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DISTRIBUTION AND ECOLOGY OF OYSTERS, *OSTREA EDULIS* (L.) IN KILKIERAN AND BERTRAGHBOY BAYS, CONNEMARA, CO. GALWAY.

by

M. D. BARRY.

Distribution and ecology of oysters, *Ostrea edulis* (L.) in Kilkieran and Bertraghboy Bays, Connemara, Co. Galway

by

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ABSTRACT

An account of Kilkieran and Bertraghboy Bay oysters is presented, including data on their distribution and ecology in these bays. Growth and population structure are compared with other oyster-producing areas in Ireland. These data are reviewed in relation to the feasibility of redeveloping such areas of former extensive oyster production.

INTRODUCTION

The surviving records of the Kilkieran and Bertraghboy Bay oyster beds go back at least to 1684 (O'Flaherty, 1684), when Bertraghboy Bay was described as . . . "the site of an inexhaustible bank of oysters". Unfortunately, this did not prove to be correct and, typical of so many natural oyster populations around the coast described by Browne (1903) and Went (1962), it is now virtually non-existant. Only the oyster beds in Kilkieran Bay, described in the *Annual Report Inspectors of Irish Fisheries of Ireland,* 1878, as "once the best in Ireland", now continue to survive, though at a very low level. The data presented are part of a wider study (Barry, 1975, 1976, 1977 unpublished reports), designed to discover the present condition of these oyster grounds and to evaluate the feasibility of their redevelopment. These oyster beds have long been known as "Chartered Beds", and this work was done on behalf of the present claimants, Gael Linn Teo.

MATERIALS AND METHODS

Locations

This work was carried out principally on the natural oyster beds of Kilkieran and Bertraghboy Bays in Connemara, Co. Galway. Relaying experiments have been carried out using the oyster grounds of Atlantic Shellfish at Rostellan in Cork Harbour, and the size frequency distribution of the Tralee Bay, Co. Kerry oyster population is contrasted with those of the Connemara sites.

Growth and effect of relaying

The growth of oysters in Kilkieran and Bertraghboy Bays was monitored between May 1975 and September 1976, as follows. One hundred oysters in three different size categories were placed in netlon bags on trestles in each bay. These oysters were recovered at regular intervals over the period and their length (from the umbo) and total weight were recorded.

In May 1976, oysters from Kilkieran Bay were laid at Rostellan, Cork Harbour, an area known for good growth of oysters (Barry, 1976). The purpose of this was to compare growth in Kilkieran Bay with that of a richer estuarine system, and furthermore to assess the effect of relaying on native Kilkieran oysters in terms of their shape, the incidence of chambering and their shell boring epibionts. For the purpose 500 oysters in each of three size groups were dredged from the Kilkieran population. Their length, width and weight were recorded before being laid on the oyster grounds in Cork Harbour.

A sample of 100 from each size group was collected in October 1976 and the same parameters re-measured. The shape of these relayed oysters was noted. The frequency of chambering and degree of green colouration (caused by shell boring symbionts) was then compared with a sample of 100 oysters taken directly from the Kilkieran beds, also in October. To enable comparison between growth rates in these areas, and comparison with other oyster growing areas elsewhere, the monthly instantaneous growth rate GM^{-1} has been calculated—

$$Gm^{-1} = (\log_e W_2 - \log_e W)/t$$

where W_1 and W_2 are the average initial and final weight in grams respectively of the oysters in each size category and t, is the duration of the trial in months, (Ricker, 1968).

Size frequency distribution

The size frequency distribution of the Kilkieran and Bertraghboy Bay oyster population was determined at regular intervals between 1975 and 1977. For this, oysters were dredged using a 122 cm (4 ft) dredge, towed until its bag was full. The contents of each such haul were carefully sorted; all oysters, cultch and other debris bearing spat were removed. A minimum of five such hauls was done on each occasion which yielded varying numbers of oysters. A minimum sample size of approximately 200 oysters was found desirable so as to have sufficient oysters of all size groups represented in the sample.

The size frequency distribution of these less productive and unexploited populations was compared with that of the Tralee Bay oyster population, which is the site of an intensive annual public fishery. The Tralee Bay population was sampled by measuring all the oysters taken by one 122 cm dredge working on the public fishery for a day in November 1976, one week after the opening of the dredging season.

Recruitment

As part of a wider study of oyster settlement (Barry, 1976), mussel shells were scattered at eleven stations in Kilkieran Bay in early July, 1976. Samples of this shell were taken using SCUBA in September, and the number of oyster spat per hundred whole mussel shells was recorded. In addition, at one station, Turlough Point, 500 kg of mussel shell were laid on a 625 m^2 plot. This area had been cleaned of weed and silt by repeated dredging with a toothed scallop dredge. Any oysters recovered during this process were returned to the ground. In April 1977, the oyster population of this plot and the adjacent natural oyster bed were sampled as described above to examine the effectiveness of this treatment of oyster ground on the recruitment of oyster spat.

Predation

The incidence of *Ocenebra erinacea* (L) predation on oysters in Bertraghboy Bay, Cashel, was estimated from examination of 193 oysters collected by hand from the oyster bank in the centre of that Bay in July 1976. This area dries out at MLWN.

Estimation of population

Finally, various attempts using grab sampling and SCUBA were made to estimate the total population size in Kilkieran Bay. However, because of the widely dispersed nature of the stock, its patchy distribution, and proportion of the population attached to rocks and large stones, these attempts failed to provide adequate data for detailed statistical analysis.

