



IRISH FISHERIES INVESTIGATIONS

SERIES B (Marine)

No. 11 (1974)

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SIZE DISTRIBUTION AND FOOD OF THORNBACK RAYS
(*RAJA CLAVATA* L.) CAUGHT ON ROD AND LINE ON THE
MAYO COAST

Size Distribution and Food of Thornback Rays (*Raja clavata* L) Caught on Rod and Line on the Mayo Coast

by

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Abstract

A total of 732 Thornback Rays (*R. clavata*) were examined for length, wingspan, weight, sex and food in two bays on the west coast of Ireland. The samples were taken by rod and line during angling festivals in Clew Bay in June 1971 and in Broadhaven Bay in September 1971.

The length/wingspan relationship for both sexes in both areas was found to be linear and the wingspan/weight relationship was the same for both sexes. The males become mature between 15.0 and 17.0 inches (38 to 43 cm) wingspan, while the females become mature between 18.0 and 20.0 inches (45.5 to 50.5 cm) wingspan. The sex ratio of males to females in each of the two samples was 1:1 in Clew Bay and 1.4:1 in Broadhaven Bay.

The main food items in the stomachs of the rays from Clew Bay were *Macropipus* spp. (44 per cent), *Crangon* (23 per cent), *Carcinus* (21 per cent) and Lamellibranchs (10 per cent). In Broadhaven Bay Ammodytidae (21.5 per cent), other fishes (19.5 per cent) and *Macropipus* spp. (14 per cent) formed the bulk of food items.

A total of 71 *R. clavata* were tagged in Broadhaven Bay in the summer of 1971 and to date there have been 8 recaptures 7 within Broadhaven Bay. The days at liberty varied from 0 to 775 and the greatest distance travelled was 14 miles.

Introduction

To date eight species of rays (*Raja* species excluding the large species known as skates) have been recorded from Irish coastal waters. (Went and Kennedy 1969). Of these eight species the Thornback ray *Raja clavata* is the most abundant ray found around the Irish coast. It is generally distributed and is caught on various types of bottom ranging from mud, sand, gravel, shingle and patchy ground to dead *Lithothamnion* beds. In vertical distribution it is known to occur commonly from the shore down to 100 fathoms and is not absent in depths of 160-180 fathoms (Steven 1932). It is the species of ray most often taken commercially and captured on rod and line by sport fishermen.

In recent years the commercial catch of rays has shown a steady increase in market value and this reflects an increase in the demand for this type of fish. Table 1 shows the quantity and value of Ray/Skate returned as landed in the Republic of Ireland for the years 1966 to 1971 inclusive. Although rays and skates have been bulked together for statistical purposes, the skates form only an insignificant part of the total landings. The annual catch of rays consists mainly of *R. clavata* and *R. brachyura*, in that order of importance.

Tourist revenue derived directly from sea angling activities over the same period as that shown in Table 1 has risen from £648,000 for 1966 to £810,000 for 1969.* In subsequent years slight changes have been made in computing the income figures from sea angling and the amount earned is now estimated to be over £1,000,000. Inshore boat angling earns a large proportion of this and the Thornback Ray forms a significant proportion of the total catch of fish caught by sea anglers.

*Tourist revenue figures supplied by Bord Failte Eireann.

Table 1. Quantity and value of ray/skate landed in Ireland between 1966 and 1971.

Year	Weight in cwts	Value in £s
1966	22,418	90,164
1967	23,124	96,073
1968	26,972	117,624
1969	28,740	130,813
1970	29,233	165,221
1971	28,792	176,509

Statistics supplied by Fisheries Division of the Department of Agriculture and Fisheries, Dublin.

In recent seasons the Westport Sea Angling Club expressed concern about the decreasing size and numbers of rays being caught and landed at Westport. The Trust's own sea angling survey staff had noticed a falling off in the size and numbers of rays which were being caught in the Belmullet area. It was accordingly decided to investigate some aspects of the biology of Irish Thornback rays.

Every year the Sea Angling Clubs of both Westport and Belmullet hold well organised sea angling competitions in June and September. During these competitions large numbers of Thornback rays are captured and taken ashore to be weighed in. Since no biological data for rays in Irish waters were available, this bringing of a large catch of rays to a central point afforded an excellent opportunity to process and examine the material.

Sizes attained by rays on the Irish coast

The Irish Specimen Fish Committee which was set up in 1955 is a voluntary body representative of all angling and fishing interests in Ireland. Its purpose is to authenticate and record the capture by fair angling of record and specimen fish in Irish waters. The term specimen means a fish of exceptional size for its species and whose capture merits recording. The Committee has drawn up a Schedule of minimum qualifying weights in respect of Irish freshwater and marine sport fishes. These qualifying weights may be changed from time to time depending on the frequency of capture of any particular species. The qualifying weights for specimen rays in Irish waters (1972) are shown in Table 2. Also shown are the authenticated record weights for six species of ray. Were it not for the fact that the Specimen Fish Committee encourages anglers to record the capture of notable or strange fish, it is possible that the species list of rays for Irish waters would not be as complete as it is. Since the inception of the Specimen Fish Committee a total of 26 authenticated specimen Thornback ray have been recorded and the largest weighed 37 pounds.

Table 2. Specimen and record weights of rays captured in Irish waters.

Name	Specimen weight (lbs.)	Record weight (lbs.)
<i>R. clavata</i> Thornback Ray	20.0	37.0
<i>R. brachyura</i> Blonde Ray	25.0	36.5
<i>R. naevus</i> Cuckoo Ray	4.5	5.1
<i>R. montagui</i> Homelyn Ray	5.0	6.15
<i>R. undulata</i> Undulate Ray	12.0	13.75
<i>R. microocellata</i> Painted Ray	10.0	12.6

P. Fitzmaurice: Thornback rays on the Mayo coast.

There appear to be some anomalies in the overall distribution of each species of ray around the Irish coast. In Tralee Bay the Undulate ray (*R. undulata*) is the dominant species and always outnumbers the Thornback rays in catches. In Cork Harbour, although Thornback rays are abundant there is also a very large population of Blonde ray (*R. brachyura*), while on the Wexford coast Blonde rays seem to be the dominant species.

From Table 3 it can be seen that more specimen Thornback rays were recorded from Greystones and the Kinsale area than from any other locality. These two areas are intensively fished by anglers with an awareness of large sized fish for their species. These areas also have a fair amount of rough patchy ground which makes trawling difficult and as a result the local stocks of rays may not be severely cropped.

Table 3. Distribution of Captures of Specimen Rod-Caught Rays on the Irish Coast (1955-1971 inclusive).

