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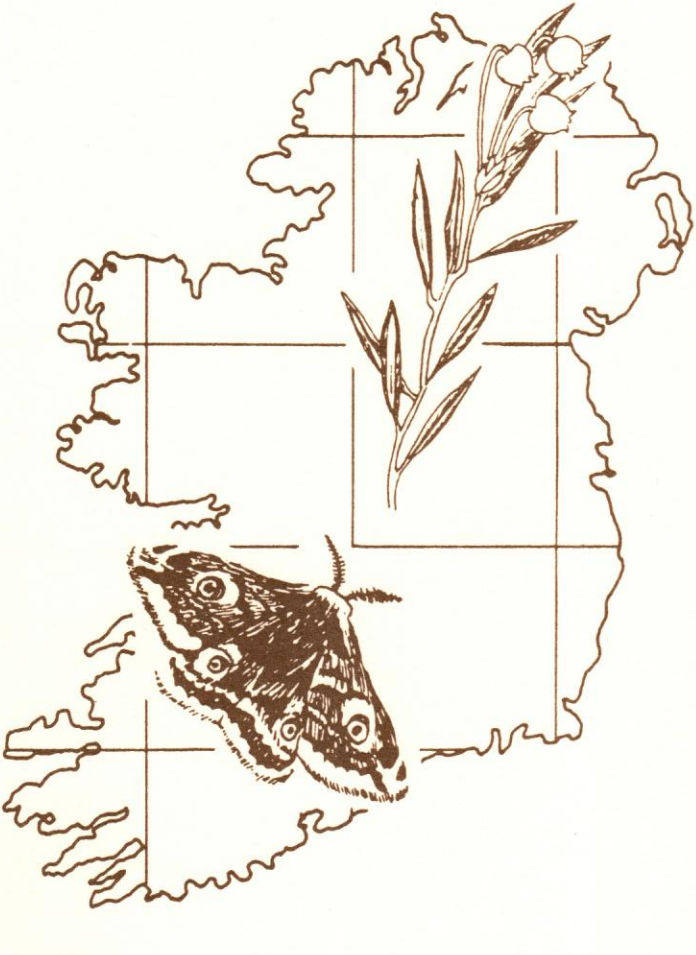

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THIS BULLETIN IS DEDICATED TO JOHN KILBRACKEN OF KILLEGAR, CO. LEITRIM IN RECOGNITION OF HIS CONTRIBUTION TO THE NATURAL HISTORY OF IRELAND AND IN APPRECIATION OF HIS GENEROUS HOSPITALITY TO THE SOCIETY.

BULLETIN OF THE IRISH BIOGEOGRAPHICAL SOCIETY

Number 19

CONTENTS

Bull. Ir. biogeog. Soc. No. 19 (1996)

EDITORIAL

The finances of the Society are now on a sound basis and it has been possible to publish another double issue of the *Bulletin* this year. The contents are diverse including articles on stinkhorn fungi and on frogs. We are very grateful to the authors for such an interesting range of papers. On behalf of the Irish Biogeographical Society, I also wish to thank our sponsors, the referees and all those who helped with this *Bulletin*. We are especially grateful to Mr J. M. C. Holmes who provided his usual invaluable assistance with its production.

J. P. O'Connor

Editor

18 October 1996

Bull. Ir. biogeog. Soc. No. 19 (1996)

THE FISHES OF MULROY BAY, NORTH-WEST IRELAND

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Introduction

The few published studies recording fish in Mulroy Bay concern sea trout (*Salmo trutta* L.) (Fahy, 1985), Couch's goby (*Gobius couchi* Miller and El Tawil) (Minchin, 1988) and wrasses. *Crenilabrus melops* (L.) and *Ctenolabrus rupestris* (L.) were collected from within the North Water and used as cleaner-fish for the control of sea-lice on farmed salmon (Costello, unpublished). Seasonal and annual trends in abundance, size distribution and sex ratios for *C. melops* were studied by Darwall *et al.* (1993) and they suggested that the fishery reduced the proportion of large males in the natural population. Other studies reported the occurrence of the ectoparasitic copepod *Leposophilus labrei* Hesse on *C. melops* (Donnelly and Reynolds, 1994) and screening of *C. melops* and *C. rupestris* for bacteria, viruses and parasites (Frerichs *et al.*, 1992; Costello *et al.*, 1996). Reviews of other taxonomic groups in Mulroy Bay include marine algae (Parkes, 1958a, 1958b; Morton, 1978) and Mollusca (Nunn, 1996).

This paper summarises records of fishes in Mulroy Bay, with most effort centered in the North Water. The study is based on incidental observations made while investigating the resident scallop and wrasse populations. Records are mainly associated with the shallower areas of the Lough where there are expanses of *Zostera*, boulder spaces and varying sediment types.

Study area

Mulroy Bay is a sheltered deep water inlet on the north coast of Ireland with a small tidal range. Its entrance consists of a number of shallow constrictions leading into two main basins, the larger Broadwater with depths to 22m which leads *via* a further shallow channel leading to the North Water, the most enclosed basin with depths to 47m in the Stookan Deep (Fig. 1). The relatively deep water, series of narrow tidal channels and small tidal range make this a unique site in Ireland. The geology of this area is made up of metamorphosed sedimentary rocks, shales and limestones. In the North Water there are steep drops, tidally winnowed sediments, large expanses of sediment deposition, and in the shallows *Zostera marina* L. meadows. Rock and stone rubble fields and scree slopes were often cemented together with encrusting corallines principally on the sheltered western side of the Lough. Rocky patches and outcrops surrounded by muds and silts rise from the sea floor. Expanses of mud below 20m form undulations and bioturbated hillocks. The Broadwater is similar but with fewer steep drop off areas and a larger area of sedimentation in its northern region. The elongated southern part of the bay is made up of tidally scoured channels, reefs, islets and still muddy areas with filamentous algae or *Zostera* stands.

The North Water has little freshwater runoff on account of the surrounding high ground providing a small catchment. The Broadwater has some streams and a small shallow river, the Bulin River, at its southern end. Salinities within Mulroy Bay remain comparatively high thoughout the year ranging from 15‰ to 33‰, with lowest salinities in the surface waters of bays, lagoons and estuarine areas. This Lough system has as a result similar features to that of Lough Hyne. However, unlike Lough Hyne, the summer stratification within the deeper North Water is not known to result in anoxic conditions in the hypolimnion. Sea temperatures normally range from 6.5° to 18°C but temperatures in the shallows of 3.8°C have been recorded. Ice appears within the shallow embayments of the Lough during prolonged cold spells.

Methods

Observations on fishes are based on about 200 SCUBA dives, and also from snorkelling in shallows, and trap and net captures. Fish observed while diving were normally easily identified; and some were collected while diving. All other methods provided specimens for identification. Fish measurements were of total length (TL, the distance between snout to end of caudal fin) or standard length (SL, the distance between the snout and the last vertebra, the hypural plate). Observations were mainly made during July and August but visits at all times of the year were made.

Records

Scyliorhinidae

***Scyliorhinus canicula* (L.) - lesser spotted dogfish**

Common, widely distributed about the Lough perimeter in shallows, including the Wee Sea and Main Channel to depths of 50m near the Stookans. Egg cases seen in shallows. Females to 65cm and males 69cm. Males were more frequently captured in a trammel net during July 1984: 47 males 50.4 - 69.3cm TL, 21 females 55.0-62.0cm TL.

Rajidae

***Raja clavata* L. - thornback ray**

Scarce, one female 33cm TL captured by trammel net in the Stookan Deep, July 1984. Observed near Scalpmore in Broadwater, and reported to have been captured in trammel nets there.

Clupeidae

***Clupea harengus* L. - herring**

Captured in gill nets during autumn 1980 (Fahy, 1985).

***Sprattus sprattus* L. - sprat**

Taken from the gut of *Salmo trutta* in the autumn 1980 (Fahy, 1985).

Salmonidae

***Salmo trutta* L. - sea trout**

Common, observed at Moross Ferry Pier, entrance to Wee Sea, Bullock Bay and off Lagnahatiny Point. Common in shallows in areas of current. Twelve fish captured on artificial fly 0.2-0.8kg near Moross Ferry Pier July 1979. Frequently fished in the narrows between the Broadwater and Island Roy, Moross and the Wee Sea. Fahy (1985) records specimens ranging 16-43cm TL. These had been feeding mainly on Crustacea but also *Atherina presbyter*, *Gasterosteus aculeatus* and *S. sprattus*.

***Salmo salar* L. - salmon**

Abundant, introduced for culture since 1978, occasional escapees. There were three companies that have cultivated within the Lough; by 1994 there was only one company operating in most of the previous sites. Cage sites are present near Deegagh Point, central North Broadwater, Rosnakill and Kindrum and Millstone Bay, sites near McSwynes Bed, and the Stookans were discontinued.

***Onchorhynchus mykiss* Walbaum - rainbow trout**

Introduced, cultivated over the period 1979 to 1983 in cages. Fahy (1983) examined the ecology of escapees in Mulroy Bay. Not currently farmed.

Anguillidae

***Anguilla anguilla* (L.) - common eel**

Common, widely distributed within the bay and the Wee Sea. Most sightings were in shallow water, but some were taken in traps to 8m. Specimens to 28.5cm.

Congridae

***Conger conger* (L.) - conger eel**

Observed in a region of kelp and bedrock at Melmore Head.

Belonidae

***Belone belone* (L.) - garfish**

Only two specimens captured near Bird Island during summer 1976 (R. Ward, pers. comm.).

Syngnathidae

***Nerophis lumbriciformis* (Jenyns) - worm pipefish**

A single specimen in algae on low shore at Moross Ferry Pier in June 1984.

***Syngnathus acus* L. - greater pipefish**

Observed in North Water (Croaghan Island), Moross Channel and Broadwater. A single specimen, 28.0cm TL captured at 8m depth in the Moross Channel, July 1982.

Gasterosteidae

***Gasterosteus aculeatus* L. - three-spined stickleback**

Abundant, often forming shoals in shallow water and associated with marine algae.

***Spinachia spinachia* (L.) - fifteen-spined stickleback**

Occasionally seen about the Lough associated with marine algae, or found close to floating or suspended materials over deeper water. Observed in Millstone Bay, Mullaghanardy Point and North Water. Specimens to 10.3cm SL.

Gadidae

***Gadus morhua* L. - cod**

Common, specimens, 7-11cm TL, occasionally seen in shallows. Fish, 31-41cm TL captured to depths of 50m by rod and line and by trap. In Stookan Deep, July 1984, specimens 8.8-11cm TL and 31-45cm TL were collected, some with *Limaria hians* (Gmelin) in their gut.

***Trisopterus minutus* (L.) - poor cod**

A large school seen south of Croaghan Island, also observed at Melmore Head and First Narrows of the Main Channel. Two fish, one captured in a trap in the Stookan Deep, the other in a trammel to the north of Red Brae in July 1984, both specimens 12.1cm SL.

***Trisopterus luscus* L. - bib**

Reported from the gut of *S. trutta* (Fahy, 1985).

***Merlangius merlangus* (L.) - whiting**

Scarce, three fish captured. One, 26cm SL, from Stookan deep, taken in trammel, July 1984. Two, 9.9 and 14.2cm SL in traps west of Croghan Island, August 1984.

***Pollachius pollachius* (L.) - pollack**

Commonly observed at Melmore Head and small individuals common in shallows, usually near marine algae and also from Stookan Deep. Specimens to 34cm TL.

***Pollachius virens* (L.) - saithe, black pollack, coalfish**

Common, frequent in areas of swift water movements and normally associated with kelps from shallows to depths of 50m where specimens 12.6-15.3cm TL were captured in traps in July 1984. Gut contents mainly polychaetes, fish remains, crustaceans and *L. hians*. Commonly seen at Melmore Head.

***Molva molva* (L.) - ling**

Observed associated with kelp on bedrock at Melmore Head, July 1993.

***Raniceps raninus* (L.) - tadpole fish**

Rare, a single fish, 20.9cm TL taken from a trap at 10m near boulders near Lagnahatinny Point, 20 July 1983.

Labridae

***Crenilabrus melops* (L.) - corkwing wrasse**

Locally abundant in shallows near marine algae and rocks or stones and in the rapids area of the Wee Sea, throughout the North Water, Moross and Main Channels. Frequently taken by traps and trammel net. Gravid females seen in August 1978 and July 1984. Nest guarding and tending by a male in breeding colouration was observed near the small island east of the

Stookan Deep (Fig. 1). The nest was composed of 1 to 5cm tufts of chlorophyte and rhodophyte algae including: *Corallina officinalis* L., *Delesseria sanguinea* (Huds.) Lamouroux, *Plocamium cartilagineum* (L.) P.Dixon, *Lomentaria* sp., *Ptilota plumosa* (L.) Agartlh, *Polysiphonia* sp., *Chondrus crispus* Stackhouse and unidentified filamentous green algae. The nest was wedge shaped, 17cm deep at the entrance, 30cm long, and built between a boulder and cliff face at 1m depth. A sample removed from the nest had eggs attached to it. Specimens to 13.5cm TL.

***Ctenolabrus rupestris* (L.) - goldsinny wrasse**

Common on west side of North Water near rock rubble in shallow water, otherwise occasionally observed to 15m. Common near the Hassens and Melmore Head and also seen in the Main Channel.

***Labrus bergylta* Ascanius - ballan wrasse**

Rare in North Water, and also observed in Main Channel and at Melmore Head.

***Labrus mixtus* L. - cuckoo wrasse**

Rare in North Water, also seen in the Main Channel and at Melmore Head.

Ammodytidae - sand eels

Locally common, seen but not captured in the Moross Channel and common over sand near the Bar Rocks near the bay entrance. Fahy (1985) reports them from the gut of *S. salar*.

Scombridae

***Scomber scombrus* L. - mackerel**

Scarce, occasionally captured within the Lough in the autumn of some years (R. Ward, pers comm.).

Gobiidae

***Gobius niger* L. - black goby**

Abundant in the Wee Sea and Broad Water to over 50m and in the North Water. Observed in the Main Channel. Specimens to 15.0cm TL, to 10.3cm TL in the Wee Sea. Seen with eggs July 1981 near Lagnahatinny Point.

***Gobius couchi* Miller and El Tawil - Couch's goby**

Common near boulders and stones at 3-16m in North Water and also present in the Broadwater at Deegagh Point. First reported by Minchin (1988), material N.M.I. 37: 1983.

Further observations in 1989, 1993 and 1994 confirm the population is established.

***Gobius paganellus* L. - rock goby**

Observed in Broad Water, Moross Channel and Main Channel.

***Lesueurigobius friesii* (Collett) - Fries' goby**

Probably common, one specimen from 8m, east of Bird Island over *L. hians* association. Several fish probably of this species seen to swim into burrows at 16-25m in Bullock Bay, south of Green Island, west of Greer's Island, south of Golamore Island, Caffard Bay and Massomount Bay.

***Gobiusculus flavescens* (Fabr.) - two-spotted goby**

Locally abundant, appears in small groups in shallows associated with marine algae, common on west side of North Water and in Main Channel.

***Pomatoschistus pictus* (Malm) - painted goby**

Locally abundant, occasionally seen from shallows to 15m, seen in clear patches of clean sand and gravel in North Water, Broad Water and Main Channel.

***Pomatoschistus minutus* (Pallas) - sand goby**

Found in the gut of *S. salar* (Fahy, 1985). Fish, probably this species, seen on shell sand slopes in North Water and Pan Bay.

***Aphia minuta* (Risso) - transparent goby**

Occasionally seen as small groups near marine algae in shallow water in north-west region of North Water in August of 1979 and 1980. Once a school of thousands seen at 2m near Croaghan Island, May 1990.

***Thorogobius ephippiatus* (Lowe) - leopard-spotted goby**

Rare, observed among sheltered rock outcrops to the south-west of Campbells Bed in the Broadwater, July 1993.

Callionymidae

***Callionymus lyra* L. - common dragonet**

Occasionally seen in the Moross Channel on shelly sand, south part of North Water and Croaghan Bay at 14m, and at the Hassins.

***Callionymus reticulatus* Valenciennes - reticulated dragonet**

Scarce, observed in kelp forest at Melmore Head, on gravel in Pan Bay (Broadwater) and on cobbles in the Second Narrows.

Blenniidae

***Parablennius gattorugine* L. - tompot blenny**

Rare, one small specimen found in a plastic tray for rearing shellfish, west side of North Water, September 1982.

***Lipophrys pholis* (L.) - shanny**

Observed in rock pools at Ballyhoorisky Point, July 1993.

***Coryphoblennius galerita* (L.) - Montagu's blenny**

Occasionally seen in rock pools at Ballyhoorisky Point, August 1990.

Stichaeidae

***Chirolophis ascanii* (Walbaum) - Yarrell's blenny**

Rare, three specimens in shallow water below Sweeney's castle, Moross Ferry, July 1984.

Pholidae

***Pholis gunnellus* (L.) - butterfish**

Common, found on lower shore in Moross Channel, North Water, Main Channel, entrance to the Back Lough and at Melmore Head. Taken by trap from near Bird Island, northern Broadwater, Rough Island, and Keadew Bay. Specimens to 14.0cm TL.

Mugilidae

***Chelon labrosus* (Risso) - thick-lipped grey mullet**

Common, captured in gill nets in North Water (Fahy, 1985), seen in Wee Sea and in shallow bays. '0' and '1' group fish not observed. One captured July 1981 36cm TL and 446g. No fish seen in winter.

Atherinidae

***Atherina boyeri* Risso - sand smelt**

Common, eggs and post larvae in Wee Sea in July 1984, juveniles and adults in Moross Channel, Rosnakill Bay and near Golamore Island. Commonly seen in shallows in summer. Fed on by *S. salar* (Fahy, 1985).

Cottidae

***Myoxocephalus scorpius* (L.) - short-spined sea scorpion**

Found on lower shore and in shallow water and on tideswept cobbles in the Second Narrows of the Main Channel. Examined specimens have reduced boney scutes above lateral line and have a large opercular skin flap extending beyond the preopercular spine. Fin rays: dorsal 1, VIII-IX; dorsal 2, 14-16; anal, 10-11; pectoral, 16-17 and pelvic, 3; for three specimens from the north Broadwater 23cm TL and Moross Channel 12.9cm and 16.8cm TL, September 1979 and July 1983.

***Taurulus bubalis* (Euphrasen) - sea scorpion**

Few records, a single specimen taken in a trap in the Moross Channel 12.1cm TL, September 1979. Fin rays: dorsal 1, VIII; dorsal 2, 11; anal, 9; pectoral, 15; pelvic, 3. Observed at Scalpmore (Broadwater) and First Narrows.

Triglidae

***Eutrigla gurnardus* (L.) - grey gurnard**

One seen near Cratlagh Island on mud at 9m, August 1978.

Agonidae

***Agonus cataphractus* (L.) - pogge**

One seen at 4m on shell sand in Moross Channel, July 1984.

Cyclopteridae

***Cyclopterus lumpus* L. - lumpsucker**

Seldom encountered, not seen in winter or spring. Small juveniles seen in August to October attached to moorings and shellfish cultivation equipment.

Scophthalmidae

***Phrynorhombus norwegicus* (Gunther) - Eckstom's topknot**

Observed in kelp forest on wave exposed bedrock at Melmore Head, July 1993.

***Zeugopterus punctatus* (Bloch) - topknot**

Observed west of Melmore Head below the kelp forest.

Pleuronectidae

***Pleuronectes platessa* L. - plaice**

Young specimens occasionally seen in muddy shallows. Two, 23 and 25cm TL captured in trammel from Stookan Deep. Large specimen seen north of Golamore at 10m and in the Wee Sea, North Water and at Melmore Head.

Microstomus kitt **(Walbaum) - lemon sole**

Rare, two fish, one captured in trammel in Stookan deep, July 1984, and a further fish seen west of Greer's Island, August 1980.

Platichthys flesus **(L.) - flounder**

Seen in the Wee Sea and beneath fish cages in the North Water, and intertidally on muddy shores at high water in the Moross Channel.

Soleidae

Solea vulgaris **(L.) - sole**

Rare, two fish, 24 and 26cm TL from trammel in Stookan Deep, July 1984.

Gobiesocidae

Lepadogaster **sp. - clingfish**

Rare, one small specimen attached to shellfish trays, September 1982. Observed in shallow water (<5m) in the North Water and Moross Channel, May 1990.

Lophiidae

Lophius piscatorius **L. - anglerfish**

One observed at Melmore Head associated with sand scoured bedrock and kelp, July 1993.

Summary

Mulroy Bay, Co. Donegal, is a deep partly enclosed and sheltered basin with a wide range of habitats and sediments. Fifty-nine fish species were recorded by trapping, netting and from observations by diving. Five species are seasonal or occasional vagrants, *Clupea harengus*, *Clupea sprattus*, *Belone belone*, *Scomber scombrus* and *Chelon labrosus*. Two species have been introduced, *Salmo salar* and *Onchorhynchus mykiss*. There is a large resident population of *Gobius couchi*, known elsewhere only from Lough Hyne and the Helford River, Cornwall. It is of interest that *Crenilabrus melops* was more frequent in Mulroy Bay than in other sites studied in Ireland, Scotland and Norway (Costello, unpublished). Some species were rarely seen within the lough but occur frequently elsewhere in Ireland, these include *Nerophis lumbriciformis*, *Labrus bergylta*, *L. mixtus*, *Thorogobius ephippiatus*, *Parablennius gattorugine*, *Microstomus kitt*, *Solea vulgaris* and *Lepadogaster* sp. Species from the lough, considered to be rare elsewhere on Irish coasts according to Went and Kennedy (1976) include *Raniceps raninus* and *Chirolophis ascanii*.

Acknowledgements

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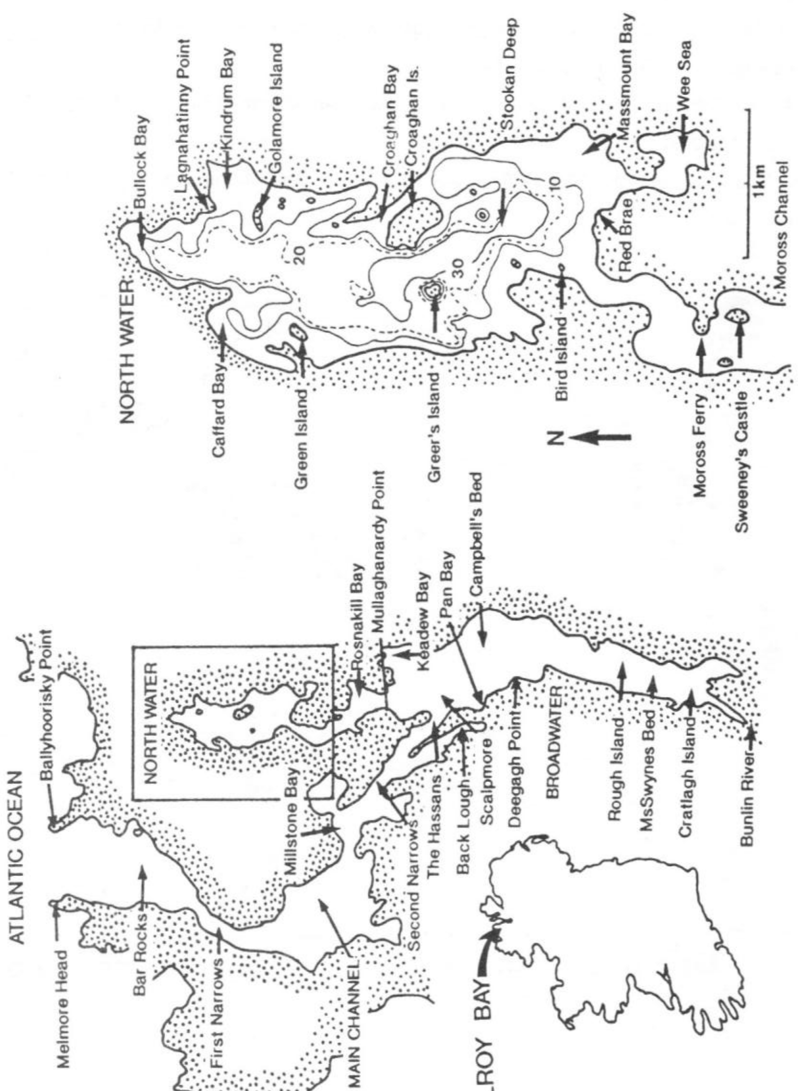
FIGURE 1: distribution of sites within Mulroy Bay.



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THE MARINE MOLLUSCA OF IRELAND 2. MULROY BAY, CO. DONEGAL

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Introduction

Mulroy Bay is a complex marine lough on the north coast of Ireland, bounded on the west by Rosguill Peninsula and on the east by Fanad Peninsula (Fig. 1), and extending inland for about 19km. The Bay is divided into three main areas: **North Water** (about 1km wide by 3km long), linked *via* Moross Channel to **Broadwater** (maximum 2.5km wide, 11km long) both lying approximately in a north-south direction, and the main **Channel** (14km long) which connects Broadwater to the open sea *via* the Mouth and Bar (Figs 2A, 2B, 2C). The total length of the shoreline is about 80km (Parkes, 1958). The Channel constricts at three places to about 100m wide, known as First, Second and Third Narrows. Tidal streams run very strongly in the Channel (1-3 knots), particularly at the Narrows, where the maximum spring rate can be as much as 5 knots at Second Narrows. There is little or no tidal stream in Broadwater or North Water, except at the approaches to Third Narrows, or Moross Channel. At Third Narrows, the streams cannot run through the narrow channel at The Hassans at a rate sufficient to maintain equality of the water levels in Broadwater and the Channel north-westward. At springs, the difference in the levels may be as much as 0.5m. As a result, the streams run very strongly, and there is, just above the narrowest part of the channel during the ingoing stream, and just below it during the outgoing stream, a rapid, where the water level falls suddenly with violent turbulence. Spring tide low water occurs at the Bar at midday, and at successively later times south through the Channel, with Broadwater and North Water being about 3 hours later. Tidal range varies from the Bar (3.2-4.2m) to Broadwater (1.2-1.6m). There is poor water exchange in North Water, with a total replacement time (assuming complete mixing) of about eight days. Maximum depths are 20m (Bar); 15m (Mouth); 20m (Channel); 40m (Broadwater); 33m (Moross Channel/Rosnakill Bay) and 47m (North Water). Much of North Water and the northern half of Broadwater is deeper than 20m. Most of the Channel, Mouth and the southern half of Broadwater is less than 10m deep, with a significant area less than 5m.

Mulroy Bay, particularly Broadwater and North Water, is sheltered from the wind by surrounding hills, and consequently rarely experiences significant wave action. There is a fetch of only 2-3m in Broadwater with prevailing westerly winds, and maximum of 11km to south/south westerly winds. The entrance (Mouth and Bar) are exposed or semi-exposed to oceanic swells, but these do not penetrate the Bay to Broadwater or North Water.

There are no large rivers which drain into the Bay to significantly affect salinity. Salinity in the Channel is about 35 $^{\circ}/_{\circ\circ}$. A few small streams (e.g. at Pan Point, Pan Bay, Cranford Bay, Carrickart, First Narrows) and the Bunlin River at the head of Broadwater, are the main sources of freshwater. The Bay is subject to general freshwater runoff from the surrounding hills during heavy rainfall, especially during the winter. A shallow halocline (about 1m deep) can develop in parts of North Water and Broadwater where the rainwater runoff lies on the surface during calmer weather.

Sea water temperatures in Mulroy Bay vary from 4°C (February) to more than 16°C (July/August) in North Water, particularly in water less than 5m deep (Minchin, 1981a; Minchin, 1988), with less extreme variation in Broadwater and the Channel (7°C-15°C), reflecting closer proximity with the open sea. Temperatures in North Water can regularly exceed 16°C, often to 18°C, and, in July 1995, a temperature of 20.5°C was recorded (D. Minchin, pers. comm.).

The coastline in Mulroy Bay is generally low, except at the entrance on the western side. A granite intrusion forms the rocky coastline at the entrance (Mouth and Bar). Ballyhoorisky Point on the east side of the Mouth and Bar consists of granite bedrock which is smooth, deeply fissured and descends seaward in step-like blocks. This bedrock is exposed to wave action, and is consequently relatively impoverished for fauna and flora, except where shelter can be found such as on the muddy/gravel causeway linking Ballyhoorisky Island to the mainland. There are long beaches of clean sand on the eastern side of the Mouth south of the Island, with little fauna or flora. Melmore Head on the west side of the Mouth consists of very steep cliffs, which give way to clean sandy bays further south. The principal substrate in the sublittoral in the Mouth is also clean sand with some shell fragments.

At about Invermore Bay, just south of First Narrows, granite is replaced by metamorphic rocks, principally quartzite with three bands crossing the whole Bay (including Broadwater and North Water) in a north-east/south-west direction, and schists, with occasional dykes of diorite (Parkes, 1958; A. Jeram, pers. comm.). Bedrock outcrops at First Narrows (e.g. Dualtys Isle, Dundooan Point) are less exposed to wave action, and are subject to strong current, with a rich and diverse fauna and flora. In the sublittoral, Dundooan Rocks is a current-swept bedrock outcrop, covered in many hydroids, sponges etc.

The Channel is mainly gravel, with boulders for both the intertidal and sublittoral. Any sites on shore close to, but slightly sheltered from the current have a rich and diverse fauna. The lower shore of current swept areas is often dominated by *Himanthalia elongata* (L.). *Zostera* sp. is common at extreme low water in the more sheltered bays, as is *Codium* sp. The free-living pink calcareous seaweed known as maerl is locally common on the gravel in areas of moderate current from 0-20m in the Channel, mainly from the First to south of the Second Narrows (Nunn, 1993a). It is also present on a sublittoral spit in Pan Bay, Broadwater, close to the entrance to Third Narrows (Jerry Gallagher, pers. comm.). The Hassans at the Third Narrows is a unique site, because strong currents run close to the shore, yet there are sheltered embayments inside the rocks where current speeds are diffused, but other characteristics pertinent to water movements exist. At the interface between the strong currents and sheltered water, a sudden change in gradient of environmental conditions provides an opportunity for several species ranges to overlap e.g. *Leptochiton* (Light and Baxter, 1990).

Broadwater has narrow shores of muddy gravel, with very soft mud at its southern head. *Zostera* sp. and *Codium* sp. are also common in bays here, particularly in the northern and middle areas. The sublittoral is a soft mud, with patches of muddy gravel and bedrock outcrops in the southern section; shoals of muddy gravel with *Laminaria* in the middle section, and mud/muddy gravel with *Laminaria* in the northern section. Campbells Bed which lies in North-East Broadwater is a large bedrock outcrop with steep silty cliffs from about 5 to 20m deep, very rich in sponges.

The shores of Moross Channel are principally muddy gravel with bedrock outcrops covered in *Ascophyllum nodosum* (L.). The sublittoral substrate is mud and muddy gravel in the south and Rosnakill Bay, with cleaner gravel, *Laminaria* and *Limaria hians* (Gmelin) nests in the narrower current swept area off Moross Castle.

The shores around North Water are narrow with muddy gravel and stones, with softer muds at the head of North Water. The west side has a very narrow foreshore below steep bedrock. The mid and southern sublittoral of North Water is dominated by bedrock cliffs and steep rock and boulder slopes, principally around the islands (e.g. Lambs Island, west of Croaghan Island) and pinnacle rocks (e.g. The Stookan) often with a covering of silt. The cliff at Lambs Island is relatively clean, as it is subject to some current from Moross Channel. These cliffs are rich in sponges and ascidians. The deeper parts of North Water are soft mud, with muddy gravel and coarse sand in shallower waters below rock outcrops at 10-20m, especially on the east side, with *Pecten maximus* (L.).

The majority of the area is not densely populated, with tourism being of minor importance (Picton *et al.*, in prep.). There are not large tourist centres, only local accommodation in a few hotels, caravan sites and bed and breakfast establishments.

Mulroy Bay was designated as a mariculture site in 1981 for the purpose of Council Directive 79/923/EC for shellfish culture. The first salmonid farm was established in 1979, with five farm sites by 1988. There are currently five active salmonid farm sites - Millstone Bay, Moross Channel, North-West Broadwater (2) and north of North Water. A site in the south of Broadwater is currently not in use. There are scallop beds laid in North Water and North-West Broadwater, and mussel lines, also in North-West Broadwater.

Mulroy Bay is clearly one of the most diverse sea loughs in Ireland. The habitat diversity is represented by a range of substrata (solid bedrock to fine muds); depth (0-47m); current (0-5 knots); salinity (Mouth to head of Broadwater); exposure to wave action (Bar to head of North Water); intertidal (steep bedrock to mud) and the presence of maerl which can introduce diversity by providing a substrate for other species to colonise (Nunn, 1993a; Nunn, 1993c). Mulroy Bay is generally accessible and small enough to sample. The wide range of habitats suggests that there is a taxonomic diversity of molluscan fauna, and consequently Mulroy Bay may be expected to have a significant number of species present. Maps display distribution clearly, and as distribution is limited by physical factors to which the physiology of the animals respond, are likely to reflect environmental conditions (Norton, 1978).

Historical background to molluscan studies in Mulroy Bay

Hart (1892) published the first account of molluscan records from walking strand lines between 1881-1888 in Donegal and Dublin, and includes records from Melmore Head (Bar, west side). Praeger (1894) published a report of the dredging activities of Mr R. D. Darbishire and Rev. A. H. Delap in Mulroy Bay. Four dredgings took place in the main body of North Water (north-west and west of Croaghan Island; south-east of Doherty's Rock; east of Lambs Island; in 31-50m, 'mainly fine thick black mud, a little gritty sand, a few sharp quartz pebbles and a few shells'). There were two further dredges in Moross Channel in 2-6f on sand and *Laminaria*. All records were presented as a single species list and not assigned to any one site, with only 27 species being recorded, the majority as dead shells. The results were considered to be 'very disappointing' and the fauna 'remarkable for its poverty' (Praeger, 1894)! Shells from this expedition were displayed at a meeting of the Conchological Society of Great Britain and Ireland and donated to that organisation (Standen, 1894). These records were further reported in Nichols (1900).

Subsequent to this study, there are very few records of molluscs from this area. A small collection of shells from Mulroy Bay in the Ulster Museum was donated by Mrs S. Parkes in the late 1960's, but there is no detailed information on site location. Since the late 1970's however, especially with the advent of SCUBA diving, considerable fieldwork has taken place. An unpublished list of molluscs recorded based on shore collections and diving observations from the Bay from 1979 to 1990 by Dan Minchin, Fisheries Research Centre, has been compiled (Minchin, 1990). Other diving observations in 1979-1981, principally of nudibranchs, were recorded in two reports to the Praeger Committee, Royal Irish Academy, by Bernard Picton, then Ulster Museum (Picton, 1979 and 1981). In 1989, the Conchological Society of Great Britain and Ireland carried out intertidal fieldwork at six sites in the Bay as part of an examination of the molluscan fauna of Donegal (Nunn, 1990).

A number of individual molluscan species have been studied within the Mulroy Bay area. Shell shape variation in the painted topshell *Calliostoma zizyphinum* (L.) has been examined (O'Loughlin and Aldrich, 1987) together with its distribution in Ireland which includes Mulroy Bay (O'Loughlin, 1989). Commercially utilized species have been studied in Mulroy Bay, including shell colour (Minchin, 1991), settlement and distribution (Minchin, 1981a; 1992a;

1995) and predation (Minchin, 1992b) in the scallop *Pecten maximus* (L.). A study of the ecological genetics of *Mytilus edulis* L. took place around Ireland (Gosling and Wilkins, 1981), which included samples from Melmore Head.

Contaminants within the Bay have also been studied for the quality of the shellfish (including mussels and oysters) under the EU directive relating to shellfish bearing waters (O'Sullivan *et al.*, 1991). The waters and shellfish were considered acceptable, although there were slightly elevated concentrations of cadmium present. The effects of the organotin tributyl-tin (TBT) have been monitored in the Bay since 1985 using various molluscan species:- the Pacific Oyster *Crassostrea gigas* (Thunberg) (Minchin and Duggan, 1986); *Pecten maximus, Cerastoderma edule* (L.), *Mytilus edulis, Littorina littorea* (L.) (Minchin *et al.*, 1987); *Nucella lapillus* (L.) (Duggan *et al.*, 1988; Minchin *et al.*, 1995) and *Limaria hians* (Minchin, 1995). The principal source of TBT in the Bay was attributed to salmonid farm cages where it was used as an anti-fouling agent between 1981 to 1985. Settlement reduction or failure for several species including *Pecten maximus* occurred during this time, and high levels of imposex in *Nucella lapillus* in 1987 near cage sites. Pacific oyster shell thickening was recorded. TBT usage in Mulroy Bay was discontinued in 1985, and legally controlled in 1987. Settlements of *Pecten maximus* have taken place since 1986, and there has been a decline in the levels of imposex (Minchin, 1995; Minchin *et al.*, 1995).

The most recent intensive fieldwork in Mulroy Bay of 26 sites (a mixture of littoral and sublittoral) was undertaken by BIOMAR (based at Trinity College, Dublin), in July 1993, as part of a survey of the marine biotopes around the coast of the Republic of Ireland, part funded by the European Union Life Programme. This included important marine fauna and flora, but not any specialised groups (Picton *et al.*, in prep.).

There is no recent account of the Mollusca for Mulroy Bay. This paper brings together all previous accounts of Mollusca for this Bay, together with the results of further fieldwork, to produce a detailed annotated checklist, distribution maps and a comprehensive bibliography.

Methods

The area called 'Mulroy Bay' refers to the area of water enclosed between Rosguill and Fanad Peninsulas, including North Water, Moross Channel, Broadwater, the main Channel linking

Broadwater with the open sea from The Hassans at Third Narrows to Dualty's Isle at First Narrows, the Mouth and Bar north to an imaginary line joining the northernmost tips of Melmore Head and Ballyhoorisky Point.

Compilation of the checklist was achieved in two distinct ways - by a search of all previous literature and museum collections referring to Mulroy Bay to obtain old records, and by a field work survey of 67 littoral sites, 18 dived sites and 16 dredged sites (101 in total) from May 1986 to February 1996 around the whole Bay.

(a) Literature search

The sources of information for records of the Mollusca of Mulroy Bay are listed in the references. The principal areas of search were:- (i) **Molluscan records for Sea Area 33**. These records are held by Bernard Picton (currently BIOMAR, Trinity College, Dublin) as marine recorder for this area on behalf of the Conchological Society of Great Britain and Ireland; (ii) **Marine Mollusca collections** (Ulster Museum and National Museum of Ireland); (iii) **Journals**. *Journal of Conchology*, *Journal of Molluscan Studies*, *Proceedings of the Malacological Society*, *Irish Naturalist*, *Irish Naturalists' Journal*, were all examined from their inception to date. Early issues of *Proceedings of the Royal Irish Academy* were also consulted, together with classic works by Forbes and Hanley (1853), Jeffreys (1863-1869, mainly 1865), Thompson (1856) and the checklist by Nichols (1900); (iv) **BIOMAR survey**. The records from this survey were kindly made available to the author by Dr Mark Costello, Director BIOMAR, Trinity College, Dublin (Picton *et al.*, in prep.); (v) **A number of individuals** were consulted for other records of species: J. Baxter; H. Chesney; I. J. Killeen; J. M. Light; D. Minchin; B. E. Picton.

(b) Littoral survey

For the present survey, **littoral sites** were selected, if possible, on the following basis to include:- (i) a full range of habitats present in the area; (ii) representative sites with habitats which occur extensively; (iii) sites with restricted or unusual features; (iv) even geographic coverage - coverage must be extensive or blank areas are due to inadequate collecting; (v) high human impact areas. Permission was sought, usually locally, from landowners to cross their land. In every case, permission was granted. Such help is gratefully acknowledged. All sites were reached without the use of a boat.

A total of 67 shore sites were surveyed from May 1986 to July 1995 (Fig. 3; Table 1). Coverage generally complied with the list of prerequisites for site selection, except that access could not be gained to the shore on the west side of North Water or the stretch of shoreline on the east side of the main channel near the First Narrows. The number of sites visited compares favourably with 118 sites visited by the author for a similar study in Strangford Lough (Nunn, 1994), which is a much larger body of water (240km shoreline compared with the 80km in Mulroy Bay).

Most sites were searched for 1-1½ hours. Tidal time differences of up to three hours between the Mouth of Mulroy Bay and North Water/Broadwater enabled several sites to be comfortably surveyed on the same spring tide. Most sites were examined on a good spring tide (predicted low water 0.5m or less above Chart Datum) between mid-morning and late afternoon. Sites were visited from early spring through to late autumn, provided suitable spring tides were available, and weather conditions permitted. Methodology was as described in Nunn (1994). Identification was based on personal experience, but several texts were used for the most difficult species *viz.* Jones and Baxter (1987), Thompson and Brown (1984), Brown and Picton (1979), Fretter and Graham (various 1976-1986), Tebble (1966). Confirmation of identification of the most difficult species was obtained from J. Baxter (chitons), B. E. Picton (opisthobranchs) and S. M. Smith (all others).

(c) Sublittoral survey

Dive site selection was subject to constraints of availability of diving support/boats, which limited the areas for sampling to popular sites for recreational divers or sites accessible from the shore. However, most major habitats under the criteria described above were sampled. A total of 18 dive sites were surveyed over the period 11.12.88 to 4.2.96 in the depth range 0-35m (Fig. 4; Table 2A). Methodology was as described in Nunn (1994).

A limited dredging survey (16 sites, depth range 4-24m) (Fig. 5; Table 2B) was carried out on 27.10.95, using the scallop boat 'Realt na Maidin', skipper Jerry Gallagher. Navigation and sounding equipment enabled accurate positioning to be obtained, together with depths for the sites. Dredge sites were chosen to fill the gaps left by the diving survey, particularly in the Broadwater. Trawling and dredging is not permitted in the North Water, and impractical close to salmonid farms in Broadwater, Moross Channel or Millstone Bay in the main Channel, or near any mussel lines. A single scallop dredge with a 10cm size mesh was used, with the bottom half lined with a nylon bag, mesh size 5mm, and towed for 5-10 minutes. Samples were washed and roughly sorted on board the boat, and then transported to the laboratory, where detailed identification took place, as described in Nunn (1994).

Depths for dive sites (Fig. 4; Table 2A) and dredge sites (Fig. 5; Table 2B) were not corrected to Chart Datum. In many cases, the exact time of the dive was unrecorded, so corrections could not be made. The greatest inaccuracy of depth recorded is no more then +/- 2m. Visibility underwater ranged from 2-6m, but occasionally to 15m.

Discussion: survey results

The total number of molluscan species recorded in Mulroy Bay since 1970 is 232 (196 living/36 shell only) + one species found living only in the 19th century. This compares favourably with other complex loughs with strong currents in an entrance channel: 249 living species found since 1960 in the larger Strangford Lough, Co. Down, a Marine Nature Reserve (Nunn, 1994), and 209+ species found since 1950 in the smaller Lough Hyne, Co. Cork, also a National Nature Reserve (Nunn, unpublished). The diversity is due to the great range of habitats present in Mulroy Bay, which include special habitats such as the coralline algae maerl, known to support high numbers of marine species, especially Mollusca (Nunn, 1993a). The phenomenon of 'subtidal emergence' (species living higher on the shore, or out of the normal shallow sublittoral e.g. the feather star *Antedon bifida* (Pennant)) occurs in the Bay, at sites where there is strong current close offshore, but shelter from wave action, such as The Hassans, in the main Channel.

Of the 196 living species (+36 dead shells only) recorded since 1970, the author has recorded 166 living, 27 shells only. Only one species, *Limaria loscombi* (G. B. Sowerby), is considered dubious, and may constitute an error of identification. The specimens were juveniles, and it is possible to confuse it with its common sibling species *L. hians* (pers. comm. S. M. Smith). Four species remain unrecorded since the early work in the 19th century (Table 3A) and may yet be found in the Bay. For example, *Thyasira flexuosa* (Montagu) was found 'living, plentiful' in North Water by dredge (Praeger, 1894), but could not be dredged for in this study for reasons stated above. *Turbonilla crenata* (Brown) has been found alive in nearby Lough Swilly recently (Smith *et al.*, in prep.).

The richest littoral sites for Mollusca were all in the Channel: Ballyhoorisky Island (80 living species); The Hassans (76) (both benefitting from the additional recording by the Conchological Society of Great Britain and Ireland (Nunn, 1990)); Second Narrows (57); Coolavaud (54); Seamount (53); Fanny's Bay (52); Murvan Head (50), with ten other sites with 40+ living species recorded (Table 1). No littoral site in North Water or Broadwater exceeded 29 living species. Only nine sites had 20+. In the sublittoral, the richest sites were associated with maerl: south-east Island Roy (dredge) (35); Dundooan Rocks (dive) (31); north of Crannoge Point (dive) (31) (Table 2).

Five recent (post-1950) or new records for Ireland are now known from Mulroy Bay; *Leptochiton scabridus* (Jeffreys); *Brachystomia angusta* (Jeffreys); *Ondina divisa* (J. Adams); *Turbonilla rufescens* (Forbes); *Plagiocardium papillosum* (Poli) (shell only) (Table 3B). 62 new Sea Area 33 records (55 living; 7 shells only) have been recorded from Mulroy Bay by fieldworkers since publication of the Sea Area Atlas of the Marine Mollusca of Britain and Ireland (Seaward, 1982) (i.e. since inception of recent fieldwork). Some of these have been published elsewhere, including in the updated Sea Area Atlas (Seaward, 1991).

Mulroy Bay holds approximately 68% of the total molluscan fauna of the north coast of Ireland (defined as coastline north of the 55°N line of latitude: 286+ living species post 1960). Of these, 28 living species (10% of total) (and 4 shells only) are apparently found only in Mulroy Bay on the north coast (Table 3D). Preliminary work by the author on a checklist of the marine Mollusca of Ireland indicates a minimum of 500 species recently recorded from inshore waters, which suggests that Mulroy Bay holds perhaps 40% of the molluscan species in Ireland.

The molluscan fauna of Mulroy Bay appears to be predominately southern/south-western in character. There are no species endemic to the Bay, although it appears to be the only known recent site in Ireland for *Ondina divisa* and *Turbonilla rufescens* (Table 3B). A number of species are at their northern limits in the Bay (*Leptochiton scabridus*, *Cuthona genovae* (O'Donoghue), *Venus verrucosa* (L.). Species which are near the limits of their range are useful indicators of changes in conditions e.g. climate, as they are the most likely species to show a response by a change in their distribution patterns (Norton, 1978). Other mainly south/south-western species present (absent in Scotland) are *Osilinus lineata* (Da Costa), *Barleeia unifasciata* (Montagu), *Epitonium clathratulum* (Kanmacher in G. Adams), *Eulimella scillae* (Scacchi), *Haminoea navicula* (Da Costa) and *Eubranchus doriae* (Trinchese), although the south-western species *Modiolus barbatus* (L.) and *Diplodonta rotundata* (Montagu) are apparently absent (Seaward, 1991). Many primarily west coast species such as *Simnia patula* (Pennant) and *Raphitoma purpurea* (Montagu) are also present. Conversely, predominantly northern species present elsewhere in the north-east of Ireland (e.g. Strangford Lough (Nunn, 1994)) and the west coast of Scotland are apparently absent. These include *Tonicella marmorea* (O. Fabricius), *Lacuna crassior* (Montagu), *Trophon truncatus* (Ström), *Doto cuspidata* Alder and Hancock, *Coryphella verrucosa* (M. Sars), *Cuthona concinna* (Alder and Hancock), *Crenella decussata* (Montagu), *Limatula subauriculata* (Montagu), *Tridonta elliptica* (Brown), *Tridonta montagui* (Dillwyn), *Circomphalus casina* (L.) together with 18+ other species which are recorded no further north-west than Northern Ireland on the north coast (Smith *et al.*, in prep.). Other northern species are present only in low numbers e.g. *Tectura testudinalis* (Müller), *Margarites helicinus* (Phipps), *Rissoella globularis* (Forbes and Hanley), *Turbonilla rufescens* (Forbes). The scarcity in the lough of *Patella ulyssiponensis* Gmelin and *Melarhaphe neritoides* (L.) (at their northern limit in the British Isles) is probably due to lack of the appropriate exposed habitats (Crisp, 1989). There are a few apparently 'missing' species: *Colpodaspis pusilla* M. Sars, *Limapontia capitata* (Müller); *Tritonia hombergii* Cuvier; *Facelina bostoniensis* (Couthouy); *Musculus costulatus* (Risso) are all found along the north coast, and may yet be found in the Bay, especially near the Mouth and Bar.