RESULTS

DISTRIBUTION OF OYSTERS IN KILKIERAN AND CASHEL BAY, 1974-1977

The location of the four main oyster stocks in Kilkieran Bay is shown in Fig. 1. Location 1, Turlough, is at the eastern end of the bay and extends southwards towards Rosmuc. It is an area of rather soft ground and rocky patches are not uncommon on the bed. There was a good stock of oysters

in the area, and a heavy spat fall (total of 78 spat per 100 mussel shells) was recorded there by the end of the 1976 spatting season in September. There were a great number of oysters attached to rocks and stones in this area, in patches where few oysters occur on the ground, indicating the presence of mature larvae ready to settle, but because of the soft nature of the ground, other suitable settling surfaces are few. An improvement of ca. 40% in recruitment was achieved in the area by laying mussel shell (Fig. 9). The area of utilisable oyster ground was about 5 hectares. Unlike most other oyster beds in the bay, there was very little eel-grass on the ground, much of which was covered by living "lithothamnia", which overlies soft mud. Wilson and La Touche (1978) have presented data on tidal currents and suspended matter in this area.

The second location, Outer Roskeeda, is a shallow (0.8m MLWN) bank, rising from a deeper narrow channel leading to Inner Roskeeda. It was partly covered by eel-grass, though largely clear of rocks or rough ground. It was the site of moderate spat fall (26 spat per 100 mussel shells in 1976). There was a good stock of oysters over much of the ground (6-7/m^2 in 1975). The extent of suitable oyster ground was about 3 hectares, half of which was covered with eel-grass which by reducing tidal current, has softened the ground.

Because the ground is largely clear of rocky outcrops or stony patches, cleaning derelict ground in this area would be relatively easy.

Area 3, south of Greeve Island (corresponds to Area 2, Wilson & La Touche (1978)) is an area of strong current (0.2-0.6m per second) and hard firm ground. It is bordered on all sides by rocky outcrops of the nearby shore and islands, and part of the area dries out at MLWS. These features combine to make this a difficult area to work using a large boat. However, much of the ground was quite clean and suitable for oysters. There was a light settlement of oysters (23 spat per 100 mussel shells in 1976) on this area of about 5 hectares. Further ground here was totally derelict. However, because it dries at MLWS and is close to the mainland shore, it could be used for rearing oysters either on trays or placed directly on the bottom.

Figure 1

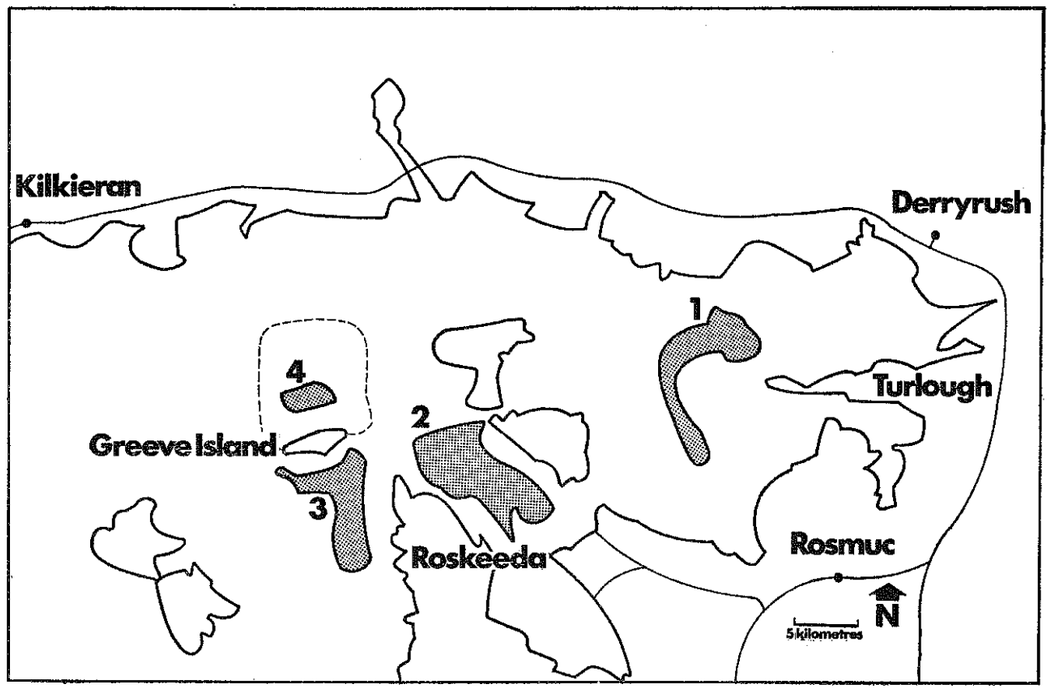

FIGURE 1. Distribution of oysters in Kilkieran Bay. 1. Turlough, 2. Outer Roskeeda, 3. Greeve Island South, 4. Greeve Island North. Present oyster stock shaded, old oyster bank within hatched line.