ANGLING CENTRE	Thornback Ray <i>Raja clavata</i>	Blonde Ray <i>Raja brachyura</i>	Cuckoo Ray <i>Raja naevus</i>	Homelyn Ray <i>Raja montagui</i>	Undulate Ray <i>Raja undulata</i>	Painted Ray <i>Raja microocellata</i>
North Antrim Coast	1	1	11	12	—	—
Belfast Lough	1	—	—	—	—	—
Lambay Island	2	1	—	—	—	—
Bray	1	—	—	—	—	—
Greystones	10	1	—	—	—	—
Arklow	1	—	—	—	—	—
Wexford Coast	—	3	—	—	—	—
Dungarvan	2	2	—	3	—	—
Ballycotton	1	1	—	—	—	—
Cork Harbour	2	80	—	3	—	3
Kinsale	5	5	1	—	—	—
Courtmacsherry	1	—	—	—	—	—
Dingle Bay	—	2	—	—	—	—
Clogher Head (Kerry)	—	—	—	—	—	1
Brandon Bay	—	—	—	—	—	3
Tralee Bay	—	1	—	1	26	—
Westport	—	1	—	—	—	—
Broadhaven Bay	—	—	—	1	—	—
Killala Bay	—	1	—	—	—	—
Killybegs	—	3	—	—	—	—
Moville	—	3	—	—	—	—
TOTAL	27	105	12	20	26	7

The numbers of examples of large rays recorded from any one locality around the coast does not necessarily reflect the intensity of fishing or the abundance of the species present. In Clew Bay large numbers of anglers fish the waters each season and though the recording of specimen fish is regarded as excellent publicity for any angling centre, no specimen Thornback ray has yet been recorded for Clew Bay. The same may also be said about Broadhaven Bay. The managements of the Sea Angling Clubs in both areas are well aware of the existence of the Specimen Fish Committee and the requirements for claiming specimen fish. This is demonstrated by the fact that one specimen Blonde ray (*R. brachyura*) has been recorded from Clew Bay and one specimen Homelyn ray (*R. montagui*) has been recorded from Broadhaven Bay. Fair numbers of specimens of other species of fish have been recorded from both bays. Large quantities of Thornback rays are captured and landed at both angling centres in the course of a season's fishing

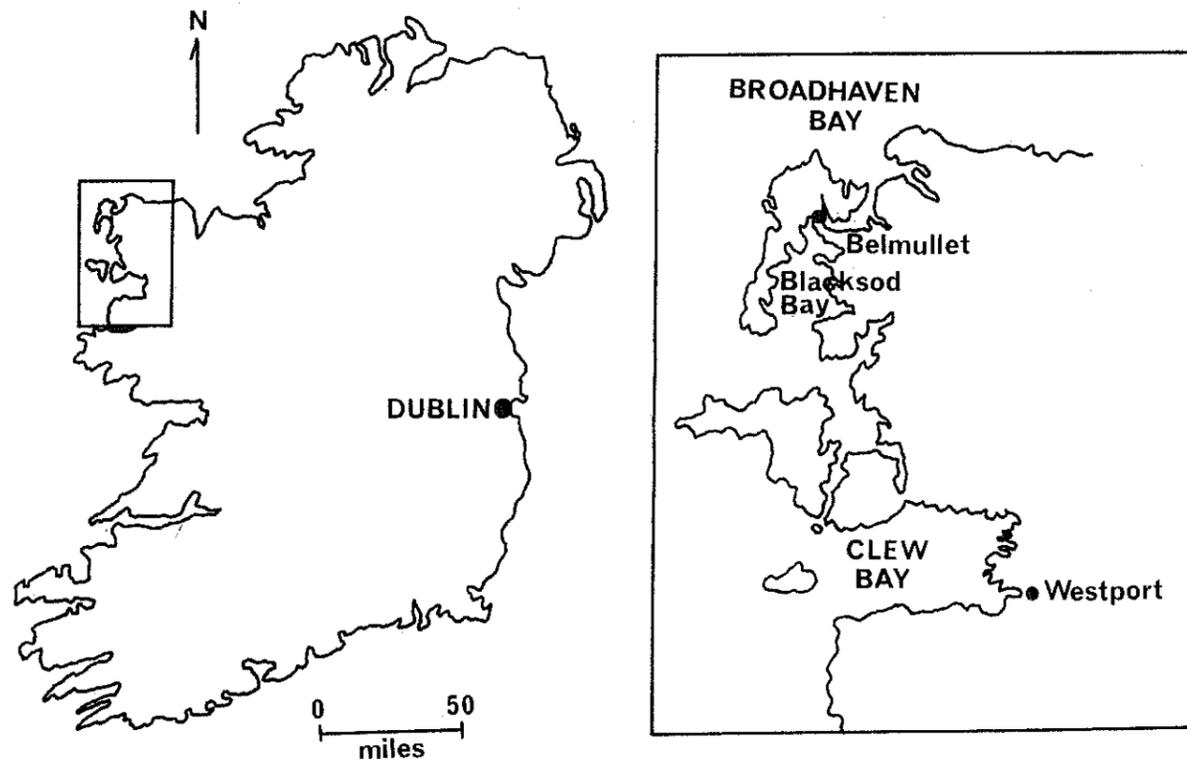


Fig. 1. Location of Clew Bay and Broadhaven Bay. (Based on the Ordnance Survey by permission of the Government, Permit No. 1833).

Description of areas sampled

The fishing

In Westport in 1971 during the June International Angling Festival 212 anglers fished in the competitions in Clew Bay. One day was given over to shore angling from the various islands and the catch consisted entirely of Lesser Spotted Dogfish (*Scyliorhinus caniculus*). Three full days from 10 a.m. to 5 p.m. were spent in angling from boats. The boats ranged in size from half deckers (26 feet long) to 50 foot trawlers. The anglers drew lots for the different sized boats and rotated between them each day so that no angler should have any advantage over a fellow competitor. The 50 foot trawlers are usually the faster boats and consequently can travel further from the weigh-in point and thus give more angling time in any particular area. It is, however, considered to be a disadvantage to fish from a trawler because of the height of the gunwhale above the water line. In the smaller boats the angler is nearer to the water and this makes it much easier to bring fish to the gaff and land them. It also takes less time to land fish if there is a run of fish on.

The total number of Thornback rays captured and weighed in at the Westport Angling Festival exceeded 550. A large number of these fish were landed on one particular day and it was not possible to record details from all the individual fish on that day but details were recorded from all the rays landed on the other days of the festival.

During the two day September angling festival in Belmullet, 83 anglers took part in the competitions in Broadhaven Bay and fished from 17 boats. Ten boats were half-deckers 26 feet long while the remaining seven boats ranged in size from 28 feet to 35 feet long. A catch of 303 Thornback rays and one Homelyn ray was recorded for the two day festival.

P. Fitzmaurice: Thornback rays on the Mayo coast.

The following is a brief description of Clew Bay and Broadhaven Bay:—

Clew Bay

This is a large rectangular bay situated on the west coast of County Mayo (Fig. 1). It is approximately 13 miles long by 7 miles wide, with the long axis running in an east-west direction. The bay is well protected from westerly gales by Clare Island which is situated at the mouth. Achill Island offers protection towards the north-west. The depth is about 17 fathoms at the mouth and the bay gradually gets shallower towards the eastern end, where there is a large number of islands. The sea bottom is varied and includes rock, sand, mud, silt and *Lithothamnion*. The salinity in the inner part of the bay at Quinsheen ranges from 33.4‰ to 34.8‰ (Fives 1970). For the most part tides are moderate.