Mulroy Bay lies, together with the majority of the British Isles, within the Eastern Atlantic Boreal Region (Briggs, 1974). The warm water of the Gulf stream runs northwards to become the North Atlantic Drift, with one branch flowing past the west coast of Ireland and then up the west coast of Scotland. This allows 'warmer water' or 'southern' species to survive further north on the coast of Ireland than is usual. In addition, summer temperatures in parts of Mulroy Bay, especially North Water, range from 14-18°C and perhaps as high as 20°C (D. Minchin, pers. comm.). These conditions would ensure the survival of viable populations of these southern species so far north. Stratified water exists during the summer offshore west of Malin

Head, where there is an oceanic front (Crisp, 1989). It is clear that this marks a biogeographical boundary - with many northern molluscan populations unable to live further west than Malin Head except perhaps in low numbers. Southern populations may be unable to exist further east than Malin Head on the north coast of Ireland beyond the oceanic front, with Mulroy Bay being the only local area with both suitable habitat (due to its great diversity) and a warm temperature range.

Checklist and distribution maps

The records collected (old and new) were used to compile a checklist of the marine Mollusca of Mulroy Bay (MB), together with ecological notes. Distribution maps for each species were drawn up (Figs 6-66). The maps here show presence/absence (not abundance), and all live records for species with three or more records.

There are a number of abbreviations and terms used in the checklist:- **MB**: Mulroy Bay; **SL**: Strangford Lough; **UM**: Ulster Museum collections; **BEP**: Bernard Picton; **DM**: Dan Minchin; **BIOMAR**: BIOMAR survey team 1993 - B. E. Picton (field leader); E. M. Sides; C. S. Emblow and C. C. Morrow; **CS**: Conchological Society of Great Britain and Ireland Field Trip (Nunn, 1990) - J. D. Nunn (field leader); J. Baxter; H. Chesney; G. V. Day; S. Francis; I. J. Killeen; J. M. Light; S. M. Smith and K. Wichtl (all other recorders of Mollusca are referred to by their full name); **det.**: 'determined by', i.e. identification made, or confirmed by a particular expert; **North coast**: defined as all coastline in Ireland north of the 55°N line of latitude. Many of the place names referred to in the text are shown in Figures 2A, 2B and 2C; **Taxonomy** follows Heppell *et al.* (in prep.), which is a modified version of Smith and Heppell (1991). Where changes have been made, the name used by Smith and Heppell (1991) has been included as a synonym.

Class POLYPLACOPHORA

Order Neoloricata

Leptochitonidae

***Leptochiton asellus* (Gmelin, 1791) (Fig. 6)**

Widely recorded living from MB (BEP, author, CS, BIOMAR) except Broadwater and most of Mouth of Mulroy Bay. Common species (large specimens, black-backed) in North Water/Moross Channel. Depth range 0-28m. New record for Sea Area 33 (Nunn and Smith, 1987).

***Leptochiton cancellatus* (G. B. Sowerby II, 1840) (Fig. 6)**

Seven sites only First to Third Narrows, not common, under small stones (CS, author (det. J. Baxter)). One record from North Water which may be error for juvenile *L. asellus*. Eight specimens dredged south-east of Island Roy. Depth range 0-14m. Only in MB and Lough Swilly on the north coast. New record for Sea Area 33 (Nunn, 1990).

***Leptochiton scabridus* (Jeffreys, 1880)**

Recorded living, common, under stones from one site only in MB *viz*. The Hassans 2.6.89 and 3.6.89 (CS: det. J. Baxter). The first site in Ireland and most northerly site in the British Isles for this species, only previously known from the Channel Islands and coast of Brittany (Smith, 1989; Light and Baxter, 1990; Nunn, 1990). Only elsewhere in Ireland in Galway Bay (Strack, 1991). It has not been found at any other site in MB despite an intensive search. New record for Sea Area 33 (Seaward, 1991).

Ischnochitonidae

***Callochiton septemvalvis* (Montagu, 1803) (Fig. 7)**

Scattered records from Third Narrows entrance to Channel and Bar only under stones, and on silty bedrock in the sublittoral (CS, author). Depth range 0-20m. Only in MB and Lough Swilly on the north coast.

***Lepidochitona cinereus* (L., 1767) (Fig. 7)**

Widely recorded and common where found throughout whole Bay except north end of North Water and most of south end of Broadwater (author, CS, BIOMAR). Generally intertidal, under stones or shells, but also to 20m. Often large and can be mistaken for *Tonicella marmorea* (O. Fabricius). New record for Sea Area 33 (Nunn and Smith, 1987).

***Tonicella rubra* (L., 1767) (Fig. 8)**

Scattered throughout Channel and parts of North Water (author, BEP, CS). Apparently absent from Broadwater except Pan Rock. Depth range 0-15m. New record for Sea Area 33 (Nunn and Smith, 1987).

Acanthochitonidae

***Acanthochitona crinitus* (Pennant, 1777) (Fig. 8)**

Confined to Mouth, and Channel to Third Narrows (author, CS, BIOMAR). Several unusual red-backed specimens found in a sample of maerl from north of Crannoge Point 10.5.92 in 10-14m. Other red-backed forms have been found in SL and off Horn Head, Co. Donegal. Depth range 0-14m. Old record: as *Acanthochitona fascicularis*, The Hassans, Mulroy Lake in 5f on rocks (Hart, 1892).

Class GASTROPODA

Order Archaeogastropoda

Superfamily Fissurellacea

Fissurellidae

***Emarginula fissura* (L., 1767)**

Recorded living from one site only in MB *viz.* the intertidal, Ballyhoorisky Island 2.6.89 (CS).

***Puncturella noachina* (L., 1771)**

Dredged alive, one specimen, from north of McSwynes Bed 14-20m 27.10.95 (author). Dead shell The Hassans 2.6.89 (SMS). Rare, probably overlooked because small. Only elsewhere in Ireland from about five miles off north-west Donegal (D. W. McKay/SMS) and Co. Mayo (Seaward, 1991).

***Diodora graeca* (L., 1758) (Fig. 9)**

Commonly found over most of the Channel, First to Third Narrows; occasional in Broadwater and Moross Channel (author, CS, BIOMAR). Apparently absent from North Water and west side of Mouth. Depth range 0-14m. Upgraded new record for Sea Area 33 (Nunn and Smith, 1987). Old record: as *Fissurella graeca*, Melmore (Hart, 1892).

Superfamily Trochacea

Turbinidae

***Tricolia pullus* (L., 1758) (Fig. 9)**

Recorded living from the Channel only, especially the west side (author, CS). Depth range 0-14m. Upgraded new record Sea Area 33 (Nunn and Smith, 1987).

Trochidae

***Margarites helicinus* (Phipps, 1774)**

Recorded living only at Dundooan Light 17.4.94 10m, and dredged south-east of Island Roy 27.10.95 10-12m in maerl (author). Dead shell Ballyhoorisky Island 2.6.89 (CS).

***Gibbula magus* (L., 1758) (Fig. 10)**

Recorded living from south and west of First to Third Narrows in gravel and maerl (BEP, DM, author, BIOMAR). Absent from Mouth and Bar. Scattered records in North Water and Broadwater, generally close to entrances to Moross Channel or main Channel. Depth range 0-19m. Old record: *as Trochus magus*, Melmore, Mulroy (Hart, 1892).

***Gibbula tumida* (Montagu, 1803)**

Recorded living from MB only from two sites *viz.* north of Crannoge Point 10.5.92 10-14m (author) and dredged south-east Island Roy 10-12m 27.10.95 (author). Both specimens were on maerl.

***Gibbula cineraria* (L., 1758) (Fig. 10)**

One of the most widely distributed species, being present throughout entire Bay except for north half of North Water and southern half of Broadwater (author, CS, BIOMAR). Common on kelp. Depth range 0-21m.

***Gibbula umbilicalis* (da Costa, 1778) (Fig. 11)**

Intertidal, mainly living in the Channel. Absent North Water and Moross Channel. Scattered records north of Broadwater (author, CS, BIOMAR).

***Osilinus lineata* (da Costa, 1778) (synonym: *Monodonta lineata*)**

Recorded living only from Ballyhoorisky Island 24.5.86 (author) and 2.6.89 (CS); and Seedagh Point 18.3.95 (author). Upper intertidal. Occasional specimens only. Recorded from Mulroy Bay by Mrs S. Clarke in the 1960's (UM).

***Calliostoma zizyphinum* (L., 1758) (Fig. 11)**

Widely recorded living mainly close to areas of strong current (Channel, Moross Channel), with additional records from Lagmore Bay, and near Campbells Bed dredged 27.10.95 (DM, author: O'Loughlin and Aldrich, 1987; O'Loughlin, 1988; CS, BIOMAR). Depth range 0-24m. No white specimens (var. *lyonsii* (Leach in Forbes and Hanley), commonly found in SL) were seen. However, the specimens were very pale.

Skeneidae

Skenea serpuloides **(Montagu, 1808)**

Recorded living from two sites only *viz*. Ballyhoorisky Island and The Hassans 2.6.89 (CS). Only MB and Lough Swilly on the north coast of Ireland. New record for Sea Area 33 (Nunn, 1990).

Dikoleps pusilla **(Jeffreys, 1847) (synonym:** *Dikoleps nitens* **(Philippi, 1844))**

Recorded living from one site only in MB *viz*. The Hassans 2.6.89 (CS). New record Sea Area 33 (Nunn, 1990). Present only in MB on the north coast of Ireland.

Order Patellogastropoda

Superfamily Patellacea

Lottiidae (synonym: Acmaeidae)

Tectura testudinalis **(Müller, 1776) (Fig. 12)**

Recorded living in MB from three sites only *viz*. Bullogfeme Bay 2.6.89 (CS); Lagmore Bay 8-15m 11.12.88 (author) and Binnean Point 30.7.92 (author). Northern species, possibly at its western limits in MB on the north coast of Ireland.

Tectura virginea **(Müller, 1776) (Fig. 12)**

Common in Channel, First to Third Narrows, especially on maerl (author/BEP, CS). Depth range 0-14m. Upgraded new record for Sea Area 33 (Nunn and Smith, 1987).

Patellidae

Patella ulyssiponensis **Gmelin, 1791 (Fig. 13)**

Only four sites, all intertidal, at mouth of Bay (CS, author, BIOMAR).

Patella vulgata **L., 1758 (Fig. 13)**

One of the most widely distributed species, being common throughout entire Bay, intertidal (DM, author, CS, SMS, BIOMAR). Old record: as *Patella vulgata* var. *depressa*, Melmore, Mulroy (Hart, 1892).

Helcion pellucidum **(L., 1758) (Fig. 14)**

Common in entire Channel on kelp or under holdfasts (author, CS, BIOMAR). Apparently absent North Water. Moross Channel and Broadwater, apart from dredge in 12m at South Rosnakill Strait close to Channel entrance. Depth range 0-12m. Upgraded new record for Sea Area 33 (Nunn and Smith, 1987).

Order Mesogastropoda

Superfamily Cerithiacea

Cerithiidae

***Bittium reticulatum* (da Costa, 1778) (Fig. 14)**

Five sites living (author, CS). Many dead shells throughout Bay. Depth range 0-15m.

Cerithiopsidae

***Cerithiopsis tubercularis* (Montagu, 1803) (Fig. 15)**

Intertidal from Mouth to Third Narrows, on orange sponge (author, CS). New record for Sea Area 33 (Nunn and Smith, 1987).

Triforidae

***Marshallora adversa* (Montagu, 1803) (Fig. 15)**

A few scattered records from Mouth to Third Narrows (author). Intertidal except for records from Dundooan Rocks 14.4.91 14m and 17.4.94 10m. Upgraded new record from Sea Area 33 (Nunn and Smith, 1987).

Turritellidae

***Turritella communis* Risso, 1826 (Fig. 16)**

Living, common in North Water and elsewhere in suitable muddy habitat (BEP, DM, BIOMAR, author). Depth range 5-30m. Many dead shells dredged in Broadwater. Old records: as *Turritella terebra*, old specimen near Melmore (Hart, 1892); dead (Praeger, 1894).

Superfamily Littorinacea

Littorinidae

***Lacuna pallidula* (da Costa, 1778) (Fig. 16)**

Scattered records throughout Bay (author, CS). Depth range 0-14m.

***Lacuna parva* (da Costa, 1778) (Fig. 17)**

Five intertidal sites only, mainly Channel (author, CS) with a single sublittoral record from Lagmore Bay, North Water 8-15m 11.12.88 (author).

***Lacuna vincta* (Montagu, 1803) (Fig.17)**

Recorded living in MB from Mouth and Channel only to south of Second Narrows (author, CS). Can be abundant e.g. Gortnatraw Point 2.8.92. Depth range 0-16m.

***Littorina littorea* (L., 1758) (Fig. 18)**

Widely recorded throughout Bay and common where found (DM, author, CS, BIOMAR). Intertidal, mid to lower shore amongst stones.

***Littorina mariae* Sacchi and Rastelli, 1966 (Fig. 18)**

Widely recorded throughout Bay and common where found (author, CS, BIOMAR). Absent at extreme south of Broadwater. Intertidal.

***Littorina neglecta* Bean in Thorpe, 1844**

It should be noted that this may not be a true species (Smith and Heppell, 1991). Its status is discussed, together with evidence for *L. neglecta* being an ecotype of *Littorina saxatilis* (Olivi), in Reid (1993). Recorded living from Ballyhoorisky Island 2.6.89 (CS), Dualty's Isle 18.3.92 (author) and west of Ballyhoorisky Point (BIOMAR).

***Littorina obtusata* (L., 1758) (Fig. 19)**

Widely recorded throughout Bay and common where found. Sparse in Mouth, north of First Narrows (author, CS). Intertidal. New record for Sea Area 33 (Seaward, 1991).

***Littorina saxatilis* (Olivi, 1792) (Fig. 19)**

Common, occasionally abundant, upper intertidal throughout Bay (author, CS, BIOMAR). Large specimens e.g. at Tirloughan Bay, can be mistaken for *Littorina nigrolineata* J. E. Gray (D. Reid pers. comm.).

***Melarhaphe neritoides* (L., 1758) (Fig. 20)**

Intertidal, upper shore, crevices and in *Lichina* sp., in the Bar and Mouth to First Narrows only (author, CS). One specimen dredged mid Mouth 10m 27.10.95.

Skeneopsidae

***Skeneopsis planorbis* (Fabricius, 1780) (Fig. 20)**

Widely recorded throughout Bay, apparently absent from extreme south of Broadwater and north of North Water (author, CS, SMS). Sparse in Mouth and absent north-east Broadwater. Mainly intertidal, but also to 15m. New record Sea Area 33 (Nunn and Smith, 1987).

Superfamily Cingulopsacea

Cingulopsidae

***Eatonina fulgida* (J. Adams, 1797) (Fig. 21)**

Commonly found living in the Channel, First to Third Narrows, but also scattered records elsewhere (author, CS). Mainly intertidal but also to 16m. New record Sea Area 33 (Nunn and Smith, 1987).

Superfamily Rissoacea

Barleeidae

***Barleeia unifasciata* (Montagu, 1803)**

Recorded living from one site only in MB *viz*. Ballyhoorisky Island 2.6.89 (CS). Upgraded new record for Sea Area 33 (Nunn and Smith, 1987).

Rissoidae

***Rissoa interrupta* (J. Adams, 1800) (Fig. 21)**

Widely distributed and common throughout Bay (author, CS). Depth range 0-16m. Apparently absent from sandy/muddy areas e.g. Island Roy, Bullogfeme Bay, Keadew Bay, Back Lough etc. New record for Sea Area 33 (Nunn and Smith, 1987).

***Rissoa lilacina* Recluz, 1843 (Fig. 22)**

Scattered records from seven sites only from Mouth to Second Narrows (CS, author). Depth range 0-12m.

***Rissoa membranacea* (J. Adams, 1798) (Fig. 22)**

Abundant where found, on blades of *Zostera marina*, generally in the sheltered areas of Broadwater and the southern end of the main Channel (author, CS). Depth range 0-8m. Found only in MB on the north coast of Ireland. New record for Sea Area 33 (Seaward, 1991).

***Rissoa parva* (da Costa, 1778) (Fig. 23)**

Widely distributed and common in the Bay, particularly Mouth to Third Narrows (author, CS). Apparently absent from sandy/muddy areas, as is *Rissoa interrupta*, although distribution extends further south in Broadwater. Depth range 0-20m.

***Alvania beanii* (Hanley in Thorpe, 1844)**

Not seen living in MB. Two dead shells North of Crannoge Point 10.5.92 in maerl 10-14m (author).

***Alvania cancellata* (da Costa, 1778)**

Not seen living in MB. One dead shell dredged south-east of Island Roy 27.10.95 in maerl 10-12m (author).

***Alvania punctura* (Montagu, 1803) (Fig. 23)**

Recorded living from six sites scattered from the Mouth to Third Narrows (author, CS). Depth range 0-10m.

***Alvania semistriata* (Montagu, 1808) (Fig. 24)**

Recorded living from five sites from the north of Island Roy to the Mouth (CS, author). Depth range 0-10m.

***Cingula cingillus* (Montagu, 1803) (synonym: *Cingula trifasciata* (J. Adams, 1800)) (Fig. 24)**

Intertidal, living throughout most of Bay (author, CS). Apparently absent from most of North Water, the east side of Broadwater and the west side of Channel from First to Third Narrows. Upgraded new record for Sea Area 33 (Nunn and Smith, 1987).

***Manzonia crassa* (Kanmacher in J. Adams, 1798)**

Not seen living in MB. Dead shells in maerl from north of Crannoge Point 10.5.92 10-14m (author) and dredged (also in maerl) from south-east Island Roy 10-12m 27.10.95 (author).

***Onoba aculeus* (Gould, 1841) (Fig. 25)**

Recorded living from scattered sites Mouth, Channel and Broadwater (det. SMS) (author, CS). Mainly intertidal, but also to 10m north-west of Reagh Island.

***Onoba semicostata* (Montagu, 1803) (Fig. 25)**

Common, living, throughout entire Bay except west side of Mouth (author, CS). Depth range 0-20m. Old record: as *Rissoa striata* (Adams), dead (Praeger, 1894).

***Pusillina inconspicua* (Alder, 1844) (Fig. 26)**

Scattered records, mainly in North Water and north of Broadwater (author, CS). Depth range 0-15m. New record for Sea Area 33 (Seaward, 1991). Old record: as *Rissoa inconspicua*; dead (Praeger, 1894).

***Pusillina sarsi* (Lovén, 1846) (Fig. 26)**

Absent only from Bar and Mouth to First Narrows (author, CS). Depth range 0-15m. New record for Sea Area 33.

Hydrobiidae

Hydrobia ulvae **(Pennant, 1777)**

Recorded living from two muddy/sandy sites only *viz*. Back Lough 3.6.89 (SMS) and 19.3.92 (author) and Carrickart (E) 19.3.92 (author). Dead shells from Carrickart (W) 19.3.92 (author).

Caecidae

Caecum glabrum **(Montagu, 1803)**

Recorded living from one site only in MB in gravel *viz*. Moross Channel at Moross Castle 6m 31.3.91 (author). Dead shells from The Hassans 2.6.89 (CS), and dredged from north of McSwynes Bed 14-20m and north of Williamsons Rock 6-20m (27.10.95, author). Living only in MB on the north coast of Ireland. New record for Sea Area 33.

Superfamily Cypraeacea

Ovulidae

Simnia patula **(Pennant, 1777)**

Recorded living on its food *Alcyonium digitatum* (L.) on bedrock at Dundooan Rocks 14.4.91 14m (author). This species is found only sporadically on the north coast of Ireland.

Superfamily Lamellariacea

Triviidae

Trivia arctica **(Pulteney, 1799) (Fig. 27)**

Recorded living from Mouth to Third Narrows and in Broadwater close to the entrance to Third Narrows (CS, author, BIOMAR). Depth range 0-23m. Old record: as *Cypraea europaea*, Melmore (Hart, 1892). This refers to both this species and the one below.

Trivia monacha **(da Costa, 1778) (Fig. 27)**

Distribution and comments as for *Trivia arctica*.

Lamellaridae

Lamellaria latens **(Müller, 1776) (Fig. 28)**

Recorded living from First to Third Narrows, mainly intertidal except for records from Dundooan Rocks 14.4.91 14m and 17.4.94 10m (author).

Lamellaria perspicua **(L., 1758) (Fig. 28)**

Only four intertidal sites south of First Narrows to north of Third Narrows *viz*. Rawros Point 28.3.91, Devlinmore Point 30.3.91, Fanny's Bay 31.3.91 and Seamount 20.3.92 (author).

Superfamily Naticacea

Naticidae

***Polinices pulchellus* (Risso, 1826) (synonym: *Polinices polianus* (delle Chiaje, 1826))**

Recorded living from one site only in MB *viz.* North of Crannoge Point 10.5.92 in maerl 10-14m (author). Dead shells from Ballyhoorisky Island 2.6.89 (CS).

Superfamily Epitoniacea

Epitoniidae

***Epitonium clathratulum* (Kanmacher in G. Adams, 1798)**

A single live specimen in a sample of maerl from south of Dundooan Rocks 14.4.91 20m (author, det. SMS). Only found in MB on the north coast of Ireland. New record for Sea Area 33 (Nunn, 1993c). Dead shell Dundooan Point 30.3.91, intertidal.

***Epitonium turtonis* (Turton, 1819)**

Not seen living in MB. One dead shell in maerl north of Crannoge Point 10-14m 10.5.92 (author).

Superfamily Eulimacea

Eulimidae

***Eulima bilineata* Alder, 1848**

Not seen living in MB. One dead shell dredged South of Black Rocks 8-20m (author, det. SMS). New record for Sea Area 33.

***Vitreolina philippi* (Rayneval and Ponzi, 1854)**

Recorded living in MB from two sites only in maerl *viz.* north of Crannoge Point 10-14m 10.5.92 (author) and Island Reagh 29.7.95 (author).

Order Neogastropoda

Superfamily Muricacea

Muricidae

***Ocenebra erinacea* (L., 1758) (Fig. 29)**

Recorded living from First to Third Narrows (DM, author, BIOMAR). Mainly intertidal under large stones, but also to 23m.

***Nucella lapillus* (L., 1758) (Fig. 29)**

Widely distributed throughout entire Bay (author, DM, CS, BIOMAR). Its distribution, and the degree of imposex due to the effects of TBT in the Bay have been studied in detail over the period 1987 to 1993 (Duggan *et al.*, 1988; Minchin *et al.*, 1995). Depth range 0-14m.

Buccinidae

***Buccinum undatum* L., 1758 (Fig. 30)**

Recorded living from Island Roy south to the rest of the Bay including North Water and Moross Channel (author, BEP, DM, CS, BIOMAR). Sparse in Broadwater. One record only from Ballyhoorisky Island 24.5.86 (author). Depth range 0-14m. New record Sea Area 33 (Seaward, 1991).

***Hinia reticulata* (L., 1758) (Fig. 30)**

Scattered records Mouth to Third Narrows (author, CS, BIOMAR). Depth range 0-19m.

***Hinia incrassata* (Strøm, 1768) (Fig. 31)**

Recorded living from Mouth to Third Narrows, mainly First to Second Narrows (author, CS, BIOMAR). Depth range 0-20m.

Superfamily Conacea

Turridae

***Mangelia attenuata* (Montagu, 1803)**

Not seen living in MB. One dead shell dredged west of Carlan Point 27.10.95 (author, det. SMS). New record for Sea Area 33. Only record for the north coast of Ireland.

***Mangelia brachystoma* (Philippi, 1844)**

Not seen living in MB. One dead shell dredged west of Carlan Point 27.10.95 (author, det. SMS). New record for Sea Area 33. Only record for the north coast of Ireland.

***Raphitoma linearis* (Montagu, 1803) (Fig. 31)**

Recorded living from five sites from First to Third Narrows (author). Depth range 0-12m.

***Raphitoma purpurea* (Montagu, 1803)**

A single living specimen found under a boulder Marks Point 31.7.92, and a single living specimen dredged in maerl off south-east Island Roy 10-12m 27.10.95 (author). The only other sites where this species has been found recently are Murles Point, Donegal Bay and Lambs Head Bay, Lough Swilly (Nunn and Smith, 1987).

Order Heterostropha

Superfamily Rissoellacea

Rissoellidae

***Rissoella diaphana* (Alder, 1848) (Fig. 32)**

Recorded living, common, throughout Bay (author, CS). Mainly intertidal, but also to 15m. New record for Sea Area 33 (Nunn and Smith, 1987).

***Rissoella globularis* (Jeffreys in Forbes and Hanley, 1853)**

A single specimen found amongst algal material from The Hassans 2.6.89 (SMS) (Nunn and McGrath, 1989). Single specimen living from Lagmore Bay 3.6.90 14m (author). Dead shell dredged north of McSwynes Bed 14-20m 27.10.95 (author). This species has been found living from only three areas in Ireland - one specimen in Galway Bay, two specimens in Mulroy Bay, and commonly in Strangford Lough (Nunn and McGrath, 1989; Nunn, 1994). New record for Sea Area 33 (Nunn, 1990).

***Rissoella opalina* (Jeffreys, 1848) (Fig. 32)**

Recorded living, common, throughout Bay (author, CS). Mainly intertidal, but to 20m. New record for Sea Area 33 (Nunn and Smith, 1987).

***Cima minima* (Jeffreys, 1858)**

Not seen living in MB. One dead shell dredged north of Williamsons Rock 6-20m 27.10.95 (author, det. SMS). A new record for Sea Area 33.

Superfamily Omalogyracea

Omalogyridae

***Omalogyra atomus* (Philippi, 1841) (Fig. 33)**

Recorded living, uncommon, throughout Bay (author, CS). Mainly intertidal, but to 15m. New record for Sea Area 33 (Nunn and Smith, 1987).

***Ammonicerina rota* (Forbes and Hanley, 1850) (Fig. 33)**

Recorded living throughout Bay, mainly Second to Third Narrows (author, CS). Mainly intertidal, but to 20m. Common, Lagmore Bay 3-10m 4.2.96. Only in MB on the north coast of Ireland. New record for Sea Area 33 (Nunn, 1990).

Superfamily Pyramidellidacea

Pyramidellidae

***Odostomia plicata* (Montagu, 1803)**

Recorded living in MB from two sites only *viz*. Ballyhoorisky Island 2.6.89 (CS) and The Hassans 2.6.89 (CS). Only in MB on the north coast of Ireland.

Odostomia turrita **Hanley, 1844 (Fig. 34)**

Recorded living from eight sites from Mouth to entrance of Third Narrows (CS, SMS, author (det. SMS)). Depth range 0-12m. Old record: dead (Praeger, 1894).

Odostomia unidentata **(Montagu, 1803)**

Not seen recently in MB. Old record: dead (Praeger, 1894).

Brachystomia angusta **(Jeffreys, 1867)**

Recorded living from one site only in MB *viz*. Ballyhoorisky Island 2.6.89 (SMS), five specimens amongst small algae. First published record of this species from Ireland, although found at earlier dates from a number of other sites in Donegal and elsewhere in Ireland. Identification of this species has only recently been clarified (pers. comm. S.M. Smith) and has been found to be not uncommon amongst specimens formerly identified as one of the other *Brachystomia* species (Smith, 1994).

Brachystomia carrozzai **(Aartsen, 1987)**

Recorded living from two sites only *viz*. The Hassans 24.5.86 det. SMS (author) and Ballyhoorisky Island 2.6.89 (SMS). New record for Sea Area 33 (Seaward, 1991).

Brachystomia eulimoides **(Hanley, 1844)**

Three living specimens only, dredged from South of Rosnakill Strait 12m 27.10.95 det. SMS (author). Dead shells only from Ballyhoorisky Island 2.6.89 (CS). Old record: as *Odostomia pallida* (Mont.), dead (Praeger, 1894).

Brachystomia scalaris **(Macgillivray, 1843) (Fig. 34)**

Recorded living from six intertidal sites throughout Bay (author (det. SMS), CS). Found only in MB on the north coast of Ireland. New record for Sea Area 33 (Seaward, 1991). Old record: as *Odostomia scalaris* dead (Praeger, 1894).

Chrysallida indistincta **(Montagu, 1803)**

Recorded living in MB from two sites only *viz*. Seamount 20.3.92 and dredged off Ranny Point 16-20m 27.10.95 det. SMS (author). Found only in MB on the north coast of Ireland.

Chrysallida interstincta **(J. Adams, 1797) (synonym: *C. obtusa* (Brown, 1827) (Fig. 35)**

Common at sites in North Water, with scattered records from north Broadwater and south part of Channel (det. SMS) (author). Generally sublittoral, but recorded from 0-15m. Found only in MB on the north coast of Ireland. New record for Sea Area 33 (Seaward, 1991). Old record: as *Odostomia interstincta*, dead (Praeger, 1894).

Ondina diaphana **(Jeffreys, 1848)**

One living specimen dredged from south of Rosnakill Strait 12m 27.10.95 (det. SMS) (author). New record for Sea Area 33. Only live elsewhere in Ireland from White Park Bay, Co. Antrim (Brisco, 1981). The voucher specimen for this Antrim record is not in the Brisco collection at the UM.

Ondina divisa **(J. Adams, 1797)**

One living specimen dredged from south of Black Rocks 8-20m 27.10.95 (det. SMS) (author). New record for Sea Area 33 and first post-1950 live record for Ireland. Old record: as *Odostomia insculpta* (Montagu), dead (Praeger, 1894).

Partulida pellucida **(Dillwyn, 1817) (synonym: *Partulida spiralis* (Montagu, 1803)**

Two sites living only *viz*. dredged south-east Ballymagowan Point 4-10m and north of McSwynes Bed 14-20m (all det. SMS) (author). Dead shells at four sites in Broadwater and off Seedagh Hill 6-24m (author). Old record: as *Odostomia spiralis*, dead (Praeger, 1894).

Turbonilla lactea **(L., 1758)**

Not seen living in MB. Dead shells scattered throughout Channel, North Water and Broadwater (CS, author (det. SMS)). Depth range 0-20m.

Turbonilla jeffreysi **(Jeffreys, 1848)**

Not seen living in MB. Dead shells dredged from three sites in Broadwater *viz*. north of McSwynes Bed, south-west of Glack Point and south of Rosnakill Strait (det. SMS) (author) in the depth range 12-20m.

Turbonilla rufescens **(Forbes, 1846)**

Single specimens were found on the shore at Devlinmore Point 30.3.91 and in 7m at Cranford Middle Shoal 9.5.92 (det. SMS) (author). Dead shell Moross Castle 31.3.91 6m (author) and four sites in Broadwater. First recent (post-1950) living record from Ireland, and new record for Sea Area 33 (Nunn, 1993a). Found only in MB on the north coast of Ireland. Recently living elsewhere in the British Isles only on the west coast of Scotland.

Turbonilla crenata **(Brown, 1827)**

Not seen recently in MB. Old record: as *Odostomia rufa* (Philippi), dead (Praeger 1894).

Eulimella laevis **(Brown, 1827)**

Not seen living in MB. Dead shells, in maerl north of Crannoge Point 10-14m 10.5.92, dredged south of Black Rocks 8-20m and west of Carlan Point 24m 27.10.95 (all author, det. SMS). Old record: as *Odostomia acicula* (Philippi), dead (Praeger, 1894).

Eulimella scillae **(Scacchi, 1835)**

Two living specimens of this rare species dredged south of Rosnakill Strait 12m 27.10.95 (det. SMS) (author). New record for Sea Area 33. Only found in MB on the north coast of Mulroy. Only live records elsewhere for Ireland in Sea Areas 35 and 36 (Seaward, 1991).

Order Cephalaspidea

Superfamily Philinacea

Philinidae

Philine aperta **(L., 1767) (Fig. 35)**

Common, living in the sublittoral, on mud, throughout North Water, Moross Channel and Broadwater (BEP, DM, author). Depth range 3-15m. Found only in MB on the north coast of Ireland.

Philine punctata **(J. Adams, 1800)**

Recorded living from one site only in MB *viz*. Dundooan Rocks 17.4.94 10m (det. SMS) (author).

Philine pruinosa **(Clark, 1827)**

Recorded living from one site only in MB *viz*. Campbells Bed 15m 1.7.84 and 29.5.88 (BEP). Found only in MB on the north coast of Ireland. New record for Sea Area 33 (Seaward, 1991).

Superfamily Diaphanacea

Diaphana minuta **Brown, 1827 (Fig. 36)**

Recorded living from seven sites clustered mid North Water, north-west Broadwater and off Crannoge Point (author, CS). Depth range 0-20m.

Superfamily Bullacea

Haminoeidae

Haminoea navicula **(da Costa, 1778) (Fig. 36)**

Recorded living from North Water and Broadwater only on mud and muddy detritus (BEP, DM, P. Somerfield, author, BIOMAR). Apparently absent from main Channel and Moross Channel apart from a single intertidal record from Coolavaud 29.3.91 (author). Generally sublittoral 2-30m, except for the record from Coolavaud. Eggs in North Water 6.8.94 (DM). Found only in MB on the north coast of Ireland.

Superfamily Retusacea

***Retusa obtusa* (Montagu, 1803) (Fig. 37)**

Recorded living from three sites *viz*. Doongonigle 25.5.86 (author); The Hassans 2.6.89 (CS); North of Doongonigle 30.7.92 (author). Dead shells in the southern part of Broadwater.

***Retusa truncatula* (Bruguière, 1792) (Fig. 37)**

Recorded living throughout Bay, although largely absent from Broadwater (author, CS). Depth range 0-15m. Upgraded new record for Sea Area 33 (Nunn and Smith, 1987). Old record: as *Utriculus truncatulus*, dead (Praeger, 1894).

***Retusa umbilicata* (Montagu, 1803)**

Not seen living in MB. Dead shells from five sites dredged in north and mid Broadwater in 4-20m (author). Old record: as *Cylichna umbilicata*, dead (Praeger, 1894).

Superfamily Runcinacea

***Runcina coronata* (Quatrefages, 1844) (Fig. 38)**

Recorded living from extreme southern end of Broadwater only from three sites *viz*. Doongonigle 25.5.86 (BEP); north of Doongonigle 30.7.92; Boat Bay 31.7.92 (author). New record for Sea Area 33.

Order Sacoglossa

Superfamily Elysiacea

Elysidae

***Elysia viridis* (Montagu, 1804) (Fig. 38)**

Very common, living at most sites in the Bay where *Codium* sp. is present i.e. First to Third Narrows, Moross Channel, sheltered causeway to Ballyhoorisky Island, southern half of North Water and Broadwater (BEP, author, CS, BIOMAR, G. Day). Generally at extreme low water to 5m depth, but recorded from depths to 21m. Apparently absent in the southern half of Broadwater, despite a careful search and the abundant presence of *Codium* sp.

Stiligeridae

***Placida dendritica* (Alder and Hancock, 1843)**

Recorded living in MB from two sites only *viz*. Campbells Bed 15m 29.5.88 (BEP) and The Hassans 2.6.89 (J. Light). Found only in MB on the north coast of Ireland.

Hermaeidae

***Hermaea bifida* (Montagu, 1815) (Fig. 39)**

Recorded living at a cluster of sites north of Cranford Bay in Broadwater, and a cluster of sites in the centre of North Water (BEP, author, BIOMAR). Several large transparent specimens found on *Zostera* sp. at Pan Rock 28.3.91 (author). Depth range 0-20m. Found only in MB on the north coast of Ireland.

Limapontidae

***Limapontia capitata* (Müller, 1774)**

Recorded living at one site in MB only at Ballyhoorisky Island 2.6.89 (CS).

***Limapontia senestra* (Quatrefages, 1844) (Fig. 39)**

Uncommon, living at three sites only *viz*. Doongonigle 25.5.86 (author); Ballyhoorisky Island 2.6.89 (CS) and Wee Sea 21.3.92 (author). New record for Sea Area 33 (Seaward, 1991).

Order Anaspidea

Superfamily Aplysiacea

Akeridae

***Akera bullata* Müller, 1776 (Fig. 40)**

Living at two clusters of sites - the centre of North Water, and the southern half of Broadwater (BEP, DM, author) in mud and muddy detritus. Depth range 0-30m. Found only in MB on the north coast of Ireland.

Aplysiidae

***Aplysia punctata* Cuvier, 1803 (Fig. 40)**

Scattered records throughout Bay, mainly First Narrows (BEP, DM, CS, author). Apparently absent from North Water. Depth range 0-20m.

Order Notaspidea

Superfamily Pleurobranchacea

Pleurobranchidae

***Pleurobranchus membranaceus* (Montagu, 1815)**

Recorded living from one site only in MB *viz.* Cranford Point 29.3.80 10m (BEP).

***Berthella plumula* (Montagu, 1803) (Fig. 41)**

Intertidal sites from the Mouth and Channel to north-west Broadwater (author, CS, BIOMAR).

Order Nudibranchia

Superfamily Dendronotacea

Lomanotidae

***Lomanotus genei* Verany, 1846**

Recorded living from Deegagh Point 23.3.75 12m and 25.3.78 4-12m, and Campbells Bed 15m 29.5.88 (all BEP).

Dotidae

***Doto coronata* (Gmelin, 1791)**

Recorded living from one site only in MB *viz.* narrow channel to north of Fanny's Bay 27.3.78 21m (BEP).

***Doto fragilis* (Forbes, 1838)**

Recorded living from one site only in MB *viz.* south-east of Deegagh Point 13.7.93 (BIOMAR). New record for Sea Area 33.

***Doto koenneckeri* Lemche, 1976**

Three specimens on their food *Aglaophenia pluma* (L.) at Dundooan Rocks 14.4.91 14m. New record for Sea Area 33 (Nunn, 1993c). Also found east of Melmore Head 17.7.93 10-21m (BIOMAR). Found only in MB and Lough Swilly on the north coast of Ireland.

Superfamily Onchidoridacea

Goniodorididae

***Goniodoris castanea* Alder and Hancock, 1845**

Recorded living at one site only in MB *viz.* Campbells Bed 29.5.88 15m (BEP). New record for Sea Area 33 (Seaward, 1991).

***Goniodoris nodosa* (Montagu, 1808) (Fig. 41)**

Recorded living from fives sites only scattered throughout Bay except for North Water and Moross Channel (BEP, author, CS). Depth range 0-12m.

Onchidorididae

Onchidoris bilamellata **(L., 1767)**

Recorded living from two sites only *viz*. Drumnacraig Point 21.3.92, and with spawn at Gortnatraw Point 2.8.92 (author).

Diaphorodoris luteocincta **(M. Sars, 1870)**

Recorded living from two sites only *viz*. Deegagh Point 25.3.78 4-12m (BEP) and Campbells Bed 1.7.84 15m (BEP).

Acanthodoris pilosa **(Abildgaard in Müller, 1789) (Fig. 42)**

Recorded living from the Channel to Third Narrows (BEP, author, BIOMAR), with one record from Carlan Bay 28.3.91 8m (author). Depth range 0-18m.

Superfamily Polyceracea

Aegiretidae

Aegires punctilucens **(Orbigny, 1937) (Fig. 42)**

Recorded living from five sites from the main Channel and north Broadwater (BEP, CS, author). Depth range 0-15m. Only in MB and Lough Swilly on the north coast of Ireland.

Polyceridae

Polycera faeroensis **Lemche, 1929**

Recorded living only from Campbells Bed (25.5.86 8-12m; 1.7.84 15m; 29.5.88 15m BEP) and Dundooan Rocks 16.7.93 5-23m (BIOMAR).

Polycera quadrilineata **(Müller, 1776)**

Recorded living from one site only in MB *viz*. Lambs Island 13.4.91 15m (author).

Limacia clavigera **(Müller, 1776) (Fig. 43)**

Scattered living records throughout Bay, although apparently absent around Second Narrows (BEP, CS, author, BIOMAR). Depth range 0-24m.

Palio nothus **(Johnston, 1838)**

Recorded living from one site only in MB *viz*. Cranford Point 29.3.80 10m (BEP).

Superfamily Doridacea

Cadlinidae

Cadlina laevis **(L., 1767) (Fig. 43)**

Common, living, throughout Bay except south Broadwater (BEP, author, CS, BIOMAR).

Depth range 0-30m.

Rostangidae

***Rostanga rubra* (Risso, 1818) (Fig. 44)**

Uncommon, living on the sponge *Ophlitospongia seriata* (Grant) at intertidal sites from Mouth to north of Third Narrows (BEP, author). New record for Sea Area 33 (Seaward, 1991).

Archidorididae

***Archidoris pseudoargus* (Rapp, 1827) (Fig. 44)**

Recorded living from sites from Mouth to Third Narrows, North Water and Moross Channel only (BEP, author, CS, BIOMAR). Apparently absent from Broadwater and west side of Mouth. Depth range 0-23m.

Discodorididae

***Geitodoris planata* (Alder and Hancock, 1846) (Fig. 45)**

Recorded living from four sites only *viz.* Ballyhoorisky Island 2.6.89 (CS); Coolavaud 29.3.91; Gravel Spit, Island Roy 19.3.92 and Marks Point 31.7.92 (all author).

Kentrodorididae

***Jorunna tomentosa* (Cuvier, 1804) (Fig. 45)**

Recorded living from intertidal sites from Mouth to Third Narrows (CS, author).

Superfamily Arminacea

Heroacea

Janolidae

***Janolus cristatus* (delle Chiaje, 1841) (Fig. 46)**

Recorded living from three sites only *viz.* Campbells Bed (1.7.84 15m; 25.5.86 8-22m; 29.5.88 15m all BEP); Eagles Nest, south Broadwater (Minchin, 1990) and Dundooan Rocks 5-23m 16.7.93 (BIOMAR).

Superfamily Aeolidiacea

Coryphellidae

***Coryphella browni* Picton, 1980**

Recorded living from one site only in MB *viz.* Lagmore Bay (N) 29.3.91 13m (author).

***Coryphella gracilis* (Alder and Hancock, 1844)**

Recorded living from Deegagh Point 25.3.78 4-12m and Cranford Point 29.3.80 10m and

15.3.81 10m (all BEP).

***Coryphella lineata* (Lovén, 1846)**

Recorded living from Dundooan Rocks 14.4.91 14m (author) and south-east Mullaghanardy Point 5-11m 11.7.93 (BIOMAR).

Flabellinidae

***Flabellina pedata* (Montagu, 1815) (Fig. 46)**

Recorded living only from north-west Broadwater (BEP, author, BIOMAR). Depth range 0-11m.

Tergipedidae

***Catriona gymnota* (Couthouy, 1838)**

Recorded living from one site only in MB *viz.* Dundooan Rocks 14.4.91 14m (author).

***Cuthona genovae* (O'Donoghue, 1926)**

Two specimens west of Greer Island 3-12m on surface of onion bags filled with monofilament mesh in September 1981 (det. author; Minchin, 1990). One specimen Stookan, North Water 14m 16.4.94 (author). New record for Sea Area 33, and most northerly record in the British Isles (Nunn and Minchin, 1994). Known elsewhere in Ireland only from Lough Hyne, Co. Cork; Salt Lake, Clifden and Bantry Bay (Nunn and Minchin, 1994; Picton and Morrow, 1994).

***Cuthona nana* (Alder and Hancock, 1842)**

Recorded living from one site only in MB *viz.* half mile north of Cranford 29.8.76 10m (BEP).

***Tergipes tergipes* (Forsskål, 1775) (Fig. 47)**

Recorded living from three sites on kelp *viz.* Moross Castle 31.3.91 6m (author); Outer Millstone Bay 15.7.93 and Dundooan Rocks 16.7.93 5-23m (BIOMAR).

Eubranchidae

***Eubranchus doriae* (Trinchese, 1874) (Fig. 47)**

Recorded living from three sites *viz.* west of Croaghan Island 23.7.77 20m; Cranford Point 15.3.81 10m and Campbells Bed 29.5.88 15m (all BEP). New record for Sea Area 33 (Seaward, 1991).

Eubranchus exiguus **(Alder and Hancock, 1847) (Fig. 48)**

Scattered records in Bay from 5-23m (BEP, author, BIOMAR).

Eubranchus farrani **(Alder and Hancock, 1844) (Fig. 48)**

Scattered records from Second Narrows, North Water to Broadwater (BEP, author, BIOMAR). Depth range 0-30m.

Eubranchus tricolor **Forbes, 1838 (Fig. 49)**

Recorded living from the sublittoral only (4-20m) in north-west Broadwater and Moross Channel (BEP, BIOMAR).

Eubranchus vittatus **(Alder and Hancock, 1842)**

Recorded living from two sites only *viz.* west of Croaghan Island 23.7.77 20m (BEP) and north of Tirloughan Bay 15.7.93 7-19m (BIOMAR). Found only in MB on the north coast of Ireland.

Favorinidae

Favorinus blianus **Lemche and Thompson, 1974**

Recorded living from Deegagh Point 25.3.78 4-12m (BEP) and Campbells Bed 15m 1.7.84 (BEP).

Aeolidiidae

Aeolidia papillosa **(L., 1761) (Fig. 49)**

Recorded living from Mouth to Third Narrows and Deegagh Point in Broadwater (BEP, CS, author). Spawning at Binnanean Point 30.7.92 (author). Depth range 0-15m.

Aeolidiella alderi **(Cocks, 1852) (Fig. 50)**

Three specimens collected from under small boulders at Seamount 20.3.92 and Drumnacraig Point 21.3.92 (author). These specimens had unusual colouration, having orange cerata, rhinophores and oral tentacles. This variety has been recorded only from Ireland, in Galway Bay, by Lemche (Just and Edmunds, 1985). Most northerly record in Ireland (Nunn, 1993b), and found only in MB on the north coast of Ireland. Several small specimens of the same orange colour variety have also been found at The Hassans 21.7.93 together with spawn (pers. comm. B.E. Picton, BIOMAR).

Aeolidiella glauca **(Alder and Hancock, 1845)**

Recorded living from Campbells Bed 20m 1.7.84 (BEP), and one specimen at Gortnatraw

Point 2.8.92 (author). New record for Sea Area 33.

Order: Systellommatophora

Superfamily: Otinacea

Otinidae

***Otina ovata* (Brown, 1827)**

Not seen living in MB. Dead shell from Ballyhoorisky Island 2.6.89 (SMS). New record for Sea Area 33 (Nunn, 1990).

Order Actophila

Superfamily Ellobiacea

Ellobiidae

***Auriculinella bidentata* Tausch, 1886 (synonym: *Leucophytia bidentata* (Montagu, 1808) (Fig. 50)**

Scattered upper intertidal records in Bay, although apparently absent from Mouth, North Water and most of Broadwater (author, SMS). Found only in MB on the north coast of Ireland.

Class SCAPHOPODA

Order Dentaliida

Dentaliidae

***Antalis entalis* (L., 1758)**

Not seen living in MB. Dead shell Ballyhoorisky Island 2.6.89 (CS).

Class PELECYPODA

Order Nuculoida

Superfamily Nuculacea

Nuculidae

***Nucula nitidosa* Winckworth, 1930**

Two specimens dredged in mud south of Black Rocks 8-20m 27.10.95 (author). Found only in MB on the north coast of Ireland. New record for Sea Area 33.

Order Arcoida

Superfamily Arcacea

Arcidae

***Arca tetragona* Poli, 1795 (Fig. 51)**

Single specimens found on the shore at Rawros Point 28.3.91 and Second Narrows 2.8.92, and at 14m north of Crannoge Point in maerl (all author). This species is relatively rare, but locally common elsewhere in Ireland.

Order Mytiloida

Superfamily Mytilacea

Mytilidae

***Mytilus edulis* L., 1758 (Fig. 51)**

Ubiquitous throughout MB (Minchin, 1981; author, CS, SMS, BIOMAR) in depths from 0-20m. Mytilids such as this species and *Modiolarca tumida* (Hanley) are less sensitive to the effects of organotins than species such as *Nucella lapillus* and *Crassostrea gigas* (Minchin *et al.*, 1987; Minchin and Duggan, 1988).

***Modiolus modiolus* (L., 1758)**

Recorded living from one site in MB only *viz.* Ballyhoorisky Island 2.6.89 (CS). Large dead shells from Rawros Point 28.3.91 and Island Reagh 29.7.95 (author).

***Modiolula phaseolina* (Philippi, 1844) (Fig.52)**

Intertidal sites from First to Third Narrows, and at 20m south of Dundooan Rocks 14.4.91 (CS, author). Only in MB and Lough Swilly on the north coast of Ireland.

***Modiolarca tumida* (Hanley, 1843) (Fig. 52)**

Abundant everywhere in the Bay except the extreme north of North Water and south of Broadwater (author, BEP, CS). Common on collectors (Minchin, 1990). Associated with a wide range of ascidians. Depth range 0-30m. New record for Sea Area 33 (Nunn and Smith, 1987).