Area 4 on Fig. 1 is an old oyster bank, north of Greeve Island. The area of the bank is 20.6 hectares (indicated by the broken line in Fig. 1), but oysters were confined almost exclusively to a small portion along the Greeve Island shore. The upper reaches of this bank dry on spring tides but ca. 1m covers the northern side of the bank, with the exception of the N.E. corner, it is totally clear of rocks. Over 80% of the ground was covered by eel-grass. The substrate comprised "Lithothamnia" and eel-grass debris and was soft but not too muddy for oysters. There was only a very light settlement of oysters (3 spat per 100 mussel shells in 1976) and potential of the area is as an on-growing site. Before oyster spat could be laid on the bottom, the ground would have to be cleaned thoroughly of eel-grass, which tends to soften ground by reducing current speed and providing cover for many predators.

Oysters do occur in other areas of Kilkieran Bay, but only in very small quantities or in areas of rocky ground unsuited to on-bottom oyster cultivation. The area south of Kinnelly Island, for example, is marked on the Admiralty chart, No. 2096, as an oyster bank. It appears to be suitable oyster ground, but very few oysters now remain in the area. A further area, Inner Roskeeda, east of Outer Roskeeda, has a narrow shallow entrance at the western end. Beyond the sill (1.5m) at the entrance, the depth increases very rapidly to 20m at LWS. SCUBA observation in this area revealed a dense population of oyster spat on the sublittoral rock faces and ledges where *Chlamys varia* (L) shells in particular have fallen from the rocks to form a carpet of cultch, thus providing suitable settling for oyster larvae. Once one moves away from the area immediately around these rocks onto the open ground, the bottom is extremely soft and has no obvious settlement surface for mature oyster larvae. Studies of oyster larvae in this area indicated the presence of many mature larvae. However, use of artificial settlement surfaces such as limed plastic oyster spat collectors (Barry, 1980) would be necessary to exploit the potential of this particular area. In addition to its potential for spat producing, the deep water and sheltered nature of this area are important advantages for forms of suspended culture of oysters or other molluscs.

Oysters settled to rocks and stones are common in many areas around the bay, known locally as "Oisri chloca" (stone or rock oysters). They are thought by many to be a different kind of oyster and better to eat than an oyster taken off the oyster bed, even though biologically identical. They are of no immediate commercial value since they cannot be easily gathered but do contribute to the larval

Figure 2

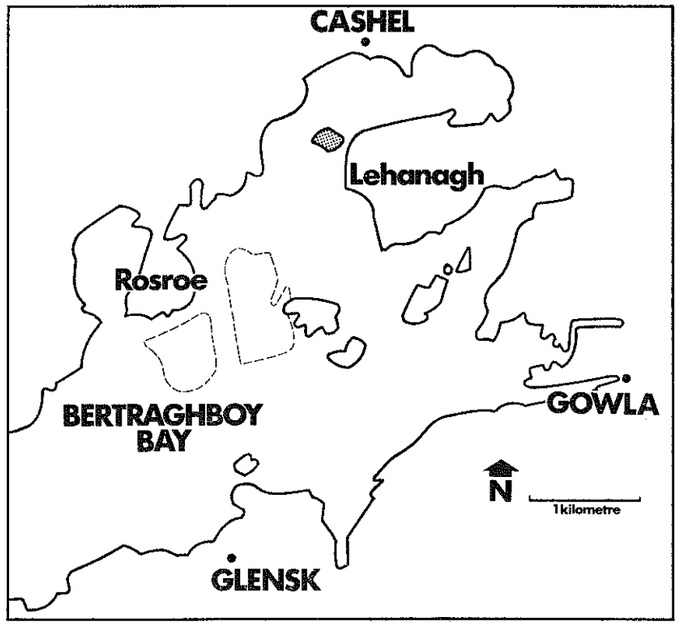

FIGURE 2. Distribution of oysters in Bertraghboy Bay. Present oyster stock shaded, old oyster banks within hatched line.

production of the bay. In this respect, it is possible that this section of the population which is widely distributed throughout the bay and which cannot be removed, has in the past insured that the oyster population in this bay was never totally fished out, and thus survived where so many similar populations in other less rocky bays have not.

DISTRIBUTION OF OYSTERS IN BERTRAGHBOY BAY, 1974-1979.

Oysters in Bertraghboy Bay are confined to Cashel Bay at the northern end. The centre of this bay is dominated by a large "Lithothamnia" bank (11.4 hectares) which dries at MLWS. There were very few oysters on the bank and those remaining were mainly large old oysters. There was very little recruitment of new stock. However, the ground is hard and it is an excellent site for both bottom and tray cultivation of small and large oysters. A second deeper bank (9.4 hectares) lies just to the south west. This, however, is never exposed and no oysters now appear to survive on the ground.

The natural settlement of oysters is mainly confined to the northern part of Cashel Bay as marked in Fig. 2. This is a very small area and though some spat does settle there, the stock is of little significance. This area is not uncovered by spring tides and there is not enough suitable clear ground to warrant extensive sublittoral cultivation.

Bertraghboy Bay has now no natural oyster population of any consequence, but is none the less a suitable growing area. One of the principal disadvantages of the area as a site for extensive bottom cultivation of oysters must be the incidence of predation by the shell boring gastrapod *Ocenebra erinacea* (L), referred to in more detail later. The importance of this species as a predator of young oysters in particular has been described by Orton (1929), Hancock (1960) and Waugh (1972). In addition to the extensive shallow oyster areas, Bertraghboy Bay also has deep sheltered water in Lehanagh, very suitable for forms of suspended culture.

DESCRIPTION OF KILKIERAN BAY OYSTERS

Kilkieran Bay oysters are distinguished by the shape and colour of their shell both inside and outside. They rarely exceed 90-100 mm and have a high degree of chambering, especially in the spring and early summer. They are shallow oysters and do not generally have large meats.