Broadhaven Bay

This is a large U-shaped bay on the north coast of County Mayo (Fig. 1). It is 6 miles wide at its mouth and 4 miles long in a north-south direction. At the inner end the bay narrows into a channel which is 6 miles long by approximately $\frac{1}{2}$ mile wide and which leads back to a narrow isthmus joining the Mullet peninsula to the mainland. Here it meets a channel connecting it to Blacksod Bay. Most of the channel dries out at low tide. The depth in the channel up to two miles from the bay varies from 3 to 7 fathoms and at the mouth of the channel the depth is approximately 12 fathoms. The open part of the bay has depths ranging from 12 to 30 fathoms. The bottom consists mainly of sand with some mud. Over the whole bay the salinity ranges from 35.0‰ to 35.2‰. (Determinations by author, June 1970). Tides in the bay are mainly moderate except for the Erris race which lies off Erris Head at the mouth of the bay.

Sizes of rays captured

In order to compare the results obtained during the present investigations with results obtained by other workers it was decided to determine the relationship between certain parameters. This would permit of direct comparison of data expressed in different terms. The parameters taken were overall length, wingspan and weight of fish. The length was taken as the distance from the tip of the snout to the tip of the tail, measured flat along the ventral surface. The wingspan was taken as the maximum width from wing tip to wing tip measured flat along the ventral surface. Measurements and weights were determined in inches and pounds to facilitate comparison with Festival Results and Specimen Fish Committee data.

The length : wingspan relationship was determined for 206 males and 189 females from Clew Bay and 177 males and 123 females from Broadhaven Bay (only intact males were measured; some examples which had portions of the tail missing or which had been de-winged were omitted). The relationships between length and wingspan are shown graphically in Fig. 2 and Fig. 3 for each sex at each centre. The relationship for females was practically the same in Clew Bay and Broadhaven Bay (1.41:1 as compared with 1.39:1). The males were slightly longer in proportion to their wingspan than the females and the ratios were somewhat different at the two centres (length : wingspan was 1.49:1 in Clew Bay and 1.44:1 in Broadhaven Bay).

The wingspan:weight relationship was worked out separately for the males and females in each bay. Here no real differences could be observed either between the sexes or between the two localities.

Fig. 4 shows the wingspan:weight relationship for 273 Thornback rays of both sexes mainly from Clew Bay and Broadhaven Bay. Data for specimen Thornback rays from various localities have been included also so as to extend the curve. It was not possible to include in the figure all the data for rays in the 11 to 23 inch wingspan range because of the coincidence of plotted points.

Fig. 5 shows the wingspan frequency distribution for both sexes of Thornback ray captured at both centres. In Clew Bay both males and females gave well defined peaks on the wingspan frequency distribution graph. The majority of the males captured had a wingspan of 15-18 inches while the majority of females captured had a wingspan of 18-22 inches. In Broadhaven Bay only the males exhibited a well defined peak comparable to the peaks graphed for the Clew Bay material. The majority of males captured in Broadhaven Bay had a wingspan of 15-19 inches with a well defined peak at 18 inches. This peak is one inch greater than the defined peak for the males in Clew Bay, but when it is considered that the sampling of Broadhaven Bay rays took place three months later during the same growing season, the small difference in peaking could be explained simply by the extra period of growth. The Broadhaven Bay female rays appear to consist of multi-modal groupings fairly evenly distributed over the wingspan frequency range 15 to 23 inches (total range 12 to 25 inches).

Sex ratios and maturity

Steven (1933) demonstrated by the use of long lines that rays occur in unispecific shoals which at times may be almost if not entirely unisexual. He also observed that the unisexual shoals could consist entirely of juveniles or adults of either sex. During tagging operations which were carried out by the Trust's personnel it was noticed that although the catch of rays for any particular day was small they did tend to be mostly unisexual and out of 71 Thornback rays tagged in the inner part of Broadhaven Bay in June 1971, 4 immature males were recaptured together in the one haul of a trawl in January 1972. Stevens' findings for English Channel rays would thus appear to be applicable also to Irish Thornback rays so far as behaviour patterns are concerned.

Assuming that rays often form unisexual shoals, it follows that sex ratio sampling errors could easily occur if catches from one locality or one boat alone are examined. However, the sampling done at both the angling festivals should be free from this type of bias owing to the number of boats involved and their spread over a wide area of both bays. Out of 414 Thornback rays examined from Clew Bay, 208 were males and 206 were females, and out of 303 Thornback rays landed from Broadhaven Bay, 178 were males and 125 were females. The Clew Bay results represent a 1 : 1 ratio while the Broadhaven Bay fish had a ratio of approximately 1.4:1 in favour of the males. No information is available on the sex ratios of large individuals of *R. clavata* except in the records of the Irish Specimen Fish Committee. On examining 15 extant photographs of specimen Thornback rays, all proved to be females.

The maturity stage of female fish was examined by slitting open the ventral side of the fish and viewing the gonads. Steven (1934) could accurately work out the sexual maturity of male rays by noting the size and condition of the claspers. During the period of juvenile growth the claspers remain small but at adolescence they suddenly begin to elongate and grow rapidly until full adult size and condition is attained. Females examined at Clew Bay and Broadhaven were considered mature if on examination they proved to have developing yolky eggs in the ovary, a large shell gland and/or shelled eggs in the oviducts. Most of the rays examined from Clew Bay had shelled eggs in the oviducts while very few of the females from Broadhaven Bay had either shelled eggs or eggs in the shell gland. However, there were numerous large developing eggs in the ovaries and this indicated that the fish were mature. The only possible explanation for the lack of shelled eggs in the oviducts is that the females were coming to the end of a breeding season.

Table 4. Wingspan dimensions (in inches) at maturity of Thornback rays from Clew Bay and Broadhaven Bay.

Location	Date	Largest immature males	Smallest mature males	Largest immature females	Smallest mature females
Clew Bay	June 1971	15.25,	15.0,	18.75,	18.0,
		15.25,	15.25,	19.25,	18.25,
		15.5,	15.75,		18.25,
		16.75,	16.0,		18.25,
			16.0,		18.75,
Broadhaven Bay	September 1971	17.0,	15.0,	18.0,	18.5,
		17.0,	15.5,	17.5,	19.0,
		16.0,	16.0,	17.0,	20.0,
			16.0,	16.0,	
			16.0,	16.0,	
			16.0,	16.0,	

P. Fitzmaurice: Thornback rays on the Mayo coast.

Steven (1934) gives the size at first maturity for the majority of male Thornbacks he examined from the English Channel as lying between 20.0 inches and 21.7 inches wingspan. Judging by the results shown in Table 4 the Thornback rays in Clew Bay and Broadhaven Bay become mature when 15.0 to 17.0 inches in wingspan. This means that the male Thornback rays in both samples examined are maturing at a much smaller size (an average of 5 inches smaller in wingspan) than those examined by Steven from the English Channel. The females were also attaining sexual maturity at a much smaller size than was recorded by Steven. His results showed that the size at first maturity for the majority of females is about 26.0 to 30.0 inches wingspan while the results obtained for the west coast material during the present investigations show that maturity was attained at approximately 18.0 to 19.75 inches wingspan.