***Musculus discors* (L., 1767) (Fig. 53)**

Widely recorded and common where found in the Bay except the extreme north of North Water and south of Broadwater (author, CS). Depth range 0-20m. Upgraded new record for Sea Area 33 (Nunn and Smith, 1987).

Order Limoida

Superfamily Limacea

***Limaria hians* (Gmelin, 1791) (Fig. 53)**

Common, living, North Water, Moross Channel, Second Narrows to Third Narrows, with scattered records in Broadwater (Hobson, 1981; BEP, DM, author, BIOMAR). Distributed from 0-30m. Common in areas of moderate current flow in channels between islands, and in areas affected by wave action (Minchin *et al.*, 1987). Dominant in shallows of Moross Channel where interwoven byssal threads form an extensive 'carpet' covering shell sand. Laminarians attach to this carpet and provide a canopy acting both as substratum and shelter for other species (Minchin, 1995). Decline in population when settlement failed for five years following the use of the organotin TBT as an anti-fouling agent on salmon cages in 1981-85. There was loss of carpet and cover leading to a substratum of unstable sand. Subsequent to 1985, when use of TBT ceased, the population began to recover and the carpet and cover have been present in Moross Channel since 1994 (Minchin, 1995). Found only in MB on the north coast of Ireland. Old records: as *Lima hians* 'plentiful at Moross ferry, Mulroy especially on 'between-water' side where specimens in 1888 gathered at low water beside boat-slip. Also taken on Fanet side of ferry' (Hart, 1892); 'live, plentiful in nests among *Laminaria* from Moross Channel' (Praeger, 1894; Marshall, 1897a).

***Limaria loscombi* (G. B. Sowerby I, 1823)**

Recorded living from two sites living (juvenile) *viz*. Lagmore Bay 3.6.90 14m and Lamb's Island 13.4.91 15m (det. SMS) (author). Small specimens are difficult to distinguish from *Limaria hians* which is common in parts of North Water (pers. comm. S. M. Smith). These identifications should therefore be considered doubtful.

Order Ostreoida

Superfamily Ostreacea

Ostreidae

***Ostrea edulis* L., 1758 (Fig. 54)**

Recorded living in MB from First to Second Narrows at four intertidal sites on muddy gravel *viz*. Fanny's Bay 31.3.91; Island Roy Bridge 19.3.92; Seedagh Point 18.3.95 and Crannoge Point 19.3.95 (all author). This species has also been transferred from Boet Mor Hatchery, Streamstown. It was ongrown in Broadwater, and in cages in 1981-82 in North Water (Minchin, 1990).

Crassostrea gigas **(Thunberg, 1793)**

Introduced species with growth trials in 1981 (Minchin, 1990). Cultured in cages in different parts of the Bay in 1985 to examine shells for the effects of TBT. The shells developed shell thickening in the manner attributed to TBT contamination (Minchin, 1991). A live specimen (free living) was found at Tirloughan Bay 30.7.95 (author) with dead shells at Carrickart (E) 19.3.92 (author).

Superfamily Pectinacea

Pectinidae

Pecten maximus **(L., 1758) (Fig. 54)**

Recorded living mainly in North Water and North Broadwater, with scattered records elsewhere north to Crannoge Point (BEP; Minchin, 1981; author, BIOMAR). Absent from the Bar and Mouth. The white and purple colour morphs, common on the west and south-west coasts of Ireland, are absent from Mulroy Bay (Minchin, 1991). The greatest density of this species is in 3-15m on coarse sand/gravel close to rocks (Minchin, 1981a), although generally found at depths from 0-30m. Settlement declined in 1982 and failed in 1983-85 while TBT was in use as an antifouling agent in Mulroy Bay (1981-1985). Settlements returned from 1986 (Minchin, 1995). About 200 adults were transferred from Valentia Harbour to study spawning behaviour (Minchin, 1990), and were subsequently destroyed.

Chlamys distorta **(da Costa, 1778) (Fig. 55)**

Recorded living in MB from three sites only amongst clean current swept boulders *viz.* Ballyhoorisky Island 2.6.89 (CS); Coolavaud 29.3.91 (author) and Crannoge Point 19.3.95 (author).

Chlamys varia **(L., 1758) (Fig. 55)**

Widely recorded and common from First Narrows throughout whole Bay (DM, author, CS, BIOMAR). Depth range 0-25m. Normally associated with kelp holdfasts, stones and boulders (Minchin *et al.*, 1987).

Palliolum striatum **(Müller, 1776)**

A single living specimen at Pan Rock 28.3.91 (det. SMS) (author). Found only in MB on north coast of Ireland. New record for Sea Area 33.

Palliolum tigerinum **(Müller, 1776)**

Not seen living in MB. Dead shells north of Crannoge Point in maerl 10.5.92 10-14m and dredged in maerl south-east of Island Roy 10-12m 27.10.95 (author).

Superfamily Anomiacea

Anomia ephippium **L., 1758 (Fig. 56)**

Common, living at muddy gravel intertidal sites south of First Narrows to south of Second Narrows (DM, author, CS, SMS, BIOMAR), with one record from Moross Channel (Minchin, 1990).

Heteranomia squamula **(L., 1758) (Fig. 56)**

Recorded living from the Mouth to Third Narrows (author, CS) with one record from Lagmore Bay 14m 3.6.90 (author). Mainly intertidal although found to 16m.

Pododesmus patelliformis **(L., 1761) (Fig. 57)**

Recorded living from sites with clean current-swept boulders, mainly First to Third Narrows (BEP, CS, author, BIOMAR) with records elsewhere from west of Croaghan Island 25.5.86 5-30m (BEP) and Ballyhoorisky Island 2.6.89 (CS).

Order Veneroida

Superfamily Lucinacea

Lucinidae

Loripes lucinalis **(Lamarck, 1818)**

Not seen living in MB. Dead shells from Bullogfeme Bay 24.5.86 and Binnanean Point 30.7.92 (author). Found only in MB on the north coast of Ireland.

Lucinoma borealis **(L., 1758) (Fig. 57)**

Scattered sites on muddy-sand in main Channel First to Third Narrows (author, CS) and one record from Moross Channel (Minchin, 1990). Depth range 0-14m.

Thyasiridae

Thyasira flexuosa **(Montagu, 1803)**

Not seen living recently in MB. Dead shells scattered throughout Broadwater at 6-24m (author), west of Croaghan Island 5-30m (BEP) and Binnanean Point 30.7.92 (author). Old record: as *Axinus flexuosus*, 'live, plentiful; alive in every haul' (Praeger, 1894); 14 valves Dr G. W. Chaster Mulroy Bay (UM).

Superfamily Galeommatacea

Kellidae

***Kellia suborbicularis* (Montagu, 1803) (Fig. 58)**

Recorded living from Mouth to Third Narrows and Moross Channel (author, CS). Depth range 0-15m. Upgraded new record for Sea Area 33 (Nunn and Smith, 1987). Old record: valves (Praeger, 1894).

***Lasaea adansoni* (Gmelin, 1791) (Fig. 58)**

Intertidal, living amongst *Lichina* sp. or in crevices, from Mouth, main Channel and Broadwater (author, CS, SMS). Apparently absent from Moross Channel and North Water.

Montacutidae

***Tellimya ferruginosa* (Montagu, 1803)**

Not seen living in MB. 25 valves from Mulroy Bay coll. Mrs S. Clarke (UM).

***Mysella bidentata* (Montagu, 1803) (Fig. 59)**

Apparently absent only from Mouth and First Narrows (author, CS), except for one record at Ballyhoorisky Beacon 20.3.92 (author). Depth range 0-20m. Dead shells dredged in Broadwater. Old record: as *Montacuta bidentata*, valves (Praeger, 1894).

***Epilepton clarkiae* (Clark, 1852)**

Recorded living from one site only in MB *viz.* Ballyhoorisky Island 2.6.89 (SMS).

Superfamily Astartacea

***Goodallia triangularis* (Montagu, 1803)**

Not seen living in MB. Dead shells south of Dundooan Rocks 14.4.91 20m (author).

Superfamily Cardiacea

Cardiidae

***Parvicardium exiguum* (Gmelin, 1791) (Fig. 59)**

Recorded living mainly on muddy gravel, from south of First Narrows, Channel, Broadwater and a cluster of sites in North Water (author, CS). Depth range 0-15m. On collectors (Minchin, 1990). Only in MB and Lough Swilly on the north coast of Ireland.

***Parvicardium ovale* (G. B. Sowerby II, 1840) (Fig. 60)**

Recorded living south of First Narrows, scattered through the Bay (DM, author). Generally sublittoral in MB, but depth range 0-24m.

***Plagiocardium papillosum* (Poli, 1795)**

Not seen living in MB. Two valves north of Crannoge Point in maerl 10-14m 1.5.92 (det. SMS) (author). A southern bivalve species, with only shells found in south-west England and the Channel Islands. First record for Ireland and new record for Sea Area 33.

***Cerastoderma edule* (L., 1758) (Fig. 60)**

Recorded living in the intertidal from Island Roy to Broadwater in suitable sheltered muddy/sandy inlets (DM, CS, author). Absent from North Water, Mouth and First Narrows. Old record: as *Cardium edule*, young (Praeger, 1894).

***Cerastoderma glaucum* (Poiret, 1789)**

Recorded living on muddy sand from one site only in MB *viz*. Back Lough (E) 19.3.92 (author). Dead shells were found at the same site 3.6.89 (SMS) and a single shell, possibly this species, at Laghnahattiny Point in north North Water on the high shore (Minchin, 1990). Elsewhere on the north coast of Ireland only in the south-east of Lough Foyle (R. Anderson (det. SMS)).

Superfamily Mactracea

Mactricidae

***Spisula elliptica* (Brown, 1827)**

Recorded living from one site only in MB *viz*. west of Bar Rocks 3m 14.7.93 (BIOMAR).

***Spisula solida* (L., 1758)**

Not seen living in MB. Dead shells only from Gortnalughogue 29.7.95 (author).

***Spisula subtruncata* (da Costa, 1778)**

Recorded living in Moross Channel (Minchin, 1990), with dead shells on the shore from Mouth to Second Narrows (author).

***Lutraria angustior* Philippi, 1844**

Not seen living in MB. Two valves collected from Church Strand, a bank of gravel and shell at 1m off Island Roy, in August 1979 (Minchin, 1985).

***Lutraria lutraria* (L., 1758)**

Recorded living from one site only in MB *viz*. west of Knox's Hole 8-24m 17.7.93 (BIOMAR).

Superfamily Solenacea

Pharidae

***Ensis arcuatus* (Jeffreys, 1865) (Fig. 61)**

Recorded living from 4m Keadew Bay (Minchin, 1990), Coolavaud 29.3.91 (author) and west of Bar Rocks 3m 14.7.93 (BIOMAR). Dead shells found throughout the main Channel. Only in MB and Lough Swilly on the north coast of Ireland.

***Ensis ensis* (L., 1758)**

Recorded living from one site only in Moross Channel (Minchin, 1990). Dead shells Ballyhoorisky Island 2.6.89 (CS). Only in MB and Lough Swilly on the north coast of Ireland.

***Ensis siliqua* (L., 1758)**

Not seen living in MB. Dead shells from Island Roy Bridge 19.3.92; Island Reagh 29.7.95 and Inverbeg Bay 30.7.95 (author).

Superfamily Tellinacea

Tellinidae

***Angulus squalidus* (Pulteney, 1799)**

Not seen living in MB. Dead shells from Inverbeg Bay 30.7.95 (author).

***Angulus tenuis* (da Costa, 1778) (Fig. 61)**

Recorded living from Lambs Island 13.4.91 15m and Carrickart (E) 19.3.92 (author), and west of Bar Rocks 3m 14.7.93 (BIOMAR). Old record: as *Tellina tenuis*, valves (Praeger, 1894).

***Moerella donacina* (L., 1758)**

Recorded living from Moross Channel (Minchin, 1990) and east of Greer Island 14m 16.4.94 (author). Dead shells in North Water only (BEP, author).

***Macoma balthica* (L., 1758)**

Recorded living from Moross Channel (Minchin, 1990) and Carrickart (W) 19.3.92 (author). Dead shells in muddy sand sites around whole Bay. Old records: Bay half mile east of Carrickart (Rees, 1939).

***Gastrana fragilis* (L., 1758)**

Not seen living in MB. Dead shells only Mulroy House 3.6.89 (SMS).

Donacidae

***Donax vittàtus* (da Costa, 1778)**

Not seen living in MB. Dead shells dredged off Doaghmore Strand 10m 27.10.95 (author).

Psammobiidae

***Gari depressa* (Pennant, 1777)**

Recorded living in MB only from the hole opposite Rosnakill Bay 30.3.80 30m (BEP) and Moross Channel (Minchin, 1990). Dead shells from Island Roy to Third Narrows (author, CS). Found only in MB on the north coast of Ireland.

***Gari tellinella* (Lamarck, 1818)**

Not seen living in MB. Dead shells from The Hassans 2.6.89 (CS) and dredged in maerl from south-east Island Roy 10-12m 27.10.95 (author). Four valves Mulroy Bay coll. Mrs S. Clarke (UM).

Semelidae

***Abra alba* (W. Wood, 1802)**

Not seen living in MB. Dead shells from Deegagh Point 8m 16.4.94 (author).

***Abra nitida* (Müller, 1776)**

Dredged living, one specimen, west of Carlan Point 24m 27.10.95 (author). Dead shells dredged north of Williamsons Rock 6-20m and south of Black Rocks 8-20m 27.10.95 (author).

***Abra prismatica* (Montagu, 1803)**

Not seen living in MB. Dead shell dredged off Ranny Point 16-20m 27.10.95 (author). New record for Sea Area 33.

***Scrobicularia plana* (da Costa, 1778)**

Not seen living in MB. Dead shells at Carrickart (W) 19.3.92 (author).

Superfamily Arcticacea

Arcticidae

***Artica islandica* (L., 1767)**

Old record: as *Cyprina islandica*, sub-fossil state near Melmore Head (Hart, 1892).

Superfamily Veneracea

Veneridae

***Venus verrucosa* L., 1758 (Fig. 62)**

Recorded living from the intertidal on muddy gravel in Moross Channel, Island Roy and Wee

Sea (Minchin, 1990), three other sites in the Channel (author) and Back Lough Narrows 22.7.93 (BIOMAR). Dead shells common in the Channel, Moross Channel and North Broadwater. At northern limit in the British Isles, only as far north as South Mayo elsewhere on the west coast of Ireland (absent on the east coast of Ireland) and the eastern Irish Sea in England (Seaward, 1991). New record for Sea Area 33.

***Chamelea gallina* (L., 1758) (Fig. 62)**

Recorded living in Moross Channel (Minchin, 1990); Island Roy (SE) 19.3.92, Island Reagh 29.7.95 and Inverbeg Bay 30.7.95 (author) and west of Bar Rocks 3m 14.7.93 (BIOMAR).

***Clausinella fasciata* (da Costa, 1778)**

Not seen living in MB. Dead shell from Gortnalughogue 29.7.95 (author).

***Timoclea ovata* (Pennant, 1777) (Fig. 63)**

Recorded living from The Hassans 24.5.86 (author) and 2.6.89 (CS); east of Greer Island 16.4.94 14m and dredged 14-20m north of McSwynes Bed 27.10.95 (author). Dead shells common in Broadwater. Old record: as *Venus ovata*, dead (Praeger, 1894).

***Tapes rhomboides* (Pennant, 1777)**

Recorded living in Moross Channel (Minchin, 1990). Dead shells from Mouth to Island Roy (author).

***Tapes decussatus* (L., 1758) (Fig. 63)**

Recorded living from intertidal sites from south of First Narrows to Second Narrows and Bullogfeme Bay (DM, CS, author). Dead shells common throughout the Bay.

***Tapes philippinarum* (Adams and Reeve, 1850)**

Introduced species. Cultured in cages in North Water and Broadwater, and ongrown on shores Moross Channel, Broadwater (Minchin, 1990).

***Irus irus* (L., 1758)**

Not seen living in MB. Three valves Mulroy Bay coll. Mrs S. Clarke (UM).

***Venerupis senegalensis* (Gmelin, 1791) (Fig. 64)**

Apparently absent from North Water only (DM, author, CS, BIOMAR), in First to Third Narrows. Dead shells common throughout Bay. Mainly intertidal, but also to 15m.

***Dosinia lupinus* (L., 1758)**

Recorded living in 7m in Fanny's Hole (Minchin, 1990). Dead shells from Ballyhoorisky

Island 2.6.89 (CS).

***Dosinia exoleta* (L., 1758)**

Recorded living south of Dundooan Rocks 14.4.91 20m and in maerl north of Crannoge Point 10-14m 10.5.92 (author).

Turtoniidae

***Turtonia minuta* (Fabricius, 1780) (Fig. 64)**

Absent from Mouth and First Narrows only except for around Ballyhoorisky Island (author, CS, SMS). Depth range 0-15m.

Petricolidae

***Mysia undata* (Pennant, 1777)**

Recorded living at one site only in MB *viz.* in 12m Bullock Bay, North Water (Minchin, 1990). Dead shells from east of Bird Isle (DM) and dredged south of Black Rocks 8-20m 27.10.95 (author).

Order Myoida

***Mya truncata* L., 1758**

A single juvenile living specimen from Ardy Point (E) 17.3.92 (det. SMS) (author). Dead shells from 1m, north side of Church Strand, Island Roy (Minchin, 1990) and other sites close to Island Roy and Second Narrows (author).

***Mya arenaria* L., 1758**

A single juvenile living specimen from Ardy Point (E) 17.3.92 (det. SMS) (author). Dead shells Channel and Broadwater.

Corbulidae

***Corbula gibba* (Olivi, 1792) (Fig. 65)**

Recorded living, common in mud/muddy gravel, from North Water, Moross Channel and Broadwater (DM, author). Depth range 0-50m. Old record: a few alive, small (Praeger, 1894).

Superfamily Hiatellacea

Hiatellidae

***Hiatella arctica* (L., 1758) (Fig. 65)**

Widely distributed throughout the Bay, although sparse in Broadwater (author, CS, BIOMAR). Common on collectors (Minchin, 1990). Old record: as *Saxicava rugosa* (L.) valves

(Praeger, 1894).

Saxicavella jeffreysi **Winckworth, 1930**

Not seen recently in MB. Old record: as *Panopea plicata* (Montagu), valves (Praeger, 1894; Marshall, 1897b); Dr G. W. Chaster, three valves Mulroy Bay (UM).

Order Pholadomyoida

Superfamily Thraciacea

Thraciidae

Thracia convexa **(W. Wood, 1815)**

Not seen living in MB. Dead shells from west of Croaghan Island 25m 2.3.88; dredged off Ranny Point 16-20m and north of Williamsons Rock 6-20m 27.10.95 (all author).

Thracia phaseolina **(Lamarck, 1818)**

Recorded living from Lurgacloghan Bay, North Water (Minchin, 1990) and Lagmore Bay 3.6.90 14m (author). Dead shells from Stookan 16.4.94 14m (author).

Thracia villosiuscula **(Macgillivray, 1818)**

Not seen living in MB. Dead shells from The Hassans 2.6.89 (CS) and Moross Castle 31.3.91 6m (author).

Class CEPHALOPODA

Order Sepioidea

Sepiolidae

Sepiola atlantica **Orbigny in Ferussac and Orbigny, 1840 (Fig. 66)**

Recorded living Lagmore Bay (N) 29.3.91 13m; and dredged north of Williamsons Rock 6-20m and off Knox's Hole 4-16m 27.10.95 (all author).

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TABLE 1. Littoral sites in Mulroy Bay.

No.	Site name	Date of visit	Species no. (live/dead)	Latitude/Longitude
(A)	**Mouth**			
1.	Ballyhoorisky Quay Beacon	20.3.92	(27,0)	55°15.50'N 07°45.10'W
2.	Illananoon	31.7.92	(25,0)	55°14.85'N 07°47.10'W
3.	Ballyhoorisky Island	24.5.86/ 2.6.89	(80,16)	55°14.70'N 07°45.50'W
4.	Melmore	30.3.91	(22,1)	55°14.50'N 07°47.30'W
5.	Gortnatraw Point	2.8.92	(28,0)	55°14.24'N 07°45.58'W
6.	Gortnalughogue	29.7.95	(8,25)	55°13.89'N 07°47.20'W
(B)	**Channel**			
2.	Dualty's Isle (**First Narrows**)	18.3.92	(16,3)	55°13.50'N 07°47.25'W
3.	Dundooan Point	30.3.91	(35,6)	55°13.33'N 07°47.75'W
4.	Inverbeg Bay	30.7.95	(42,4)	55°13.25'N 07°48.00'W
5.	Murvan Head	1.8.92	(50,7)	55°12.37'N 07°47.65'W
6.	Crannoge Point	19.3.95	(46,4)	55°12.30'N 07°48.43'W
7.	Coolavaud, Glinsk Bay	29.3.91	(54,5)	55°12.22'N 07°47.20'W
8.	Fanny's Bay	31.3.91	(52,3)	55°12.08'N 07°48.55'W
9.	Drumnacraig Point	21.3.92	(31,2)	55°11.90'N 07°46.62'W
10.	Island Reagh	29.7.95	(48,11)	55°11.88'N 07°47.80'W
11.	Gravel Spit, Island Roy (N)	19.3.92	(41,7)	55°11.85'N 07°47.00'W
12.	Island Roy Bridge	19.3.92	(25,6)	55°11.33'N 07°48.00'W
13.	Island Roy (SE)	19.3.92	(27,6)	55°11.28'N 07°47.10'W
14.	Carrickart (W)	19.3.92	(6,7)	55°10.90'N 07°48.20'W
15.	Carrickart (E)	19.3.92	(9,5)	55°10.87'N 07°47.50'W
16.	Tirloughan Bay	30.7.95	(13,6)	55°11.13'N 07°46.07'W
17.	Second Narrows (**Second Narrows**)	2.8.92	(57,5)	55°11.50'N 07°45.65'W
18.	Rawros Point (**Second Narrows**)	28.3.91	(44,3)	55°11.32'N 07°45.90'W
19	Bullogfeme Bay	24.5.86/ 2.6.89	(29,10)	55°11.90'N 07°44.30'W
25.	Ardy Point (E)	17.3.92	(40,3)	55°11.70'N 07°44.95'W
26.	Seedagh Point	18.3.95	(40,4)	55°11.58'N 07°44.85'W
27.	Ardy Point (W)	17.3.92	(25,1)	55°11.40'N 07°45.10'W
28.	Seedagh (N)	18.3.95	(30,3)	55°11.35'N 07°44.75'W
29.	Binnanean Point	30.7.92	(40,9)	55°10.90'N 07°44.90'W
30.	Marks Point	31.7.92	(45,10)	55°10.90'N 07°44.45'W
31.	Seamount Point	20.3.92	(53,5)	55°10.68'N 07°43.60'W
32.	Dawsons Bay Point	24.9.95	(19,7)	55°10.58'N 07°43.18'W
33.	Devlinmore Point	30.3.91	(42,6)	55°10.55'N 07°43.70'W
34.	Dawsons Bay (S)	24.9.95	(37,4)	55°10.47'N 07°42.98'W
35.	Back Lough (E)	19.3.92	(10,4)	55°09.66'N 07°42.82'W
36.	Third Narrows (**Third Narrows**)	18.3.92	(28,2)	55°10.05'N 07°42.70'W

TABLE 1. (continued)

No.	Site name	Date of visit	Species no. (live/dead)	Latitude/Longitude
37.	The Hassans (**Third Narrows**)	24.5.86/ 2.6.89	(76,13)	55°10.10'N 07°43.70'W
38.	Opposite Scalpmore (**Third Narrows**)	18.3.92	(8,0)	55°09.84'N 07°42.50'W
(C)	**North Water**			
39.	Bullock Bay	20.3.92	(9,4)	55°13.82'N 07°42.50'W
40.	South of Kindrum Bay	17.3.92	(17,3)	55°13.28'N 07°42.18'W
41.	Croaghan Island Causeway	24.5.86	(19,2)	55°12.80'N 07°42.30'W
42.	Lambs Island	13.4.91	(7,0)	55°12.40'N 07°42.60'W
43.	Agharooney Point (S)	13.4.91	(22,5)	55°12.40'N 07°41.90'W
44.	Wee Sea	21.3.92	(15,3)	55°12.03'N 07°42.10'W
45.	Moross Point	21.3.92	(12,4)	55°12.15'N 07°42.60'W
(D)	**Moross Channel**			
46.	Ross Point, Ballyheerin	29.3.91	(29,6)	55°11.90'N 07°43.05'W
47.	Moross Castle	3.6.89	(27,4)	55°11.75'N 07°42.90'W
48.	Moross Strand Head	21.3.92	(4,3)	55°11.56'N 07°41.70'W
49.	Trabeg Bay	17.3.92	(18,3)	55°11.28'N 07°42.90'W
50.	Mullaghanardy Point	17.3.92	(24,3)	55°10.85'N 07°42.25'W
(E)	**Broadwater**			
51.	Keadew Bay	1.8.92	(17,3)	55°10.80'N 07°41.03'W
52.	Opposite Green Isle	20.3.92	(19,6)	55°10.38'N 07°42.50'W
53.	South of Keadew Bay	1.8.92	(16,5)	55°10.30'N 07°40.85'W
54.	Ballymagowan (E)	18.3.95	(12,3)	55°09.65'N 07°40.54'W
55.	Pan Rock	28.3.91	(27,3,)	55°09.18'N 07°41.80'W
56.	Deegagh Point	29.7.95	(21,0)	55°09.10'N 07°41.56'W
57.	Carlan Isle	30.3.91	(22,6)	55°09.10'N 07°40.15'W
58.	Cranford Bay	18.3.92	(16,6,)	55°08.65'N 07°41.60'W
59.	Pan Point	2.8.92	(19,2)	55°08.42'N 07°40.45'W
60.	Ranny Point	30.7.95	(18,3)	55°07.97'N 07°40.95'W
61.	North of Doongonigle	30.7.92	(24,0)	55°07.40'N 07°42.00'W
62.	Opposite Rough Island	19.3.92	(19,0)	55°07.30'N 07°41.08'W
63.	NE Point, Doongonigle	25.5.86	(24,1)	55°07.10'N 07°42.20'W
64.	Boat Bay	31.7.92	(16,3)	55°06.82'N 07°41.33'W
65.	Opposite Cratlagh Island	18.3.92	(12,2)	55°06.58'N 07°42.30'W
66.	Milford Quay	18.3.92	(5,3)	55°06.33'N 07°41.25'W
67	South Bunlin Bay	30.7.92	(4,2)	55°05.94'N 07°42.85'W

TABLE 2. Sublittoral sites in Mulroy Bay.

No.	Site name	Date of visit	Depth range	Species no. (live/dead)	Latitude/Longitude
(A)	**Dive Sites** *samples collected by G. V. Day				
(i)	**Channel**				
1.	Melmore Head (E)	17.4.94	-15m	(10,0)	55°15.35'N 07°47.20'W
2.	Invermore Bay*	10.5.92	-12m	(10,0)	55°13.31'N 07°47.45'W
3.	Dundooan Rocks	14.4.91/			
		17.4.94	-14m	(31,0)	55°13.08'N 07°48.30'W
4.	South of Dundooan Rocks*	14.4.91	-20m	(16,5)	55°12.70'N 07°48.30'W
5.	North of Crannoge Point	10.5.92	10-14m	(31,15)	55°12.50'N 07°48.32'W
(ii)	**North Water**				
6.	West of Croaghan Island	2.3.88	-25m	(3,5)	55°12.75'N 07°42.60'W
7.	Lagmore Bay (N)	29.3.91	0-13m	(21,2)	55°12.70'N 07°42.20'W
8.	East of Greer Island	16.4.94	-14m	(13,5)	55°12.66'N 07°42.80'W
9.	Lagmore Bay	11.12.88			
		- 4.2.96	0-15m	(40,3)	55°12.60'N 07°42.05'W
10.	Stookan	9.5.92			
		- 16.4.94	3-35m	(15,4)	55°12.53'N 07°42.40'W
11.	Lambs Island	13.4.91	0-15m	(15,5)	55°12.40'N 07°42.60'W
(iii)	**Moross Channel**				
12.	Moross Castle	31.3.91	0-6m	(19,10)	55°11.80'N 07°43.00'W
13.	Rosnakill Bay	13.4.91	-15m	(14,5)	55°11.50'N 07°42.00'W
(iv)	**Broadwater**				
14.	Carlan Bay	28.3.91	0-8m	(8,2)	55°09.55'N 07°39.95'W
15	NE Campbells Bed*	9.5.92	-23m	(2,0)	55°09.30'N 07°40.50'W
16.	Campbells Bed	14.4.91	3-15m	(8,1)	55°09.25'N 07°40.75'W
17.	Deegagh Point	16.4.94	0-8m	(11,5)	55°09.04'N 07°41.54'W
18.	Cranford Middle Shoal	9.5.92	3-7m	(13,2)	55°08.88'N 07°40.90'W
(B)	**Dredge Sites**				
(i)	**Mouth**				
1.	Mouth	27.10.95	10m	(5,1)	55°14.66'N 07°46.30'W
2.	Mouth	27.10.95	12m	(7,2)	55°14.63'N 07°46.24'W
3.	off Doaghmore Strand	27.10.95	10m	(9,5)	55°13.89'N 07°46.67'W

TABLE 2. (continued)

No.	Site name	Date of visit	Depth range	Species no. (live/dead)	Latitude/Longitude
(ii)	**Channel**				
4.	off Knox's Hole	27.10.95	4-16m	(10,1)	55°12.79'N 07°48.27'W
5.	NW Reagh Island	27.10.95	10m	(22,1)	55°12.11'N 07°48.33'W
6.	SE Island Roy	27.10.95	10-12m	(35,16)	55°11.35'N 07°46.71'W
7.	off Seedagh Hill	27.10.95	6-12m	(22,3)	55°11.52'N 07°45.33'W
(iii)	**Moross Channel**				
8.	Moross Channel	27.10.95	8-12m	(4,3)	55°11.50'N 07°42.75'W
(iv)	**Broadwater**				
9.	south of Black Rocks	27.10.95	8-20m	(10,18)	55°10.51'N 07°41.54'W
10.	South Rosnakill Strait	27.10.95	12m	(22,10)	55°10.30'N 07°41.81'W
11.	SE Ballymagowan Point	27.10.95	4-10m	(12,5)	55°09.77'N 07°40.57'W
12.	west of Carlan Point	27.10.95	24m	(11,22)	55°09.04'N 07°40.70'W
13.	off Ranny Point	27.10.95	16-20m	(7,4)	55°08.04'N 07°41.36'W
14.	north of Williamsons Rock	27.10.95	6-20m	(6,20)	55°07.95'N 07°41.40'W
15.	north of McSwynes Bed	27.10.95	14-20m	(15,11)	55°07.14'N 07°41.62'W
16.	SW of Glack Point	27.10.95	12m	(3,8)	55°06.78'N 07°41.81'W

TABLE 3. Molluscan records from Mulroy Bay.

(A) Not seen since 19th century
Living: *Thyasira flexuosa*.
Shells only: *Odostomia unidentata*; *Turbonilla crenata*; *Saxicavella jeffreysi*.

(B) New or upgraded records for Ireland from Mulroy Bay
Living: *Leptochiton scabridus*; *Brachystomia angusta*; *Ondina divisa*; *Turbonilla rufescens*.
Shells only: *Plagiocardium papillosum*.

(C) New or upgraded records for Sea Area 33 from Mulroy Bay
Since publication of the Sea Area Atlas of the Marine Mollusca of Britain and Ireland (Seaward, 1982). All author unless otherwise stated.
Living: *Leptochiton asellus* (BEP); *Leptochiton cancellatus* (CS); *Leptochiton scabridus* (CS); *Lepidochitona cinereus*; *Tonicella rubra*; *Diodora graeca*; *Tricolia pullus*; *Skenea serpuloides* (CS); *Dikoleps nitens* (CS); *Tectura virginea*; *Helcion pellucidum*; *Cerithiopsis tubercularis*; *Marshallora adversa*; *Littorina obtusata*; *Skeneopsis planorbis*; *Eatonina fulgida*; *Barleeia unifasciata*; *Rissoa interrupta*; *Rissoa membranacea*; *Cingula cingillus*; *Pusillina inconspicua*; *Pusillina sarsi*; *Caecum glabrum*; *Epitonium clathratulum*; *Buccinum undatum*; *Rissoella diaphana*; *Rissoella globularis* (SMS); *Rissoella opalina*; *Omalogyra atomus*; *Ammonicerina rota* (CS); *Brachystomia carrozzai*; *Brachystomia scalaris*; *Chrysallida interstincta*; *Ondina diaphana*; *Ondina divisa*; *Turbonilla rufescens*; *Eulimella scillae*; *Philine pruinosa*; *Retusa truncatula*; *Runcina coronata* (BEP); *Limapontia senestra*; *Doto fragilis* (BIOMAR); *Doto koenneckeri*; *Goniodoris castanea* (BEP); *Rostanga rubra* (BEP); *Cuthona genovae* (DM/author); *Eubranchus doriae* (BEP); *Aeolidiella alderi*; *Aeolidiella glauca* (BEP); *Nucula nitidosa*; *Musculus discors*; *Modiolarca tumida*; *Palliolum striatum*; *Kellia suborbicularis*; *Venus verrucosa* (DM).
Shells only: *Eulima bilineata*; *Mangelia attenuata*; *Mangelia brachystoma*; *Cima minima*; *Otina ovata* (SMS); *Plagiocardium papillosum*; *Abra prismatica*.

(D) Species apparently found only in Mulroy Bay on the north coast of Ireland
Leptochiton scabridus; *Dikoleps nitens*; *Rissoa membranacea*; *Caecum glabrum*; *Epitonium clathratulum*; *Mangelia attenuata* (shell only); *Mangelia brachystoma* (shell only); *Rissoella globularis*; *Ammonicerina rota*; *Odostomia plicata*; *Brachystomia scalaris*; *Chrysallida interstincta*; *Ondina divisa*; *Turbonilla rufescens*; *Eulimella scillae*; *Philine aperta*; *Philine pruinosa*; *Haminoea navicula*; *Placida dendritica*; *Hermaea bifida*; *Akera bullata*; *Cuthona genovae*; *Eubranchus vittatus*; *Aeolidiella alderi*; *Auriculinella bidentata*; *Nucula nitidosa*; *Limaria hians*; *Palliolum striatum*; *Plagiocardium papillosum* (shell only); *Loripes lucinalis* (shell only); *Gari depressa*; *Venus verrucosa*.

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FIGURE 1: the location of Mulroy Bay.

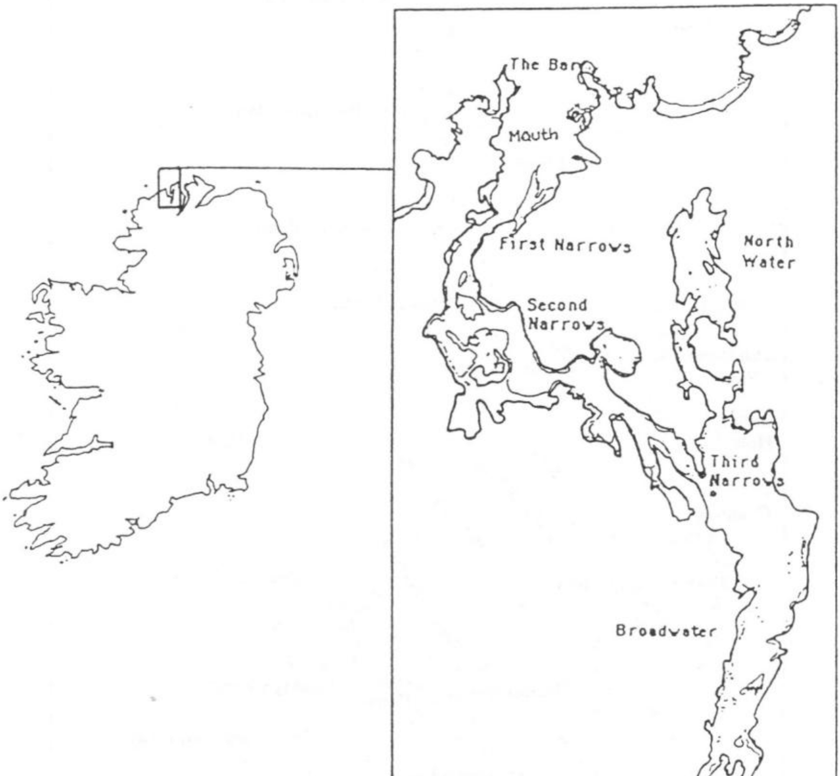

FIGURE 2A: Mulroy Bay - Bar, Mouth and Main Channel.

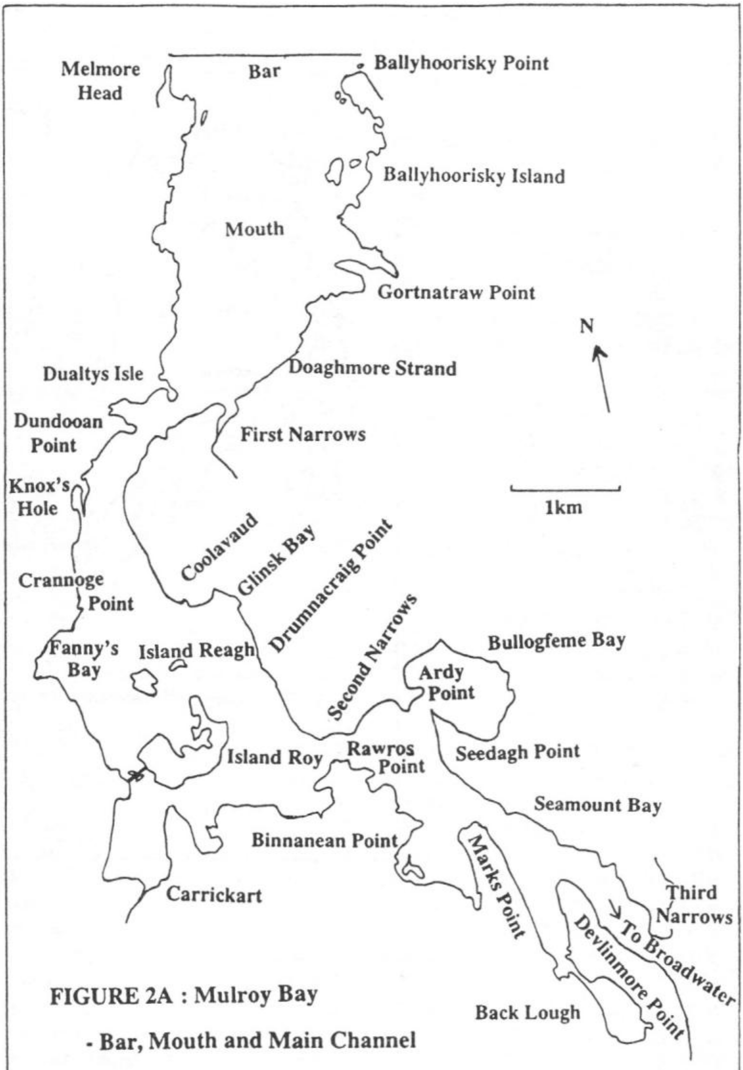

FIGURE 2B: Mulroy Bay - Broadwater.

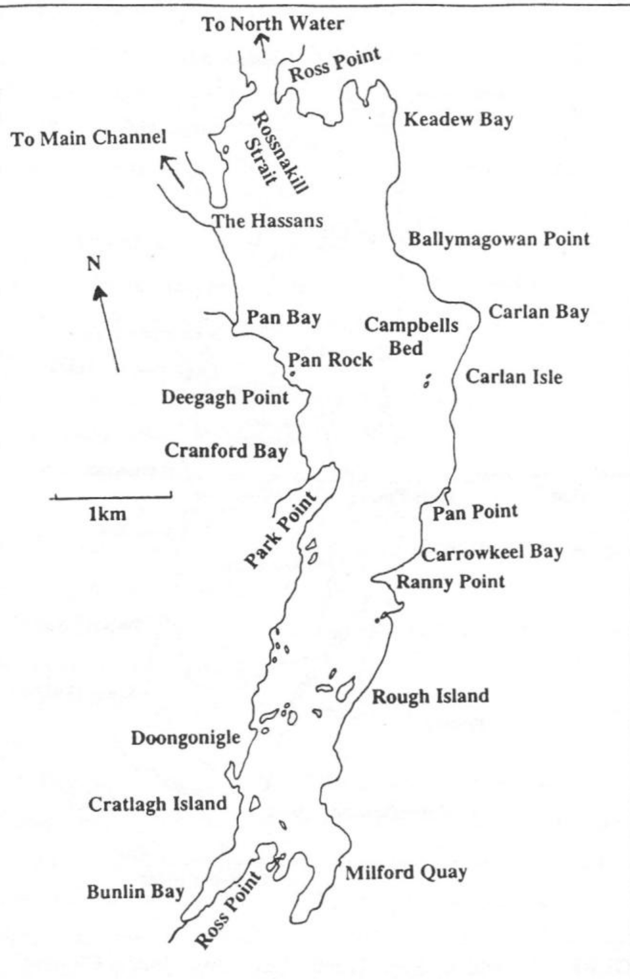

FIGURE 2B : Mulroy Bay - Broadwater

FIGURE 2C: Mulroy Bay - North Water and Moross Channel.

FIGURE 2C : Mulroy Bay - North Water and Moross Channel

FIGURE 3: littoral sites in Mulroy Bay.

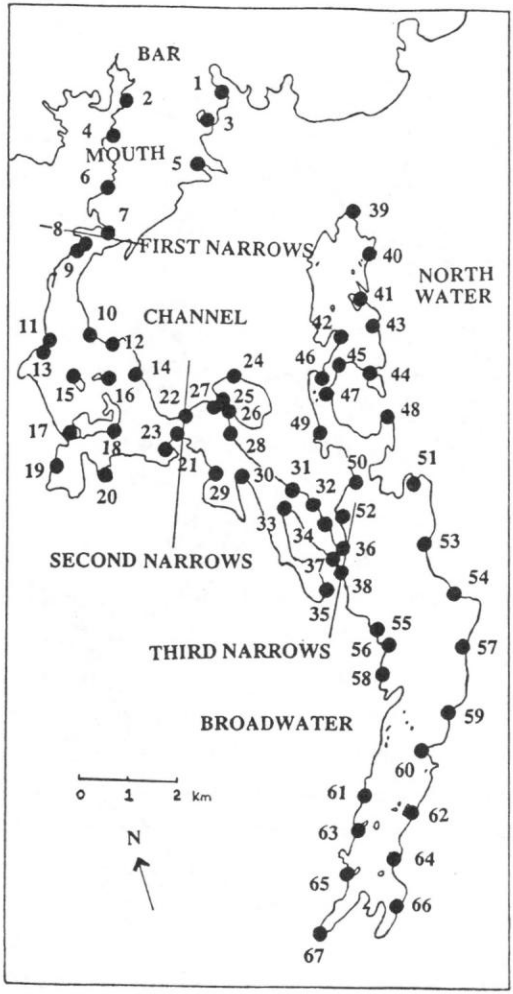

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FIGURE 4: dive sites in Mulroy Bay.

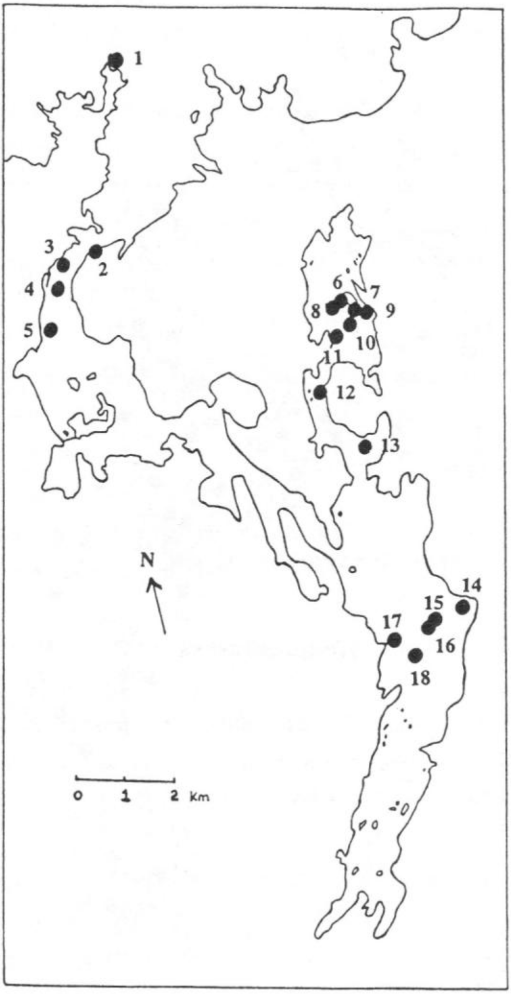

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FIGURE 5: dredge sites in Mulroy Bay.

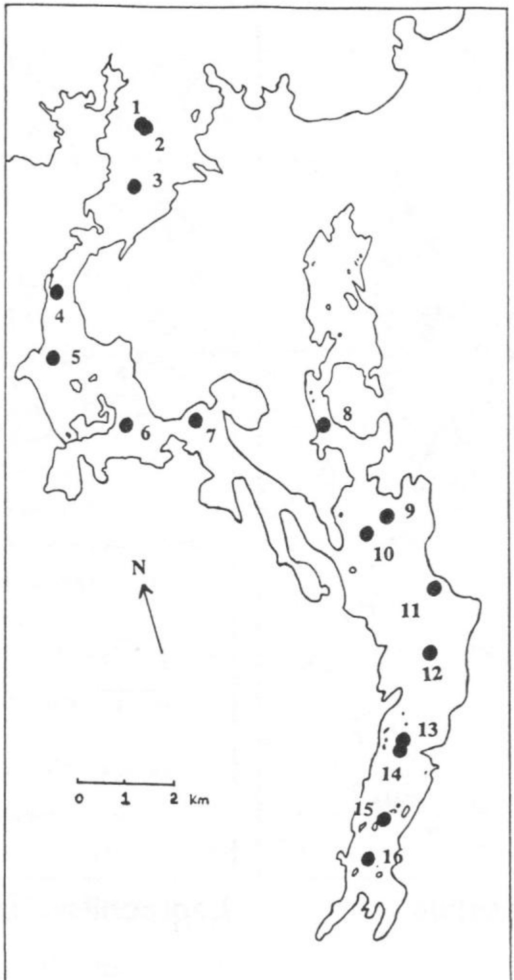
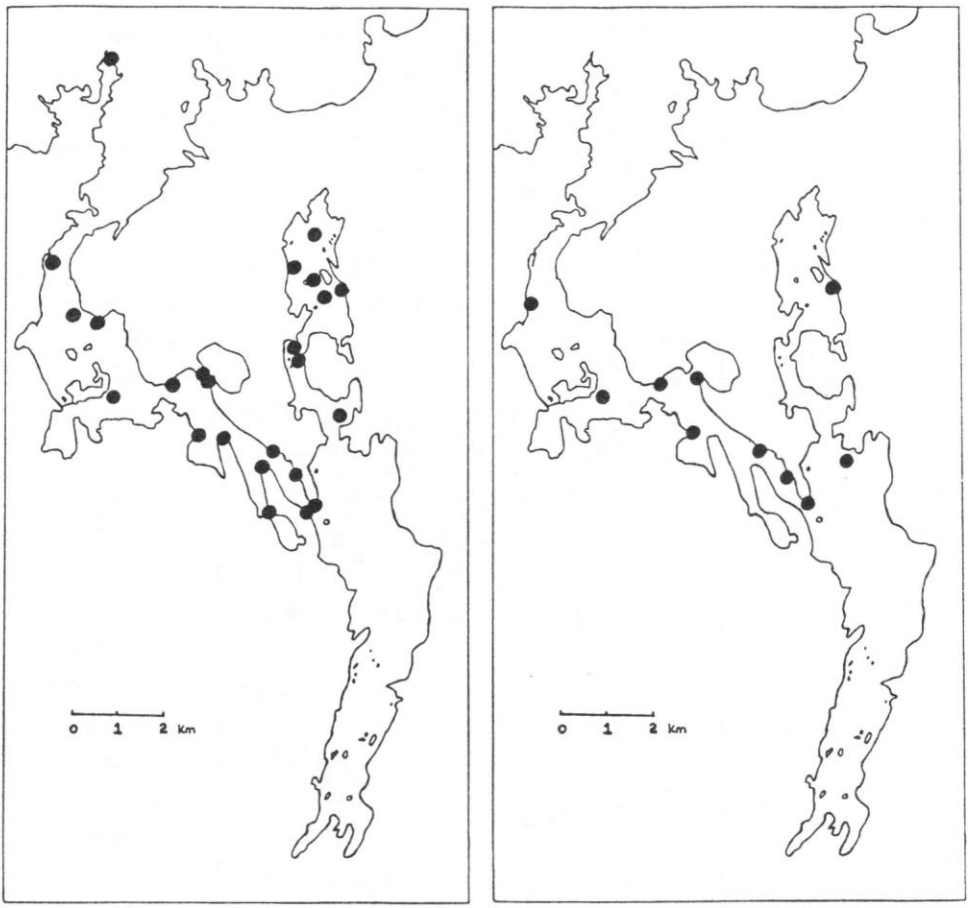
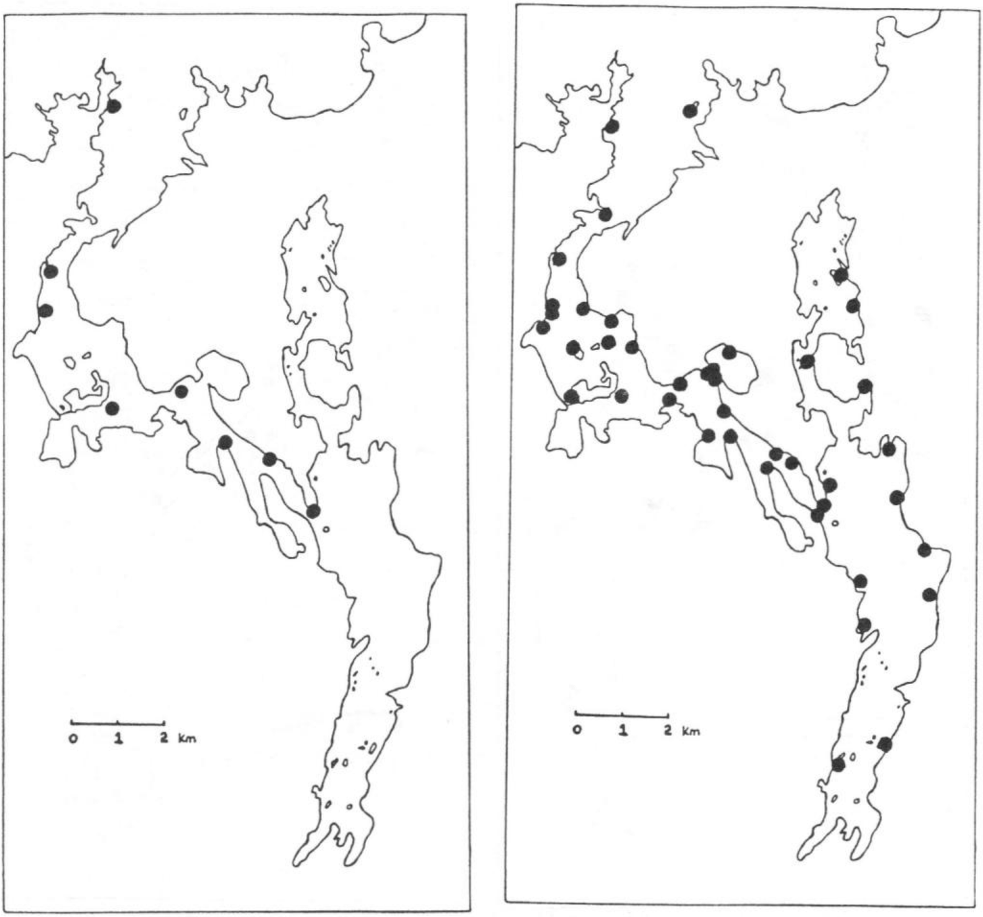


FIGURE 6: distribution maps of *Leptochiton asellus* and *Leptochiton cancellatus*.