The characteristic "boss" shape of Kilkieran oysters is caused by a lack of shell shoot and thickening of the shell edges along the postero-dorsal side of the shell, giving the animal an almost triangular shape and a marked heel. These features are illustrated in Fig. 3. It is clearly not a genetic feature of Kilkieran Bay oysters, since it quickly gives way to a normal rounder shape when the oyster is relaid elsewhere on hard ground (Fig. 4). It is more likely to be related to the loose coral substrate so prevalent in Kilkieran Bay. Oysters may become partially buried in this substrate but continue to survive quite well, provided the inhalant siphon, on the anterior ventral side, and the exhalant siphon, on the posterior ventral side, are free. Thus from the umbo to the exhalant siphon can remain buried without interference with the filtering mechanisms. If an oyster were buried in this manner in a sandy coralline substrate, the mantle would tend to be withdrawn each time it encountered the grit, thus tending to produce shell growth in a vertical rather than the more normal lateral plane, along the line in which the animal was buried. It is on this area of the shell, not vital to effective filtering by the oyster, that this shell edge thickening is found. The same condition is also present to a lesser degree in oysters from coralline substrates in parts of Clew Bay, Co. Mayo.

Colouration

The green colour of the shell of Kilkieran Bay oysters is also diagnostic. It is of two kinds. Dark olive green streaks, both close to the shells' margins, and often more central on the shell, are common in oysters from many areas. It results from layers of conchyolin, laid down by the oyster in normal growth at the edges of the shell, or in other areas, to combat the intrusion of shell-boring organisms or other forms of irritation. However, more unusual is the light green colour on the inside of the shell, particularly around the exhalant chamber. The green colour of the outside of the shell is quite commonly caused by various shell-boring epibionts. Korringa (pers. comm.) has suggested that in the case of Kilkieran Bay oysters, these also occur inside the shells and can get sufficient light to survive in this position because of the shallowness and clarity of the water in the bay. The fact that the colour is seen in areas of the exhalent chamber and not above the adductor muscle would appear to support this. Furthermore, because of the nature of the substrate on the oyster banks in Kilkieran Bay, many oysters lie vertically, partly buried in "lithothamnia", and when open, light would penetrate between the valves, unlike the oyster lying flat on a hard bottom. Examination of shell material indicates this greening is caused by the siphonaceous green shellboring alga *Ostrebium quekettii* (Born et Flah). It is found in 80% of left hand valves and 62% of right hand valves of oysters in Kilkieran Bay. The extent and intensity of this colouration in the population is given in Table 1. Kilkieran Bay oysters relaid in Cork Harbour completely lost the green colour on the inside of the shell and hard white shells developed in all cases, within one growing season.

Figure 3

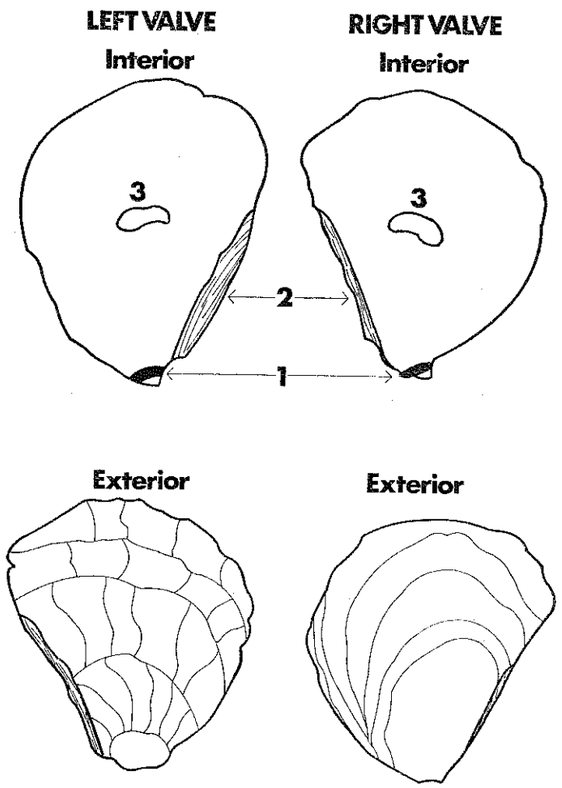

FIGURE 3. Shell shape of Kilkieran Bay oysters. 1. Pronounced "heel" at umbo. 2. Thickening of shell edge along postero-dorsal margin of both valves caused by lack of lateral shell growth in this area. 3. Adductor muscle scar. Shell shape is almost triangular.

Table 1. Extent and intensity of green colouration on the inside of shells of Kilkieran Bay oysters.

N = 100 animals	Intense	Mild	Absent
Left valve	32	48	20
Right valve	41	21	38

Chambering

Chambering of the shells of Kilkieran Bay oysters was also common. But, as with the green colouration inside the shells, the frequency of chambering also decreased when the oysters were relaid in Cork Harbour. It is caused by shrinkage of the shell forming mantle-surface (Yonge, 1960). Such shrinkage of the soft parts of the oyster may be caused by fluctuations in salinity, or changing volume of the meat post spawning for example. Though chambering does reduce the commercial

Figure 4

FIGURE 4. Shell shape of Kilkieran Bay oyster after transplantation and growth in Cork Harbour. 1. Umbo less conspicuous and not protruding as marked "heel". 2. Even lateral shell growth along all sides of the shell; no pronounced thickening of any margin. 3. Adductor muscle scar. Shell shape is circular rather than triangular.

value of oysters for table consumption, it should not greatly devalue relaying oysters. It is not usual to find chambering in oysters of less than two and a half years (ca. 50mm, 25g), and even if larger oysters were relaid in an area such as Cork Harbour, then the incidence of chambering would be greatly reduced. The effects of relaying on the frequency of chambering in Kilkieran oysters is illustrated in Table 2.