Owing to the limited amount of ecological data available for Clew Bay and Broadhaven Bay it is at present difficult to explain why the results obtained there should differ so much from those of Steven. The difference could possibly be attributable to difference in age, growth and population dynamics. Water temperatures have a great influence on the growth rates of fishes. Mean sea surface temperatures in the English Channel, however, are only about 1°C higher than on the West coast of Ireland (Lumb 1961) and it is unlikely that temperature alone is the explanation for the difference in size at maturity (see discussion).

Food of Thornback rays examined

The identification of the material in the ray stomachs was made on the spot after the weigh-in each evening. Any items of diet which could not be identified immediately or the identity of which was doubtful were bottled and preserved in 5% formalin so that identification could be carried out in the laboratory at a later date. The recognisable food items in the Clew Bay material were easier to identify than those from Broadhaven Bay. It appeared as if digestion was taking place more rapidly in the Broadhaven material and could have been the result of the warm, fine weather at the time of the festival. The Clew Bay rays were landed during cold stormy weather. The overall amount of unrecognisable food items in the stomachs of the fish was negligible.

The stomach contents of 421 Thornback rays from Clew Bay and 311 rays from Broadhaven Bay were examined and the results are summarised and presented in Fig. 6. For comparative purposes the stomach analysis results for each centre are arranged together in histogram form. The percentages expressed on the diagram are expressed as percentages of the total sample.

The organisers of both festivals supplied a number of Mackerel (*Scomber scombrus*) to each individual angler and this was to be used as bait. This ruled out any bait advantage an angler might otherwise have had over a fellow competitor. No problem was encountered in recognising the mackerel bait among the stomach contents because it was freshly ingested and more often than not a clean knife cut through the flesh could be seen. Mackerel bait turned up in stomachs of 15% of the Clew Bay fish and in 16.5% of the Broadhaven fish examined. Most such fish had other food items in their stomachs. Those that held only bait were regarded as "empty" for the purpose of Fig. 6 (though also included in the "mackerel bait" column).

The percentage of fish having empty stomachs was almost the same for both bays—16.5% for Broadhaven and 14.5% for Clew Bay. Such a low percentage of empty stomachs from both areas could well be a pointer as to the number of empty stomachs in the overall population while it also suggests that Thornback rays, when hooked and played on rod and line, do not regurgitate their food to any great extent. (The stomachs of sharks caught on rod and line are generally empty).

The dietary spectrum of the rays was practically the same for both bays. The emphasis on particular food items was different in the two samples and this probably reflects the ecological differences between the bays rather than the dietary preference of the rays. The main items of food, in order of importance, in the Clew Bay rays were, *Macropipus* spp. (44%); *Crangon crangon* (23%); *Carcinus maenas* (21%) and Lamellibranchs (10%). In the Broadhaven Bay sample the main items were Lamellibranchs (29%), (almost entirely *Ensis*); Ammodytidae (21.5%); other fish (19.5%); and *Macropipus* spp. (14%). The Lamellibranchs found in the stomach contents were usually identified from shell remains and the bulk of these remains in the Clew Bay fish proved to be *Ensis* although pieces of broken shell from *Pecten maximus*, *Lutraria* sp. and *Mytilus edulis* each occurred in single stomachs. *Macropipus puber* occurred frequently in the stomachs of rays from both bays. It was the only swimming crab which occurred in the stomach contents of rays from Clew Bay, but *M. depurator* was more often present than *M. puber* in the stomach contents of the Broadhaven Bay fish. *Carcinus maenas* was present in only 2% of the fish from Broadhaven Bay. *Crangon crangon* were present in only 3.5% of the Broadhaven Bay fish and when present they did not form a significant proportion of the overall stomach contents. In the Clew Bay fish, *C. crangon* was often present in large numbers and a number of stomachs contained more than 100 individuals.

The Annelida were poorly represented in the ray stomachs. *Aphrodite aculeata* was present in 3% of the fish examined from Clew Bay but no specimens were encountered in the stomachs from Broadhaven Bay. One fish from Clew Bay had a single specimen of *Arenicola marina* and one fish from Broadhaven Bay had remains of a ragworm (Nereidae). These results may not be indicative of the true role that Annelids play in the diet of *R. clavata* because the food present in the stomachs depends to a large extent on the ground that the fish has fed over and on the rates of digestion. Annelids, apart from *Aphrodite*, are difficult to recognise in the stomach contents unless they have been ingested immediately prior to capture. The soft parts of the body are digested relatively quickly and only the bristles or jaws are left for identification. M. Kennedy (pers. comm.) has examined the stomach contents of freshly caught *R. clavata* in the Irish Sea and he has found *Nereis* spp. and other ragworms fairly frequently in their stomachs.

Amphipods were present in 3.5% of the Broadhaven Bay sample and occurred in 3.0% of the Clew Bay stomachs. They were mostly present as individual items and were often well digested, making identification impossible. Isopods were present in 8.5% of the fish from Broadhaven Bay but were never present to any great extent in any individual stomach. The species present were mostly *Idotea baltica* and *I. linearis*; one *Ligia oceanica* was present in a single stomach. *I. baltica* was present in the stomachs of four fish from Clew Bay while one *Eurydice* sp. was present in one other fish. Mysids were present only in fish from Broadhaven Bay (7.8%). There were only a few individuals present in each stomach. For the want of a better description, other small shrimp like animals found in the stomachs have been recorded on Fig. 6 as "other shrimps". This grouping includes *Hippolyte* sp. and three specimens of *Philocheras trispinosus* in three fish from Broadhaven Bay. *Hippolyte* occurred in 3.5% of the Clew Bay rays and one specimen each of *Palaemon serratus* and *Philocheras fasciatus* occurred in fish from this Bay.

Galathea strigosa, *G. squamifera* and one claw of *Cancer pagurus* were present in the Broadhaven Bay material while remains of a *Pagurus* sp. were discovered in the stomach contents of one fish from Clew Bay. *Macropodia rostrata* (3%-4%) was represented to almost the same degree in the rays from both bays.

The remaining items of diet from the stomach contents of the Clew Bay material consisted of the Cephalopods *Eledone cirrhosa* and *Loligo* sp. "Other fish remains" included some well-digested remains of *Trachinus vipera*, *Gobius* sp., a sea scorpion and some scales of mullet *Crenimugil labrosus*. The remains of a *Processa* sp. were encountered in one stomach and *Calinassa subterranea* was found in the stomachs of two fish. This latter species is interesting in that its distribution around the Irish coast is unknown and only the larvae of the species appears to have been taken previously in Galway Bay and Kilkieran Bay (O'Ceidigh 1963). Other incidental items found among the stomach contents of Thornback rays from Clew Bay included *Fucus vesiculosus* and *Lithothamnion*.