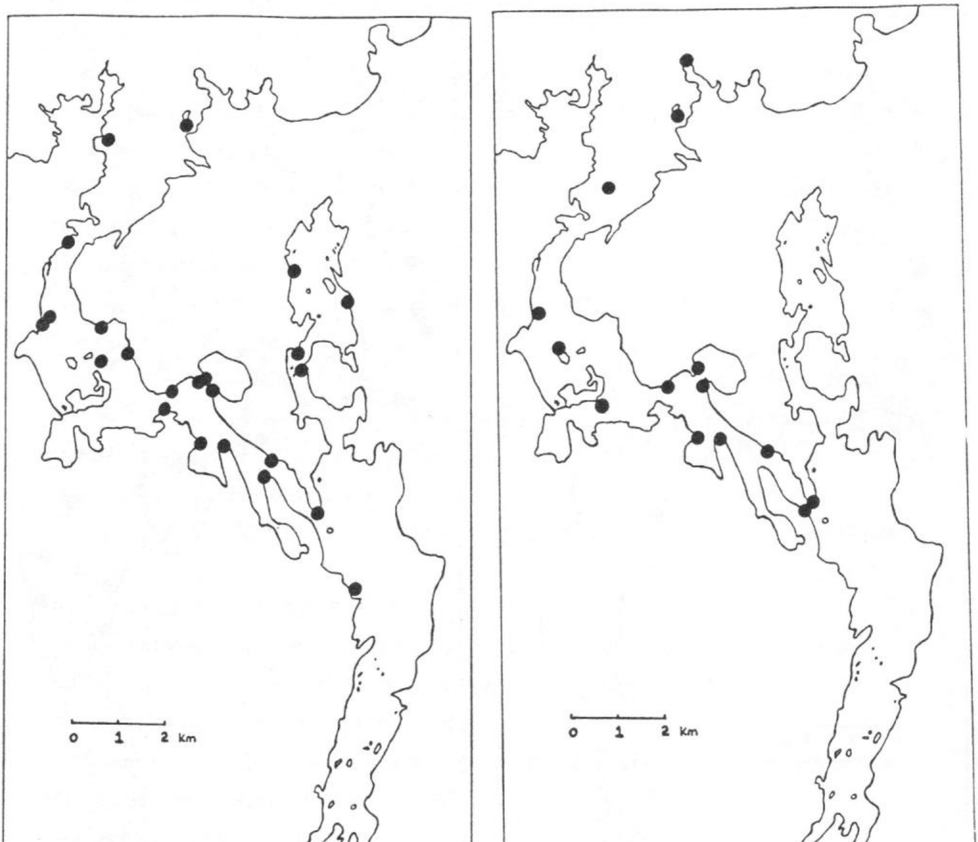
Leptochiton asellus **Leptochiton cancellatus**

FIGURE 7: distribution maps of *Callochiton septemvalvis* and *Lepidochitona cinereus*.



Callochiton septemvalvis **Lepidochitona cinereus**

FIGURE 8: distribution maps of *Tonicella rubra* and *Acanthochitona crinitus*.



Tonicella rubra **Acanthochitona crinitus**

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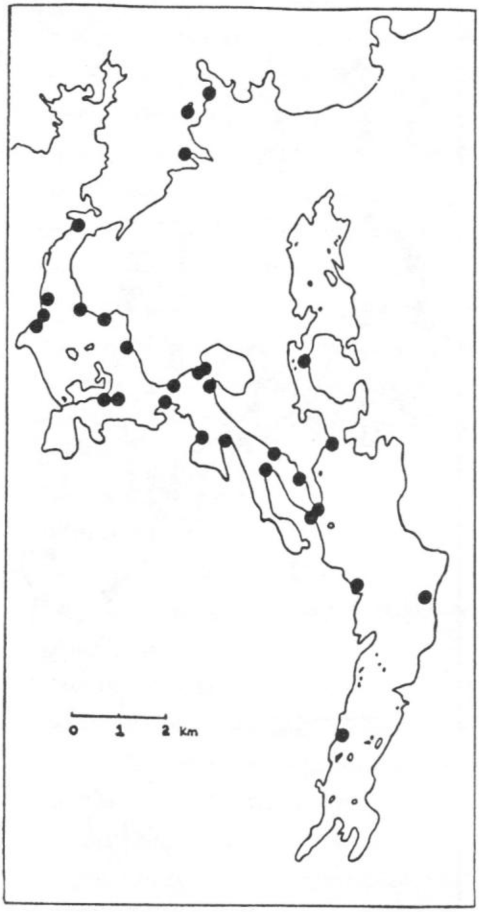
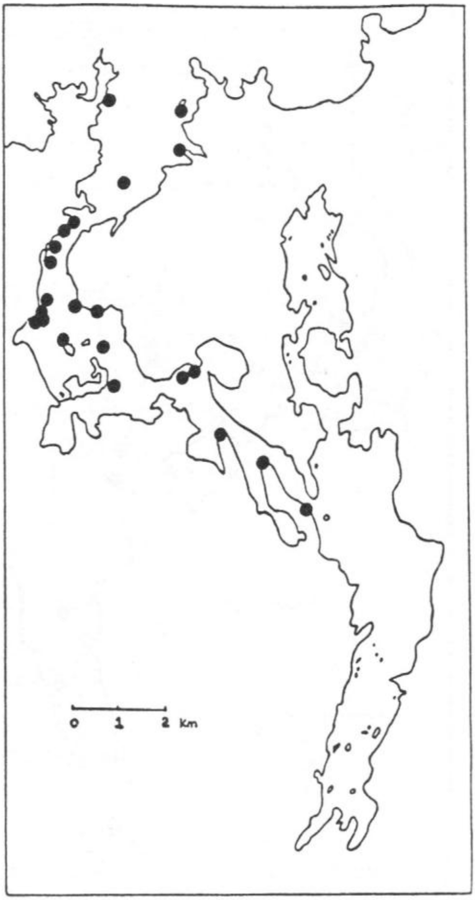
FIGURE 9: distribution maps of *Diodora graeca* and *Tricolia pullus*.

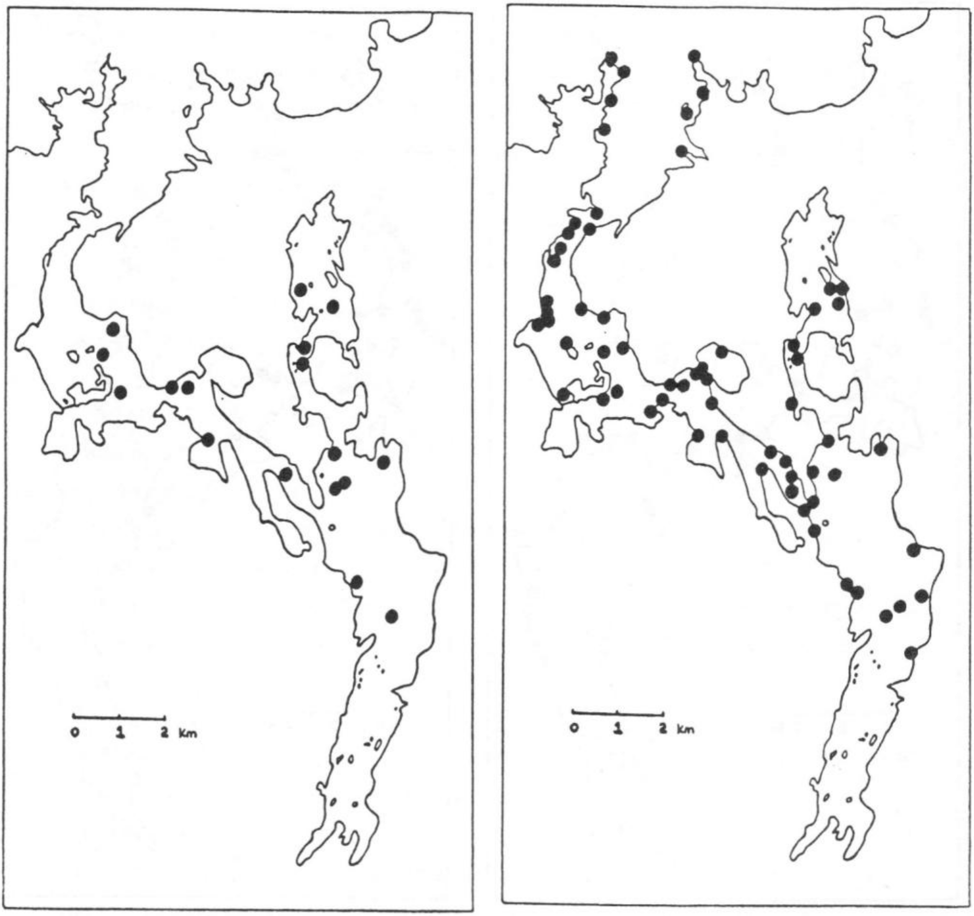


Diodora graeca



Tricolia pullus

FIGURE 10: distribution maps of *Gibbula magus* and *Gibbula cineraria*.



Gibbula magus   Gibbula cineraria

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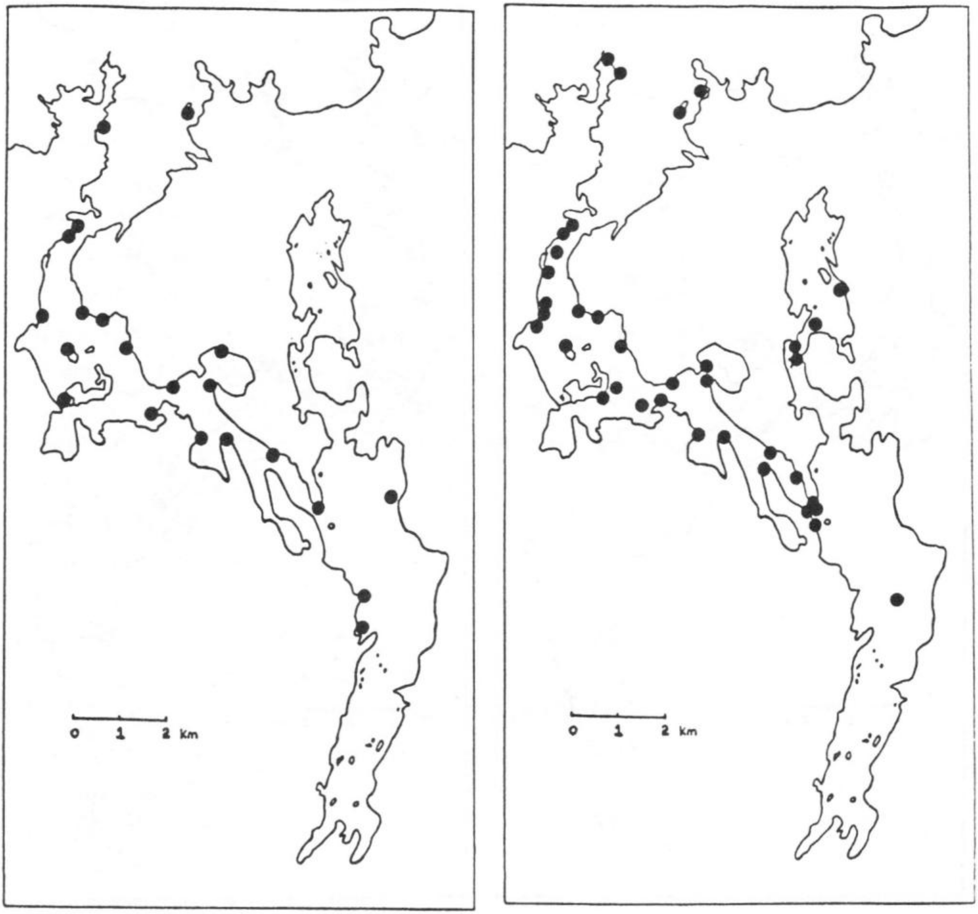
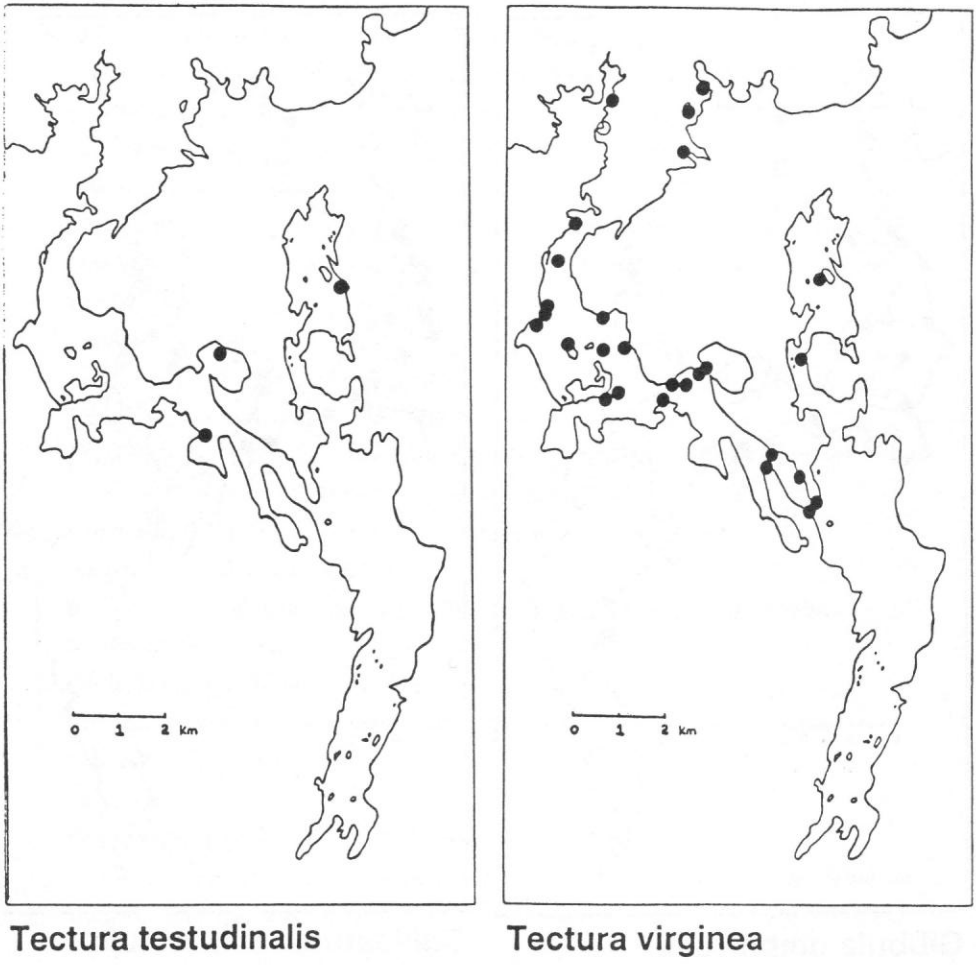
FIGURE 11: distribution maps of *Gibbula umbilicalis* and *Calliostoma zizyphinum*.



Gibbula umbilicalis **Calliostoma zizyphinum**

FIGURE 12: distribution maps of *Tectura testudinalis* and *Tectura virginea*.



Tectura testudinalis   Tectura virginea

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FIGURE 13: distribution maps of *Patella ulyssiponensis* and *Patella vulgata*.

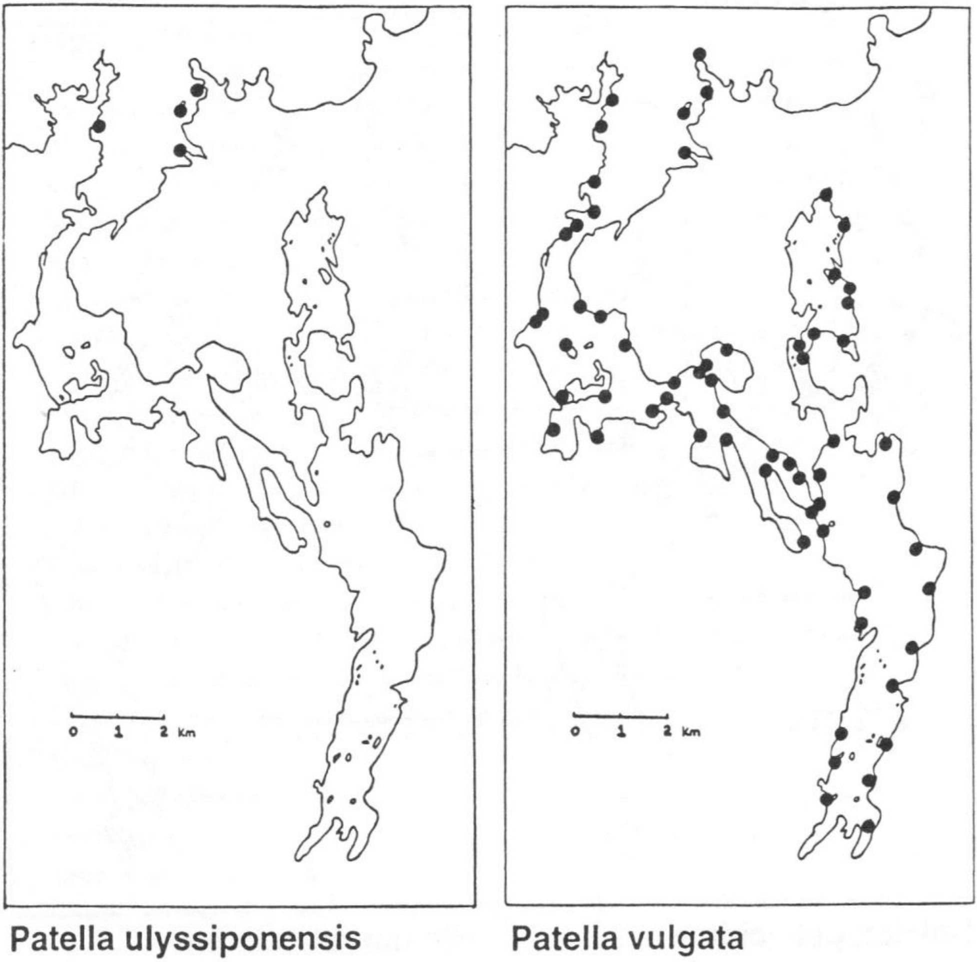
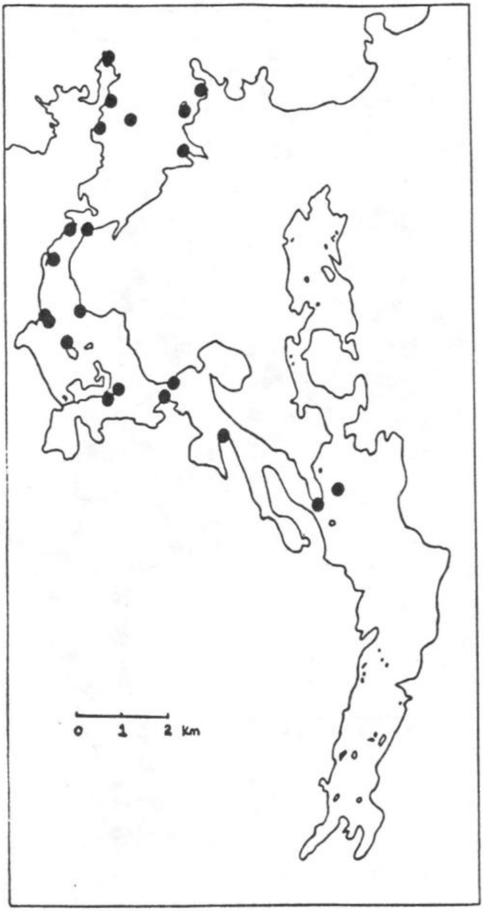
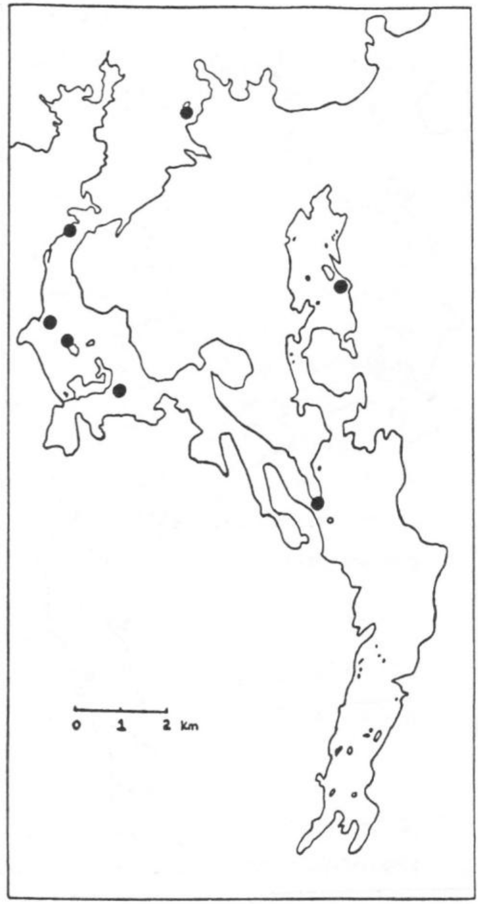


FIGURE 14: distribution maps of *Helcion pellucidum* and *Bittium reticulatum*.

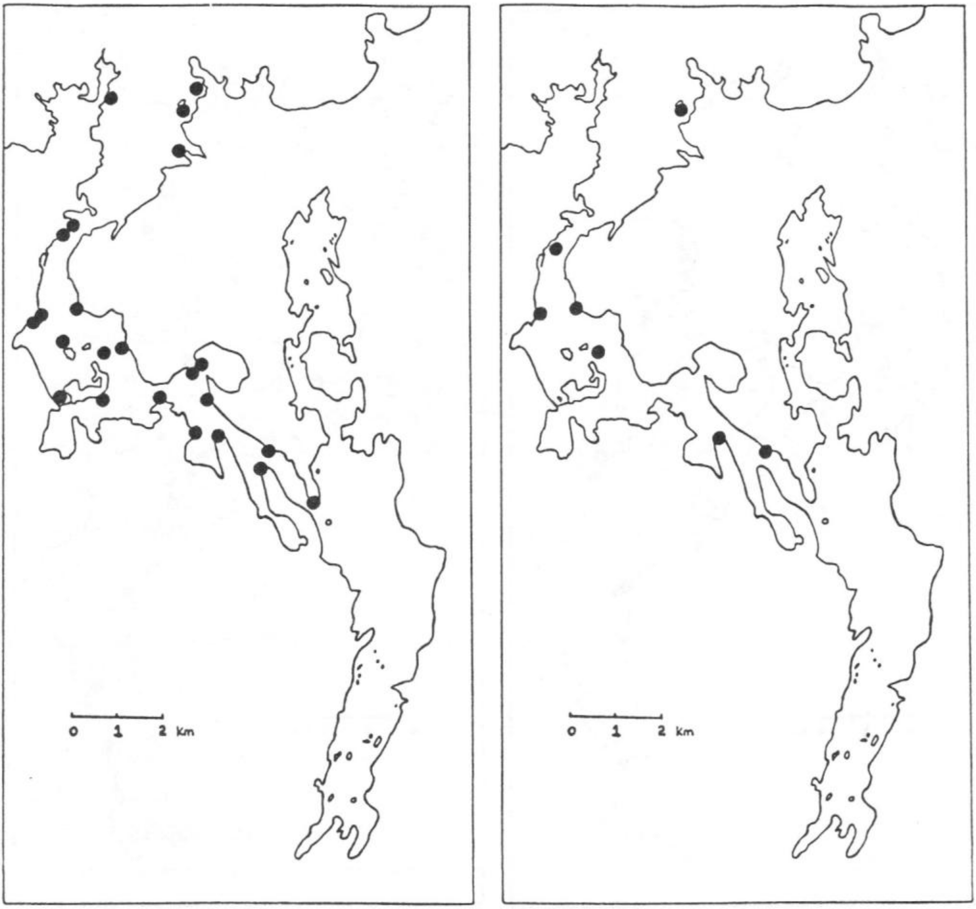


Helcion pellucidum



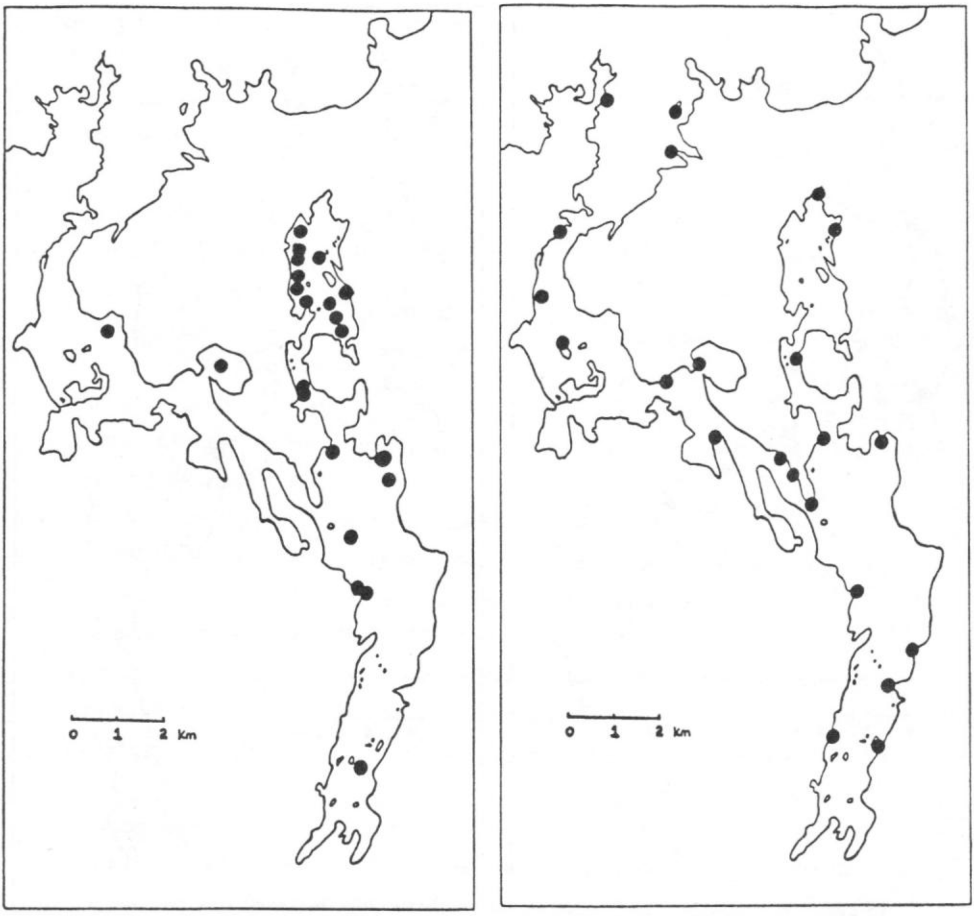
Bittium reticulatum

FIGURE 15: distribution maps of *Cerithiopsis tubercularis* and *Marshallora adversa*.



Cerithiopsis tubercularis **Marshallora adversa**

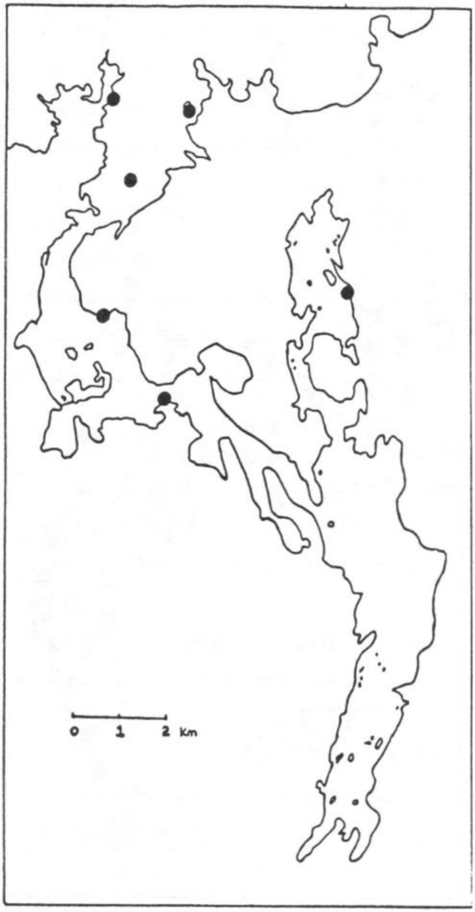
FIGURE 16: distribution maps of *Turritella communis* and *Lacuna pallidula*.



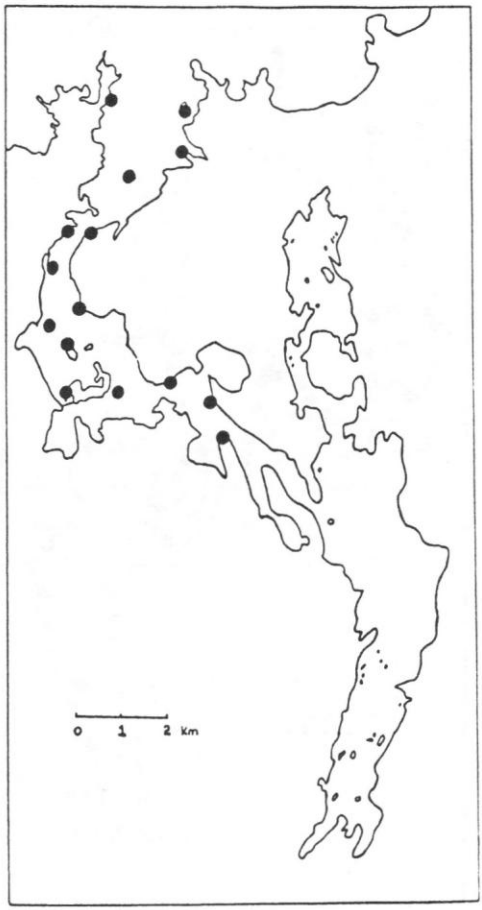
Turritella communis

Lacuna pallidula

FIGURE 17: distribution maps of *Lacuna parva* and *Lacuna vincta*.

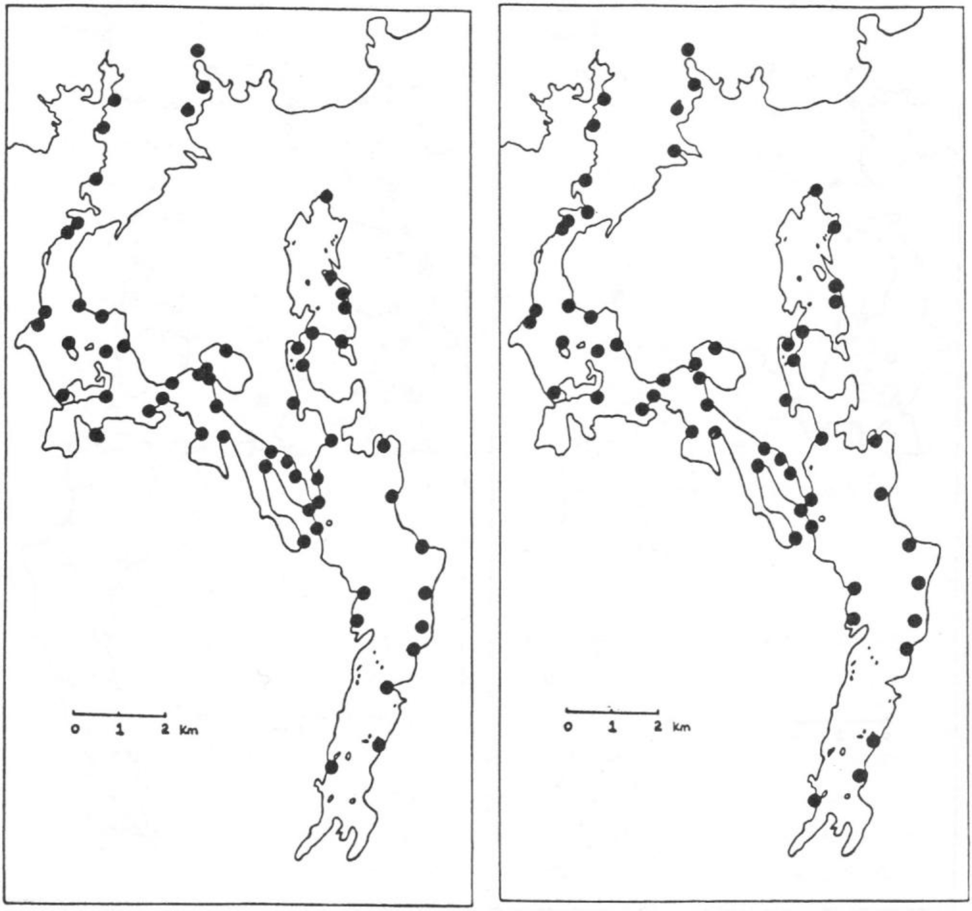


Lacuna parva



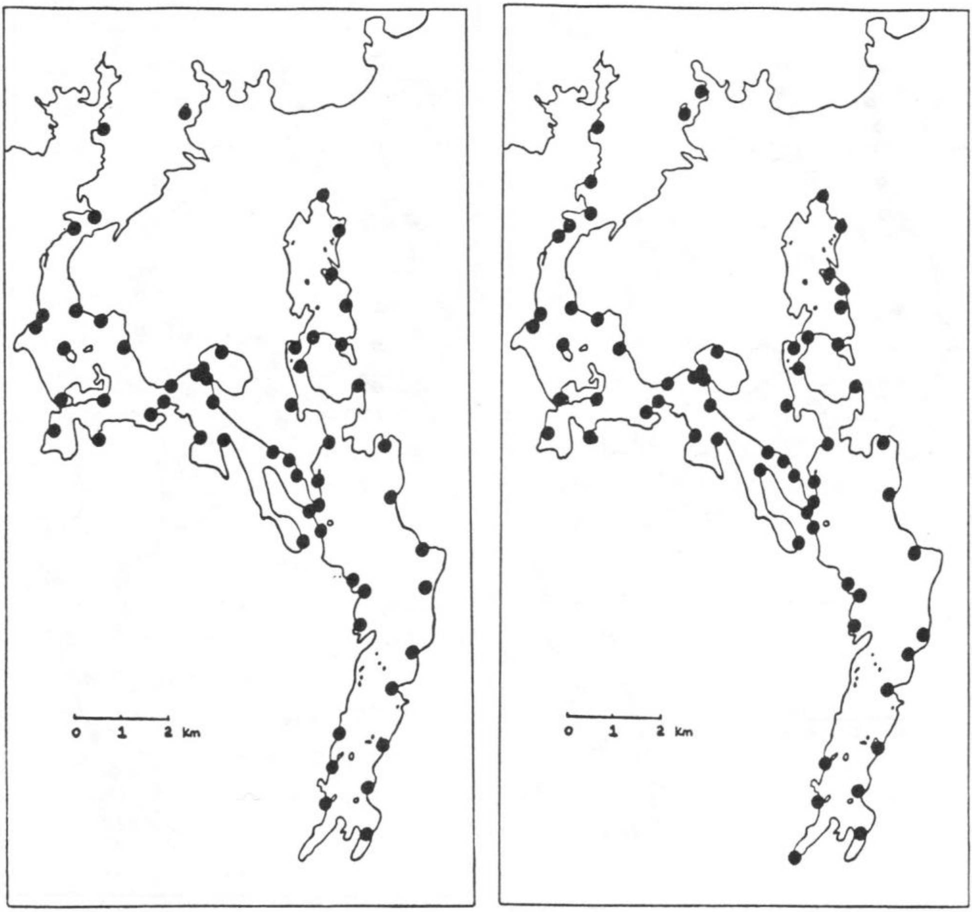
Lacuna vincta

FIGURE 18: distribution maps of *Littorina littorea* and *Littorina mariae*.



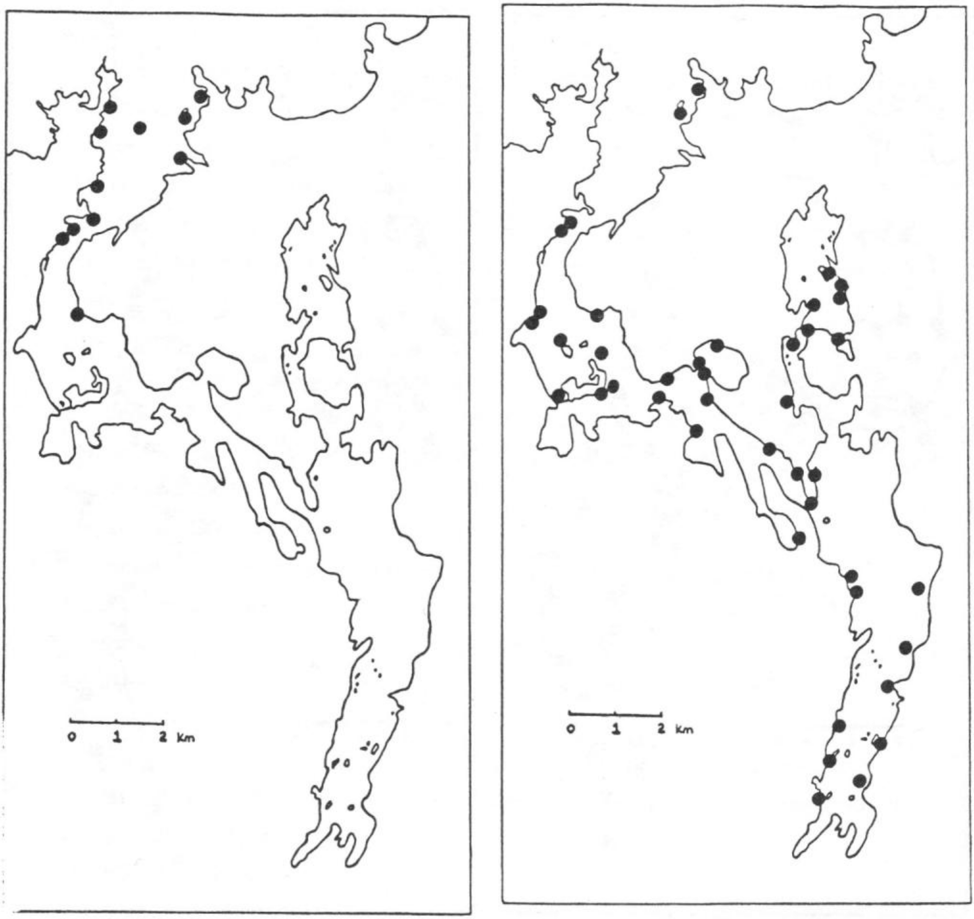
Littorina littorea **Littorina mariae**

FIGURE 19: distribution maps of *Littorina obtusata* and *Littorina saxatilis*.



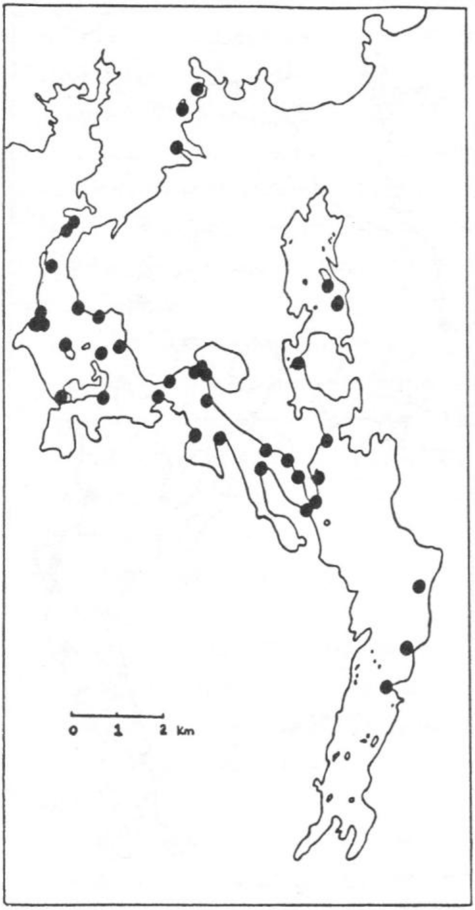
Littorina obtusata **Littorina saxatilis**

FIGURE 20: distribution maps of *Melarhaphe neritoides* and *Skeneopsis planorbis*.

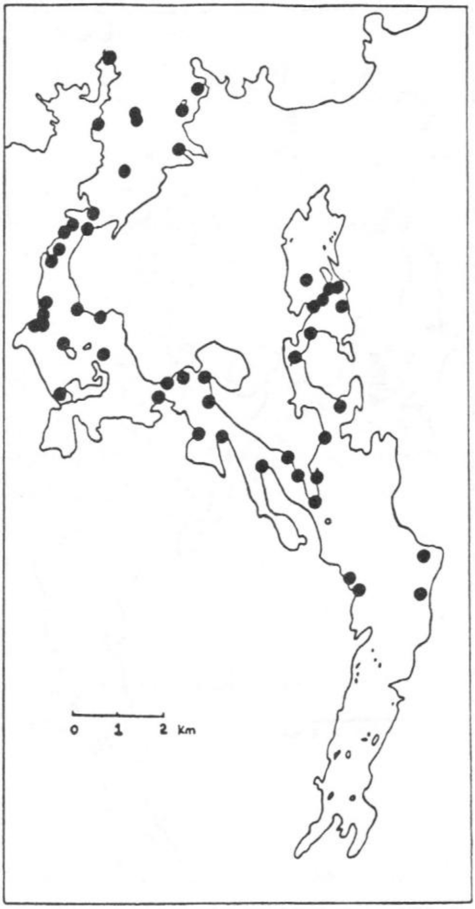


Melarhaphe neritoides   Skeneopsis planorbis

FIGURE 21: distribution maps of *Eatonina fulgida* and *Rissoa interrupta*.

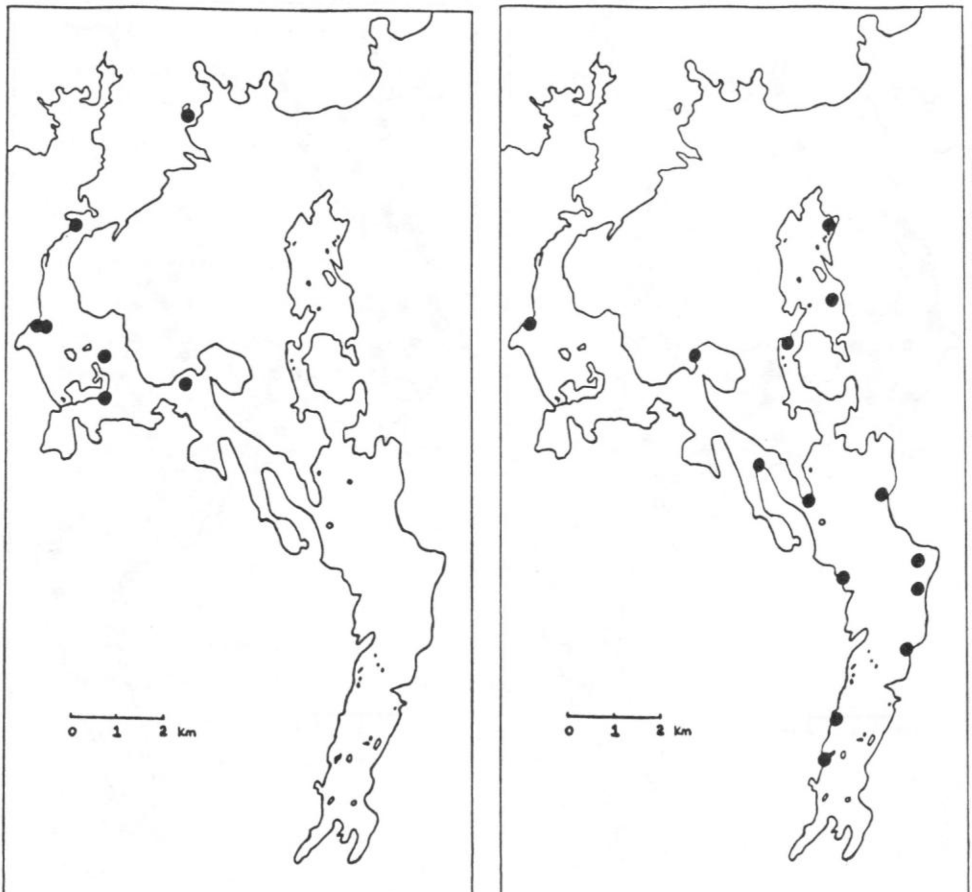


Eatonina fulgida



Rissoa interrupta

FIGURE 22: distribution maps of *Rissoa lilacina* and *Rissoa membranacea*.



Rissoa lilacina

Rissoa membranacea

FIGURE 23: distribution maps of *Rissoa parva* and *Alvania punctura*.