Table 2. The effect of relaying for one growing season on the frequency of chambering in Kilkieran Bay oysters.

N = 100 in each size group	Natural population Kilkieran Bay			Kilkieran oysters relaid in Cork Harbour		
	Left valve	right valve	Total	Left valve	right valve	Total
>50g	48	8	56	8	0	8
30—50g	21	0	21	9	5	14
30g	0	0	0	0	0	0

COMPARISON OF KILKIERAN AND BERTRAGHBOY BAY OYSTERS

Size, shape and colour

Oysters larger than 90mm were quite common in the Cashel area of Bertraghboy Bay, accounting for 24% of the population in April 1977. This size group accounted for only 0.4% of the Turlough Point population and 8.7% of the totally unexploited population north of Greeve Island, both in Kilkieran Bay. Though some dredging had taken place at Turlough Point, very few oysters had been removed from the Greeve Island area. Thus, oysters in the latter area can be considered to have reached their maximum length of 100-105mm. In Cashel Bay, 6.3% of the natural population were in excess of 105mm. The size frequency distribution of these populations is illustrated in Fig. 5.

Figure 5

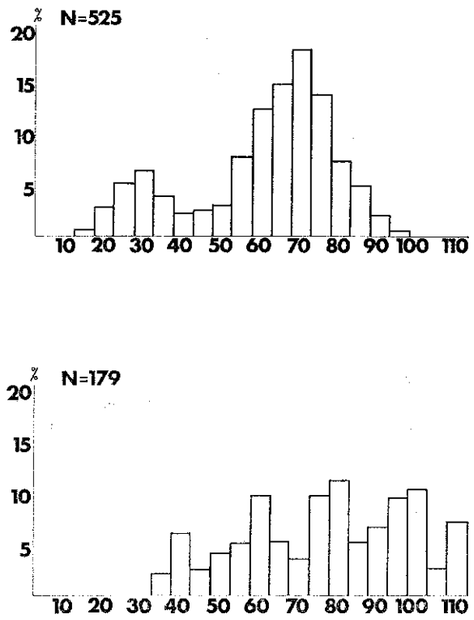

FIGURE 5. Dorso ventral shell height frequencies of samples taken in April 1977 at Turlough Point, Kilkieran Bay and Cashel, Bertraghboy Bay.

In addition to the presence of larger oysters in the natural unexploited population of Cashel Bay, oysters from this area are also more regular in shape and do not exhibit the almost triangular shape described as typical of Kilkieran Bay oysters. The exterior of the shell is not as green, but a more normal, golden colour. The interior of the shell is much whiter and the green shell-boring symbionts characteristic of Kilkieran oysters are absent. However, a dark olive green to brown colour caused by the laying down of layers of conchyolin is far more common in oysters from Cashel. This deposition takes place to combat shell boring predators or other forms of irritation.

Predation of Ocenebra erinacea *(L)*

The gastropod *O. erinacea* (L) is common on the shallow oyster grounds particularly in spring and summer. Larger oysters can frequently resist attack by laying down new shell, but small animals are very vulnerable, because of the lesser time required to penetrate the shell. The incidence of attack by this species on a sample of naturally occurring oysters in Cashel Bay is given in Fig. 6. The "Lithothamnia" substrate combined with a rich epiflora and fauna make this snail very difficult to see on these grounds, and attempts to clear areas by collecting the snails by hand failed to have any noticeable effect.

Figure 6

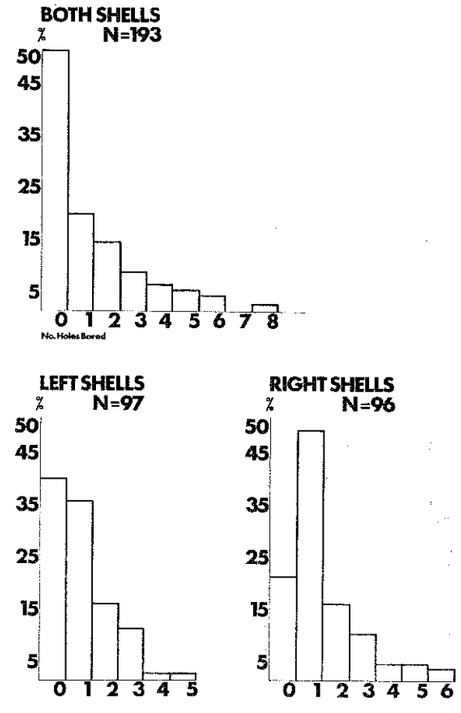

FIGURE 6. Incidence (%) of *Ocenebra* attack on Bertraghboy Bay oysters on number of holes bored.

GROWTH OF PLANTED OYSTERS

The changes in shell length, width and total wet weight of 100 individuals, in each of three different size categories held in Kilkieran and Bertraghboy Bay during 1975 and 1976, are recorded in Table 3, (a) and (b) respectively. From these data, the instantaneous monthly growth rates (Gm^{-1}) have been calculated for each group of oysters for the period February-September 1976. Accurate comparison of G values requires that the initial weight (W_1) of each group be the same and that growth is recorded over a similar period (t). The initial weights (W_1), time (t), and G values computed are given on Table 4.

