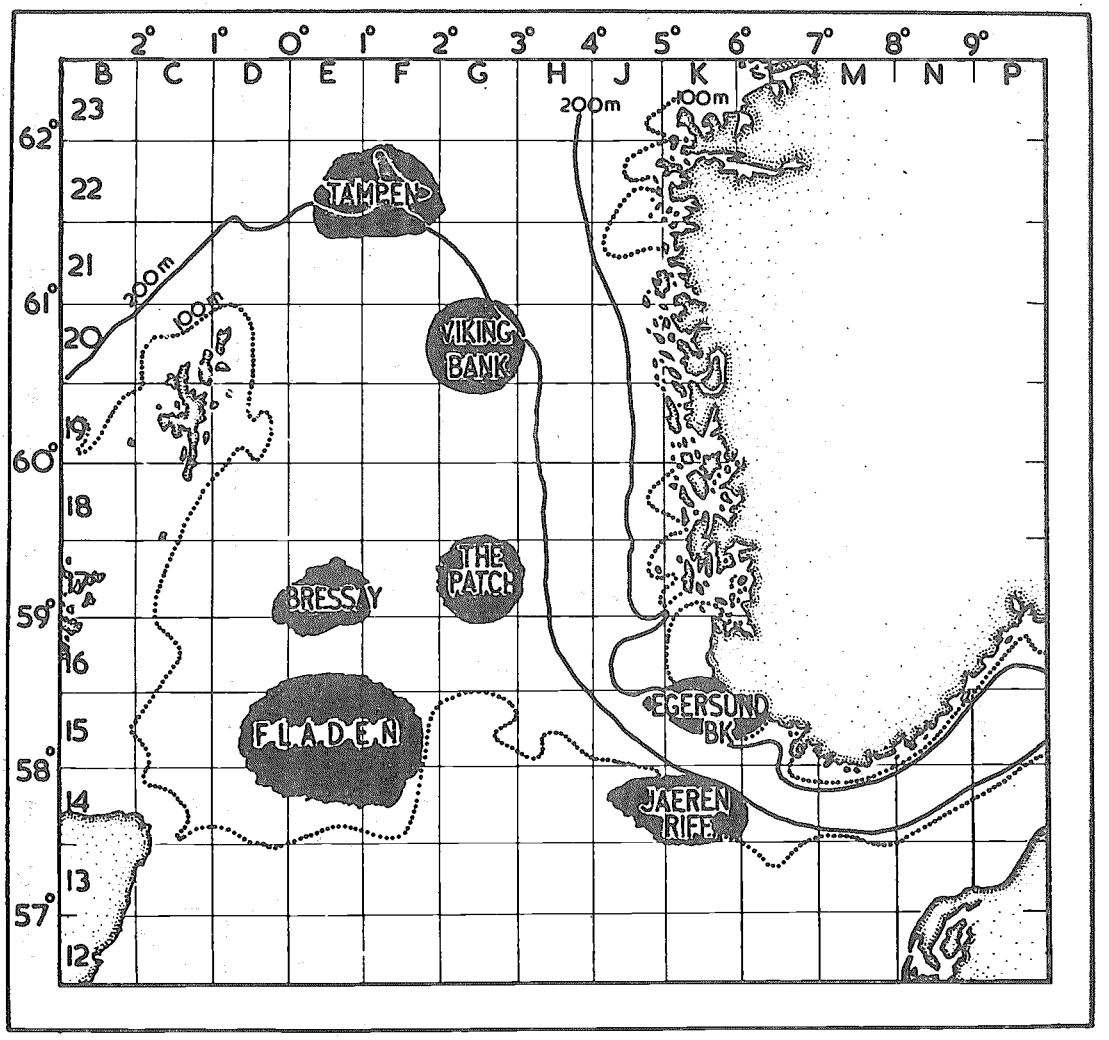

Figure 6. Distribution of main fishing areas in the North Sea

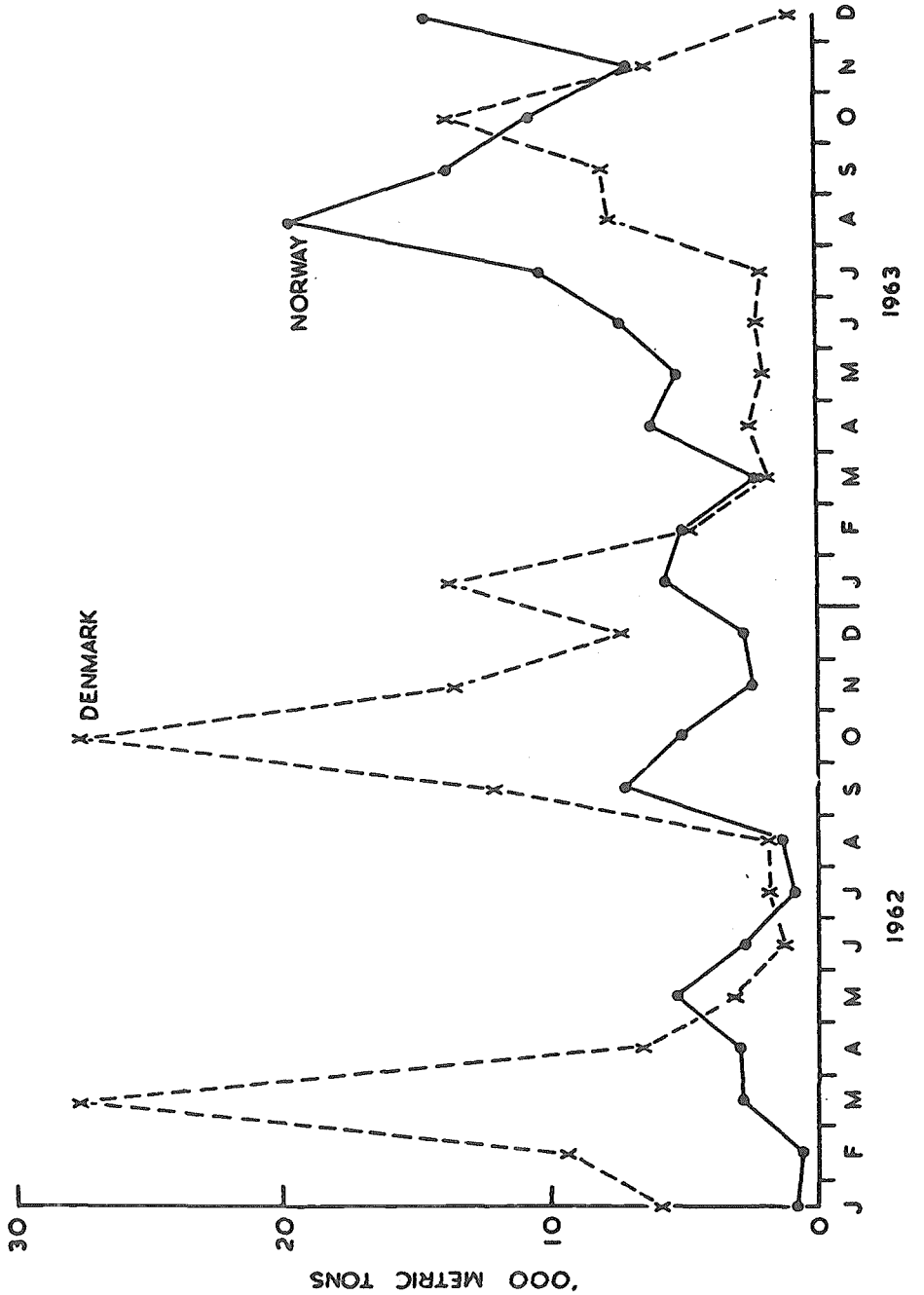

Figure 7. Monthly landings of Norway pout - Norway and Denmark - North Sea (data from ICES Bull. Stat. for 1962 and 1963 and from Johannesen et al., 1964)

TABLE 8

Monthly landings in 1964, of Norway pout from Egersund Bank delivered to one Norwegian factory in Egersund, and the oorresponding numbers of trips and the landings per trip (bottom trawl only) - from proceedings NEAFC, 1965

Month	No. of landings	Total catch in HL	HL/ Landings
January	171	12050.0	70.5
February	103	4074.0	39.6
March	70	1311.0	19.7
April	115	5467.5	47.4
May	84	3734.0	44.5
June	39	3645.0	93.5
July	41	3742.0	91.3
August	67	5396.0	80.5
September	45	2453.0	54.5
October	288	21269.0	73.9
November	249	25477.0	102.3
December	62	4540.0	73.2
	1334	93159.0	69.8

Dickson (1960) has shown that by doubling the headline height during day-hauls the catch could be doubled. The inference from these observations would appear to be that Norway pout are normally just clear of the bottom but are even further off the bottom by night than by day.