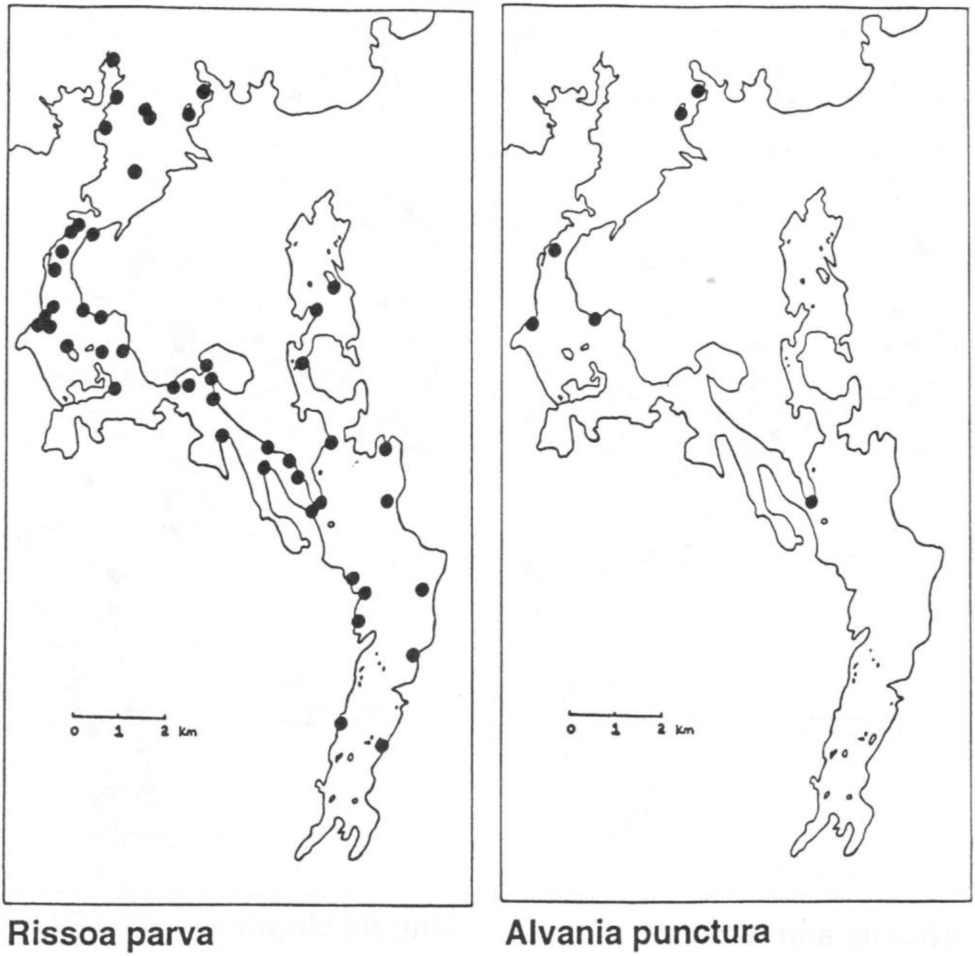
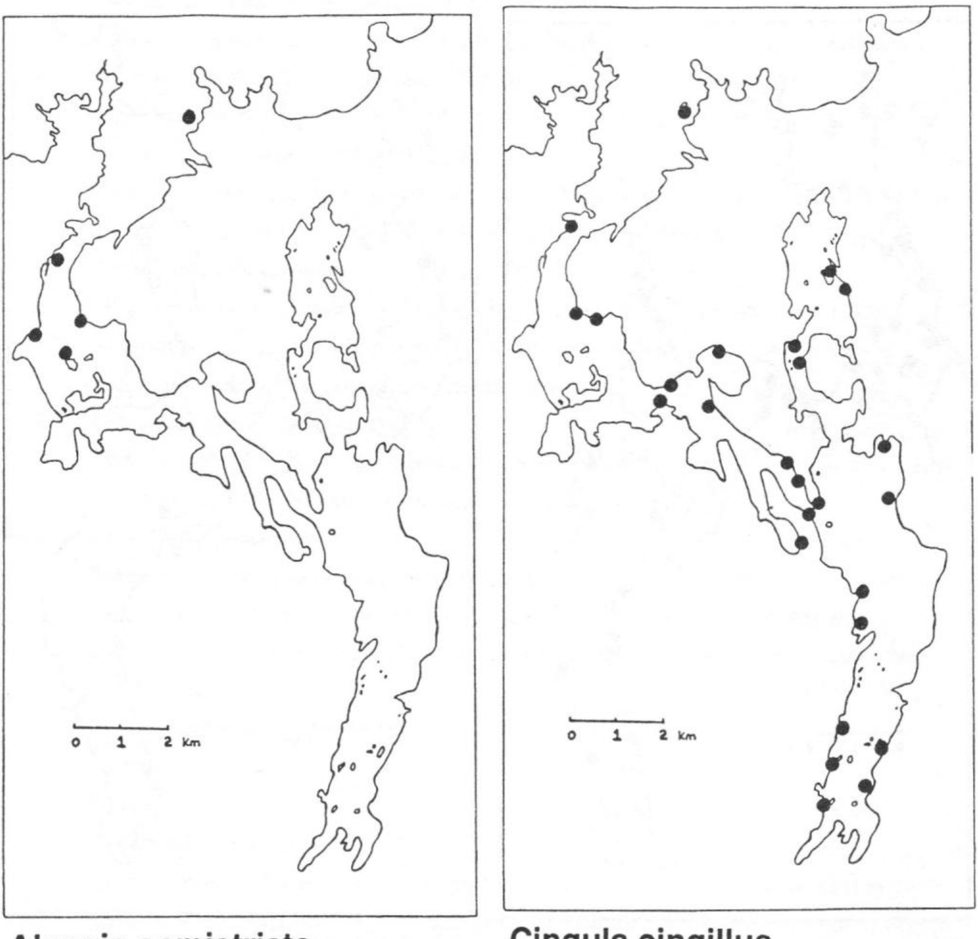
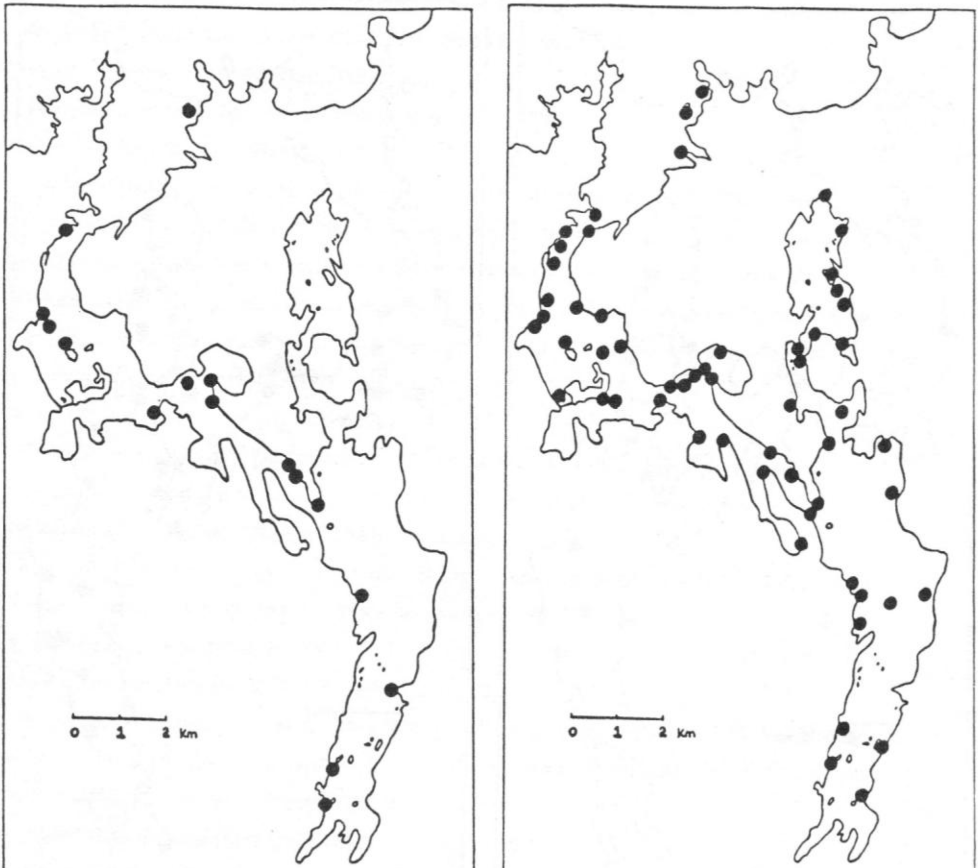


FIGURE 24: distribution maps of *Alvania semistriata* and *Cingula cingillus*.



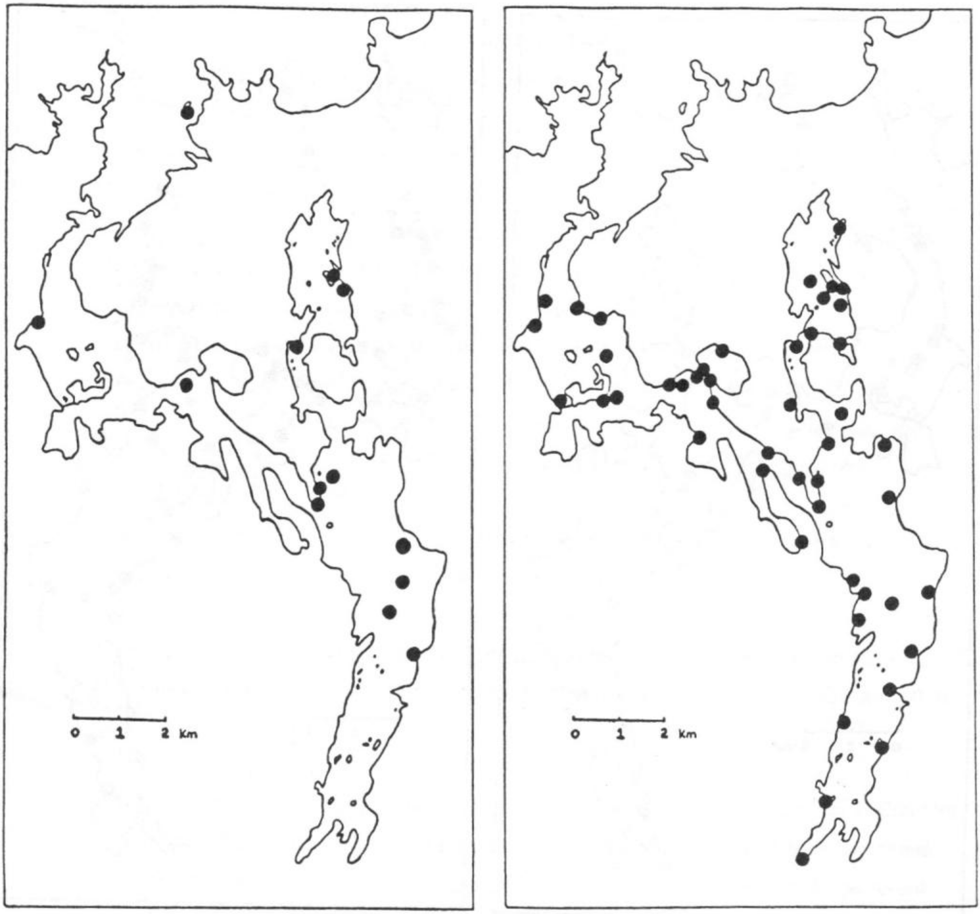
Alvania semistriata **Cingula cingillus**

FIGURE 25: distribution maps of *Onoba aculeus* and *Onoba semicostata*.



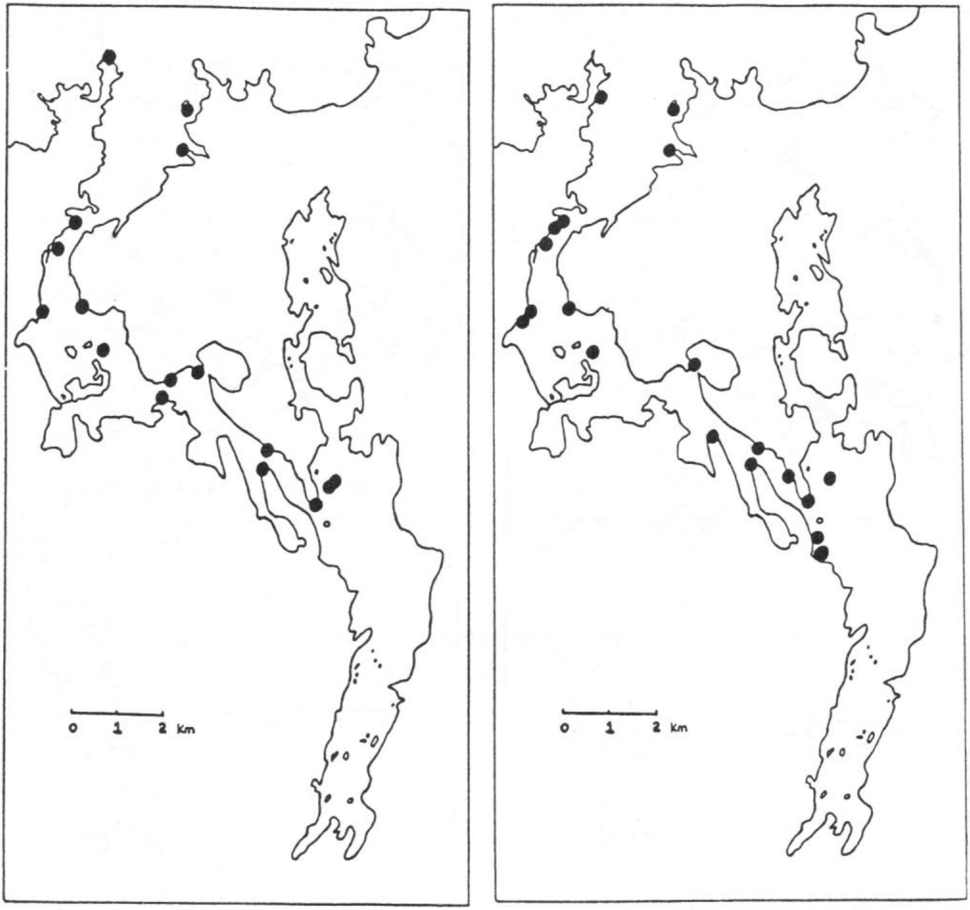
Onoba aculeus **Onoba semicostata**

FIGURE 26: distribution maps of *Pusillina inconspicua* and *Pusillina sarsi*.



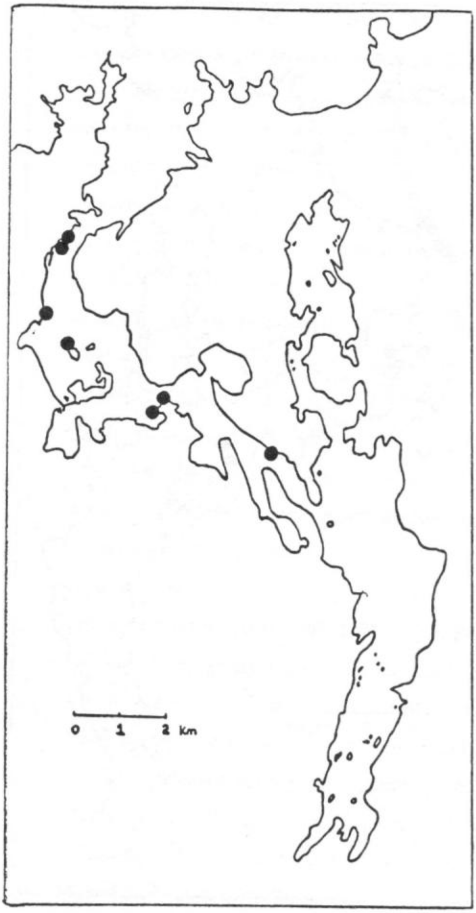
Pusillina inconspicua **Pusillina sarsi**

FIGURE 27: distribution maps of *Trivia arctica* and *Trivia monacha*.

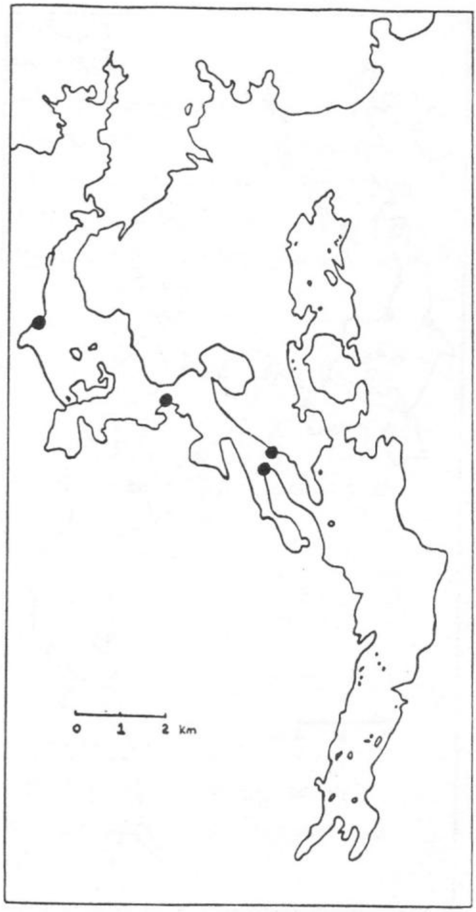


Trivia arctica **Trivia monacha**

FIGURE 28: distribution maps of *Lamellaria latens* and *Lamellaria perspicua*.



Lamellaria latens



Lamellaria perspicua

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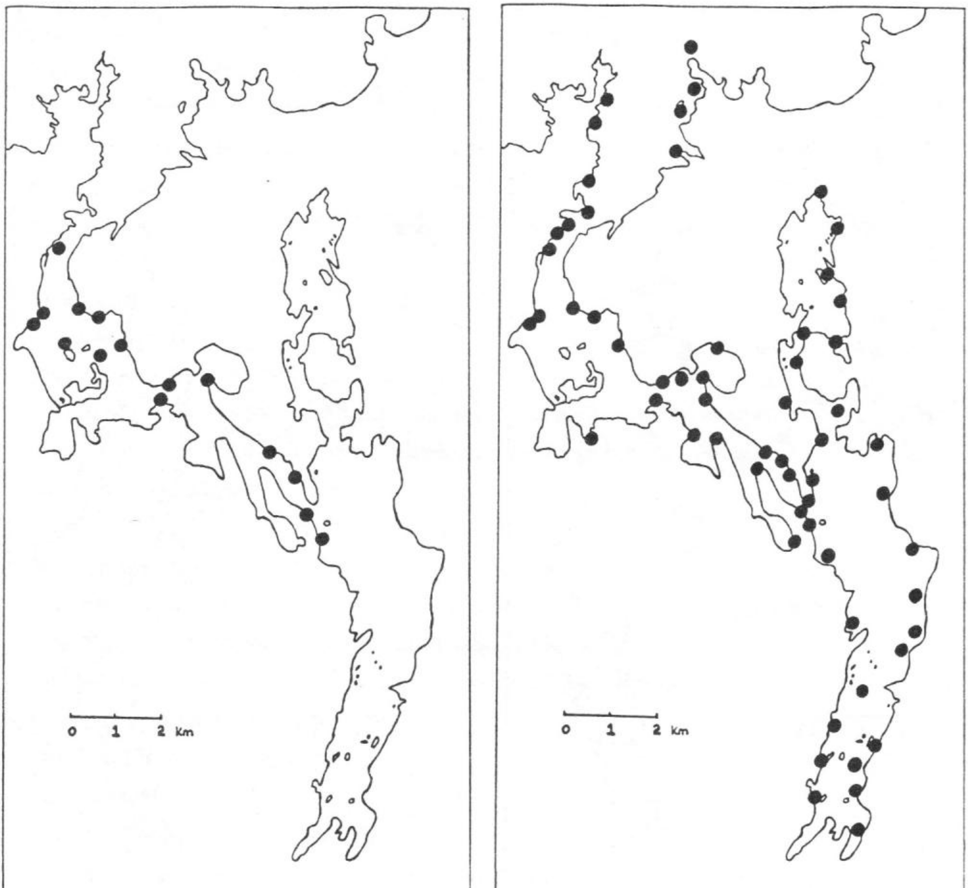
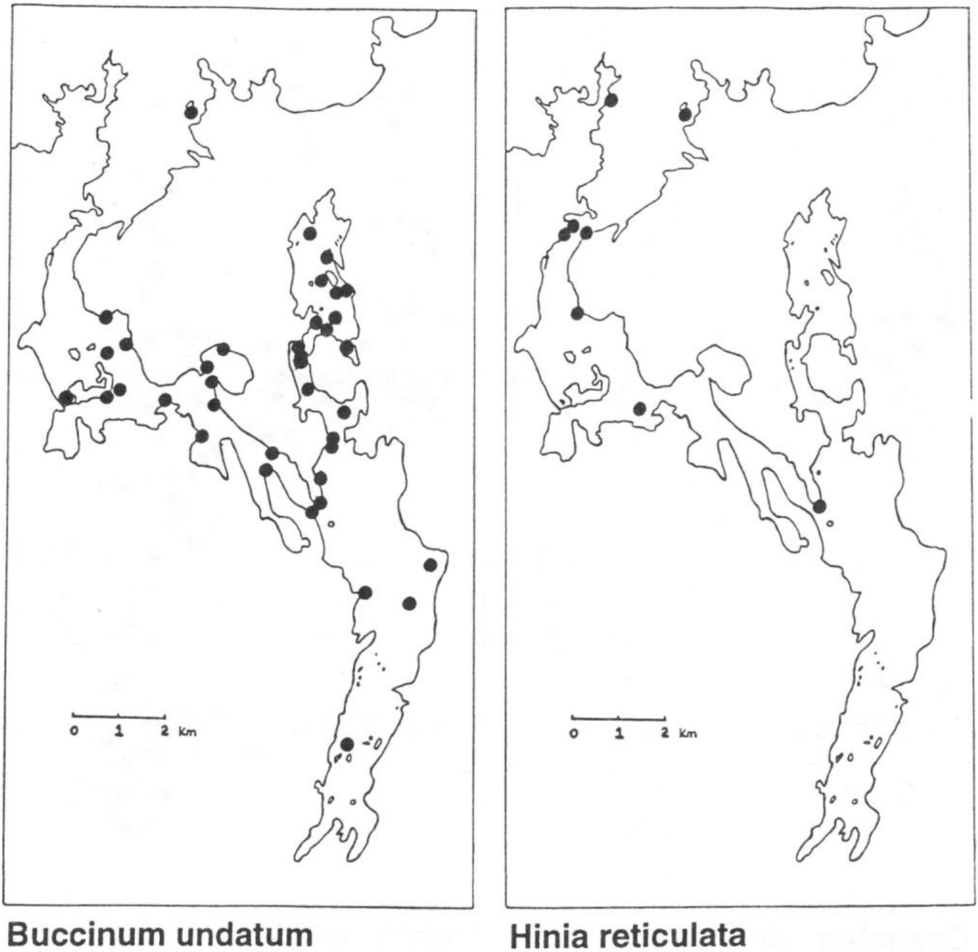
FIGURE 29: distribution maps of *Ocenebra erinacea* and *Nucella lapillus*.



Ocenebra erinacea **Nucella lapillus**

FIGURE 30: distribution maps of *Buccinum undatum* and *Hinia reticulata*.



Buccinum undatum **Hinia reticulata**

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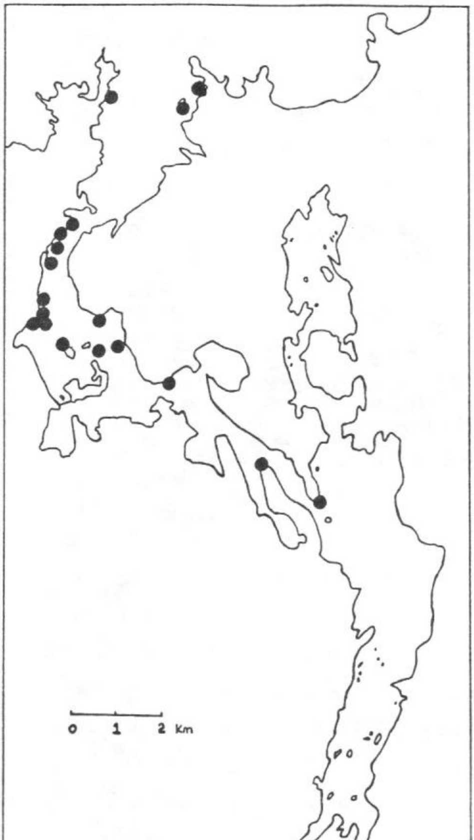
FIGURE 31: distribution maps of *Hinia incrassata* and *Raphitoma linearis*.



Hinia incrassata

Raphitoma linearis

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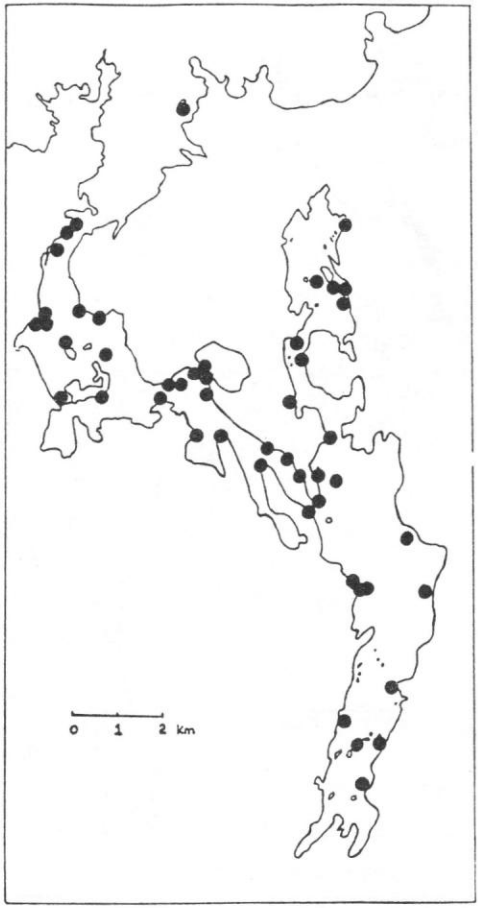
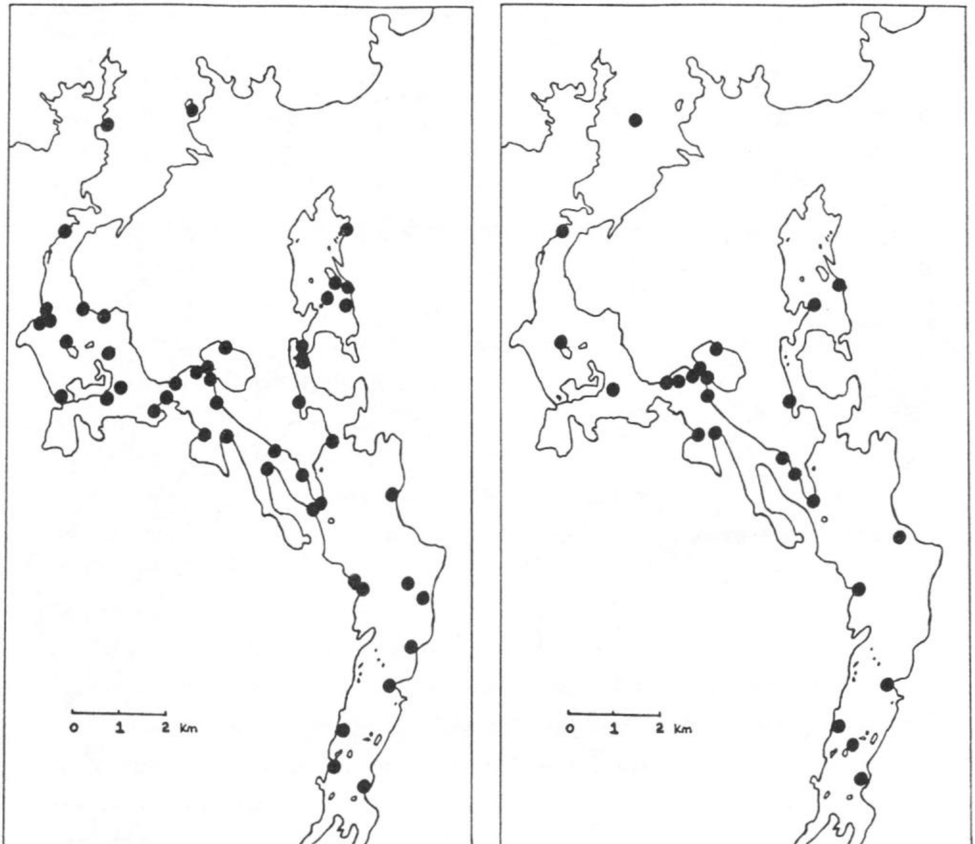
FIGURE 32: distribution maps of *Rissoella diaphana* and *Rissoella opalina*.

Rissoella diaphana



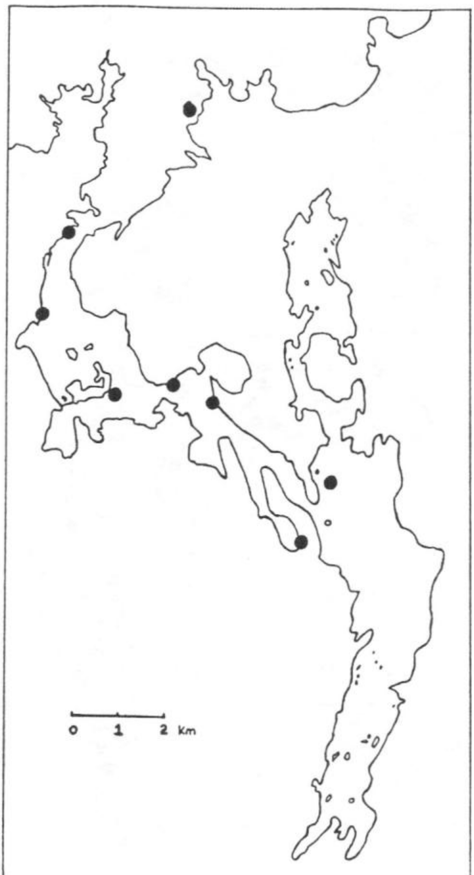
Rissoella opalina

FIGURE 33: distribution maps of *Omalogyra atomus* and *Ammonicerina rota*.

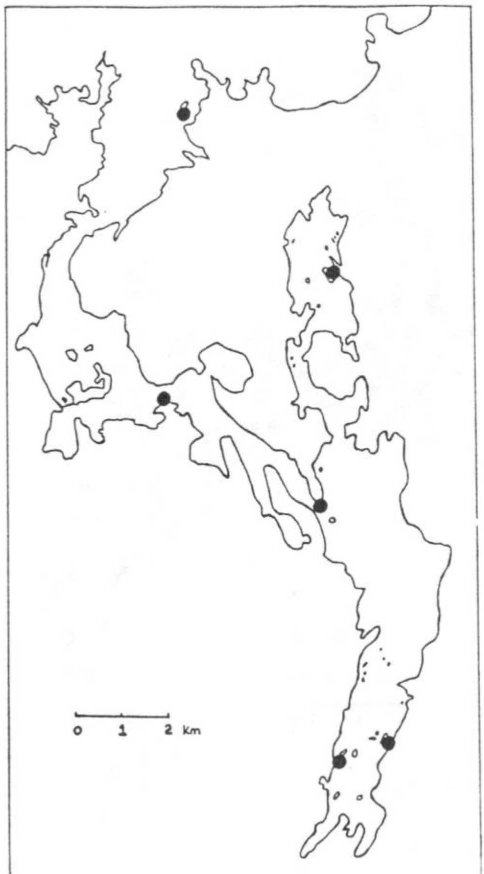


Omalogyra atomus **Ammonicerina rota**

FIGURE 34: distribution maps of *Odostomia turrita* and *Brachystomia scalaris*.

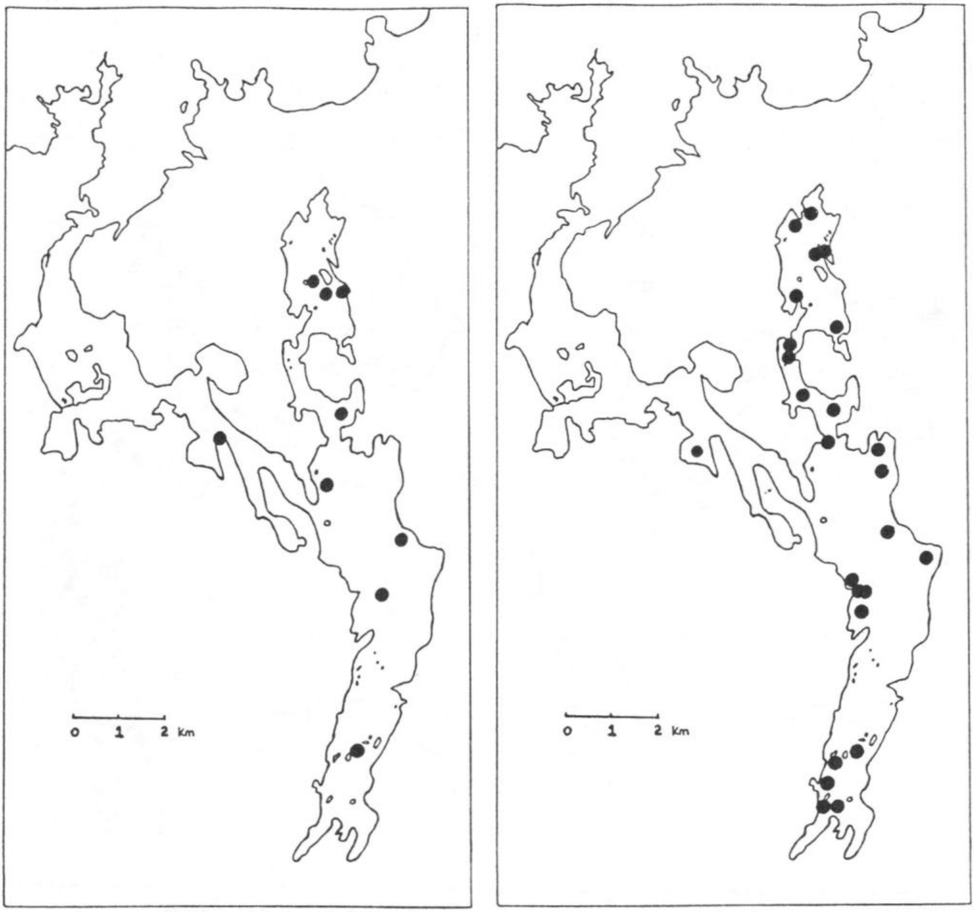


Odostomia turrita



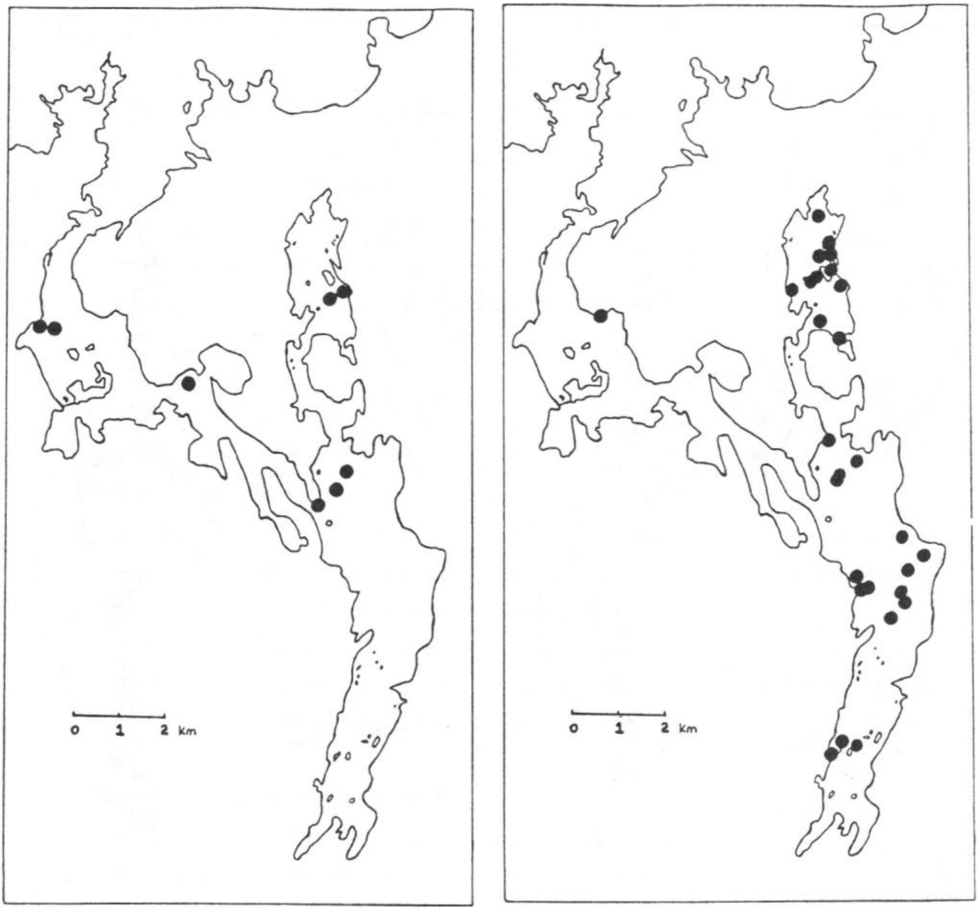
Brachystomia scalaris

FIGURE 35: distribution maps of *Chrysallida interstincta* and *Philine aperta*.



Chrysallida interstincta **Philine aperta**

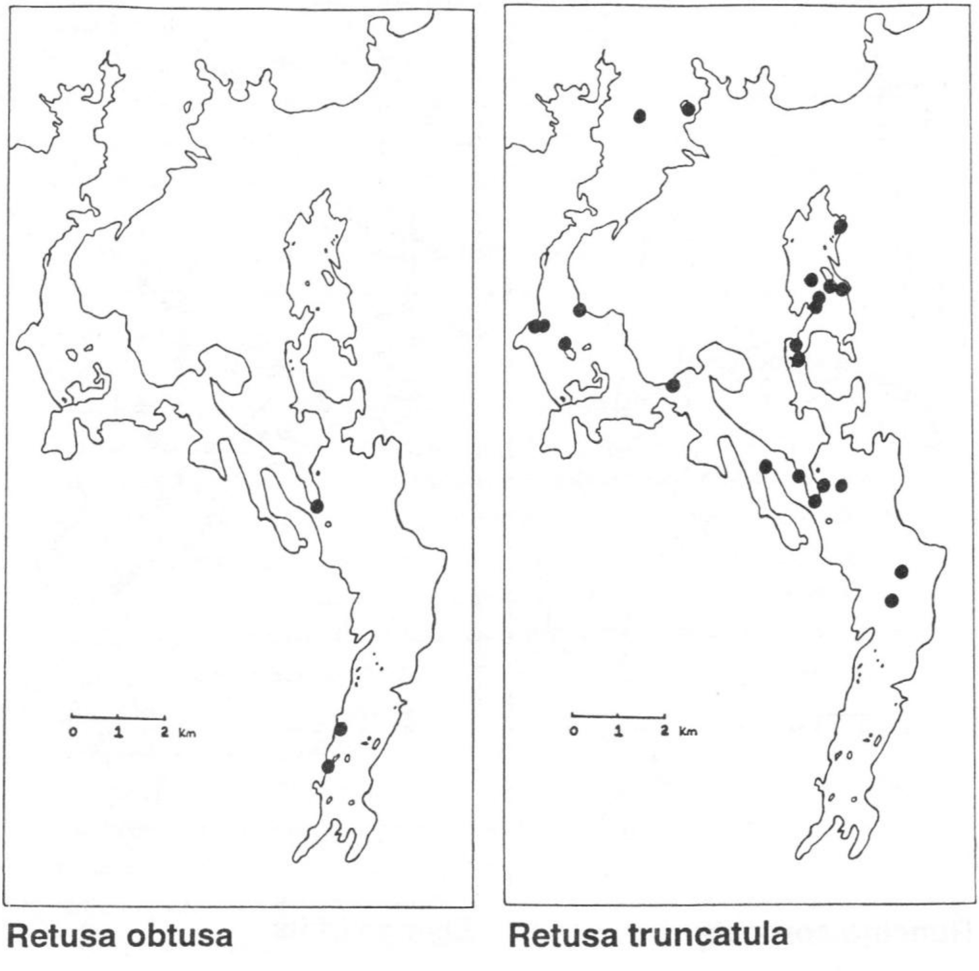
FIGURE 36: distribution maps of *Diaphana minuta* and *Haminoea navicula*.



Diaphana minuta **Haminoea navicula**

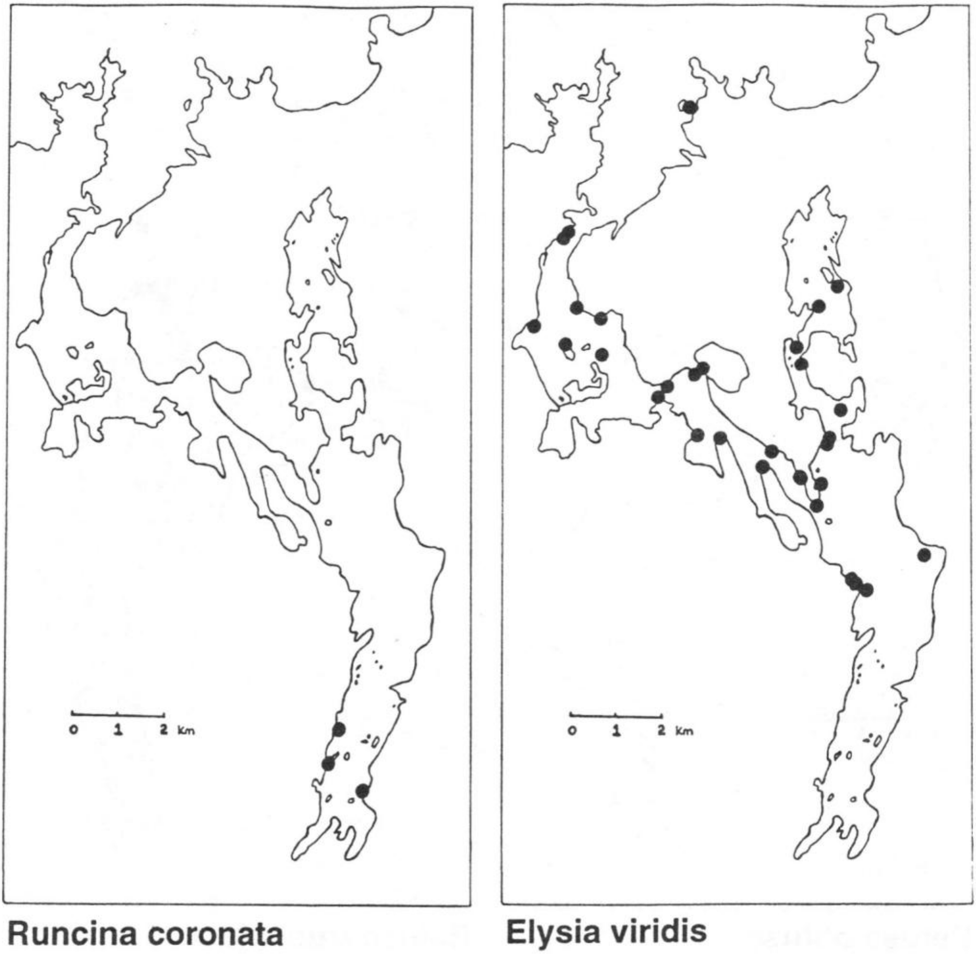
Bull. Ir. biogeog. Soc. No. 19

FIGURE 37: distribution maps of *Retusa obtusa* and *Retusa truncatula*.



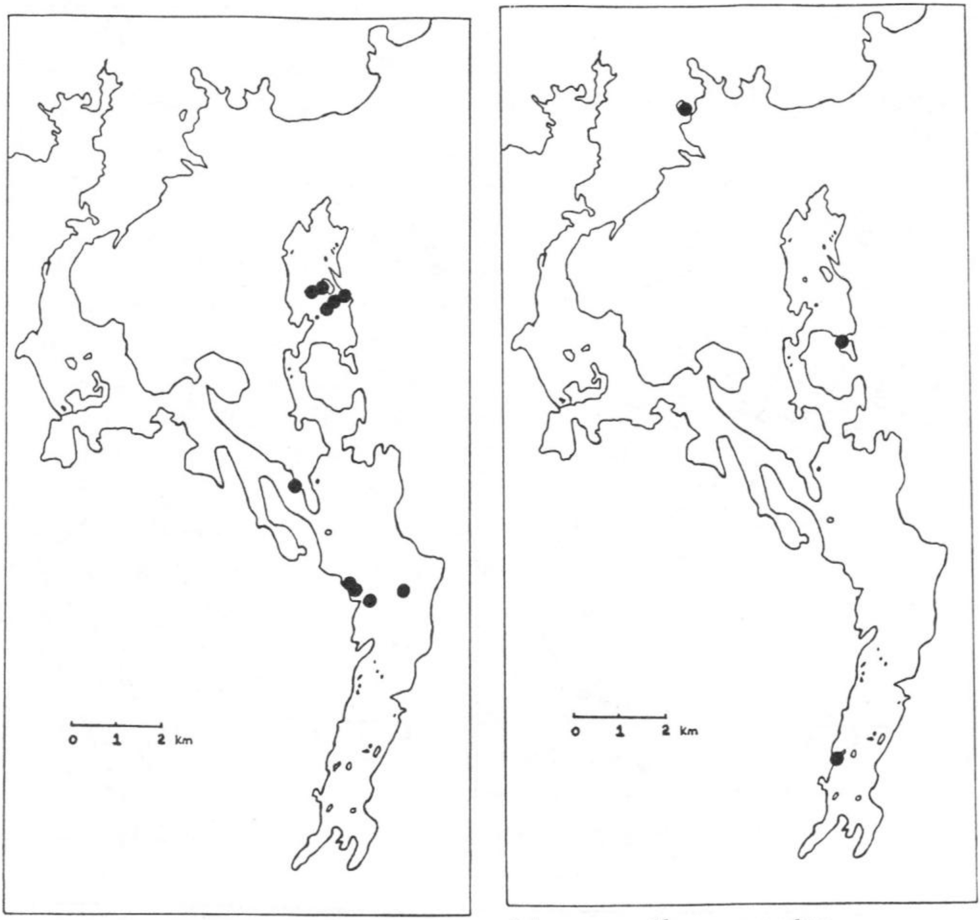
Retusa obtusa **Retusa truncatula**

FIGURE 38: distribution maps of *Runcina coronata* and *Elysia viridis*.



Runcina coronata **Elysia viridis**

FIGURE 39: distribution maps of *Hermaea bifida* and *Limapontia senestra*.



Hermaea bifida **Limapontia senestra**

FIGURE 40: distribution maps of *Akera bullata* and *Aplysia punctata*.