The rate of growth slows down as oysters get older and heavier. Despite the fact that the large oysters used in Cashel Bay were 25g heavier than those in Kilkieran Bay starting the trial, they still showed a faster growth rate. Similarly, the growth rate of medium sized oysters was slightly faster in Cashel Bay. Using these observed values of Gm^{-1}, a 70g oyster laid in Kilkieran and Cashel for six months would achieve a weight of 79g and 84g respectively. Unfortunately, the corresponding sample of 30g oysters was lost in Cashel Bay and the observed Gm^{-1} value for Kilkieran suggests a 30g oyster would grow to 38g in six months in that Bay.

Also in 1976, the growth of three different size categories of Kilkieran oysters laid in Kilkieran and in Cork Harbour was examined. The results are summarised in Table 5, (a) and (b) respectively. The initial weights (W_1), time (t), and calculated values for Gm^{-1} are shown in Table 6. Using these growth rates, a 15g oyster can be expected to reach 28g and 34g in six months in Kilkieran and Cork respectively. A 40g animal can be expected to grow to 63g and 64g, and a 75g oyster would grow to 85g in Kilkieran Bay but 106g in Cork Harbour over the same six month period. These predicted growth figures are approximations and observed values will differ with different growing seasons, slight differences in tidal exposure etc.

The observed oyster growth in Cork Harbour was appreciably better than that in Kilkieran, though the G values for medium size oysters appears very close (.0793 and .0779). This may be caused by a 7g difference in W_1 for these two samples.

Improved growth, shell shape and colour, combined with a reduction in the incidence of chambering were all achieved by relaying Kilkieran oysters in Cork Harbour.

These results further stress the desirability to concentrate attempts at commercial production in Kilkieran Bay on seed or small oysters for relaying elsewhere rather than the production of larger heavier oysters for direct table consumption.

DEVELOPMENT OF NATURAL POPULATIONS

Kilkieran Bay population

The size frequency distribution of the natural oyster population in Kilkieran is given in Fig. 7. In February 1975, the population shows a fairly normal distribution. Some spat, less than 20mm may have been missed because of the difficulty of seeing this material in a large general sample. However, few spat of this size were attached to adult oysters indicating poor recruitment during the 1974 summer.

Figure 7

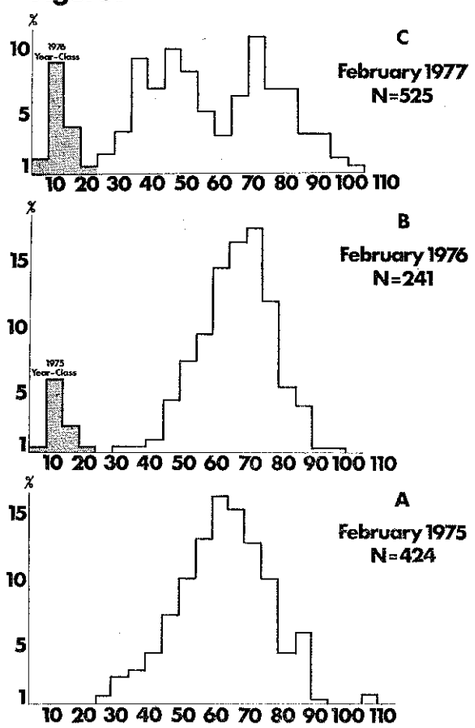

FIGURE 7. Shell height frequencies (mm) of Kilkieran Bay oysters.

The size frequency distribution of the population in February 1976 is shown in Fig. 7, B. The recruitment of that summer is evident on the left hand side of the diagram. As in the case of the 1975 figures it may also be an underestimate. The 1975 year class, as it appeared in the February 1976 population, then accounted for 9% of the total population.

The size frequency distribution of the population in February 1977 is given in Fig. 7, C. The 1976 year class, then accounted for 15% of the total population or 6% more than the recruitment for 1975. While these estimates may be underestimates, they are comparable as they refer to spat of similar size recorded at the same time each year. Attempts to conserve oysters during this period are also reflected in the greater proportion of oysters in the larger size categories. The upper limit of oysters may to some degree be set by fishing, but even in areas where no dredging takes place oysters in excess of 100mm are rare in Kilkieran Bay.

Comparison of Kilkieran and Tralee Bay populations

The size frequency distribution of oysters on the Tralee Bay population in October 1976 is compared with that of Kilkieran in Fig. 8. Tralee Bay, unlike Kilkieran, is a very clean sandy area, and even very small spat are easy to see. Even allowing for this, it is clear from Fig. 8 that the recruitment in to the Tralee population is far greater than that experienced in Kilkieran, since 1976 settled spat account for 38% of the population as opposed to 14% in Kilkieran. As a further comparison, the approximate age of different groups of oysters is also shown in Fig. 8. In Kilkieran oysters it is possible to segregate visually 18 month old oysters from older oysters of similar length.

The Tralee population is characterised by continuous recruitment and reasonably discreet year classes throughout the population. Only oysters of over 75mm can be harvested in this fishery. Because of this, and the intensity with which this stock has been fished in recent years, the upper limits of individuals in the population is to some degree determined by fishing.