Other items in the diet of rays from Broadhaven Bay included the Cephalopods *Sepiolo atlantica* and *Eledone cirrhosa* while included under other fish were remains of a pipe fish (Syngnathidae) gurnards (Triglidae) and the anal fin of a *Crenimugil labrosus*. Other items taken incidental to the main food items were Hydroids and *Zostera*.

The examination of the stomach contents of the rays from Broadhaven Bay and Clew Bay shows that the dietary spectrum tends to be rather wide. The fish were captured over a wide area, which should tend to exclude any bias. The dietary spectrum obtained from both of the bays was very much different from that obtained for rays from the Channel coast in Britain. Steven (1932) had samples of rays taken by nets in shallow water and when the stomachs were examined he found that they were feeding exclusively on herrings and sprats.

Results of tagging

As part of a general elasmobranch tagging programme on the south and west coasts of Ireland, which was begun in 1970, 71 Thornback rays were tagged in Broadhaven Bay in July-August, 1971. These rays and others included in the tagging programme were caught on rod and line and were marked with Petersen discs attached to the wing of the fish. To date six of the Broadhaven rays have been recaptured (Table 5). One was recaptured on rod and line within an hour of being tagged on 14 June 1971 and was released again. Four others were recaptured together in a trawl in Broadhaven Bay on 6th January 1972, two were trawled in Broadhaven Bay in May and September 1972 and one was recaptured outside the Bay in 1973.

The number of days at liberty varied from 0 to 775. No information is available as to the length of some of the rays recaptured. The four rays recaptured in Broadhaven in January 1972 were examined by the author and all had increased in length since tagging. The greatest increase in length was made by a male fish

P. Fitzmaurice: Thornback rays on the Mayo coast.

which was 19.0 inches long when tagged and released and had grown to 21.3 inches long when recaptured 202 days later. Other length increments made were 2.0 inches over a period of 202 days and 1.6 inches over a period of 206 days. The smallest length increment of 0.5 inches was made by the smallest of the fish recaptured. This was rather surprising at first but when the original tagging log was examined it was discovered that the fish was released with the hook left in the gut. On dissecting the fish, the hook was found in the ray's stomach with the point protruding through the gut wall. The hook still had all its original bronzing intact except around the barb area where it was a little rusted and the fish appeared to be in the best of health.

Table 5. Details of recaptures of Thornback rays tagged in Irish waters.

Place tagged	Date	Length (inches)	Place recaptured	Date	Length (inches)	Days at liberty	Distance travelled (miles)
Fenit, Tralee Bay	3/7/'70	—	4 miles SE Dingle	14/9/'70	29.0	74	40-50
Broadhaven (Channel)	14/6/'71	30.0	Broadhaven (Channel)	14/6/'71	30.0	0	0
"	14/6/'71	23.0	Broadhaven Bay	6/1/'72	24.6	206	4½
"	18/6/'71	22.5	" "	6/1/'72	24.5	202	4½
"	18/6/'71	19.0	" "	6/1/'72	21.3	202	4½
"	24/6/'71	15.5	" "	6/1/'72	16.0*	196	4½
"	18/6/'71	26.0	" "	18/5/'72	?	335	4½
"	15/6/'71	18.0	" "	15/9/'72	?	456	4½
"	11/6/'71	21.0	Annagh Head	2/11/'73	?	775	14

* This particular fish grew only 0.5 inches in length during 6½ months at liberty. This was due to the presence of a fishing hook in the gut of the fish for its entire period at liberty.

Apart from Broadhaven Bay, Thornback rays were tagged as follows:— Tralee Bay, July 1970, 2 fish; Blacksod Bay, August-September 1971, 3 fish; Cork Harbour, August 1971, 3 fish; Dungarvan Bay, September 1971, 6 fish. One of the Tralee Bay Thornback rays was recaptured in Dingle Bay after 74 days at liberty; it had travelled approximately 45 miles. There have been no recaptures so far from the other localities.

The evidence so far collected from the recaptures appears to agree with the findings of Fulton (1893) and Steven (1936). Fulton tagged 71 rays in Scottish waters and had two recaptures 6 and 14 miles from the point of release and the greatest time at liberty was 278 days. Steven tagged 614 rays and had 203 recaptures varying from 12 days to 1,357 days and the greatest distance travelled was 50 miles. The indications are, therefore, that Thornback rays are relatively sedentary.

Discussion

There appears to be some evidence for the reported decline in the size of Thornback rays in Clew Bay and more especially in Broadhaven Bay. In 1966 and 1967 the Trust's Sea Angling Officers investigated the sport-fishing potential of Broadhaven Bay and from photographic evidence of the catches there is no doubt that the average individual size of the rays as well as their numbers have declined. There are possibly two reasons for this. One is that angling pressure is fairly high and the other is pressure from commercial fishing. During the angling surveys, turbot grounds were discovered in Broadhaven Bay and as soon as the news spread to the commercial fishermen trawlers came to fish the turbot grounds. Turbot, being a prime fish, was the main goal of the trawlers but fair numbers of rays were also being taken continuously and this added to the total value of their catch. Clew Bay is trawled to a lesser extent but although the bay is bigger the angling pressure is much greater than that in Broadhaven Bay.

The decline in catches seems to follow a similar pattern to that reported from some parts of Britain. Clark (1971) refers to a national survey of coastal sport fishing in Britain and suggests that natural fluctuations and perhaps intensive commercial fishing are responsible for most of the changes reported by anglers. He also states that "there has probably been a fall in catches of Skates and Thornback Rays in the Thames Estuary and on the Channel coast and possibly on the coast of South Wales, but elsewhere there is little evidence of an

appreciable decline in numbers. The areas he mentions, in which a possible decline in catches have occurred, are intensively fished by large numbers of anglers who are in direct competition with commercial fishermen. In this way anglers can contribute to the decline of fish stocks.

No specimen Thornback rays have ever been recorded from either Clew Bay or Broadhaven Bay, although the anglers and angling clubs are conscious of specimen fish and their qualifying weights. The sizes of both male and female Thornback ray at first maturity are much smaller than the sizes reported for first maturity of rays in the English Channel. In other species of fish it is quite usual for slow growing populations to mature at a smaller size than faster growing fish of the same species e.g. brown trout *Salmo trutta* (Southern 1932, 1935; Kennedy and Fitzmaurice, 1971) and freshwater bream *Abramis brama* (Kennedy and Fitzmaurice, 1968).