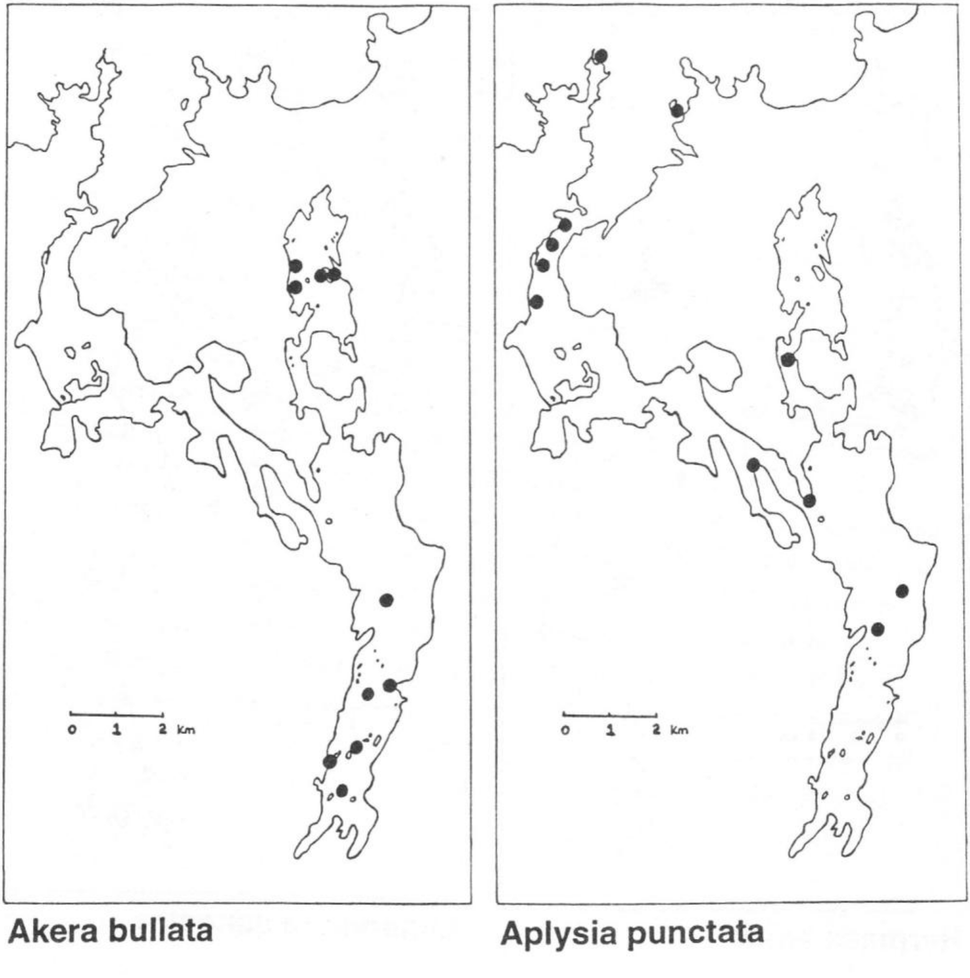


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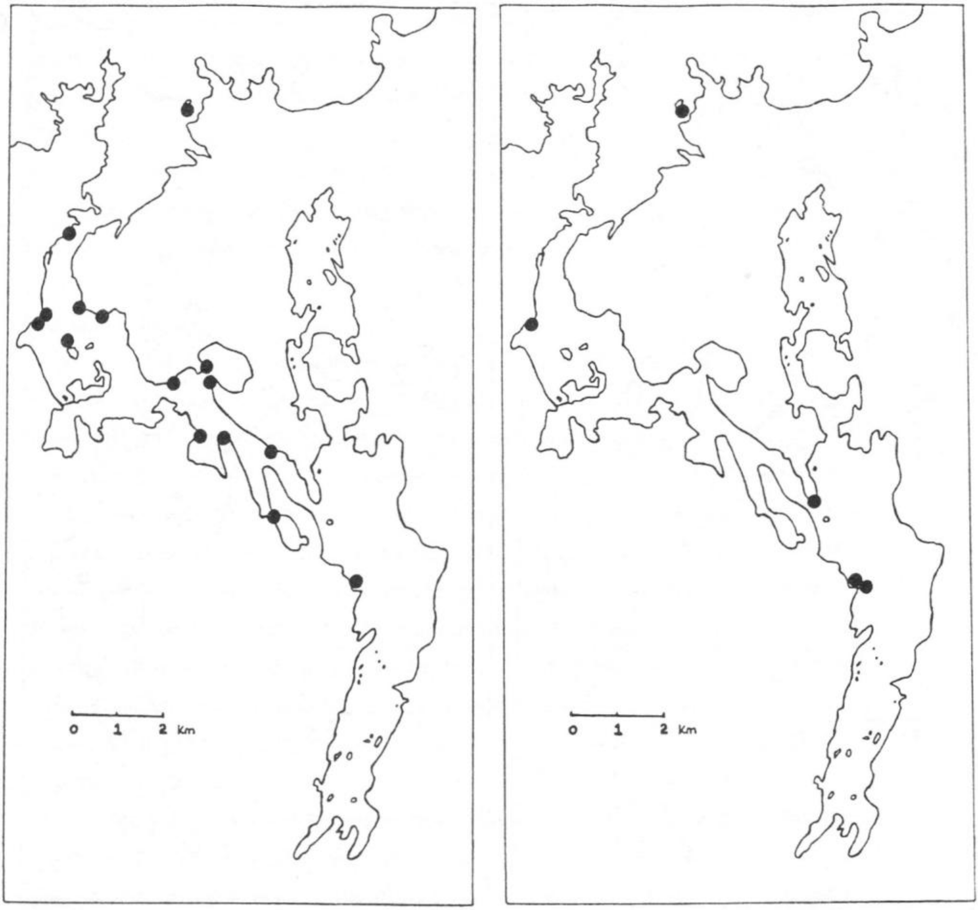
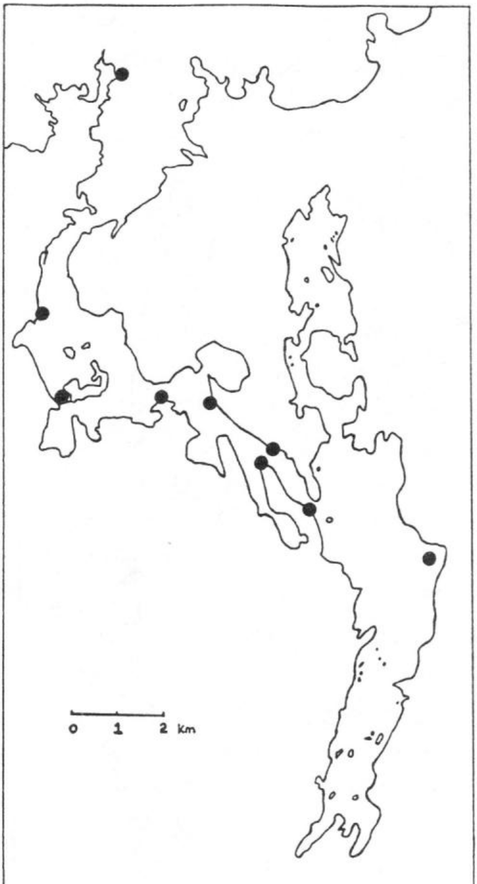
FIGURE 41: distribution maps of *Berthella plumula* and *Goniodoris nodosa*.

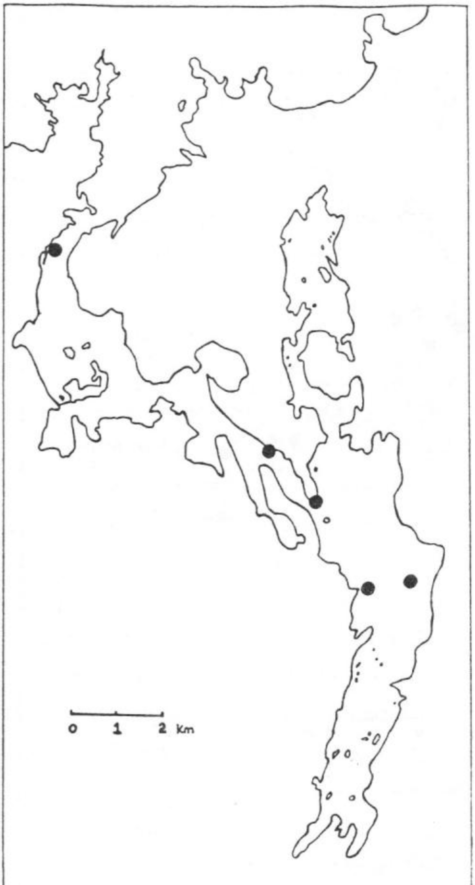


Berthella plumula **Goniodoris nodosa**

FIGURE 42: distribution maps of *Acanthodoris pilosa* and *Aegires punctilucens*.



Acanthodoris pilosa



Aegires punctilucens

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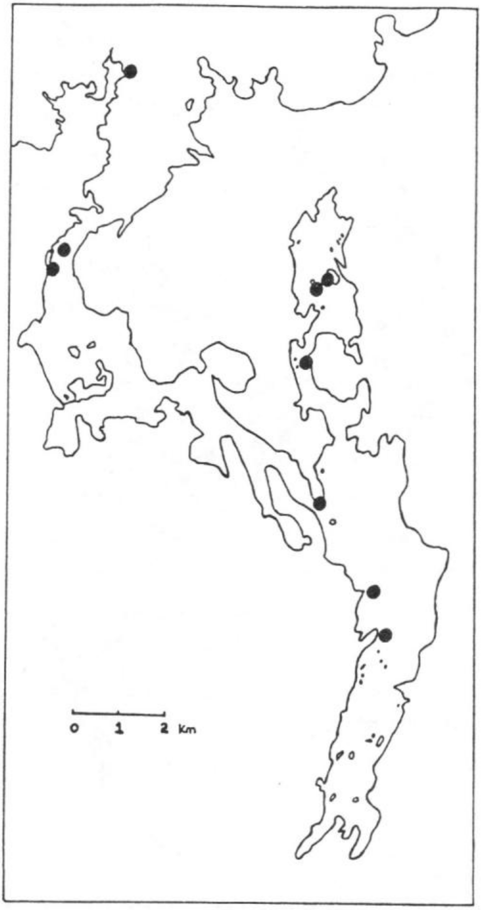
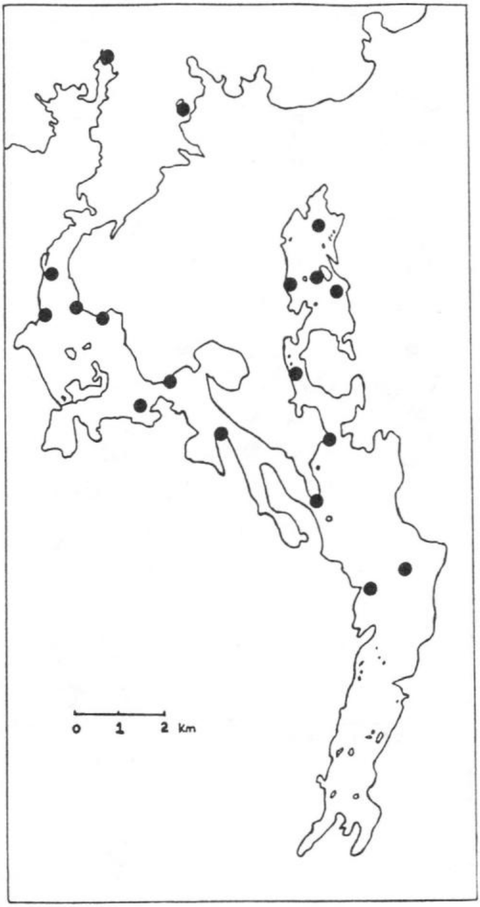
FIGURE 43: distribution maps of *Limacia clavigera* and *Cadlina laevis*.



Limacia clavigera



Cadlina laevis

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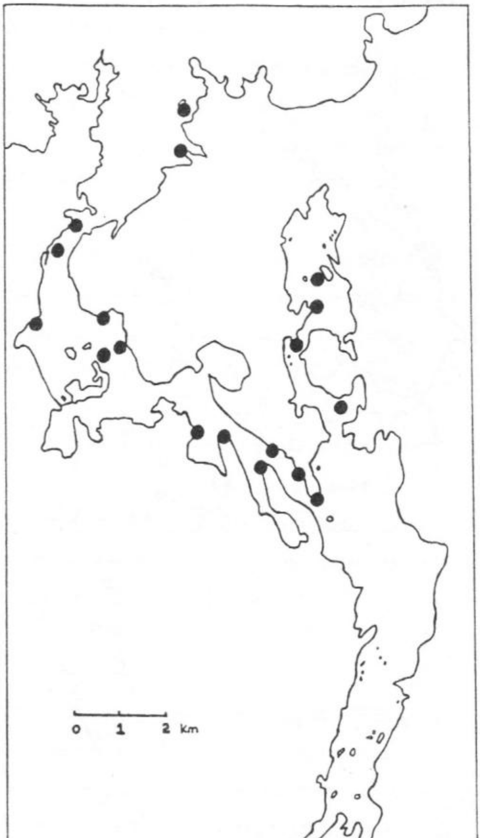
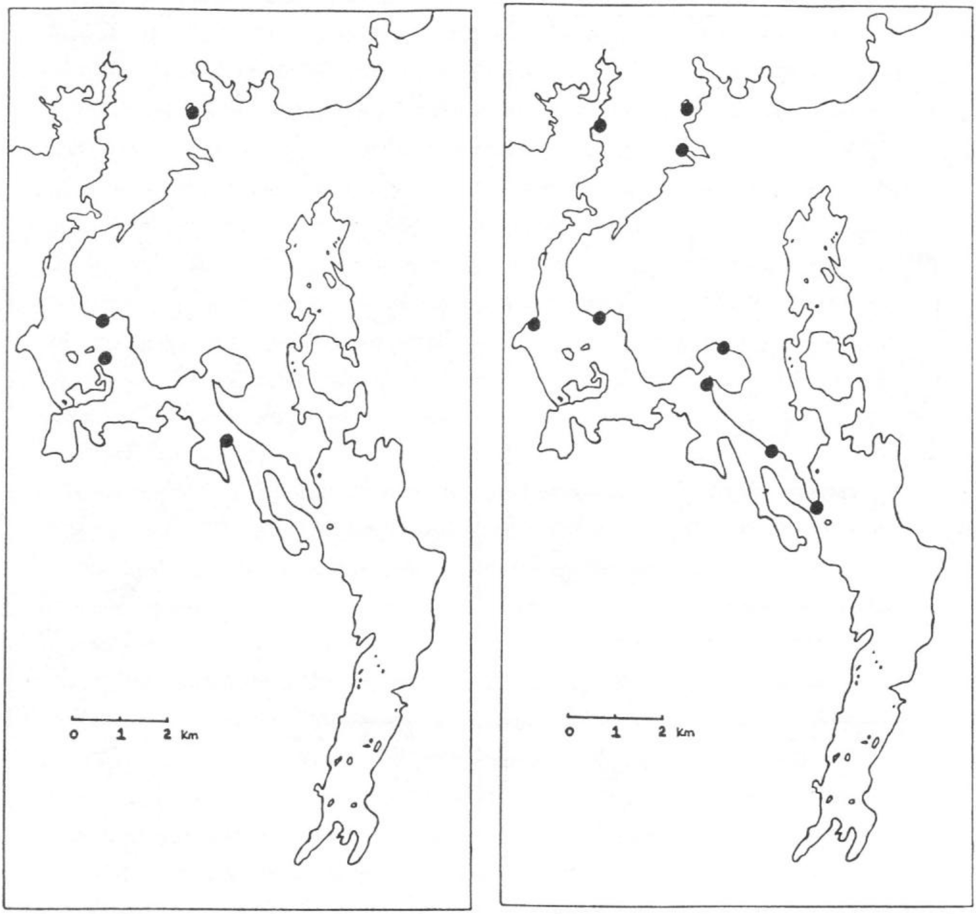
FIGURE 44: distribution maps of *Rostanga rubra* and *Archidoris pseudoargus*.

Rostanga rubra



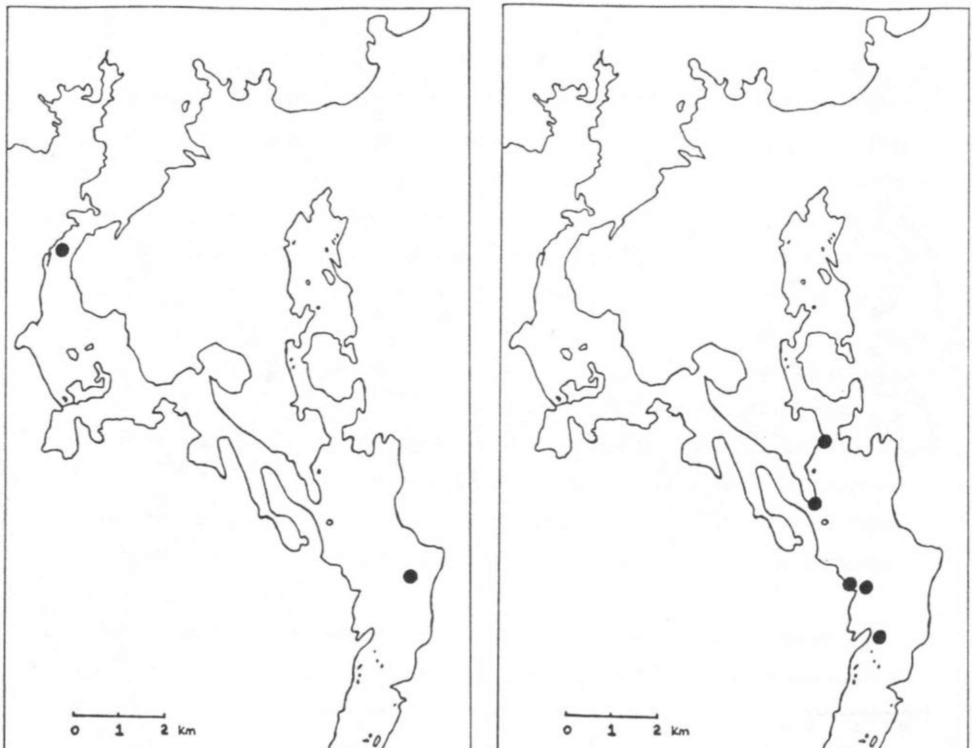
Archidoris pseudoargus

FIGURE 45: distribution maps of *Geitodoris planata* and *Jorunna tomentosa*.



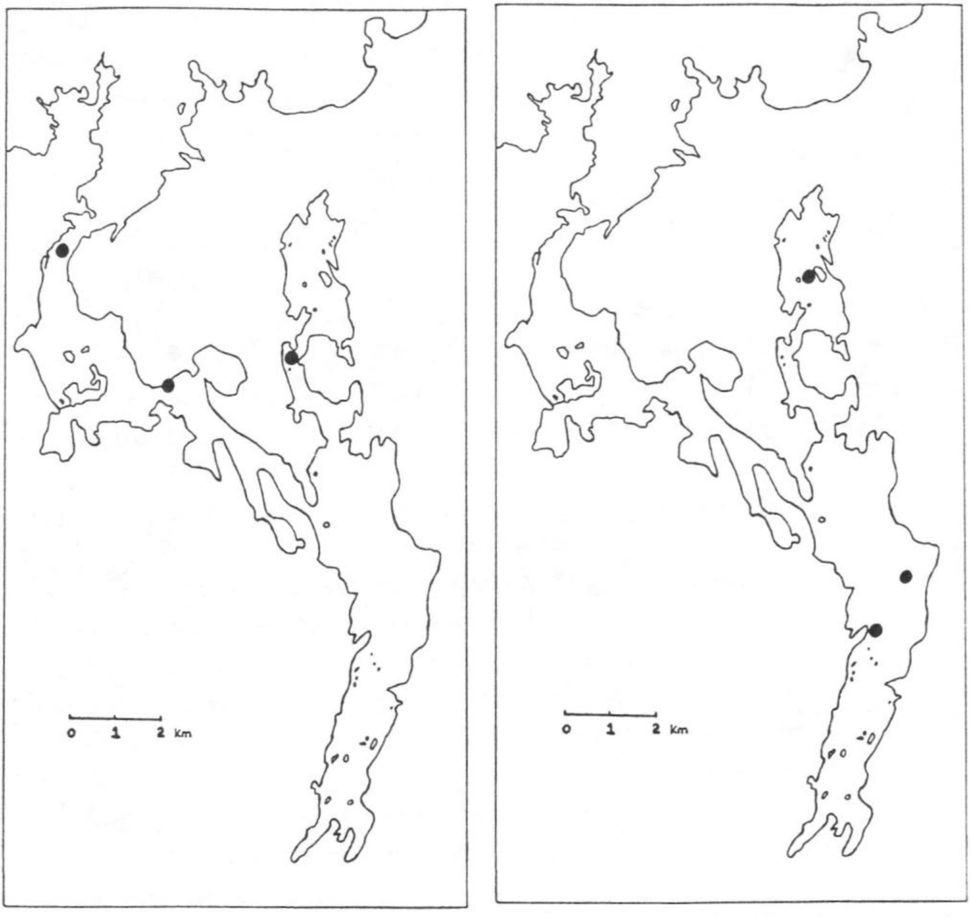
Geitodoris planata **Jorunna tomentosa**

FIGURE 46: distribution maps of *Janolus cristatus* and *Flabellina pedata*.



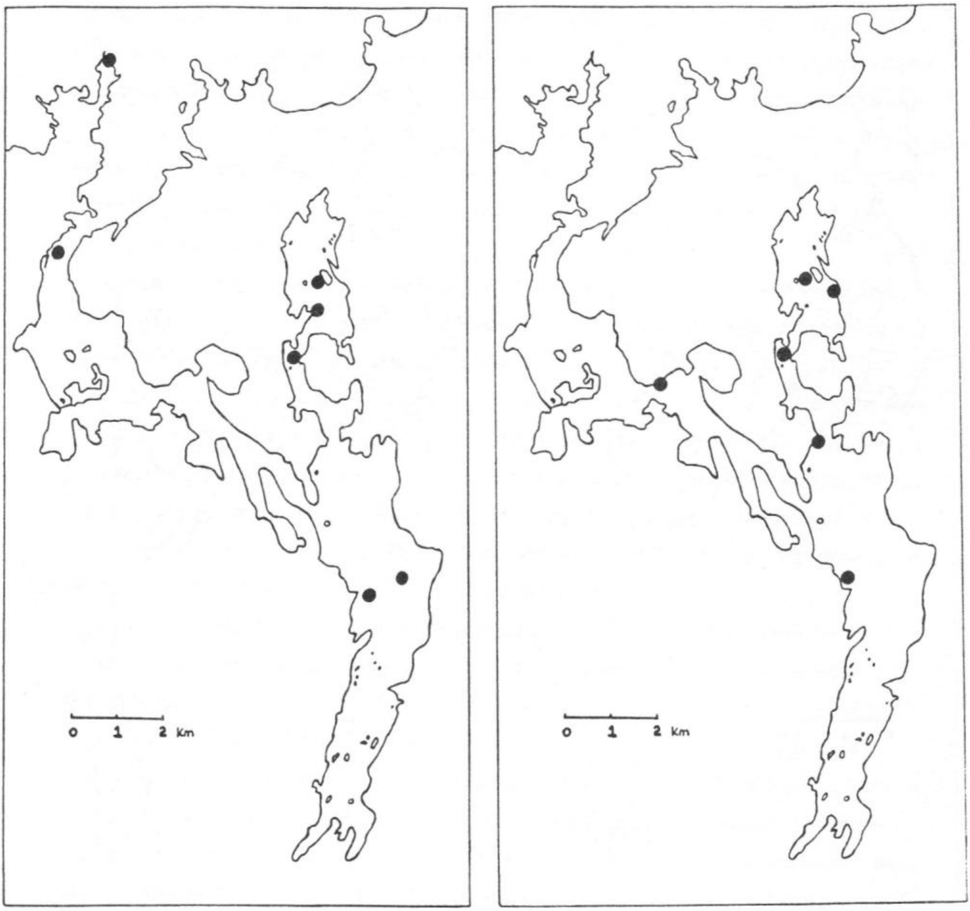
Janolus cristatus **Flabellina pedata**

FIGURE 47: distribution maps of *Tergipes tergipes* and *Eubranchus doriae*.



Tergipes tergipes **Eubranchus doriae**

FIGURE 48: distribution maps of *Eubranchus exiguus* and *Eubranchus farrani*.



Eubranchus exiguus **Eubranchus farrani**

FIGURE 49: distribution maps of *Eubranchus tricolor* and *Aeolidia papillosa*.

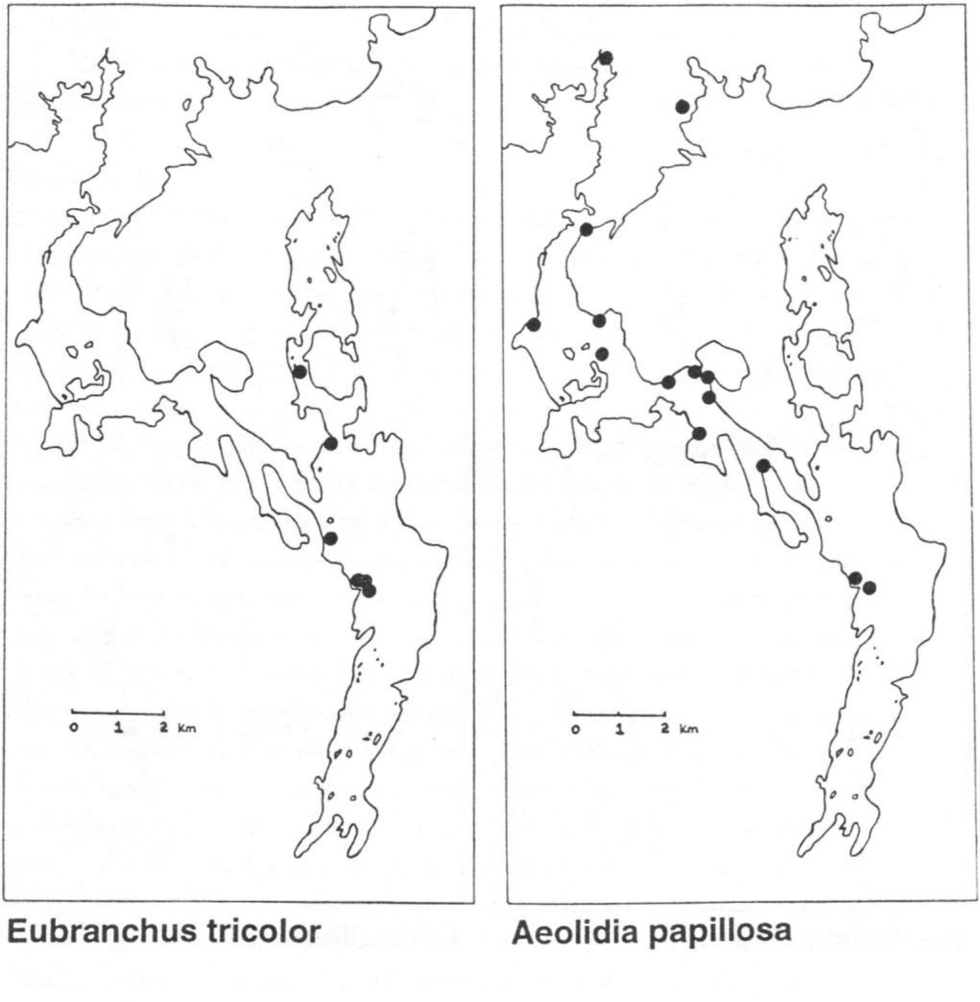
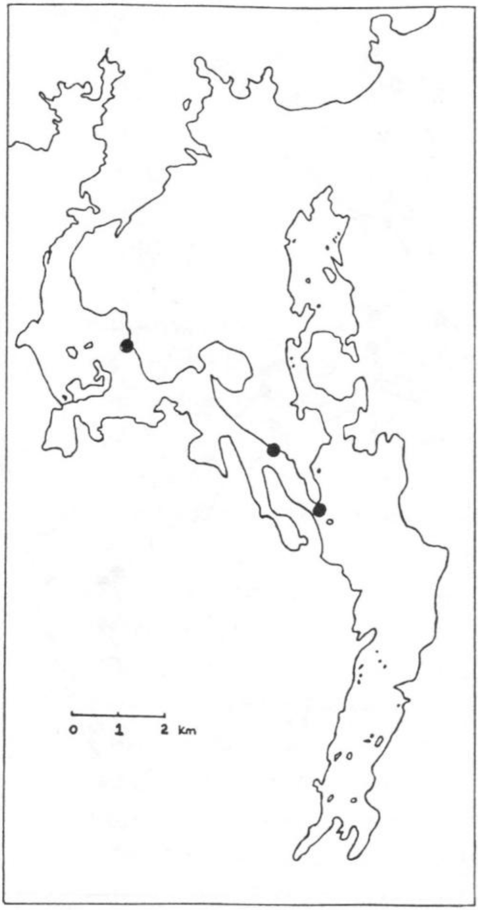
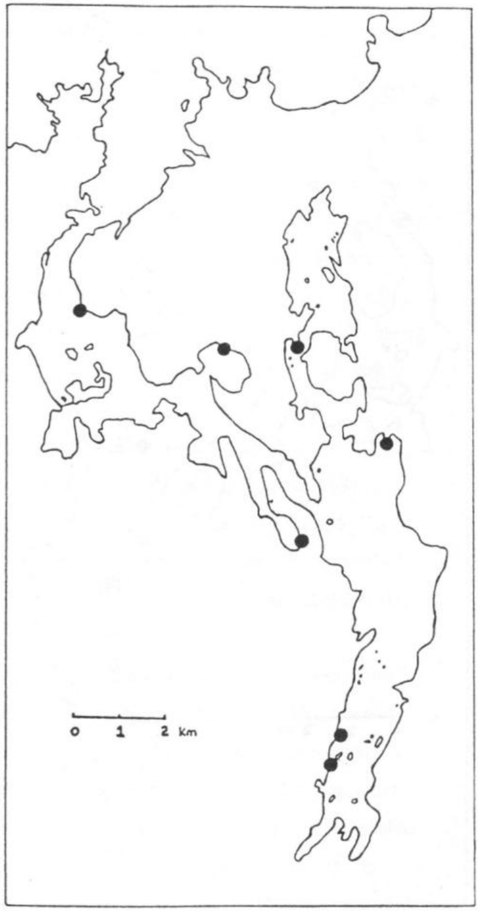


FIGURE 50: distribution maps of *Aeolidiella alderi* and *Auriculinella bidentata*.

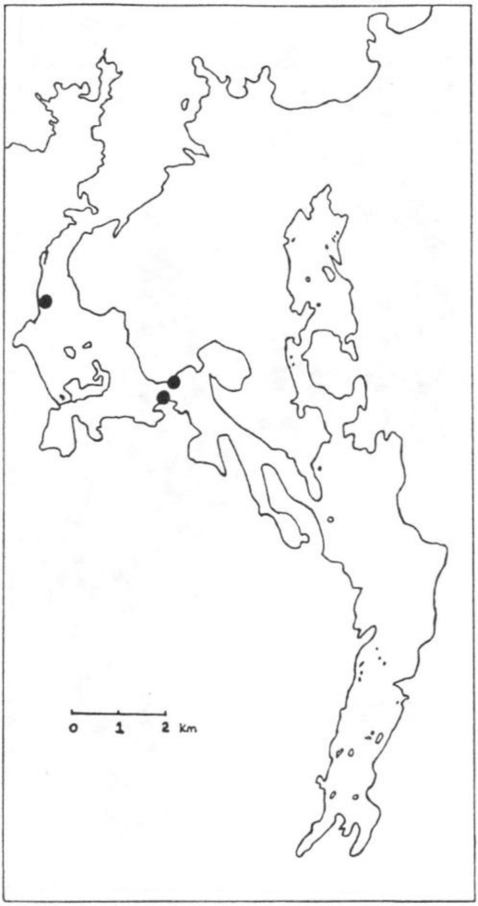


Aeolidiella alderi



Auriculinella bidentata

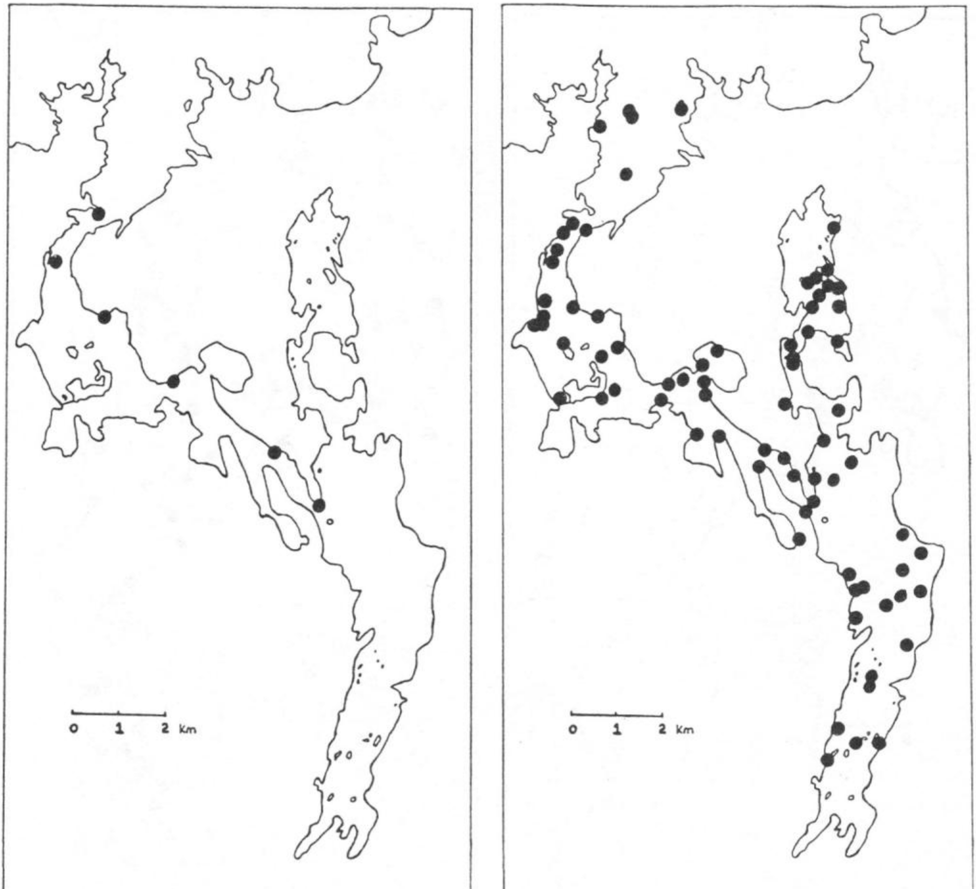
FIGURE 51: distribution maps of *Arca tetragona* and *Mytilus edulis*.



Arca tetragona

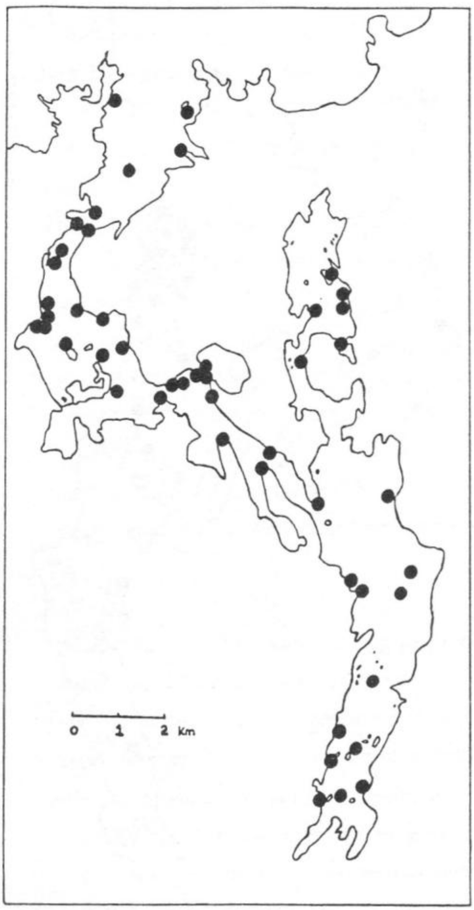
Mytilus edulis

FIGURE 52: distribution maps of *Modiolula phaseolina* and *Modiolarca tumida*.

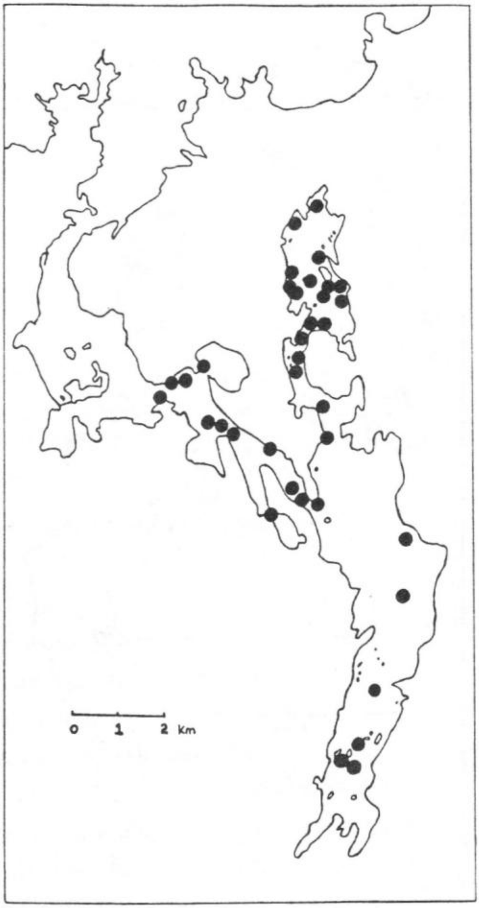


Modiolula phaseolina **Modiolarca tumida**

FIGURE 53: distribution maps of *Musculus discors* and *Limaria hians*.

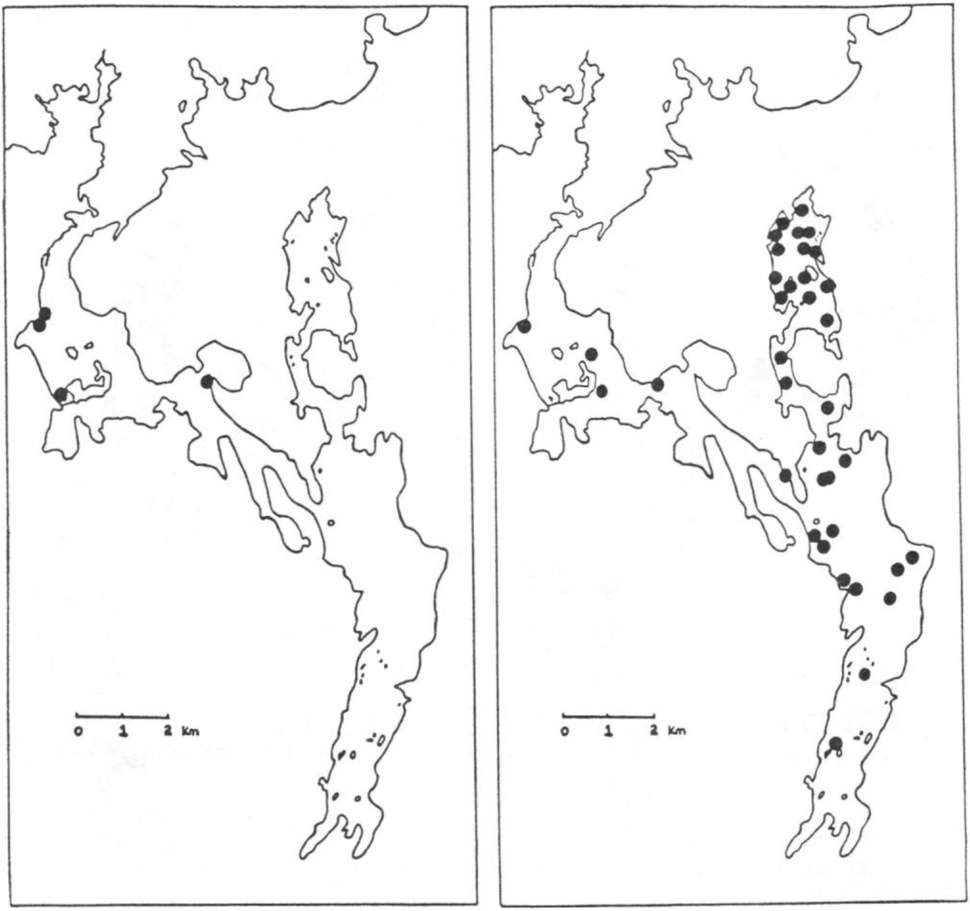


Musculus discors



Limaria hians

FIGURE 54: distribution maps of *Ostrea edulis* and *Pecten maximus*.



Ostrea edulis **Pecten maximus**

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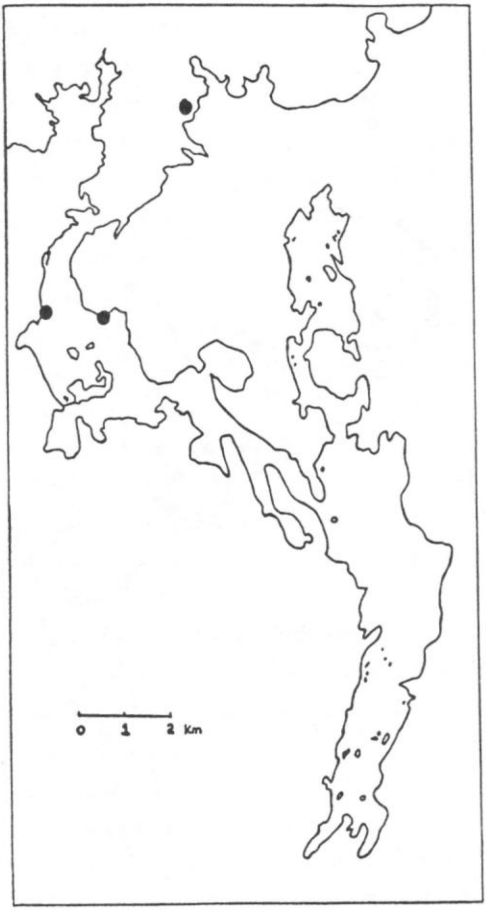
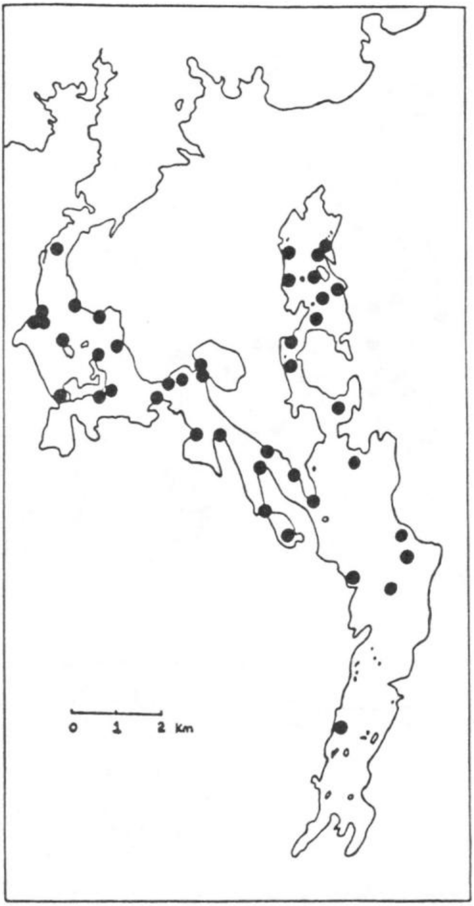
FIGURE 55: distribution maps of *Chlamys distorta* and *Chlamys varia*.



Chlamys distorta



Chlamys varia

FIGURE 56: distribution maps of *Anomia ephippium* and *Heteranomia squamula*.

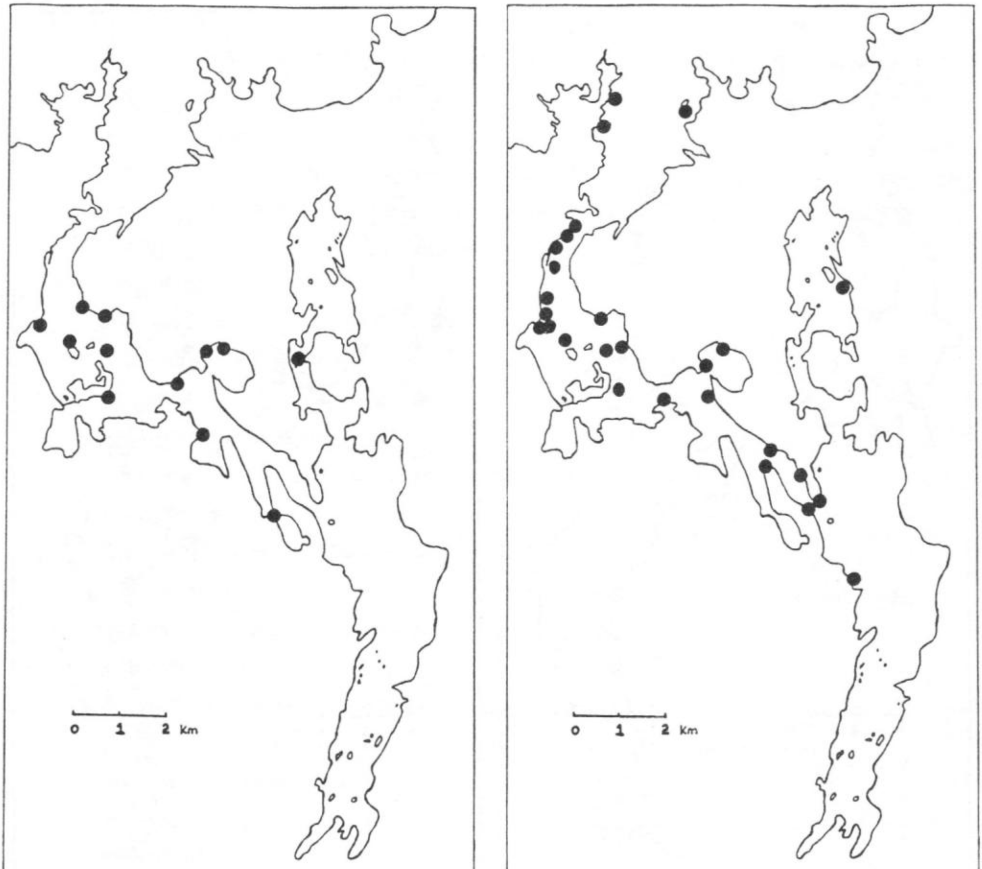


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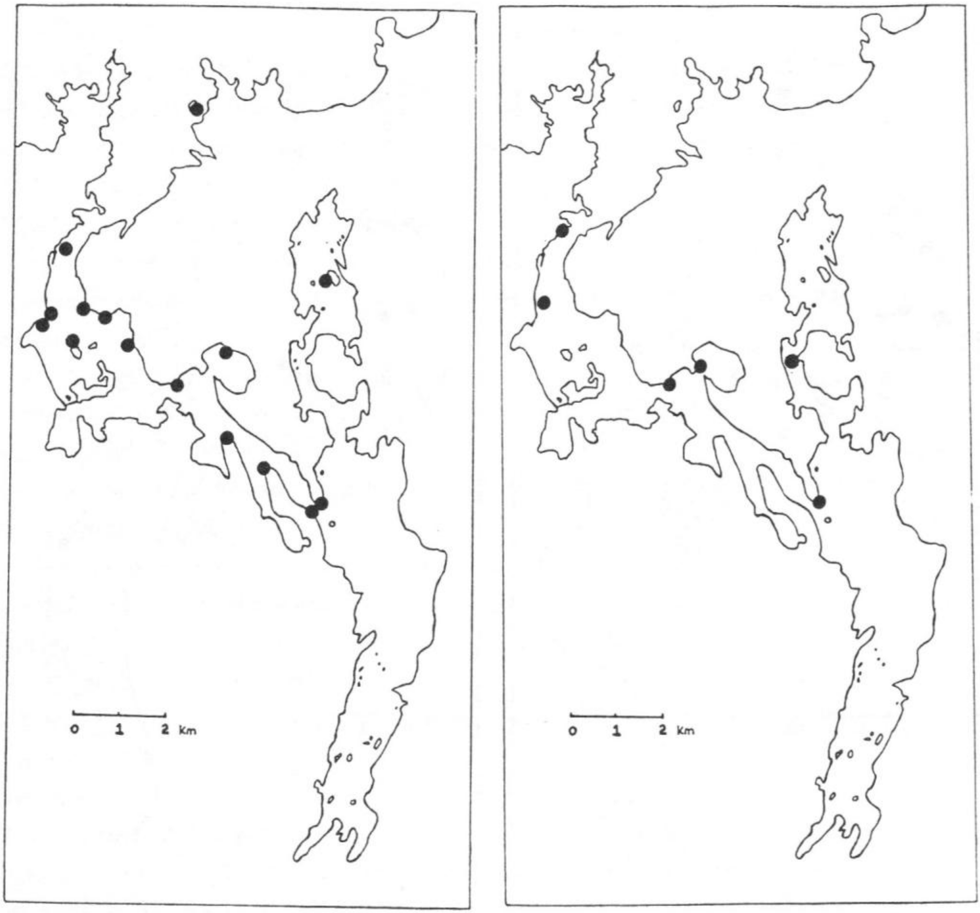
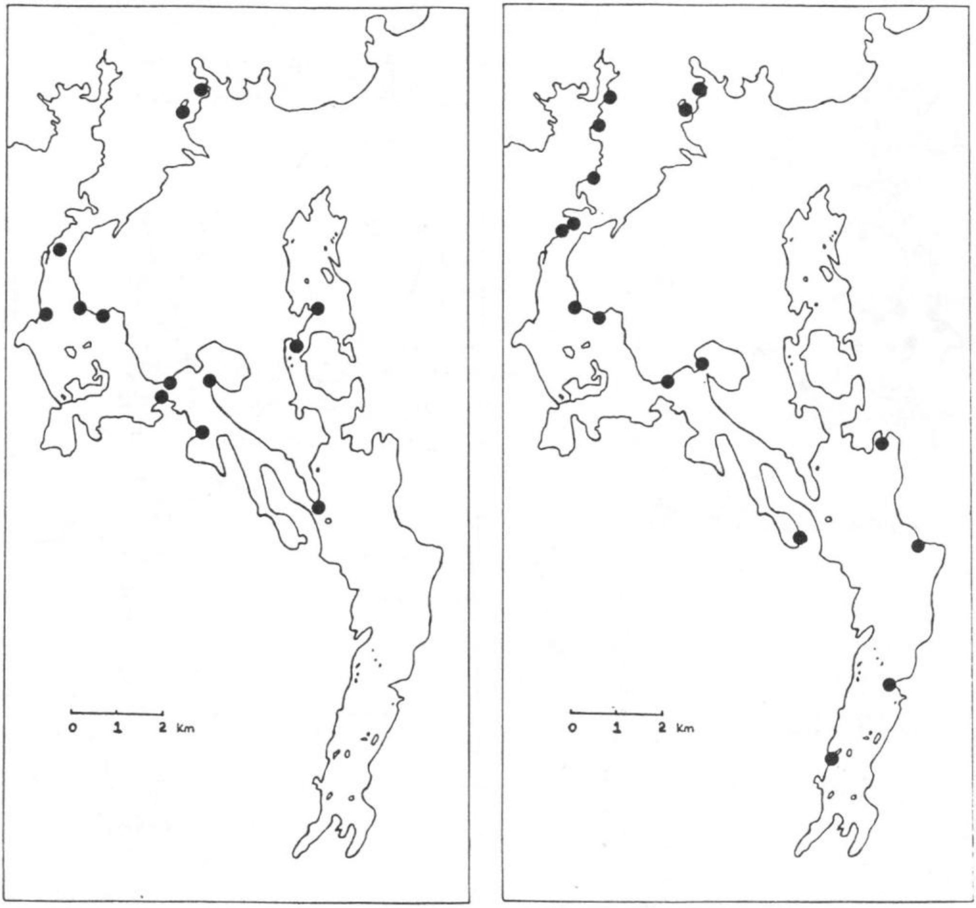
FIGURE 57: distribution maps of *Pododesmus patelliformis* and *Lucinoma borealis*.