Only 4.3% of the population were of commercial size one week after the opening of the season in 1976. In Kilkieran, however, the year classes quickly merge and it is not possible to age with certainty oysters older than two years. This task was made more difficult by the lack of a strong 1974 year class in these samples. The lack of intensive fishing in Kilkieran allows oysters to survive longer and grow larger than in Tralee Bay, but their presence in the sample does not necessarily indicate a greater growth potential of larger oysters in Kilkieran.

Figure 8

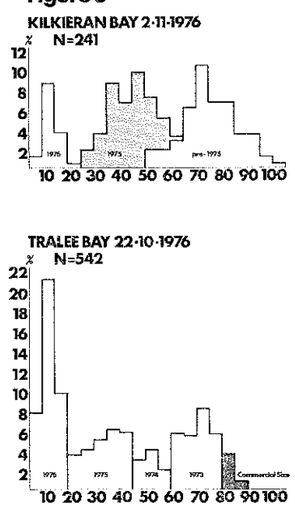

FIGURE 8. Shell height frequencies (mm) and year class of Kilkieran Bay and Tralee Bay oysters.

Figure 9

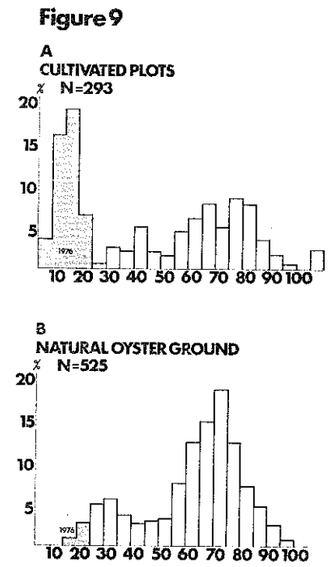

FIGURE 9. Shell height frequencies (mm) of Kilkieran Bay oysters sampled on cultivated and unculturated plots in February 1977.

The Effect of Cultivation on the Recruitment of Oysters in Kilkieran Bay.

Both populations shown on Fig. 8 are natural populations, where no effort has been made to improve recruitment by the cleaning of ground or laying of cultch. Fig. 9 shows the natural population of Turlough Point, Kilkieran Bay, compared with a plot in the same area which had been cleaned and on which mussel shell was laid as a collector in 1976. On the uncultivated plot without any shell, the 1976 year class only amounted to 2.4% of the total population. On the adjacent plot seeded with mussel shell, the 1976 year class comprised 44% of the population. Though higher recruitment on some of the natural beds has been observed (Fig. 7) than that on the control plot in this experiment, eight to nine month old oysters have never exceeded 15% of the population on uncultivated ground. Consequently, the value of this technique to increase recruitment can be considerable, where a natural population exists, where recruitment is a regular event and where settling surface is a limiting factor.

CONCLUSIONS

The oyster populations of Kilkieran Bay and Bertraghboy Bay are typical of so many areas around the coast, formerly the site of oyster production. However, the productivity of such populations was generally low and incapable of withstanding increased pressures of fishing, disease and many other factors in the latter part of the last and early part of this century. The great residues of old oyster shell now to be found in such sites is an indication of former standing stock, but little or no indication of former productivity. Bertraghboy Bay, in particular is typical of this, and its present potential for growing oysters on a very large scale could only be realised by the use of seed oysters produced elsewhere. The number of oysters necessary to restore a natural population capable of restoring a significant natural settlement to the area would be very large. Consequently, the chances of achieving such a revival, though theoretically not impossible, must be very remote.

Kilkieran Bay, on the other hand, has continued to sustain a naturally reproducing oyster population from at least the seventeenth century. Oysters have continued to settle regularly, thus ensuring the continuation of the stocks. The bay, in addition to a stock of fishable oysters on the oyster banks, has a large section of the population attached to rocks and stones, and in rough ground which can never be recovered. This may well provide a reservoir of larvae in the case of depletion of stocks on open ground. In addition, the fact that the oysters of this bay have always been owned privately, the degree of exploitation has not been the same as on many other natural stocks, the sites of public fisheries. Oyster beds will not develop if left just unattended and unfished for long periods (Millar, 1968), positive action has to be taken to encourage their growth. Through the use of various techniques for the artificial collection of natural seed oysters (Barry, 1980), it should be possible to increase significantly recruitment into this stock. Consequently, it appears that Kilkieran Bay could of itself be redeveloped into a worthwhile fishery if properly managed without the use of other sources of oysters to build up stocks. The rate of such a stock redevelopment, based on natural reproduction must ultimately depend on the frequency of good breeding years. Attempts at commercial production in this area would best be confined to producing relaying oysters, up to 40g, rather than fully grown oysters for table consumption.

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TABLE 3(a). Growth of large, medium and small *Ostrea edulis* at Turlough Point, Kilkieran Bay, between May 1975 and September 1976.