As yet no data on the growth rate of rays in Irish waters are available but the few short-term results obtained from tagging in Broadhaven Bay suggest that they are a slow growing fish. Tagging results from the Scottish coasts and the English Channel coast indicate that populations of rays are relatively sedentary and they do not tend to migrate far away from the place of marking (Fulton 1893; Steven 1936). This also appears to be the case with rays on the west coast of Ireland where the bays are wide and cut deeply into the mainland. This type of topography would tend to isolate the various populations of rays much more than if the populations existed off an open, straight coastline. It is obvious that large scale tagging would need to be carried out to see if in fact populations tend to stay isolated and also to determine the growth rates of rays in Irish waters.

The dietary spectrum of the rays examined from both bays indicate the versatility of the Thornback ray as a feeder, at least during the months in which the samples were obtained. It does not appear to specialise on any particular food items and the prey eaten comes from a wide variety of bottom type. In nearly all cases the food eaten is ingested live.

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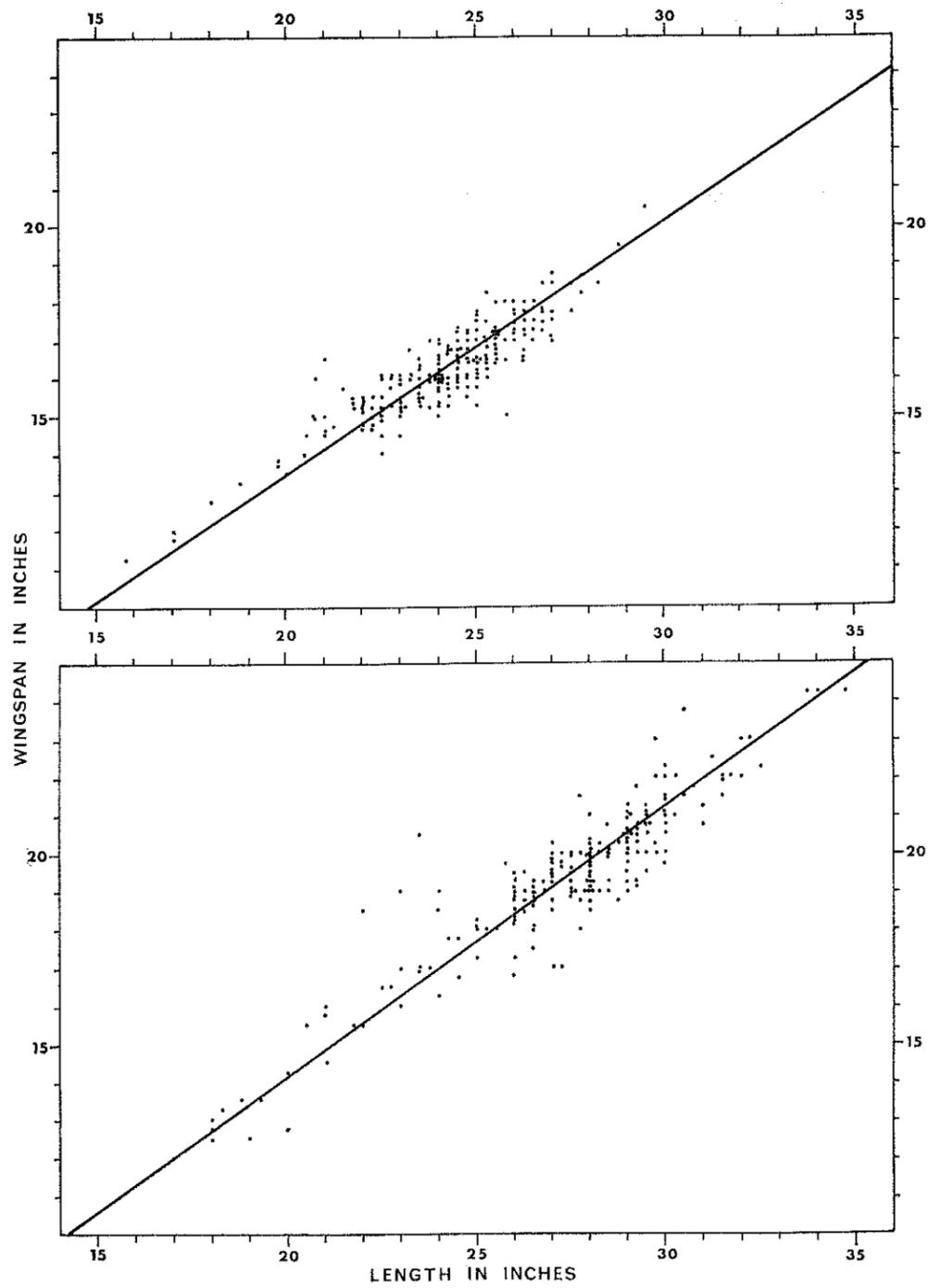


Fig. 2. Wingspan/total length relationship for 206 male (above) and 289 female (below) Thornback rays from Clew Bay.