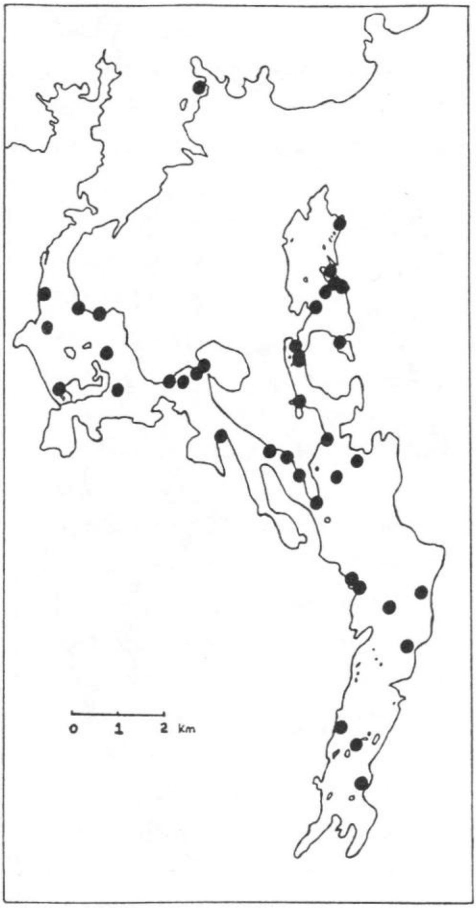
Pododesmus patelliformis **Lucinoma borealis**

FIGURE 58: distribution maps of *Kellia suborbicularis* and *Lasaea adansoni*.

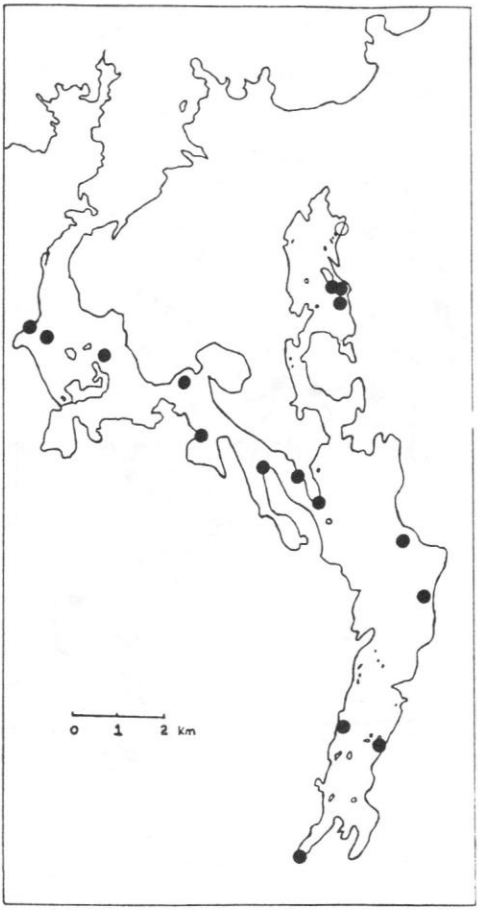


Kellia suborbicularis **Lasaea adansoni**

FIGURE 59: distribution maps of *Mysella bidentata* and *Parvicardium exiguum*.

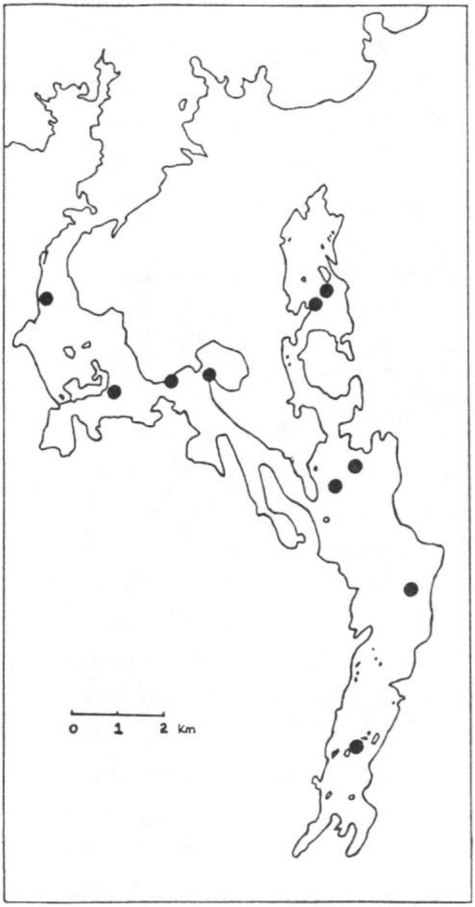


Mysella bidentata

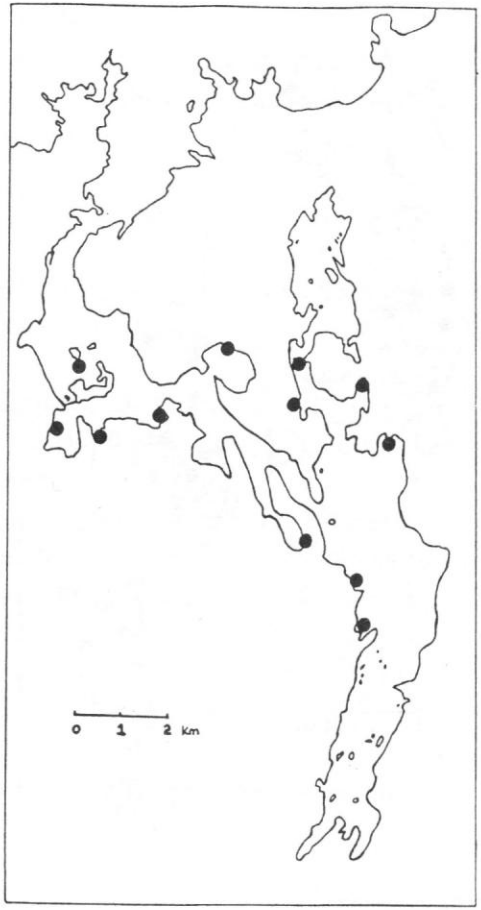


Parvicardium exiguum

FIGURE 60: distribution maps of *Parvicardium ovale* and *Cerastoderma edule*.

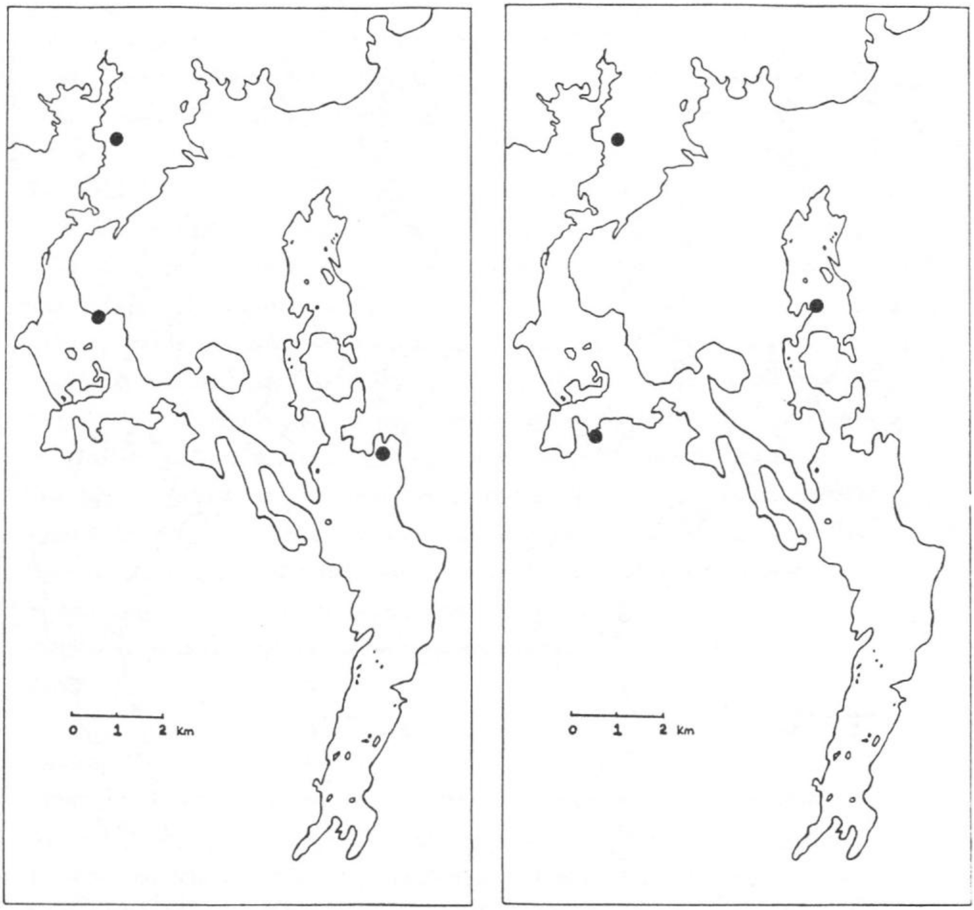


Parvicardium ovale



Cerastoderma edule

FIGURE 61: distribution maps of *Ensis arcuatus* and *Angulus tenuis*.



Ensis arcuatus **Angulus tenuis**

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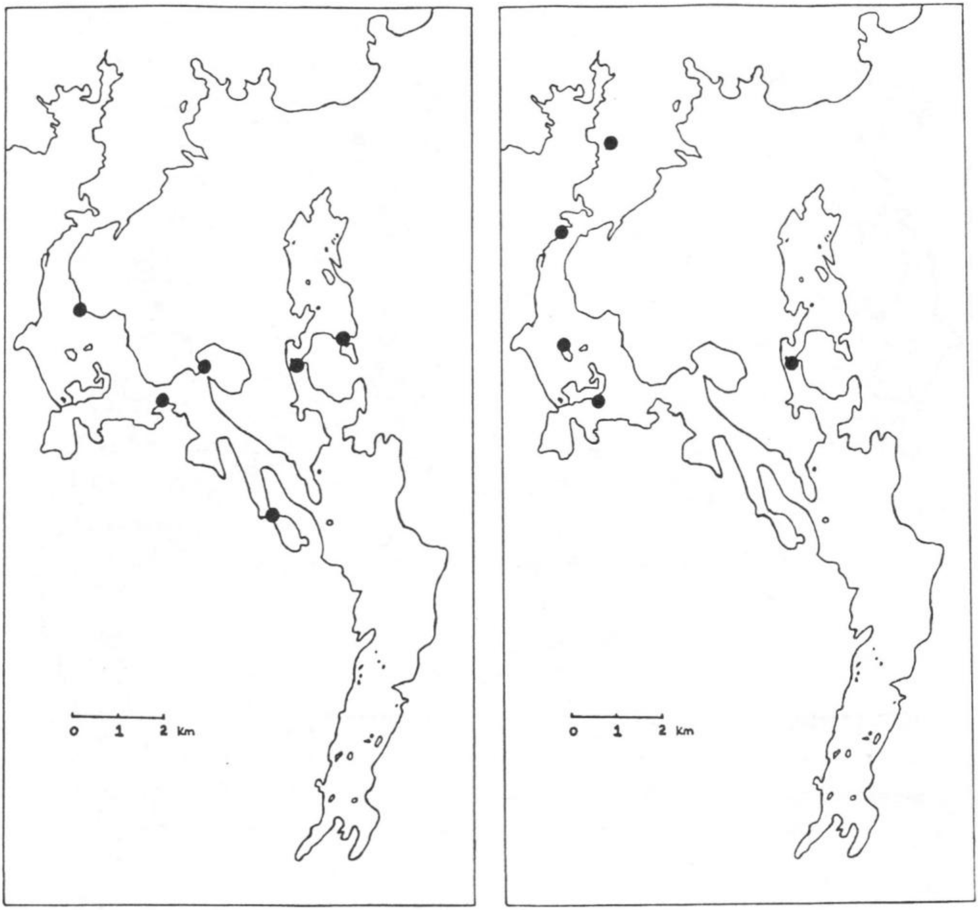
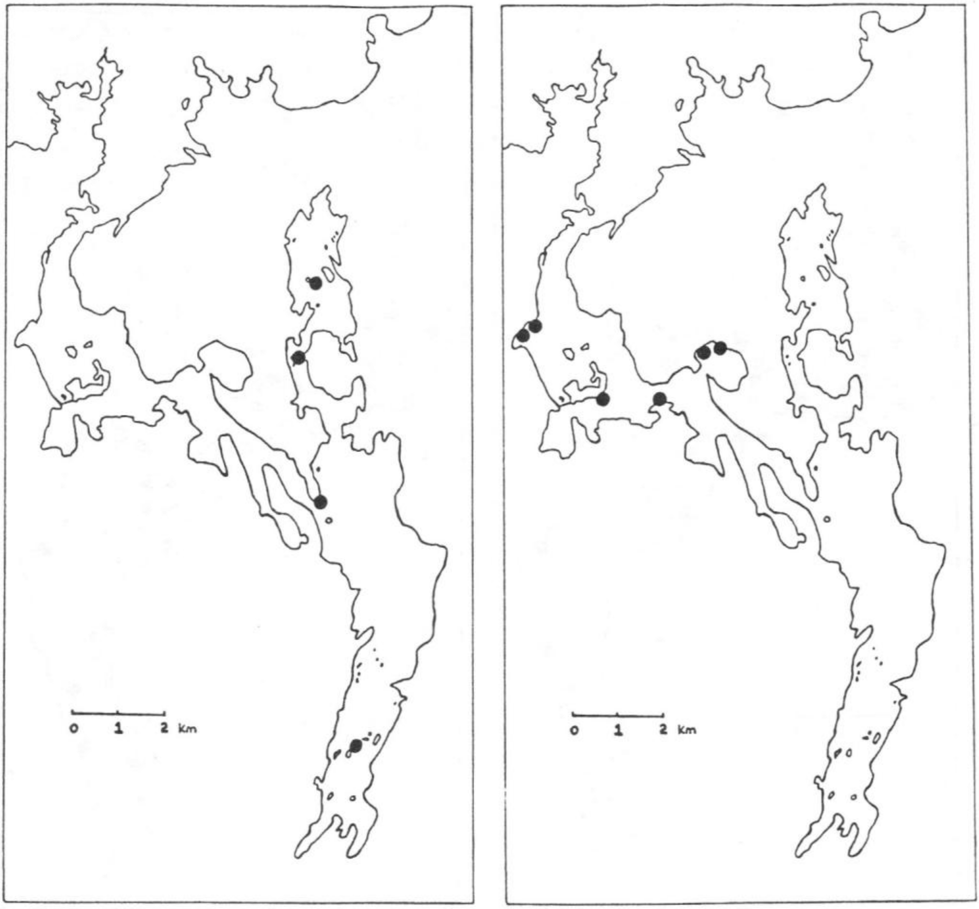
FIGURE 62: distribution maps of *Venus verrucosa* and *Chamelea gallina*.



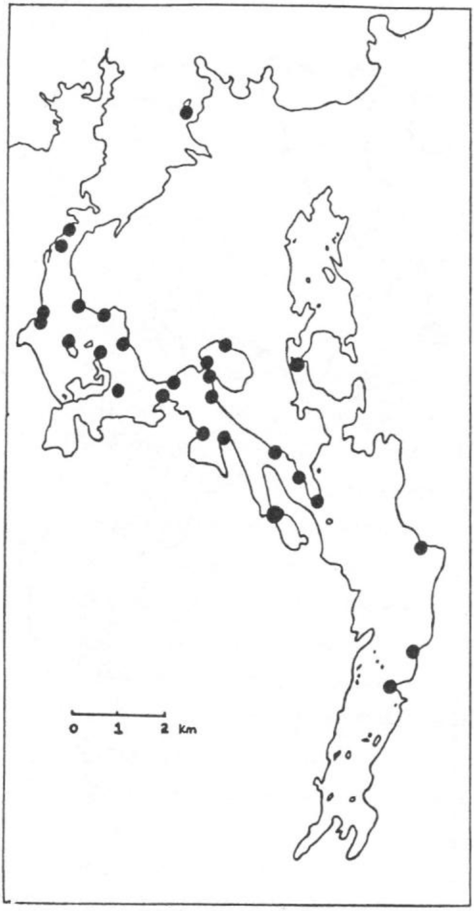
Venus verrucosa **Chamelea gallina**

FIGURE 63: distribution maps of *Timoclea ovata* and *Tapes decussatus*.

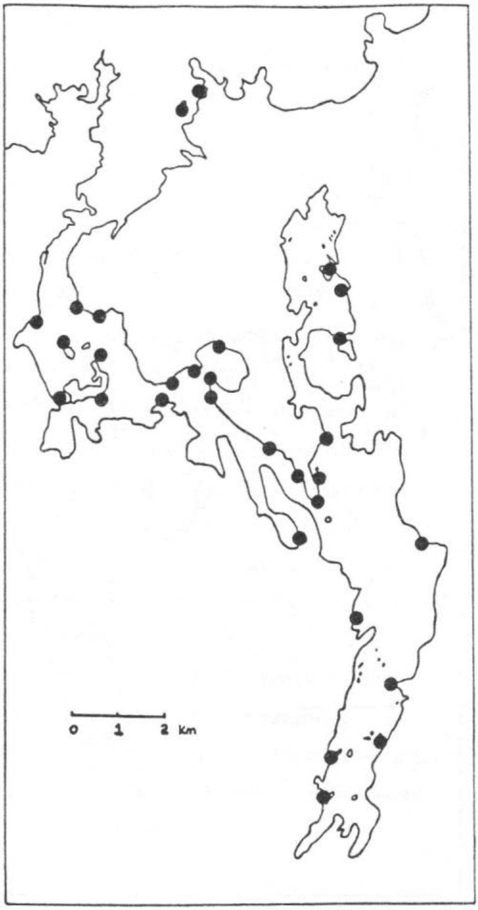


Timoclea ovata **Tapes decussatus**

FIGURE 64: distribution maps of *Venerupis senegalensis* and *Turtonia minuta*.



Venerupis senegalensis



Turtonia minuta

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FIGURE 65: distribution maps of *Corbula gibba* and *Hiatella arctica*.

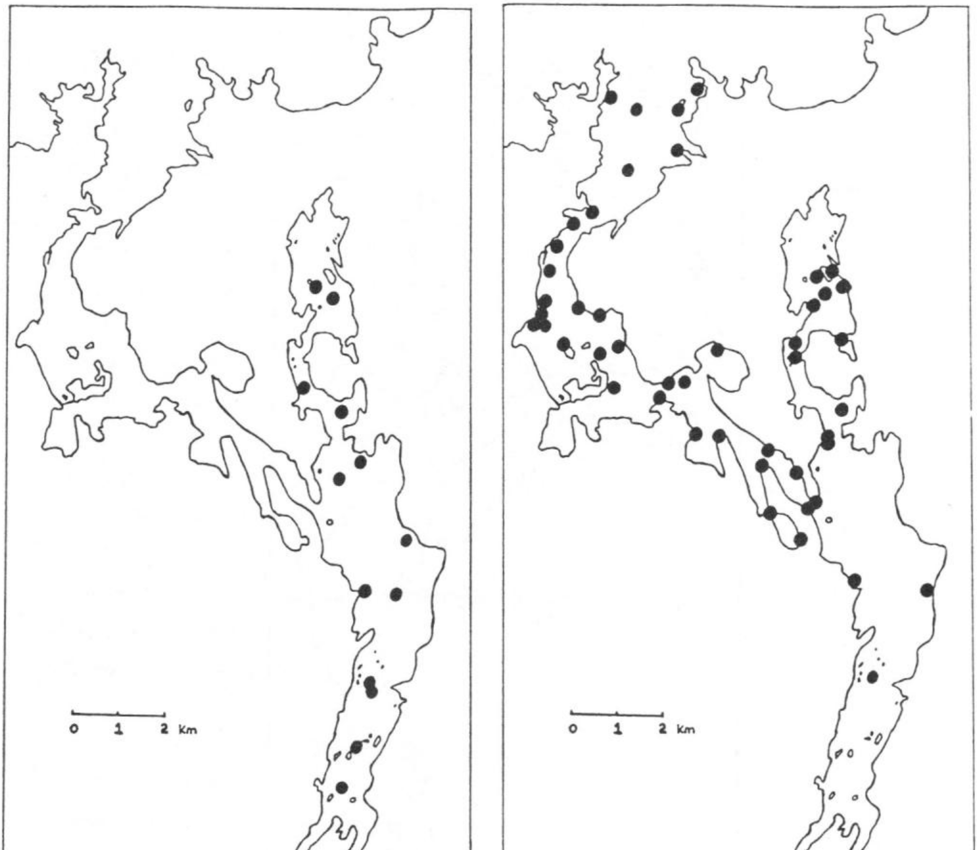
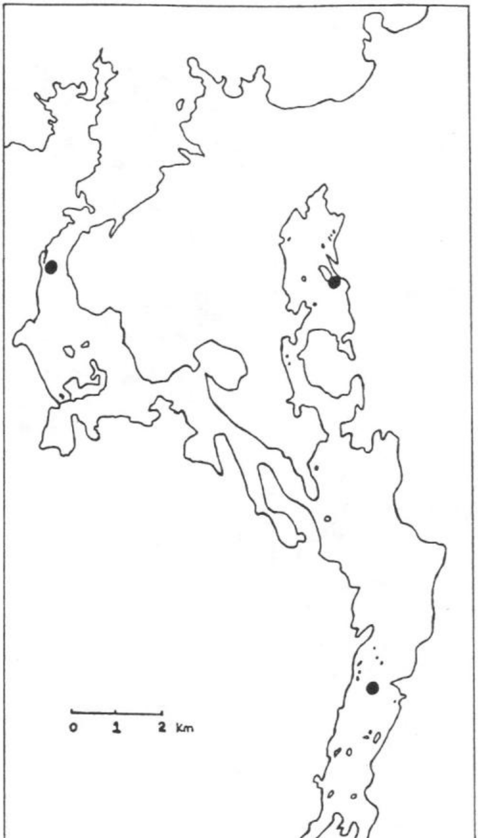


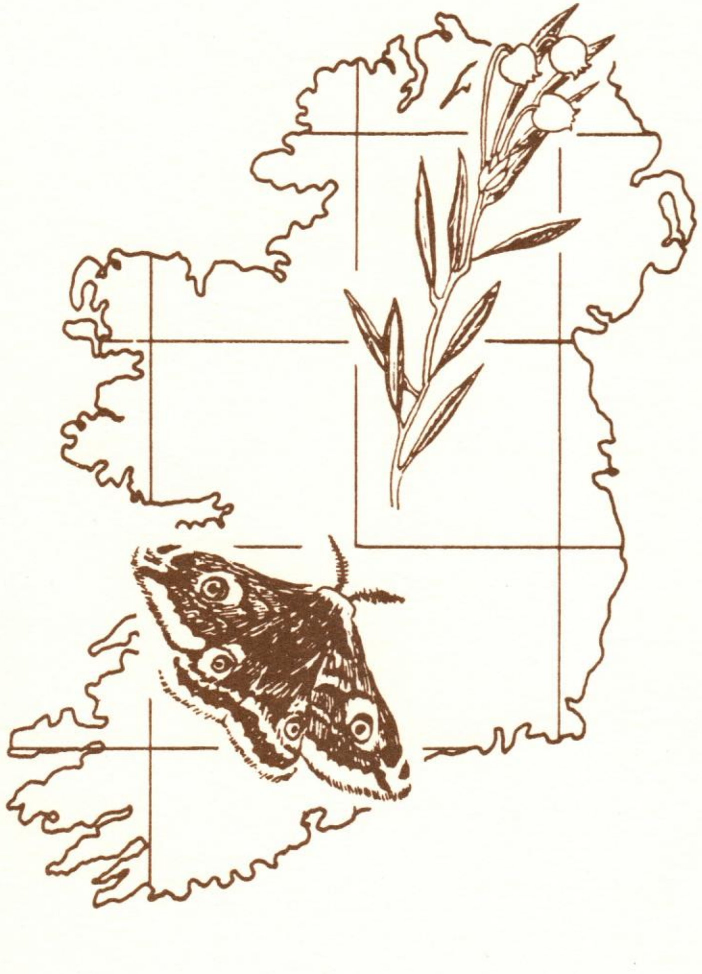
FIGURE 66: distribution map of *Sepiola atlantica*.



Sepiola atlantica

Fodhla Printing

IRISH BIOGEOGRAPHICAL SOCIETY



Bulletin No. 19(2): 139-212

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CRUSTACEAN RECORDS FROM LOUGH HYNE (INE), CO. CORK, IRELAND: PART VI

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This is the sixth contribution in a series on the crustacean fauna of Lough Hyne (Ine) (W0928), the marine nature reserve in West Cork, and reports additions to the earlier lists (Holmes, 1980, 1983, 1985, 1987, 1991).

Sampling was carried out by a variety of methods during the summer months; sorting through shallow sublittoral weed and sponges, and taking small samples of sublittoral gravel. Some collecting was done by underwater light-trap (Holmes and O'Connor, 1988).

The Lough Hyne Nature Reserve has been well documented and many of its geographical features and areas have been given individual names. These are mentioned and marked on maps in numerous papers (e.g. Renouf, 1931; Kitching, 1987; Minchin, 1987a, 1987b). Most of the species in the present list are from one of three sampling areas:- a) the coarse gravels in Barloge Creek (W100280). These gravels are made up of coarse shelly material lying beneath a strong water current, and have already proved to be a rich collecting ground for rare species (e.g. Holmes, 1987). The fauna has similarities to that of equivalent gravels in Kilkieran Bay, Co. Galway (Myers and McGrath, 1982) and the Eddystone shell gravel, off the south coast of England (Spooner, 1960); b) submerged wood. Several samples of oak (*Quercus*) were taken, from branches lying in shallow water in the Goleen (W095278) and along by the western shore (W094280). Some of the components of the specialised fauna living on wood submerged in the sea around Ireland have already been documented by Holmes and Jeal (1987); c) Sublittoral boulders. Apart from just at the Whirlpool Cliff, the east end of the South Basin is lined by boulders which are covered in a rich fauna and flora of encrusting organisms. Many crustaceans live amongst this profusion and can be collected by soaking some of the smaller rocks in a bucket of water, with a few drops of formalin as an irritant. This causes the mobile species to leave their shelter and accumulate in the bottom of the bucket, from which they can easily be retrieved. Several samples were taken by this method.

The species list is laid out in a similar way to previous lists in the series. Some of the data on the poecilostomatoid copepods have already been published in a checklist of the Poecilostomatoida of Ireland (Holmes and Gotto, 1992), but in a different series and in a different format. They are included here for completeness.

New Irish Records are indicated by *. Voucher specimens have been deposited in the National Museum of Ireland.

Order PODOCOPIDA

***Aspidoconcha limnoriae* de Vos, 1953**

Several specimens, west shore near the Goleen (W094280), submerged wood infested with gribble (*Limnoria*), 19.vii.1991.

This species is known to be associated with gribble (de Vos, 1958). In Ireland, *A. limnoriae* has been recorded from Strangford Lough (Holmes and Jeal, 1987) and Lough Hyne (Wouters and de Grave, 1992).

***Pseudocythere caudata* G. O. Sars 1866**

Present in washings from sublittoral boulders in the South Basin. The species was overlooked until recently, but it appears to be abundant in all samples taken in that area.

***Paradoxostoma variabile* (Baird, 1835)**

Several specimens in washings from sublittoral boulders near the Rapids (100282). Horne and Whittaker (1985) regarded the species as common and well-known.

***Redekea perpusilla* de Vos, 1953**

Several specimens, west shore near the Goleen (W094280), submerged wood infested with gribble (*Limnoria*), 19.vii.1991.

The only previous Irish record of this species is also from wood and from Lough Hyne (Wouters and de Grave, 1992).

Order CALANOIDA

****Pseudocyclops crassiremis* Brady, 1873**

Several specimens, Barloge Creek (W100280), coarse gravel, 7.vii.1994; 1♂1♀, South Basin (W099283), washings from boulder, 1m, 7.vii.1995.

Order HARPACTICOIDA

***Longipedia helgolandica* Klie, 1949**

1♀, South Basin (W099282), 10.viii.1989.

***Halectinosoma gothiceps* (Giesbrecht, 1881)**

Eight specimens, north shore (W093288), 8.vii.1982 (Holmes and O'Connor, 1990).

****Harpacticus giesbrechti* Klie, 1927**

2♂1♀, Barloge Creek (W100280), light-trap, 1m, 15.vii.1990.

****Tachidiella minuta* G. O. Sars, 1909**

1♀, South Basin (W100282), washing from boulder, 5.viii.1992.

***Tisbe angusta* (G. O. Sars, 1905)**

Several specimens, Whirlpool Cliff (W100283), washings from *Echinus esculentus* L., 13.vii.1995.

The discovery of *T. angusta* with *Echinus* is intriguing but the copepods may have been more closely associated with green algae (*Ulva*) with which the urchins had covered themselves rather than with the urchins themselves.

***Tisbe ensifer* Fischer, 1860**

1♀, South Basin (W099283), washing from boulder, 1m, 7.vii.1995.

****Tisbe tenella* (G. O. Sars, 1910)**

1♂1♀, Barloge Creek (W100280), coarse gravel, 7.vii.1994.

****Donsiella anglica* Hicks, 1988**

Several specimens, west shore near the Goleen (W094280), submerged wood with gribble (*Limnoria*), 19.vii.1991.

These specimens correspond closely to the *D. limnoriae* of Krishnaswamy and Jones (1958), designated by Hicks (1988) as *D. anglica* sp. nov., and they are similar to but distinct from *D. victoriae* Hicks. It is possible that there is an association between *D. anglica* and *Limnoria quadripunctata* Holthuis on the one hand, and between *D. limnoriae* Stephensen and *L. limnorum* (Rathke) on the other. Wouters and de Grave (1992) recorded *D. limnoriae* Stephensen from wood in Lough Hyne, but this copepod was not encountered in the present study.

Idomene forficata **Philippi, 1843**

Nine specimens, South Basin (W099283), 7.vii.1995.

The only previous Irish record is from Killary Harbour (Farran, 1913).

Amphiascus propinqvus **G. O. Sars, 1906**

Several specimens, Barloge Creek (W100280), coarse gravel, 7.vii.1994.

Bulbamphiascus denticulatus **(I. C. Thompson, 1893)**

Several specimens, Barloge Creek (W100280), coarse gravel, 7.vii.1994.

Stenocopia spinosa **(T. Scott, 1892)**

1♀, Barloge Creek (W100280), coarse gravel, 7.vii.1994.

The only previous Irish record is from off Killary Harbour (Farran, 1913).

Paramesochra dubia **T. Scott, 1892**

Several specimens, Barloge Creek (W100280), coarse gravel, 7.vii.1994.

******Diagoniceps menaiensis*** **Geddes, 1968**

1♀, Barloge Creek (W100280), coarse gravel, 7.vii.1994.

This species is otherwise known only from the Menai Strait, North Wales (Geddes, 1968).

Tetragoniceps malleolatus **Brady, 1880**

Six specimens, Barloge Creek (W100280), coarse gravel, 7.vii.1994.

The only previous Irish record is from off Killary Harbour (Farran, 1913).

******Fultonia*** **sp.**

Five specimens, Barloge Creek (W100280), coarse gravel, 7.vii.1994.

These specimens are similar to but distinct from *F. hirsuta* T.Scott, the only species known from the British Isles. Their correct identification awaits further examination.

Harrietella simulans **(T. Scott, 1894)**

Several specimens, west shore near the Goleen (W094280), submerged wood, 19.vii.1991.

This species is known to be associated with submerged wood, but its association with gribble (*Limnoria*) is problematic (Hicks, 1988). Previous Irish records are from Strangford Lough (Holmes and Jeal, 1987) and Lough Hyne (Wouters and de Grave, 1992), in each case with wood.

Pseudolaophonte spinosa **(I. C. Thompson, 1893)**

Several specimens, Barloge Creek (W100280), coarse gravel, 7.vii.1994.

Order MISOPHRIOIDA

***Misophria pallida* Boeck, 1864**

1♀, South Basin (W099284), 15.vii.1992; 3♀, South Basin (W100282), viii.1992; 2♀, South Basin (W100282), 19.vii.1993.

Order CYCLOPOIDA

****Cyclopina brachystylis* G. O. Sars, 1921**

1♀, Barloge Creek (W100280), coarse gravel, 24.vii.1986.

***Notodelphys caerulea* Thorell, 1859**

Several specimens, the Goleen (W095278), in *Ascidiella aspersa* (O. F. Müller) on submerged wood, 20.vii.1991.

Order SIPHONOSTOMATOIDA

****Acontiophorus armatus* Brady, 1880**

Several specimens, Barloge Creek (W1027), from *Alcyonium digitatum* L., 10m, 15.vii.1992.

****Collocheres elegans* A. Scott, 1896**

2♀, South Basin (W100282), boulder with *Ophiocomina nigra* (Abildgaard), 5m depth, 19.vii.1993.

This species is known to be associated with the black brittle- star *O. nigra*, from off south-west England and Scotland, the Isle of Man and west Norway (Gotto, 1992).

***Clavella adunca* (Strøm, 1762)**

Several specimens, south end of Barloge Creek, gills of pollack *Pollachius pollachius* (L.), 22.vii.1991, 3.vii.1994.

Order POECILOSTOMATOIDA

***Critomolgus bulbipes* (Stock and Kleeton, 1963)**

Several specimens, Barloge (W103271), from *Alcyonium digitatum*, 15.vii.1992 (Holmes and Gotto, 1992).

The species was described from the soft corals *Alcyonium acaule* Marion and *Parerythropodium coralloides* (Pallas) in the Mediterranean (Stock and Kleeton, 1963). Irish records were listed by Holmes and Gotto (1992).

***Myxomolgus myxicolae* (Bocquet and Stock, 1958)**

Several specimens, Lough Hyne, from the mucous tubes of *Myxicola infundibulum* (Rénier).

18.vii.1991, 8.viii.1992 (Holmes and Gotto, 1992).

This species is well-known from the polychaete *Myxicola infundibulum* (Rénier) (Bocquet and Stock, 1958).

Astericola clausi **Rosoll, 1889**

1♀, L.Hyne (W099283), washings from boulder with *Marthasterias glacialis* (L.), 12.vii.1993.

This copepod is known from several species of starfish (Humes and Stock, 1973). Other records from Lough Hyne were listed by Holmes and Gotto (1992).

***Lichomolgella pusilla* G. O. Sars, 1918**

1♂4♀ specimens, South Basin (W100282), washings from boulder, 11.vii.1993.

The associate for this species is unknown (Humes and Stock, 1973). Other Irish records were listed by Holmes and Gotto (1992).

***Lichomolgus forficula* Thorell, 1859**

1♂1♀ specimens, South Basin (W100282), washings from boulder, 11.vii.1993.

This species is associated with large simple ascidians such as *Ascidia* spp. and *Phallusia mammillata* (Cuvier) (Humes and Stock, 1973). Irish records were listed by Holmes and Gotto (1992).

***Zygomolgus didemni* (Gotto, 1956)**

Several specimens, South Basin (W100282), washings from boulders, 19.vii.1993, 28.vi.1994.

This species was described from the ascidian *Didemnum maculosum* (Milne Edwards), probably living in the cloacal cavities (Gotto, 1960). It is otherwise known only from Strangford Lough (Gotto, 1993).

***Pseudanthessius dubius* G. O. Sars, 1918**

1♂, South Basin (W100282), washings from boulder with *Asterias rubens* L., 19.vii.1993.

This species is known from the starfish *Asterias rubens* (Bresciani and Lützen, 1962). The only previous Irish record is from Lough Hyne (Holmes and Gotto, 1992).

***Pseudanthessius nemertophilus* Gallien, 1936**

Several specimens, north shore, (W093288), from the bootlace worm *Lineus longissimus* (Gunnerus), 2m, 17.vii.1991, 14.vii.1992 (Holmes and Gotto, 1992, as *Nemerthessius* *nemertophilus*).

This copepod is included here in the genus *Pseudanthessius* following Humes and Boxshall (1996).

***Splanchnotrophus brevipes* Hancock and Norman, 1863**

1♀, Whirlpool Cliff (W001283), from nudibranch *Cuthona genovae* (O'Donoghue), collected by J.Nunn, 18.vii.1993 (Holmes and Nunn, 1996).

***Enalcyonium forbesi* (T. Scott, 1901)**

1♀, Barloge (W103271), from *Alcyonium digitatum*, 15.vii.1992 (Holmes and Gotto, 1992).

Order ISOPODA

***Limnoria quadripunctata* Holthuis, 1949**

Several specimens, west shore near the Goleen (W094280), submerged wood, 19.vii.1991.

L. lignorum (Rathke) was also present, and also the amphipod *Chelura terebrans* Philippi, both associates of wood.

***Microcharon harrisi* Spooner, 1958**

Seven specimens, Barloge Creek (100280), coarse gravel, 7.vii.1994.

This species is otherwise known in Ireland from Strangford Lough (Wells, 1963).

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Bull. Ir. biogeog. Soc. No. 19 (1996)

RECORDS OF STINKHORN FUNGI (*PHALLUS IMPUDICUS* PERS.) FROM IRELAND, ENGLAND AND ITALY

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Fungi are a neglected yet important part of natural systems (Hawksworth, 1992), and associations between vertebrates and fungi are virtually unstudied. We hope that the records reported here will stimulate more attention to this area. The records presented are of stinkhorn fungus (*Phallus impudicus* Pers.) which were mainly found at badger (*Meles meles* (L.)) setts. We noted large numbers of the stinkhorns (405) at badger setts at Warrenscourt, west Cork, in May 1993 - June 1994 and have hypothesised that there may be a relationship between the fungus and badgers *via* blowflies (Diptera: Calliphoridae) (Sleeman *et al.*, 1995).

Due to the unusual shape and obvious smell of stinkhorns, all records from suitable habitat (i.e. woods or scrub, but not sand dune) were accepted. Records are listed under country, and then county/shire in the case of Ireland and England. Each record has the numbers and stage (egg or fruiting body - both called fruits hereafter) of stinkhorns, the month and year, badger sett type and/or type if available. Setts were defined as main, subsidiary or outlier setts, based on physical characteristics (Thornton, 1988). Exact locality data, where available, are limited to national grid references to avoid indicating the precise location of setts which are vunerable to persecution in all three countries. Lastly the recorder, if not one of the authors, is noted in brackets.

IRELAND

Co. Cork

Warrenscourt W3668: ninety nine fruits, July 1994, at two subsidiary setts, (same setts as referred to in Sleeman *et al.* (1995); Fota Estate W8071: three fruits, March 1994, at deserted main sett in mixed woods; Fota Estate W8071: 22 fruits in beech (*Fagus*) woods (no sett nearby): Fota Estate W8071: one fruit, July 1995, at main sett under house; Great Island W8468: five fruits, March 1994, at a main sett; Great Island W8267: one fruit at main sett and four fruits, April 1994, at an above ground badger bed; Great Island W8567: fifteen fruits, March and April 1994, (no sett nearby) in coniferous woods at Marlogue (J. Prendergast); West Cork (for details see McCarthy, 1993): one fruit, in summer 1994, at sett, in the badger vaccination trial study area; Farren Wood W4970: two fruits, June 1994, at main sett (P. F. Cross); Dunisky W3668: three fruits, July 1994, at main sett, in hedgerow/scrub; near Blarney (W5980): four fruits, July 1994, at subsidiary sett in woods (D. Walsh); Kilnardrish (W4169): two fruits, one May 1995 and one in August, in a hedge (T. O'Mahony); Kilcolman R5810: one fruit, August 1995, at subsidiary sett (P. Holt).

It is interesting to note that both stinkhorns and badgers were noted as being rare in Co. Cork in the last century (Harvey, 1845). It is clear that both are now common.

Co. Limerick

Glenstal Abbey R7456: one fruit, August 1994, at a main sett in the woods.

Co. Meath

River Boyne N9070: three fruits, October 1993, at main sett in deciduous woods on the bank.

Co. Waterford

Glenshelane S1100: twenty eight fruits, July 1994, at two main setts in mixed woods.

ENGLAND

Avon

Dyrham wood ST736739: one fruit, August 1991, at main sett (C. Collett).

Kent

Farningham Wood TQ5468: many fruits, September 1994, at sett (C. Ferris); Northward Hill TQ7765: four eggs, May 1995, at main sett (D. Jones).

Oxfordshire

Wytham Wood SP40: two fruits, 1992, at main sett at Holly Hill (R. W. Woodroffe).

This record is of interest as Elton (1966, page 274) has described stinkhorns as rare in Wytham.

Suffolk

near Bures St Mary TL9335: fruits, October 1995, at sett in Arger Fen (B. Kettle).

ITALY

Lombardy

Many fruits, summer 1993, at main sett at edge of pear (*Pyrus*) orchard (G. Barbieri).

Discussion

The records show that these fungi are widely and commonly found at setts in Ireland, England and possibly parts of Europe. The fact that the most obvious part above-ground, the ripe fruit, only lasts about a day means that despite the fungus being present it is easily missed unless the sett is visited regularly. While we can say from these records that the fungus is common at setts, we cannot say that it is not as common in other likely habitats, or that badgers prefer to dig setts at areas also favoured by such fungi.

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ANCIENT PASTURE AS A HABITAT FOR STAPHYLINIDAE (COLEOPTERA) AT THE CURRAGH, CO. KILDARE, IRELAND

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Introduction

The biological conservation value of the ancient pasture at the Curragh, Co. Kildare has been demonstrated by the species diversity of *Hygrocybe* and related soil fungi (Feehan and McHugh, 1992). The Curragh is an unenclosed area of commonage sheep pasture on fluvio-glacial moraine. Details of the site are given in Feehan and McHugh (1992). The combination of heavy grazing by sheep and acid soils has resulted in a short turf sward with relatively dense moss cover in many parts of the Curragh. In a few areas swards dominated by *Nardus stricta* L. occur. Given that an ecologically well-developed pasture ecosystem (i.e. with many local or rare stenotopic species) is indicated by the soil flora, one would expect groups of soil fauna to indicate the same. Staphylinid beetles are one of the most diverse groups of soil biota in Ireland, and are particularly abundant in moist humus-rich soils. The staphylinid fauna of the Curragh was surveyed to discover if it indicates a similar conservation value of the site to the soil fungi studied by Feehan and McHugh (1992).

Methods

Three sets of samples were taken for adult staphylinids. (1) Pasture on slopes and flat areas was sampled using pitfall traps with ethylene glycol preservative (N8010, 14 June - 6 July 1991, n = 24 traps; N8109, 21 May - 10 June 1992, n = 12 traps), and a D-vac suction sampler (N8109, 21 May 1992). The area sampled is in the south-eastern part of the Curragh. (2) The same area was also sampled in late winter using Tullgren funnel extraction of sods (N8010, 26 March 1991). (3) Another site with an almost pure sward of *Nardus stricta* on the north-western side of the Curragh (N7514) was sampled with pitfall traps (14 June - 6 July 1991, n = 4 traps) and D-vac (22 September 1992).

Species were selected as indicators of well-developed habitat on the basis of two attributes:- (1) restricted habitat preference to a specific type of microhabitat associated with the ecosystem in question; (2) reported in the literature as being uncommon or local, from which it is assumed that they are less likely to survive in historically degraded ecosystems. Voucher specimens of *Amischa bifoveolata* (Mannerheim) and *Tachyporus tersus* Erichson have been deposited in the National Museum of Ireland, and specimens of many of the other species have been retained in the senior author's collection.

Results

In total 51 species of staphylinid were recorded (Table 1). As would be expected, many of the species recorded in abundance indicate grassland which has not had external nutrient inputs in the form of fertilizer or manure (e.g. *Geostiba circellaris* (Gravenhorst), *Quedius nitipennis* (Stephens), *Q. semiobscurus* (Marsham), *Sepedophilus nigripennis* (Stephens), *Tachyporus dispar* (Paykull)) (comparative data from Good and Giller, 1991; J. A. Good, unpublished). A further group of species have moss as a preferred habitat (e.g. *Gabrius subnigritulus* (Reitter), *Tachyporus atriceps* Stephens, *T. tersus*; data from Horion, 1965, 1967; Koch, 1989), and this group includes two species which could be regarded as indicator species based on the attributes listed above.

Amischa bifoveolata (= *cavifrons* (Sharp)), has been recorded at only one other locality in Ireland (Anderson, 1978). It may, however, occur more widely in machair and similar grasslands - Waterston *et al.* (1981) record it from six islands in the Outer Hebrides. While it is recorded from a variety of biotopes on the continent, such as woods, fields, grass slopes (Koch, 1989), it appears to have a more restricted habitat preference in the Atlantic region (Good, 1995). Koch (1989) summarizes its microhabitat as leaf detritus and moss. It is a brachypterous, bisexual species, unlike the three other Irish *Amischa* species which are all winged and parthenogenetic, and are associated with more disturbed grasslands (Good, 1995).

Tachyporus tersus was recorded from seven sites in six counties by Johnson and Halbert (1902), but these records have not been confirmed. The species has been recorded from Louth more recently (near Drogheda, Co. Louth (O1176), July 1991, J. A. Good) and it appears to be a local species in Ireland (R. Anderson, pers. comm.). Horion (1967) describes it as hygrophilous, occurring in flood debris, mosses and grassy vegetation, and Koch (1989) refers to it as stenotopic and muscicolous.

The occurrence of *Amischa bifoveolata* and *Tachyporus tersus* as *dominant* species in the sample indicates that the Curragh pasture is of a different type to many other types of grassland occurring in Ireland. Neither of these species were *present* in a survey of 28 unmanured grasslands (i.e. not receiving external inorganic or organic nutrient inputs) in Ireland (J. A. Good, unpublished) conducted in the same season and using the same sampling techniques. However, upland short-turf pastures (e.g. Bleasdale and Sheehy Skeffington, 1995) or maritime moss-rich grasslands (e.g. Bassett and Curtis, 1985) were not included in this survey.

Two further species occurred in the *Nardus stricta* sward which were not recorded from Irish grasslands previously, and are associated with marshes and bogs rather than grassland. These are *Cryptobium fracticorne* (Paykull), a stenotopic paludicolous species (Koch, 1989), and *Stenus brevipennis* Thomson, a stenotopic bog species (Anderson, 1984; Koch, 1989). The former, a distinctive species, is recorded from at least five sites in five counties (Johnson and Halbert, 1902; Lott and Bilton, 1991), and there is a second record from Kerry cited by Bullock (1935), who states that it is rare in the county. The latter species has been recorded from five sites in four counties (Anderson, 1984; Good, 1985; Lott and Foster, 1990), associated with moss or *Sphagnum* on peat.