5.43 Catches

Prior to 1959 the landings of Norway pout in Denmark and Norway were probably quite small and no separate estimates of the quantities are available.

Table 9 shows the annual catches from the North Sea, Skagerrak and Norwegian Sea by Norway and Denmark from 1959-64. All data are taken from the ICES Bulletin Statistique except those for 1959 and 1964 which are from the proceedings of the North East Atlantic Fisheries Commission (NEAFC).

Mainly because of the low world fish meal prices the Danish catch in 1960 and 1961 was reduced to about a third of that of 1959 but in 1962 the landings rose to a higher level than in any previous year. The decline in the Danish landings for 1960 and 1961 was not paralleled in the Norwegian fisheries which show a continuous rise to a peak in 1963. The landings of both countries fell in 1964.

Annual yields from individual fishing grounds are available for Norway only from the proceedings of the NEAFC for the years 1962-64 (Table 10).

T A B L E 9

Annual landings (metric tons)

(Data from ICES Bull. Stat. and Proceedings NEAFC)

	1959	1960	1961	1962	1963	1964
Denmark						
North Sea	100,000	20,000	20,455	121,780	67,436	10,432
Skagerrak	+	16,000	9,447	10,558	12,199	13,782
Total	100,000	36,000	29,902	132,338	79,635	24,214
Norway						
North Sea	18,550	20,677	13,379	34,900	99,314	71,338
Skagerrak	218	285	-	509	576	602
Norwegian Sea	-	3,665	2,604	4,984	6,197	-
Total	18,768	24,627	15,983	40,393	106,087	71,940
Total North Sea	118,550	40,677	33,834	156,680	166,750	81,770
Total Skagerrak	218+	16,285	9,447	11,067	12,775	14,384
Total Norwegian Sea	-	3,665	2,604	4,984	6,197	-
Total all areas	118,768	60,627	45,885	172,731	185,722	96,154

T A B L E 10

Yearly landings by Norway from fishing grounds 1962-64
(metric tons) - (Data from Proceedings NEAFC, 1962-64)
(See also Figure 6)

Ground	St. Sq.	1962	1963	1964
Tampen	22E.F	-	2,010.4	6,963.1
Viking Bk	20G	2,049.6	12,248.3	14,002.6
Shetland Bks	19-20D	3.7		
Bressay Shoal	17E	-	6,450.5	3,845.7
Patch	17G	13,133.5	26,431.3	13,369.2
Sirahavet	16-17 H-J	9.5	-	-
Coral Bk	16G	-	-	1,247.8
Fladen	15E	10,460.9	27,516.3	3,750.5
Ling Bk	15G		1.6	984.2
Egersund Bk	15J.K	11,572.4	22,252.3	11,179.1
Sira	15L	-	-	31.0
Jaeren Riff	14J.K	2,839.8	10,136.5	14,167.2
Vestbanken	13L	234.0	46.9	
Holmen Ground	13M	37.4	-	-
Steinrevet	12.13G	610.6	200.2	689.9
Gt. Fisher Bk	12H.J	121.6	-	-
Danish Coast	10.12M	-	-	129.3
Blåden	10K	11.0	-	-
Dogger Bk	9G	93.9	-	-
Leirbanken	9J	2.2	-	-
Skagerrak Coast	15N	383.0	540.9	587.0
Halse Bk	14O	51.5	38.9	14.9
Hanstholmen	13N	75.0	-	-
		41,689.6	107,874.1	70,966.5

6 PROTECTION AND MANAGEMENT

As far as the North East Atlantic Fisheries Commission is concerned, Norway pout is now (since 1960) one of the Article 6 species, for which it is permissible to fish with small mesh nets, and on which there are no minimum landing size limits.

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