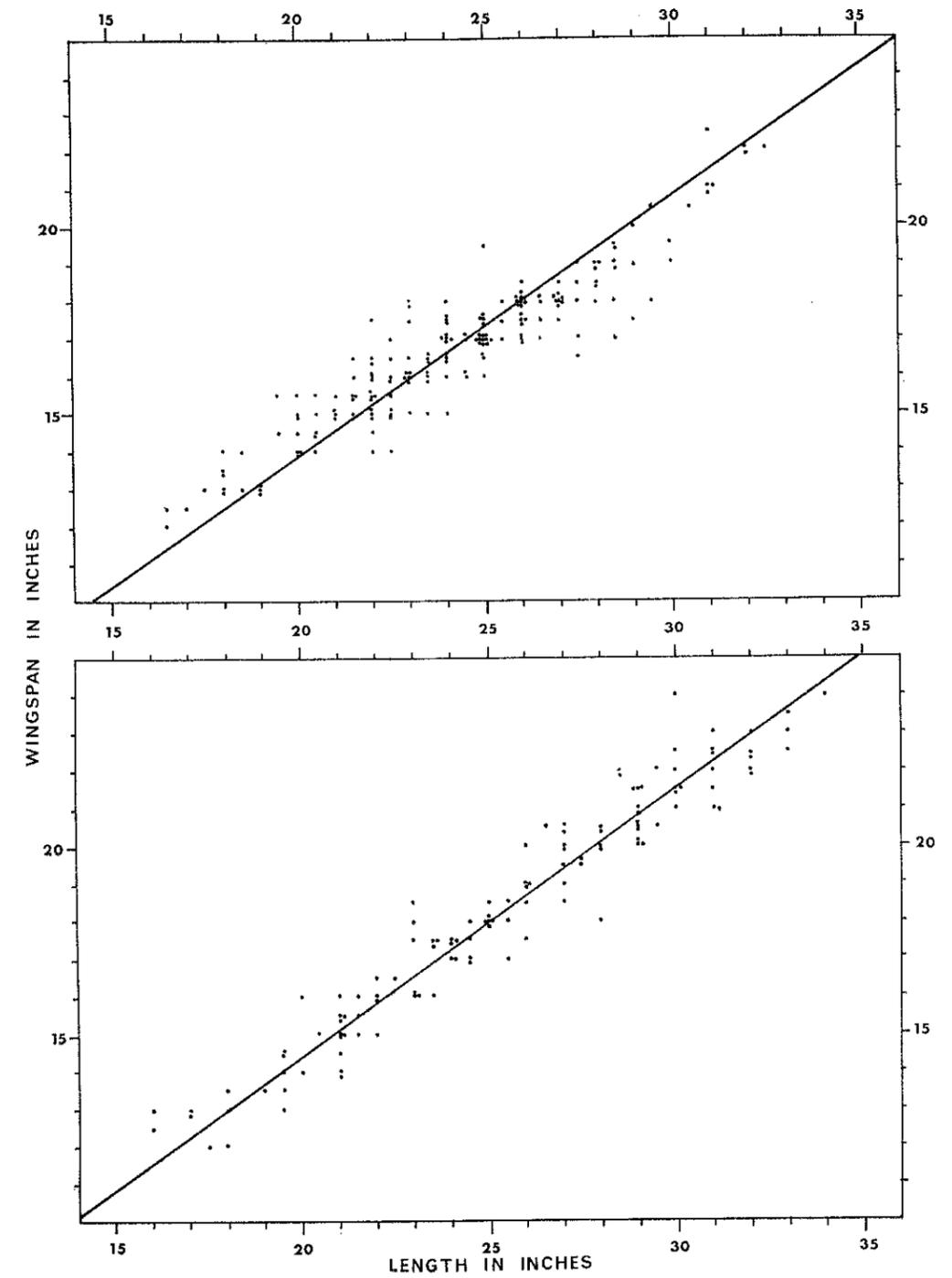


Fig. 3. Wingspan/total length relationship for 177 male (above) and 123 female (below) Thornback rays from Broadhaven Bay.

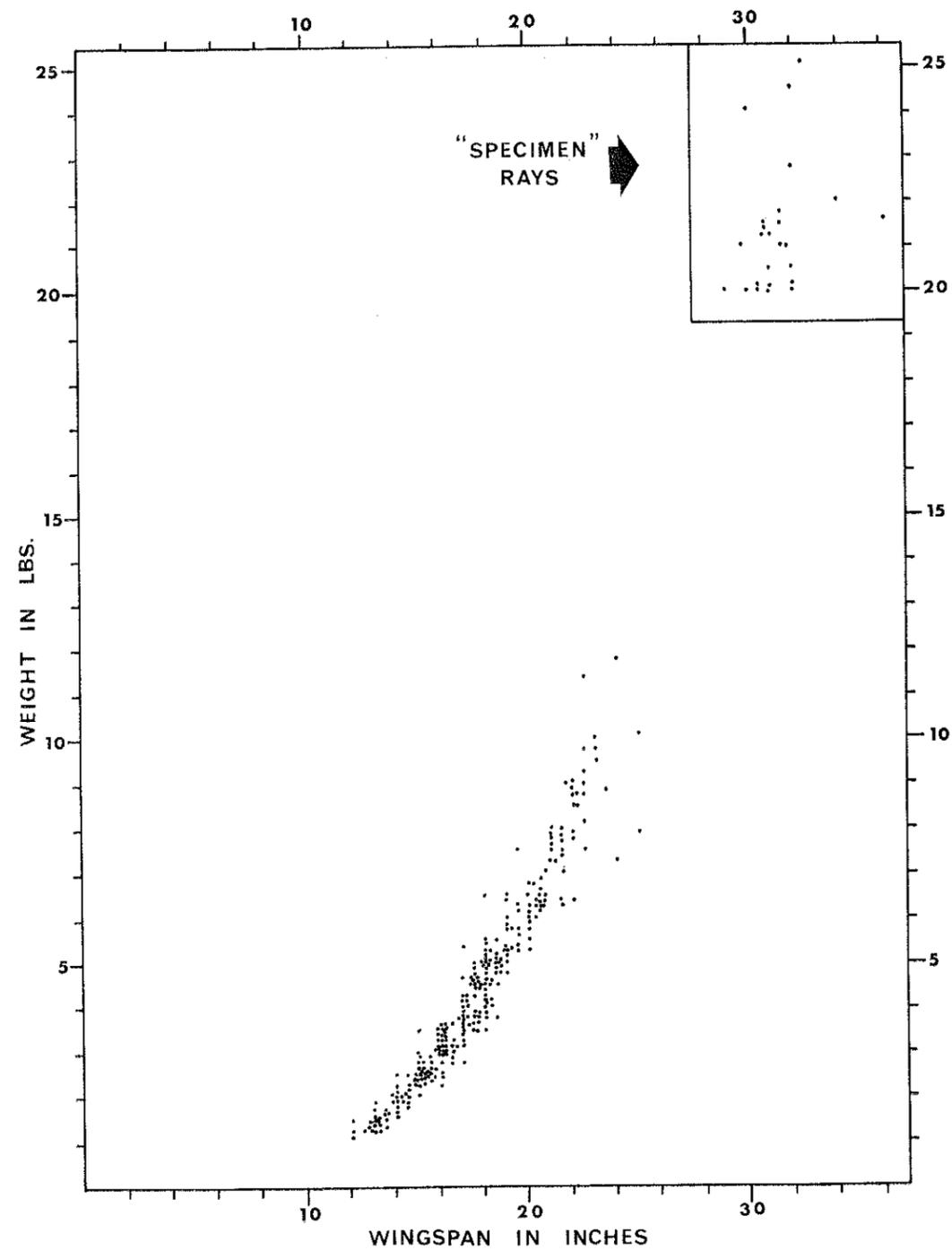


Fig. 4. Wingspan/weight relationship for Thornback rays from Clew Bay and Broadhaven Bay (both sexes combined) and for specimen Thornback.