Date	Size Group	Mean length (mm)	S.D.	Mean width (mm)	S.D.	Mean weight (g)
	Large	80.8	6.4	77.5	6.8	103.9
30.5.75	Medium	65.8	6.3	64.2	6.4	52.3
	Small	46.7	9.8	43.0	10.7	15.3
	Large	88.1	7.0	74.0	8.6	116.2
28.7.75	Medium	74.5	6.5	63.2	7.3	61.3
	Small	55.0	9.4	51.6	10.3	—
	Large	88.7	6.9	79.2	9.5	131.1
15.9.75	Medium	75.6	6.5	66.8	8.5	67.8
	Small	60.8	9.7	52.2	10.5	29.5
	Large	85.9	6.4	79.6	9.6	122.6
9.2.76	Medium	73.4	6.9	64.9	7.6	67.3
	Small	57.5	9.4	54.5	10.8	30.1
	Large	85.5	7.1	75.2	8.0	128.5
7.4.76	Medium	72.3	5.5	66.7	6.6	76.8
	Small	56.4	9.6	53.6	10.8	29.7
	Large	86.1	6.8	79.3	9.1	134.1
4.6.76	Medium	72.9	9.6	67.9	7.3	72.3
	Small	59.5	8.8	57.8	10.7	33.9
	Large	85.3	6.8	77.5	7.8	130.1
19.7.76	Medium	72.8	6.3	67.8	7.0	70.9
	Small	59.5	8.5	57.0	10.2	35.2
	Large	89.3	6.1	76.8	9.0	139.2
26.8.76	Medium	75.6	7.8	69.2	8.3	76.9
	Small	64.4	9.6	62.0	11.2	40.5
	Large	85.1	7.1	78.1	7.6	136.7
11.9.76	Medium	73.6	9.4	67.2	10.0	77.8
	Small	62.3	9.4	58.8	10.7	42.7

TABLE 3(b). Growth of large, medium and small *Ostrea edulis in* Cashel Bay between May 1975 and September 1976.

Date	Size Group	Mean length (mm)	S.D.	Mean width (mm)	S.D.	Mean weight (g)
	Large	83.9	13.7	81.1	11.9	125.4
30.5.75	Medium	64.1	6.5	60.7	6.7	49.2
	Small	47.8	10.1	44.2	10.5	—
	Large	84.1	12.5	74.4	10.0	132.6
2.8.75	Medium	69.5	8.3	60.7	8.9	57.4
	Small	54.5	9.0	48.3	8.2	27.0
	Large	89.7	10.6	79.5	10.5	143.4
10.9.75	Medium	74.3	9.0	64.7	9.8	64.1
	Small	61.5	10.0	57.4	10.5	34.3
	Large	88.9	11.5	79.3	8.5	150.7
10.2.76	Medium	72.3	9.1	66.2	10.6	69.5
	Small	62.5	8.7	57.5	9.2	38.8
	Large	87.2	11.2	81.9	10.0	151.9
27.4.76	Medium	70.9	9.4	67.6	11.6	72.0
	Small	61.4	8.2	57.6	9.8	39.5
	Large	89.2	11.3	81.0	10.8	158.0
24.6.76	Medium	72.2	6.4	68.4	11.3	78.3
	Small	—	—	—	—	—
	Large	89.3	11.5	83.8	9.9	164.6
19.7.76	Medium	72.4	9.7	69.4	10.8	79.0
	Small	—	—	—	—	—
	Large	91.5	10.9	86.2	9.7	169.9
26.8.76	Medium	78.8	11.1	74.3	12.9	89.4
	Small	—	—	—	—	—
	Large	89.9	10.4	83.6	10.7	167.2
9.9.76	Medium	75.9	12.3	72.0	12.0	88.4
	Small	—	—	—	—	—

TABLE 4. Comparison of Gm^{-1} values for oysters in Kilkieran and Cashel Bays, 1976.

Location	W_1 (g)	Period	t (months)	Gm^{-1}
Kilkieran	125.6	February—October	8.5	0.0146
Cashel	150.7	February—October	8.5	0.0156
Kilkieran	67.3	February—September	7.13	0.0203
Cashel	69.5	February—October	8.5	0.0294
Kilkieran	30.9	February—October	8.7	0.0393
Cashel*	—	—	—	—

* No data for Cashel Bay for this size group in 1976.

TABLE 5. Height and weight means of samples of 100 relayed Kilkieran oysters of each size group on given dates.

A. KILKIERAN BAY

Date	1st June 1976		2nd December 1976		% increase	
Size group	Weight g	length mm	Weight g	length mm	Weight	Length
Small	14.5 ± 1.5	44.2 ± 6.7	27.6 ± 5.2	54.5 ± 5.6	92%	23.3%
Medium	35.0 ± 2.3	58.6 ± 5.4	56.6 ± 5.8	67.8 ± 5.8	42%	15%
Large	78.9 ± 7.9	75.7 ± 5.2	90.2 ± 10.4	77.6 ± 6.9	14%	2.5%

B. CORK HARBOUR

Date	14th May 1976		24th November 1976		% increase	
Size group	Weight g	length mm	Weight g	length mm	Weight	Length
Small	17.3 ± 3	46.0 ± 6.5	42.1 ± 4.8	61.7 ± 7.3	147%	34%
Medium	42.2 ± 5.3	60.6 ± 5.6	70.2 ± 3.7	71.3 ± 6.8	59%	18%
Large	71.8 ± 6.0	71.8 ± 5.8	105 ± 12.9	82.1 ± 6.9	47%	14%

TABLE 6. Comparison of Gm^{-1} values for oysters laid in Kilkieran Bay and Cork Harbour, 1976.

Location	W_1 (g)	period	t/month	Gm^{-1}
Kilkieran	78.9	June—December	6.17	.0217
Cork	71.8	May—November	6.5	.0585
Kilkieran	35.0	June—December	6.17	.0779
Cork	42.2	May—November	6.5	.0783
Kilkieran	14.5	June—December	6.17	.1043
Cork	17.3	May—November	6.5	.1368

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