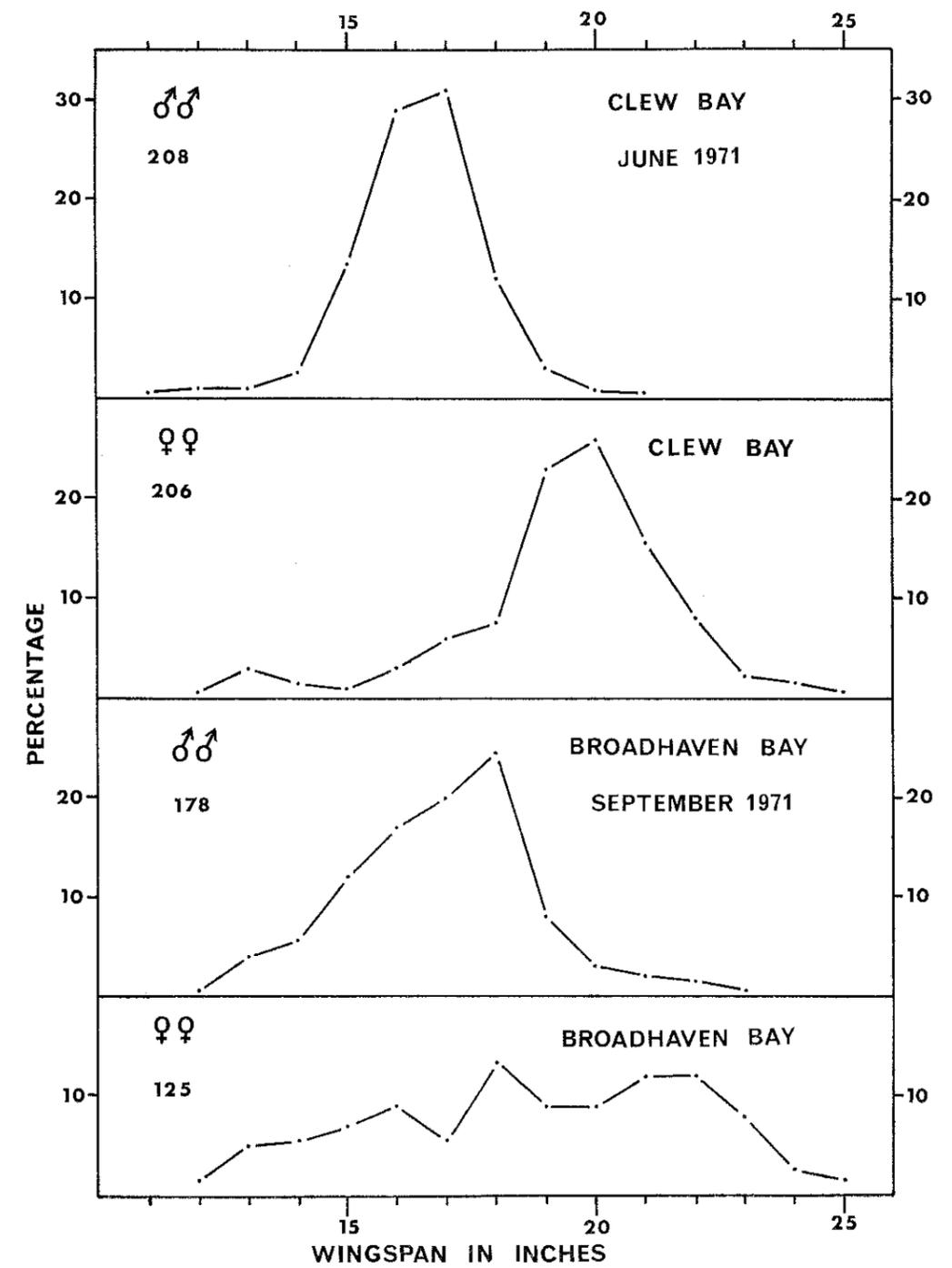


Fig. 5. Wingspan-frequency distributions for Thornback rays from Clew Bay and Broadhaven Bay.

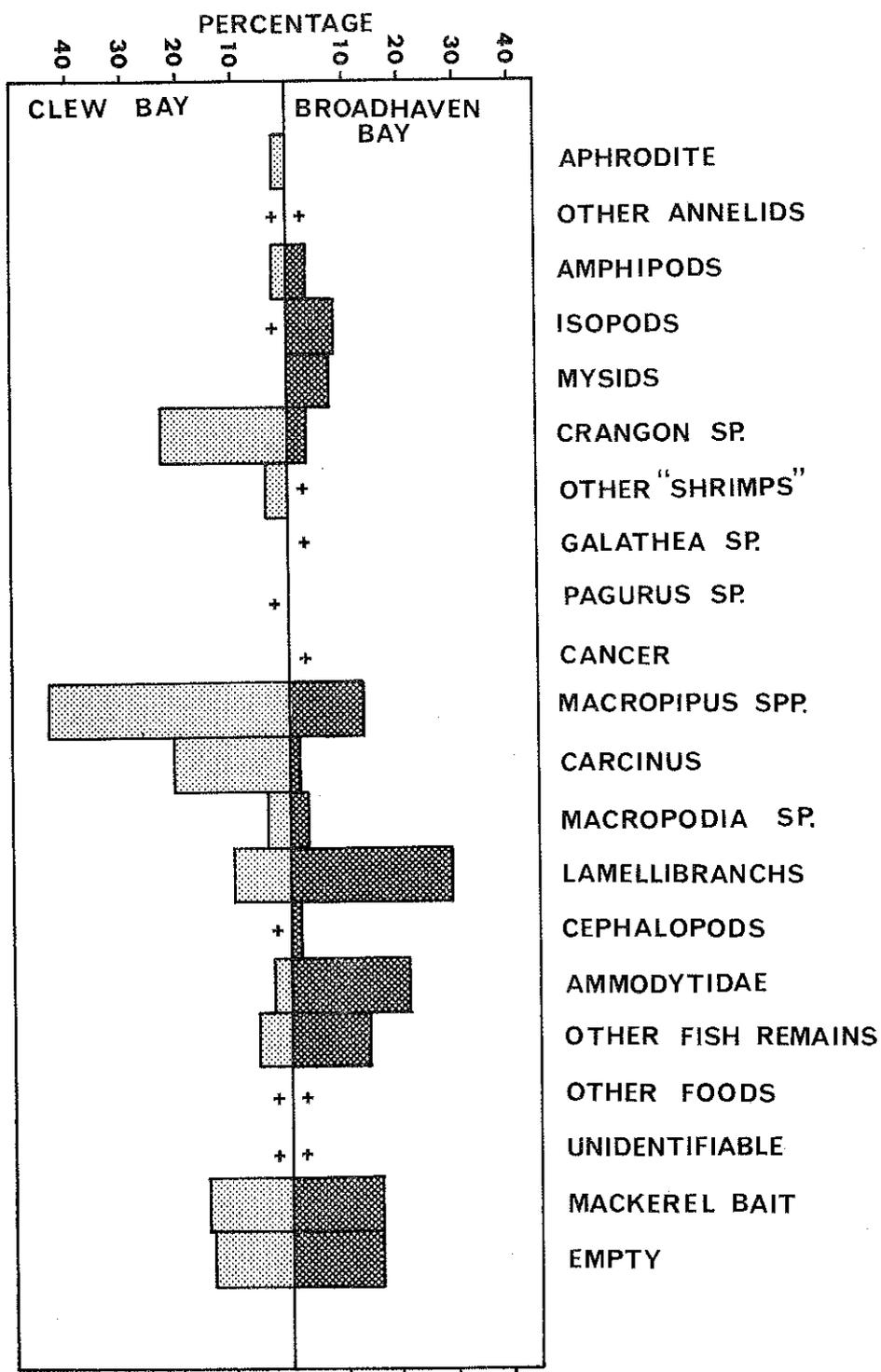


Fig. 6. Percentage frequency occurrences of different foods in Thornback rays captured in Clew Bay (Westport) and Broadhaven Bay (Belmullet). + indicates present in less than 3 per cent of the fish in the sample.

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