Discussion

The fauna of Irish grasslands is species-poor in comparison with other regions of Europe, lacking the thermophilic and xerophilic assemblages which occur there (see Speight, 1986). In fact, many staphylinids (especially *Stenus* spp.) abundant in the wet microclimate of Irish grassland (Good and Giller, 1990) are restricted to marshes and wet meadows in Central Europe (Horion, 1967; Koch, 1989). The recorded staphylinid fauna of the Curragh reflects this hygrophily, with an assemblage associated with moss being characteristic. Two species, which occurred in a sward of *Nardus stricta*, are more characteristic of peatland than grassland.

Short-turf Atlantic-region pastures without a history of disturbance by cultivation or nutrient application are becoming scarce, due to the lack of viability of low-input farming, and because of their suitability for other land uses. Using an evaluation method based on the number of species of *Hygrocybe* and related fungi, Feehan and McHugh (1992) concluded that the Curragh was a particularly good example of an ancient sheep-pasture ecosystem. The abundance of the staphylinids *Amischa bifoveolata* and *Tachyporus tersus* reported here is also considered to indicate a mature undisturbed ecosystem. This is despite the fact that both groups (fungi and staphylinids) have different microhabitat requirements which appear to be better represented in different parts of the site. However, similar vegetation and soil types occur in upland areas elsewhere in Ireland, such as Connemara (Bleasdale and Sheehy Skeffington, 1995), and it is not known to what extent these soil assemblages are represented in these areas.

The degree of rarity of any one species is superfluous here, if this type of ecosystem is becoming rare itself. That both these soil assemblages indicate that the Curragh is a well-developed example of such an ecosystem is therefore sufficient to demonstrate its conservation value, if such mature sites are indeed rare.

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TABLE 1. Staphylinid beetles from the Curragh pasture. Nomenclature follows Lucht (1987), Lohse and Lucht (1989), Booth (1988) and Muona (1990). Note that species are not listed alphabetically for the whole table, but in three groups corresponding to the habitats sampled, to allow a more clear comparison between habitats.

Species	Pasture Traps/D-vac	Moss Tullgren	*Nardus* Traps/D-vac
Amischa analis (Gravenhorst)	9	7	2
Amischa bifoveolata (Mannerheim)	17	7	3
Atheta amplicollis (Mulsant and Rey)	2	-	4
Atheta atramentaria (Gyllenhal)	1	-	-
Atheta fungi (Gravenhorst)	1	1	3
Atheta macrocera (Thomson)	2	-	-
Atheta orbata (Erichson)	3	-	-
Bolitobius castaneus (Stephens)	1	-	-
Drusilla canaliculata (Fabr.)	3	-	-
Gabrius subnigritulus (Reitter)	1	-	-
Geostiba circellaris (Gravenhorst)	15	12	41
Mycetoporus lepidus (Gravenhorst)	1	-	-
Ocypus aeneocephalus (DeGeer)	14	-	-
Ocypus olens (Müller)	1	-	-
Othius myrmecophilus Kiesenwetter	1	2	-
Oxypoda brachyptera (Stephens)	2	-	-
Philinorum sordidum (Stephens)	1	-	-
Plataraea brunnea (Fabr.)	1	-	-
Quedius boops (Gravenhorst)	1	-	-
Quedius curtipennis Bernhauer	1	1	1
Quedius molochinus (Gravenhorst)	1	-	-
Quedius nitipennis (Stephens)	6	-	-
Quedius semiobscurus (Marsham)	7	1	-

Species	**Pasture Traps/D-vac**	**Moss Tullgren**	***Nardus* Traps/D-vac**
Quedius tristis (Gravenhorst)	2	-	-
Sepedophilus nigripennis (Stephens)	10	6	2
Stenus brunnipes Stephens	8	2	2
Stenus nanus Stephens	1	-	2
Tachyporus atriceps Stephens	2	-	-
Tachyporus dispar (Paykull)	8	8	12
Tachyporus nitidulus (Fabr.)	1	-	-
Tachyporus pusillus Gravenhorst	3	-	-
Tachyporus tersus Erichson	22	-	-
Xantholinus linearis (Olivier)	31	1	7
Amischa nigrofusca (Stephens)	-	4	-
Anotylus rugosus (Fabr.)	-	1	-
Atheta graminicola (Gravenhorst)	-	1	-
Atheta longicornis (Gravenhorst)	-	4	-
Ocypus globulifer (Fourcroy)	-	1	-
Othius punctulatus (Goeze)	-	1	-
Philonthus carbonarius (Gravenhorst)	-	1	-
Philonthus cognatus (Stephens)	-	2	-
Philonthus marginatus (Ström)	-	1	-
Philonthus varians (Paykull)	-	1	-
Tachyporus chrysomelinus (L.)	-	2	1
Tachyporus hypnorum (Fabr.)	-	4	24
Cryptobium fracticorne (Paykull)	-	-	1
Mycetoporus longulus Mannerheim	-	-	1
Stenus brevipennis Thomson	-	-	2
Stenus clavicornis (Scopoli)	-	-	1
Stenus fulvicornis Stephens	-	-	9
Stenus impressus Germar	-	-	3

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MORPHOLOGICAL VARIATION IN LARVAE OF *RANA TEMPORARIA* L. (ANURA: RANIDAE) IN THE REPUBLIC OF IRELAND

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Abstract

Rana temporaria larvae from five differing habitats in Ireland, n=26 each, were analyzed for 25 external morphological characters by means of descriptive and multivariate statistical analyses. A prioritized list of the variables best suited to be predictors of location was determined by a stepwise discriminant analysis. Assignment of tadpoles to their correct locality by discriminant function analysis averaged 96.796%. Spearman coefficients were calculated for correlations between developmental stage and the other 24 variables, and suggest variation between localities is not an artifact of size differences.

A north-south clinal variation pattern for either three (north) or four (south) upper tooth rows is reported, with four occurring farther north than previously reported. Data and mechanisms relative to tooth row additions and deletions are discussed. An atypical pigmentation pattern of tail blotching, characteristic of stream larvae, is reported for a pond reared sample (Malahide, locality 9), and may represent nonadaptive morphological variation or a response to a subtle selection factor.

Key words: tadpoles, morphological variation, tooth rows, pigmentation, *Rana temporaria*, Ireland.

Introduction

The study of geographic variation, the spatial occurrence of variation in populations, has long been a preeminent goal of researchers in many groups of organisms. Such variation may express itself in morphological, physiological, and behavioural characteristics. Mayr (1970), Ricklefs (1973), and Hillis (1988) provide considerable discussion of the historical aspects of the topic, as well as more contemporary documentation and analysis of its occurrence and significance in a variety of animals and plants. Techniques to describe and analyze the causal factors of geographic variation and its potential bearing on group relationships range from the anecdotal and speculative, to those employing powerful, multivariate statistical analyses. This continuum exists in the herpetological literature relative to amphibian tadpoles as follows in part:- Korky and Webb (1992) used descriptive statistics to document 20 morphological characters of field-collected *Rana montezumae* Baird tadpoles from Mexico in a redescription of this taxon; Korky (1978) used a univariate analysis of covariance to test for significant differences between means of 28 morphological variables for two species of the *Rana pipiens* Schreber complex in Nebraska as a means of differentiating their tadpoles; Hillis (1982) used a combination of multivariate principal component analysis and discriminant function analysis to analyze morphological variability and its adaptive significance for field-collected versus laboratory-reared tadpoles of two species of the *Rana pipiens* complex in Texas; Scott and Jennings (1985) used an analysis of variance to test for significant differences between means of morphological variables and a principal component analysis to account for the variance in those characters for five species of tadpoles of the *Rana pipiens* complex in New Mexico; Korky and Webb (1991) used descriptive statistics, a T-test for significant difference between means, and principal component analysis to analyze morphometric data for 16 variables from tadpoles of members of the *Hyla eximia* Baird group in Mexico; Jennings and Scott (1993) used univariate analyses of variance and covariance and principal component analysis to assess the varying morphology of four populations of one species of the *Rana pipiens* complex in New Mexico; Grillitsch *et al.* (1993) used descriptive statistics, an analysis of variance, tests for significant difference among means, and discriminant function analysis with stepwise variable selection to assess the morphological variability of tadpoles of *Rana graeca* Boulenger and *R. italica* Dubois from Greece and Italy, respectively. While the afore-mentioned type of studies will always contribute to our understanding of variation in nature, it is the nascent field of molecular systematics that will provide further insight in this area as discussed by Hillis and Moritz (1996).

The historical background, ecology, general external morphology, and systematic status of

Rana temporaria in Ireland were discussed, primarily for larvae, but with some observations on adults, by Korky and Webb (1993). It was noted that tadpoles of *R. temporaria* in Ireland usually have only three (instead of four) upper tooth rows, but some with four were obtained from southern localities. The purpose of this study is to:- (1) document geographic variation of 25 external morphological character states of these larvae from selected sites in Ireland using descriptive statistics; (2) determine if larvae could be correctly assigned to a given locality by discriminant function analysis using the 25 variables; and (3) determine which of the variables were most critical in assigning location by a stepwise discriminant analysis with stepwise selection.

Materials and methods

Field activities in the Spring of 1992 in Ireland by one of us (JKK) resulted in the collection of 748 tadpoles (sample size varying from 1 to 131) from 17 different sites in 15 counties. This study uses larvae from five of those sites chosen for their disparity of microhabitat and relative geographic position. The terms "larvae" and "tadpoles" are used interchangeably. Descriptive features follow Altig (1970). Larvae were staged according to Gosner (1960).

Larvae were collected by seining or using small, fine-mesh hand nets, then preserved in 10% buffered formalin. Larvae were collected under licence and are in the custody of the senior author. They will be placed in the systematic collection of the National Museum of Ireland, Dublin, following this study and the completion of another in progress focusing on the geographic variation of their DNA.

Measurements of body length, tail length, tail height, tail musculature height, dorsal and ventral fin height, interocular and internarial width were made with Cenco calipers, whereas those of "tooth" rows that included A-1 length, left and right A-2 lengths, A-2 gap, A-3 length, left and right A-3 lengths, left and right A-4 lengths, and lengths of P-1, P-1 gap, P-2, P-3, and P-4 were made with a binocular dissecting microscope and ocular micrometer calibrated to the nearest 0.1mm. A total of 25 variables, including those above and certain derived characters in addition to developmental stage, were recorded for each of 26 larvae from the five selected sites. Some specimens had missing or damaged features. Features used by others in ranid tadpole studies such as corneal diameter, lateral line branching, and mouth width (Scott and Jennings, 1985), and oral disk papillae and buccopharyngeal characters (Grillitsch *et al.*, 1993), were not included in this study. However, Viertel (1982) has previously described the morphology of the buccopharyngeal apparatus in *R. temporaria*.

Data analyses

Descriptive statistical analysis was done on the 25 variables for the pooled larvae, 26 for each of the five localities, n = 130. A similar descriptive analysis was also done for each separate locality, n = 26. Multivariate analyses were also employed. All 25 variables were used in a discriminant function analysis with location as the single independent variable, producing a matrix showing the number of tadpoles that could be correctly or incorrectly assigned to a given locality. The classification criterion used to characterize localities was determined by a measure of generalized squared distance (Rao, 1973: 574-577). Additionally, those variables which were most important in discriminating between locations were determined by a stepwise discriminant analysis by stepwise selection with an entry level significance of 0.15, providing a prioritized list of such predictor variables based on partial correlation coefficients (r**2). Although the synthesis of a classification criterion was conducted with parametric procedures, the performance of this criterion in assigning sample observations as being from potential localities was distribution free. Finally, Spearman coefficients (r_S) were calculated for correlations between stage and each of the remaining 24 variables.

Localities and samples

The date of collection (all dates are for the year 1992) and brief habitat description of each of the five localities chosen from the original 17 are noted below (numbers refer to Figure 1). The localities are arranged from north to south (Irish grid map reference follows county, then altitude). The original sample size that ranged from 26 to 71 is indicated for each of the five localities. Localities with more than 26 larvae were subsampled by stratified random procedure for 26 in this study to include a variety of sizes and stages and account for any ontogenetic variation.

2) Colloney, Co. Sligo, G6826, 27m, 19 May, n = 43. Flooded ditch (0.6m deep) along hedgerow in field east of junction of roads N17 and N4.

7) Tuam, Co. Galway, Ballygaddy Road, M4253, 46m, 19 May, n = 62. Tadpoles in surface algal mats (water 2-3cm deep) and shallow depressions on wet bog land in mixed deciduous/coniferous forest south of road. Additionally five postmetamorphic frogs collected, snout-vent length: 17.5; 19.5; 24.0; 34.5; 38.0mm.

9) Malahide, Co. Dublin, 02245, 21m, 11 May, n = 26. Artificial garden pond with uniform silt bottom, 0.3m deep.

11) Shannon, Co. Clare, Drumgeeley Point, R3960, 9m, 22 May, n = 62. Marshy area below housing estates and flooded pedestrian gravel path on peninsula, 25m above river Shannon estuary. Significance as being within brackish, supratidal zone discussed in Korky and Webb (1993).

15) Kilmacthomas, Co. Waterford, S3804, 58m, 16 May, n = 71. Flooded heavy machinery wheel ruts (0.3m deep) in bog soil of coniferous forest located south of road N25.

Results

Descriptive Statistics

Table 1 shows the descriptive statistics for the pooled larvae (n = 130) of all five localities. The number (n) is less than 130 in some cases due to missing or damaged features.

Table 2 shows the descriptive statistics for each locality separately, and again number (n) is similarly variable. Much of the variation in tooth rows, length of entire rows, or their segments, or gap (between rows) is associated with sample size. The pooled data samples for any one of these tooth row associated variables is less than 130, whereas the developmental stage ranges from 27 to 41. Gosner (1960) noted the developmental period between approximate stages 30 and 40 as one of relative stability in "key" traits, with the oral disc and labial tooth rows beginning to differentiate at about stage 23, and mouth parts beginning to break down following stage 40. Reasons for the volatility of these traits in the present study will be discussed later.

Our study of 1993 reported a typical LTRF (labial tooth row formula) of 3(2-3)/4(1) indicating three upper rows of teeth, but some, (3.6%, n = 748), exhibited the LTRF 4 (2-4)/ 4(1) indicating four upper tooth rows. The latter were obtained from southern localities only. Table 1 of the present study indicates a full (right and left segments) A-3 row present in 108 of

130 tadpoles (83%), with five more having only the right A-3 segment, and five only the left A-3 segment. Table 2 shows the number of larvae with either three or four upper tooth rows and their respective localities. The left A-4 is present in a total of 14 (three localities) of 130 (10.7%), and the right A-4 in 12 (two localities) of 130 (9.2%) larvae. A full A-4 row was present in a total of 12 of these 14 larvae. The localities with A-4 segments in the present study now include some further north (Malahide and Shannon) than reported in 1993, but the frequency for both A-4 segments is still greatest in the south (Kilmacthomas, 10 of 26 or 38.5%). These A-4 segments are extremely short, and have few teeth. Table 3 summarizes the data for the three localities from which larvae have either or both A-4 segments in terms of tooth row length and number of teeth present on them. Figures 2 and 3 respectively, show an oral disc with three upper tooth rows, and the fullest complement of four upper tooth rows.

Multivariate Analyses

Results of the discriminant function analysis with location as the single independent variable are shown in the matrix of Table 4. The data show the performance of the classification criterion in correctly assigning each sample to the correct location and where specific assignment errors occurred. The average correct assignment for the five localities was 96.796% with a range of 91.67% to 100%.

Table 5 displays the variables best suited to be predictors of location that were chosen by a stepwise discriminant analysis by stepwise selection with an entry significance level of 0.15, producing a prioritized list of such variables based on partial correlation coefficients (r**2). Although stage with its temporal ramifications of age and date of collection is highly ranked among the predictors, it is not the prime predictor, and ranks below ventral fin height and interocular distance. Stage also has a probability value of 0.0001, which is shared by four other highly significant predictors. Since the data are nonparametric, Spearman Correlation Coefficients (r_S) were calculated to examine the relationship between developmental stage and the 24 other variables. Table 6 displays the results of this analysis. All variables with the exception of left A-3 length were positively correlated. Body measurement variables ranged from $r_S = 0.18599$ for interocular distance to $r_S = 0.65865$ for tail length. Stage and body length have $r_S = 0.54925$. The latter value is not as high as reported by Korky (1978, $r = 0.99$

for *R. blairi* Mecham *et al.* and *R. pipiens* in Nebraska) and Hillis (1982, r = 0.94 for *R. berlandieri* Baird, and r = 0.81 for *R. sphenocephala* Cope in Texas).

Developmental stage and tooth row variables of this study, except left A-3 length as noted, were positively correlated and ranged from $r_s = 0.00987$ for right A-3 length to $r_s = 0.57723$ for P-3 length.

Typical pigmentation, colour and pattern, of larval specimens in this study was noted at the time of collection prior to preservation by one of us (JKK), and was reported in our 1993 study. Altig (1970), Scott and Jennings (1985) discussed changes in colour and pattern associated with tadpole preservation that involves leaching of pigments. Although we did not use pigmentation as a variable in this study, of the five localities, all larvae from Malanide were consistent in having the least melanic bodies, but the most darkly blotched tails, both in the live and subsequent preserved state (Fig. 4). The melanophores were more uniformly distributed on the body and tail of larvae from the other four localities. No other larva from any sample (1-17) displayed the degree of dark blotching that occurred in the Malahide larvae. Additionally, those from Malahide uniquely have more marginal papillae on the oral disc, and a wider oral disc width *sensu* Jennings and Scott (1993); in one of these larvae, stage 36, the oral disc width = 3.8, and total length = 47. No other data were recorded.

Discussion

The descriptive statistical analyses provide data for both the pooled larvae, as well as individual localities, allowing an assessment of variability of selected larval parameters within and between localities. The greatest variability occurs among the tooth row associated variables as a whole, particularly in a north-south clinal pattern with regard to the A-3 and A-4 rows. Boulenger illustrated (1897: 110-111) and described (1898: 312-313) a tooth row formula of 3-4 (2-4)/4 (1), as did Altig and Johnston (1986) 4 (2-4)/4 (1), based on the illustration and description of Liu (1950: 284-285). Altig and Johnston (1989) comprehensively reviewed the topic of tooth row diversity and row homology, and its possible ecological implications. They noted that the sequence of appearance of labial tooth rows is known only for relatively few taxa and that metamorphic atrophy is even less well understood. They did propose a model of gain and loss involving five rows in a 2/3 configuration, which were designated the prime rows or prime formula. The proposed model (see Altig and Johnson, 1989, p. 91, fig. 5E) accounted for the method by which ranids, which include many stream forms with a LTRF greater than the prime formula, as well as incomplete marginal papillae, could add subsequent rows alternately on each labium proximal to the jaw sheaths. Their mechanism for metamorphic atrophy as a general pattern involved phylogenetic loss of tooth rows in reverse order of the ontogenetic gain of the prime formula: what is added last is lost first. Thus, the rows proximal to the jaw sheaths (A-3, A-4, P-1, P-2) should show the most variability for additions and deletions. Our data support the proposed mechanism with regard to the anterior tooth rows, and this may account for the observed A-3, A-4 LTRF variability. However, our data do not support the proposed mechanism regarding the posterior rows since the P-4 row in particular, rather than the P-1, is most often atrophied (n = 34 of 130 or 26.15%). A similar tendency noted by us was atrophy in the P-3 row. Loss of both P-3 and P-4 rows was clearly due to reabsorption rather than trauma. The ecological implication of the observed tooth row variability is unknown, but would probably be dietary related, since the oral disc plays only a minor roll in position maintenance within the habitat.

The multivariate discriminate function analysis shows that larvae differ significantly in morphology for the selected variables between localities, and can be discriminated with a high probability (average of 96.796%) that far exceeds random assignment to a locality (20%). The stepwise discriminant analysis prioritizes which variables are the best predictors of location, and although stage is among them, it is not prime. This analysis plus the relatively modest correlation coefficients for developmental stage and variables associated with body form, in comparison to other ranid studies cited, shows that the variation between localities is not purely an artifact of size *per se*. Presumably, most of the morphological variation represents adaptations to different larval habitats, which we purposely chose for geographic and ecologic diversity; however, some variation could be nonadaptive random variation resulting in the few misallocated larvae of the discriminant analysis. Thus, this study confirms that of Hillis (1982), who demonstrated that dissimilarity of habitat types between environments results in dissimilar field collected tadpole types. Conversely, he was able to demonstrate considerable morphological convergence for laboratory reared conspecific larvae in a uniform environment.

A corollary principle in the above study, and reported also by Jennings and Scott (1993), is that stream collected tadpoles have more prominently blotched concentrations of tail melanophores in comparison to their more uniformly distributed pond counterparts. all other factors being equal. This is not fully supported by our study in that the actual pond reared Malahide larvae clearly exhibit the most pronounced tail blotching, while their bodies are the palest of all localities. Their artificial garden pond habitat with uniform silt bottom was far less ecologically diverse in many aspects compared to other localities. The melanophores of the body and tail were much more uniformly distributed, with no tail blotching, in the other four localities. These sites were essentially more lentic than lotic, with little or no water flow, thus somewhat pond-like, producing uniform pigmentation consistent with published data for that character as an isolated variable. They include the Shannon site, elevated above the estuary but with brackish water, whose salinity appears not to be a factor with regard to pigmentation pattern, or any other variable for that matter. Paler coloration of the tail, and the body as well, has been suggested by Jennings and Scott (1993) possibly to provide crypsis in lentic water with greater amounts of suspended particles than in lotic ones. The reason the Malahide larvae have a dichotomous pattern of pale body and blotched tail pigmentation is enigmatic, but could represent nonadaptive variation, or a response to some subtle selective factor, and warrants further study. The larger oral disc width of the Malahide larvae in comparison to the other localities may also be related to their pond environment, in that drag may be of less consequence in a still habitat. Their increased number of marginal papillae is probably a phenotypically plastic response to a dietary factor. Lastly, the Malahide larvae exhibited the largest mean total length for any locality, and the largest individual total length, while having a mean developmental stage slightly less than that for the pooled larvae. The reason they are more robust is conjectural, but may be related to reduced predator pressure in a confined artificial habitat, and/or increased supply of a critical nutrient, although food availability in larval habitats generally is not a factor. Other environmental influences that may affect the variable characteristics used in this study were reviewed by Webb and Korky (1977); Beattie and Tyler-Jones (1992).

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Conclusion

Field collected larvae of *Rana temporaria* from selected habitats in Ireland may be statistically distinguished by locality based on the variables used in this study. One locality, Malahide, can be visually discriminated from the others on the basis of pigmentation, larger total length, larger oral disc width, and increased number of marginal papillae.

Tadpoles with 4 upper tooth rows are reported from localities further north than previously reported, and the method of gain and loss of lower tooth rows is an alternate pattern to that proposed by Altig and Johnston (1989).

These larvae exhibit considerable phenotypic plasticity in response to varying habitat type that represents varying combinations of adaptive and nonadaptive morphological variation to different selective regimes and environmental influences.

In regard to the ecomorphological guilds of exotrophic anuran larvae proposed by Altig and Johnston (1989), these larvae express the characters of the lentic-benthic: type 2: profundal to lotic-clasping type.

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TABLE 1. Descriptive statistics of selected parameters for pooled larvae of five localities showing: n = number of specimens; Mean = mean value; Median = median value; SD = standard deviation; Range = minimum value-maximum value. Number of specimens (n) may vary due to missing or damaged features.

Variable	n	Mean	Median	SD	Range
Body Length	130	12.02308	12	2.059071	7-18
Tail Length	130	19.33077	19	5.494731	8-33
Total Length	130	31.35385	31	7.298573	16-51
Tail Height	130	7.415385	7	2.130562	3-12
Tail Muscle Height	130	3.638462	4	1.049207	2-6
Dorsal Fin Height	130	2.753846	3	0.889748	1-5
Ventral Fin Height	130	1.938462	2	0.734043	1-4
Interocular Distance	130	2.272308	2.2	0.424632	1.4-3.2
Internareal Distance	130	1.876923	1.9	0.276057	1.1-2.5
A-1 Length	129	1.808527	1.8	0.421684	0.3-2.9
Left A-2 Length	124	0.687903	0.7	0.245146	0.2-1.9
Right A-2 Length	125	0.6968	0.7	0.247222	0.1-1.9
A-2 Gap	121	0.505785	0.5	0.116403	0.2-1
A-2 Gap Ratio	121	1.53314	1.4	0.692007	0.29-4
A-3 Length	108	1.709259	1.7	0.40477	0.4-3
Left A-3 Length	5	0.32	0.3	0.044721	0.3-0.4
Right A-3 Length	5	0.28	0.3	0.044721	0.2-0.3
Left A-4 Length	14	0.235714	0.2	0.08419	0.2-0.5
Right A-4 Length	12	0.216667	0.2	0.071774	0.1-0.4
P-1 Length	124	1.654032	1.7	0.364792	0.3-2.4
P-1 Gap	120	0.16	0.1	0.082401	0.1-0.5
P-2 Length	124	1.679032	1.8	0.436221	0.4-2.6
P-3 Length	123	1.381301	1.4	0.476729	0.3-2.4
P-4 Length	96	1.069792	1	0.356922	0.3-1.9
Stage	130	33.80769	34	2.8122	27-41

TABLE 2. Descriptive statistics of selected parameters for each locality showing, n: number of specimens; Mean: mean value; Median: median value; SD: standard deviation; Range: minimum value-maximum value. Number of specimens (n) may vary due to missing or damaged features.

		Colloney	Tuam	Malahide	Shannon	Kilmacthomas
Body Length	n	26	26	26	26	26
	Mean	12.30769	10.65385	13.92308	10.5	12.73077
	Median	12	11	14.5	11	13
	SD	1.59422	1.623387	2.398718	1.334166	0.666795
	Range	8-15	7-13	8-18	8-13	12-14
Tail Length	n	26	26	26	26	26
	Mean	16.11538	17.46154	25.96154	14.80769	22.30769
	Median	16	18	27	14.5	22
	SD	3.558954	2.370329	5.716508	3.23752	1.934306
	Range	8-23	12-22	12-33	9-22	17-26
Total Length	n	26	26	26	26	26
	Mean	28.42308	28.11538	39.88462	25.30769	35.03846
	Median	27.5	29	41.5	25	35
	SD	4.965264	3.766451	7.951488	4.470071	2.271225
	Range	16-37	19-33	20-51	17-34	29-39
Tail Height	n	26	26	26	26	26
	Mean	7.769231	6.153846	9.807692	5.115385	8.230769
	Median	8	6	11	5	8
	SD	1.305609	1.084152	2.154423	0.993053	0.992278
	Range	4-10	4-8	5-12	3-7	7-10
Tail Muscle Height	n	26	26	26	26	26
	Mean	3.461538	2.961538	4.651385	2.692308	4.461538
	Median	3.5	3	5	3	4
	SD	0.581774	0.662164	0.941357	0.788377	0.508391
	Range	2-4	2-4	2-6	2-5	4-5
Dorsal Fin Height	n	26	26	26	26	26
	Mean	2.923077	2.076923	2.076923	1.923077	3.076923
	Median	3	2	2	2	3
	SD	0.392232	0.483576	0.483576	0.483576	0.483576
	Range	2-4	1-3	1-3	1-3	2-4

TABLE 2 (cont.)

Ventral Fin Height	n	26	26	26	26	26
	Mean	2.076923	1.576923	2.846154	1.115385	2.076923
	Median	2	2	3	1	2
	SD	0.483576	0.503831	0.543493	0.325813	0.392232
	Range	1-3	1-2	2-4	1-2	1-3
Interocular Distance	n	26	26	26	26	26
	Mean	2.542308	1.996154	2.75	1.923077	2.15
	Median	2.55	2	2.8	1.9	2.2
	SD	0.288684	0.267553	0.389102	0.247075	0.167929
	Range	1.6-3.2	1.5-2.4	1.7-3.2	1.4-2.3	1.8-2.4
Internareal Distance	n	26	26	26	26	26
	Mean	1.880769	1.865385	2.076923	1.630769	1.930769
	Median	2	1.9	2.1	1.6	1.95
	SD	0.23498	0.211551	0.311522	0.264982	0.134964
	Range	1.4-2.3	1.5-2.1	1.5-2.5	1.1-2.1	1.7-2.2
A-1 Length	n	26	26	26	25	26
	Mean	1.573077	1.438462	2.234615	1.896	1.903846
	Median	1.65	1.4	2.25	2	1.9
	SD	0.448605	0.23165	0.386722	0.289367	0.139945
	Range	0.3-2.2	1-1.8	1.3-2.9	1.2-2.3	1.6-2.2
Left A-2 Length	n	26	21	26	25	26
	Mean	0.557692	0.509524	0.915385	0.72	0.703846
	Median	0.55	0.5	1	0.7	0.7
	SD	0.217574	0.141084	0.209174	0.294392	0.07736
	Range	0.2-0.9	0.3-0.8	0.5-1.2	0.4-1.9	0.6-0.9
Right A-2 Length	n	24	24	26	25	26
	Mean	0.5625	0.529167	0.930769	0.732	0.707692
	Median	0.65	0.5	1	0.7	0.7
	SD	0.228059	0.136666	0.214978	0.288271	0.097665
	Range	0.1-1	0.3-0.8	0.5-1.2	0.5-1.9	0.4-0.9
A-2 Gap	n	24	20	26	25	26
	Mean	0.541667	0.48	0.473077	0.56	0.515385
	Median	0.5	0.5	0.5	0.5	0.5
	5D	0.183953	0.089443	0.091903	0.08	0.100766
	Range	0.3-1	0.2-0.6	0.3-0.7	0.4-0.7	0.3-0.7

TABLE 2 (cont.)

A-2 Gap Ratio	n	24	20	26	25	26
	Mean	1.305417	1.2325	2.085769	1.472	1.480769
	Median	1.4	1	2.2	1.33	1.4
	SD	0.683647	0.692789	0.671662	0.6146	0.493752
	Range	0.29-3.33	0.6-4	1-3.67	0.83-3.8	0.86-3
A-3 Length	n	18	19	24	21	26
	Mean	1.55556	1.268421	2.15	1.714286	1.726923
	Median	1.5	1.4	2.2	1.7	1.7
	SD	0.299455	0.324983	0.406469	0.245531	0.111562
	Range	1-2.1	0.4-1.7	1-3	1.2-2.1	1.4-1.9
Left A-3 Length	n	1	1	2	1	-
	Mean	0.3	0.3	0.35	0.3	-
	Median	0.3	0.3	0.35	0.3	-
	SD	-	-	0.070711	-	-
	Range	0.3-0.3	0.3-0.3	0.3-0.4	0.3-0.3	-
Right A-3 Length	n	2	3	-	-	-
	Mean	0.3	0.266667	-	-	-
	Median	0.3	0.3	-	-	-
	SD	-	0.057735	-	-	-
	Range	0.3-0.3	0.2-0.3	-	-	-
Left A-4 Length	n	-	-	3	1	10
	Mean	-	-	0.333333	0.2	0.21
	Median	-	-	0.3	0.2	0.2
	SD	-	-	0.152753	-	0.031623
	Range	-	-	0.2-0.5	0.2-0.2	0.2-0.3
Right A-4 Length	n	-	-	2	-	10
	Mean	-	-	0.3	-	0.2
	Median	-	-	0.3	-	0.2
	SD	-	-	0.141421	-	0.04714
	Range	-	-	0.2-0.4	-	0.1-0.3
P-l Length	n	26	22	26	24	26
	Mean	1.515385	1.409091	1.880769	1.570833	1.85
	Median	1.55	1.5	1.95	1.6	1.8
	SD	0.309441	0.371495	0.383687	0.325014	0.160624
	Range	0.8-2	0.3-2.2	0.5-2.4	0.8-2	1.5-2.2

TABLE 2 (cont.)

P-1 Gap	n	25	21	25	24	25
	Mean	0.124	0.185714	0.16	0.166667	0.168
	Median	0.1	0.2	0.1	0.2	0.1
	SD	0.052281	0.079282	0.122474	0.048154	0.080208
	Range	0.1-0.3	0.1-0.4	0.1-0.5	0.1-0.2	0.1-0.3
P-2 Length	n	26	23	26	23	26
	Mean	1.546154	1.334783	1.961538	1.582609	1.919231
	Median	1.7	1.4	2	1.6	1.9
	SD	0.402225	0.449857	0.391997	0.405252	0.13862
	Range	0.7-2.2	0.4-2.3	0.8-2.6	0.5-2.2	1.7-2.3
P-3 Length	n	26	22	26	23	26
	Mean	1.080769	1.018182	1.811538	1.334783	1.6
	Median	1.05	1.05	1.85	1.3	1.55
	SD	0.365534	0.343146	0.475249	0.421694	0.2
	Range	0.3-1.9	0.3-1.9	0.4-2.4	0.4-2.1	1.3-2
P-4 Length	n	13	13	25	20	25
	Mean	0.892308	0.630769	1.264	1.115	1.16
	Median	0.9	0.7	1.3	1.1	1.2
	SD	0.383974	0.160128	0.367287	0.277726	0.225642
	Range	0.3-1.8	0.3-0.9	0.5-1.9	0.6-1.9	0.7-1.6
Stage	n	26	26	26	26	26
	Mean	32.53846	33.07692	33.61538	33.26923	36.53846
	Median	33	34	34	33.5	36
	SD	1.678827	2.313838	2.192294	3.975502	1.30325
	Range	28-35	28-36	28-36	27-41	34-39

TABLE 3. Data summary of A-4 tooth row segments.

Variable	Locality	n	Length Range	No. Teeth Range
Left A-4 Length	Malahide	3	0.2-0.5	4-11
	Shannon	1	0.2	7
	Kilmacthomas	10	0.2-0.3	5-7
Right A-4 Length	Malahide	2	0.2-0.4	4-10
	Shannon	-	-	
	Kilmacthomas	10	0.1-0.3	2-7

TABLE 4. Matrix of performance of a classification criterion from discriminant function analysis showing assignment of larvae to localities. Bottom number for each entry is the percent of sample correctly assigned.

Actual Locality	Locality Assigned by D.F.A.					
	Colloney	**Malahide**	**Kilmacthomas**	**Shannon**	**Tuam**	**Total**
Colloney	22 91.67	1 4.17	0 0.00	0 0.00	1 4.17	24 100.00
Malahide	2 7.69	24 92.31	0 0.00	0 0.00	0 0.00	26 100.00
Kilmacthomas	0 0.00	0 0.00	25 100.00	0 0.00	0 0.00	25 100.00
Shannon	0 0.00	0 0.00	0 0.00	24 100.00	0 0.00	24 100.00
Tuam	0 0.00	0 0.00	0 0.00	0 0.00	20 100.00	20 100.00

Error Count Estimates:

	Colloney	Malahide	Kilmacthomas	Shannon	Tuam	Total
Rate	0.0833	0.0769	0.0000	0.0000	0.0000	0.0321
Priors	0.2000	0.2000	0.2000	0.2000	0.2000	

TABLE 5. Results of stepwise discriminant analysis with an entry level significance of 0.15 showing variables useful as predictors of location.

Step	Variable	Partial r**2	F Statistic	Prob > F
1	Ventral Fin Height	0.6564	54.440	0.0001
2	Interocular Distance	0.4916	26.838	0.0001
3	Stage	0.4470	22.629	0.0001
4	Tail Length	0.4326	20.964	0.0001
5	A-l Length	0.3862	17.773	0.0001
6	Internareal Distance	0.1739	5.631	0.0004
7	Right A-4 Length	0.1706	5.604	0.0004
8	P-3 Length	0.1413	4.442	0.0023
9	Body Length	0.1352	4.142	0.0037
10	A-2 Median Gap	0.1307	3.836	0.0060
11	Tail Muscle Height	0.1292	3.894	0.0055
12	P-l Median Gap	0.1108	3.241	0.0150
13	A-2 Length	0.1005	2.878	0.0264

TABLE 6. Spearman Correlation Coefficients (r_S) for stage versus remaining 24 variables.

Stage	r_S	Prob.	n
Body Length	0.54925	0.0001	130
Tail Length	0.65865	0.0001	130
Total Length	0.65431	0.0001	130
Tail Height	0.43509	0.0001	130
Tail Muscle Height	0.60958	0.0001	130
Dorsal Fin Height	0.37182	0.0001	130
Ventral Fin Height	0.28209	0.0011	130
Interocular Distance	0.18599	0.0341	130
Internareal Distance	0.38854	0.0001	130
A-l Length	0.45877	0.0001	130
Left A-2 Length	0.46805	0.0001	130
Right A-2 Length	0.48753	0.0001	128
A-2 Median	0.15529	0.0890	121
A-2 Gap Ratio	0.34610	0.0001	121
A-3 Length	0.51472	0.0001	130
Left A-3 Length	-0.20911	0.0170	130
Right A-3 Length	0.00987	0.9113	130
Left A-4 Length	0.34305	0.0001	130
Right A-4 Length	0.31361	0.0003	130
P-l Length	0.56977	0.0001	130
P-l Median Gap	0.19981	0.0237	128
P-2 Length	0.56336	0.0001	129
P-3 Length	0.57723	0.0001	129
P-4 Length	0.52519	0.0001	129

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FIGURE 1: map of Ireland showing localities of larval samples (numbers correspond to the numbered localities in the text).

FIGURE 2: oral disc of *Rana temporaria* larvae from Ireland exhibiting three upper tooth rows in LTRF of 3(2-3)/4(1).

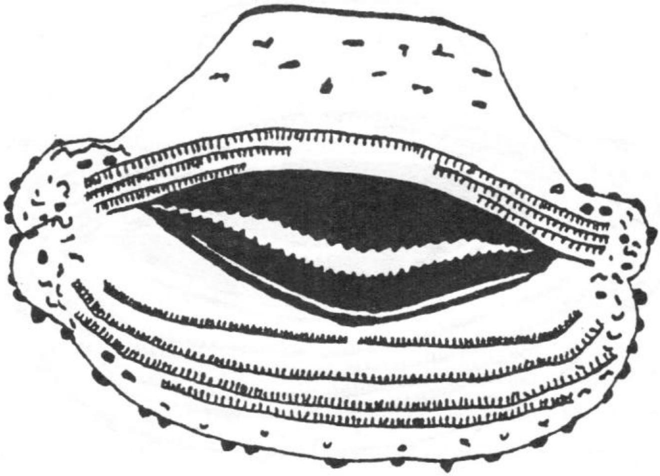


FIGURE 3: oral disc of *Rana temporaria* larvae from Ireland exhibiting fullest complement of four upper tooth rows in LTRF of 4(2-4)/4(1).

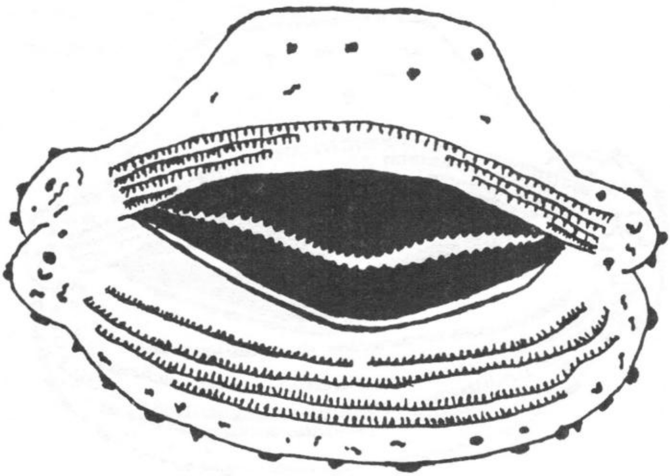
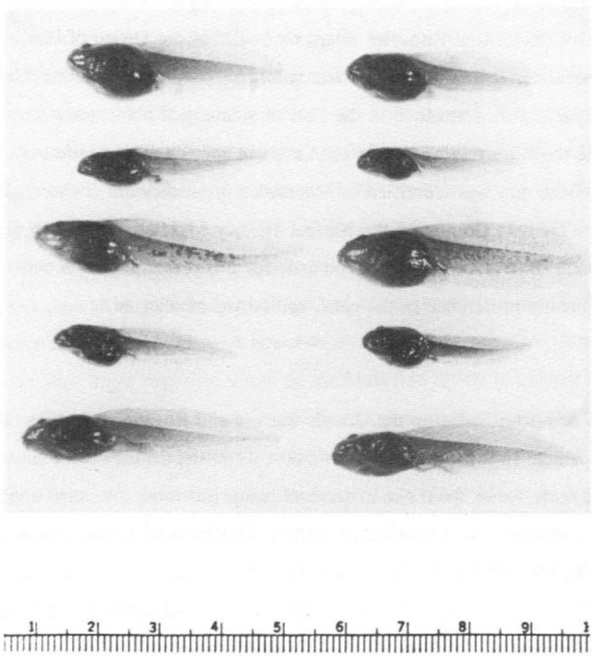


FIGURE 4: tadpoles of *Rana temporaria* shown as pairs from northern to southern sites (numbers correspond to the numbered localities in the text): Colloney (2); Tuam (7); Malahide (9); Shannon (11); Kilmacthomas (15). Scale in cm.



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MACROPLEA APPENDICULATA (COLEOPTERA) IN THE ROYAL AND GRAND CANALS: A RARITY OR AN OVERLOOKED SPECIES IN IRELAND

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During the course of aquatic plant survey work on the Royal, Grand and Barrow Canals, being conducted by the Central Fisheries Board on behalf of the Office of Public Works, a rarely reported aquatic coleopteran species was recorded. Initial observations related to gold or dark-coloured pupae/cocoons attached to the base of submerged plant stems, removed in an effort to elucidate the life cycle of certain aquatic plant species. This beetle belongs to the family Chrysomelidae and was identified as *Macroplea appendiculata* (Panzer). Identification was confirmed by Dr J. O'Connor of the Natural History Museum. This is an invertebrate species about which little is known in Ireland and, for this reason, some details regarding its distribution and habitat preference in the canal habitat were collected.

Study sites

The study area comprised sites on the Grand, Barrow and Royal Canals (Fig. 1). These canals are roughly trapezoidal in cross-section and support water depths between 1.55 and 1.75m. The nature of the substrate varies from site to site and comprises mud, silt, sand and gravel. Boat traffic intensity is relatively low on all three canals. The majority of the sites selected for study supported dense stands of aquatic vegetation.

Materials and methods

During 1992 and 1993 vegetation sampling in the canals was conducted using a stovepipe sampler (Caffrey, 1990). The stovepipe, made from heavy-duty plastic material (wavin), measured 80cm in height and 23cm in internal diameter. The stovepipe was thrust forcefully into the target plant stand and pushed into the substratum. All living plant material within the pipe, to a depth of *circa* 20cm below ground, was removed by hand. Sampling was conducted at each site on at least 10 occasions during the 24 months sampling period and, on each occasion, five stovepipe samples were taken. The presence or absence and the stage of development of *Macroplea appendiculata* was recorded on each sampling occasion. At Belmont on the Grand Canal, where the beetle was first discovered, the density of *M. appendiculata* individuals was recorded on two separate occasions (February and April, 1992).

The physico-chemical data of the water at each site was analysed throughout the sampling period.

Results

The physico-chemistry of the water at each site where *Macroplea appendiculata* was recorded is presented (Table 1). The water is clear, low in plant growth-promoting nutrients, alkaline and has a high pH buffering capacity.

Macroplea appendiculata was observed during the sampling period at different stages in its life cycle. "Grub-like" larvae, immature pupae encased in gold-coloured cocoons, mature pupae encased in brown/black cocoons and emerged adults were recorded at different stages during the sampling programme. All stages were found underwater, either attached to or lying on submerged aquatic vegetation. This macroinvertebrate species is well adapted to underwater conditions where it obtains oxygen released by aquatic plants (Crowson, 1981; Harde, 1985).

In April, large numbers of emerged adults were found clinging to submerged *Potamogeton pectinatus* L. shoots. Free-living larvae were prevalent during the months of May and June. Sampling in July revealed that many of the larvae were encased in transparent gold-coloured cocoons where they continued to develop throughout the season. The majority of specimens recorded from October to March were mature pupae encased in brown/black cocoons.

In all instances where cocoons were found, they were attached directly to the root, immediately below the substrate/water interface.

During the investigation, *M. appendiculata* was recorded at six canal sites. These were on the Grand Canal at Belmont (N0622) and east of Lock 12 (O0332), on the Barrow Canal at Umeras Bridge (N0415) and Vicarstown (N6100), and on the Royal Canal at Baltrasna (N4751) and Coolnahay (N3553). While the aquatic vegetation at many other canal sites was regularly sampled, no *M. appendiculata* specimens were observed.

In February 1992 in dense *Potamogeton pectinatus* vegetation (333 ± 50g dw m^{-2}), 109 ± 32

mature pupae.m^{-2} were recorded. Also present in the samples at this time were small numbers of free-living larvae ($5 \pm 1m^{-2}$) and immature pupae ($7 \pm 3m^{-2}$).

In April 1992, when a reduced *P. pectinatus* biomass (78 ± 35g dw m^{-2}) was present, no free-living larvae were observed, although $92 \pm 26m^{-2}$ black cocoons containing fully developed adults and $28 \pm 7m^{-2}$ emerged adults were recorded at this time.

Macroplea appendiculata showed some selectivity regarding its plant host. At sites dominated by *Potamogeton pectinatus*, the beetle was found only on this plant, even though other submerged rooted plant species were present. At Vicarstown, where *Potamogeton* x *salicifolius* Wolfg. and *Sparganium emersum* Rehmann predominated, *M. appendiculata* was confined to the former species. At the other sites, however, the beetle did not colonise the dominant flora. At Coolnahay, for example, where *Myriophyllum verticillatum* L. was the dominant macrophyte, *M. appendiculata* was only observed on small, localised stands of *Potamogeton coloratus* Hornem. At Baltrasna, where *Elodea canadensis* Michx. and *Fontinalis antipyretica* Hedw. dominated the flora, the beetle attached only to *Potamogeton natans* L., and east of Lock 12 on the Grand Canal, where a very mixed macrophyte community was present, the beetle attached exclusively to *Sagittaria sagittifolia* L.

Discussion

Macroplea appendiculata is considered to be a rare coleopteran species (Mellanby, 1963; Foster, 1986; Shirt, 1987; Parsons, 1992), but this probably reflects the lack of attention given to this family of beetles by entomologists (Shirt, 1987; Bilton and Lott, 1991; Parsons, 1992; O'Connor pers. comm). In Ireland there are few previous records for this aquatic Chrysomelid. Interestingly, all previous records available are from the Royal and Barrow Canals (O'Connor pers. comm.) and from Loughrea Lake, South Galway (Halbert, 1937). The only documented sightings of the beetle from the canals are given by Johnson and Halbert (1902), who recorded *M. appendiculata* in the Royal Canal at "Hill of Down" and near Dublin. No subsequent references to Irish sightings are available in the literature.

From the limited data gathered on the life cycle of this species in the canal habitat, it appears that *M. appendiculata* may survive the winter period as a larva, a developing pupa, or as a fully developed pupa at the point of emerging. It is interesting, however, that the majority of the specimens recorded at Belmont in February 1992 were mature pupae. Two months later the majority were mature pupae or emerged adults. In July empty cocoons, larvae and immature pupae were found at Belmont and immature pupae were recorded at Baltrasna, which suggests the beginning of a new generation. According to Mellanby (1963) and Fitter and Manuel (1986), the adults emerge between August and October. Parsons (1992) likewise suggests that the adults emerge between June and August, although they were also recorded from September to November. Results from the present investigation do not support these observations and suggest that adults, in Irish canal habitats, emerge during April.

Canals and lakes with abundant vegetation are the favoured habitats of most Chrysomelidae (Foster *et al.*, 1992). Results from the present work would suggest that *M. appendiculata* exhibits a distinct substrate preference. In the present study the beetle displayed a definite preference for *Potamogeton* species, and particularly *P. pectinatus*. This specificity is also documented in Fitter and Manuel (1986), Parsons (1992) and Jacobsen and Sand-Jensen (1995). A study carried out on the variability of invertebrate herbivory on *P. perfoliatus* L. (Jacobsen and Sand-Jansen, *op. cit.*) revealed that the biomass of *M. appendiculata* was correlated to loss in plant abundance in Danish lakes. Parsons (*op. cit.*) observed that *M. appendiculata* also attached to *Myriophyllum spicatum* L. plants in Britain. *Myriophyllum* spp. are widespread in Irish canals (Caffrey and Monahan, 1995) and represent the dominant flora over long sections. Intensive examination of this vegetation for *M. appendiculata* specimens failed to reveal any. In the present study, *M. appendiculata* also was found attached to *Sagittaria sagittifolia*, which has also been identified as a suitable substrate for aquatic members of the Chrysomelidae family (Fitter and Manuel, *op. cit.*).

The findings from this preliminary survey suggest that *M. appendiculata* is distributed rather widely in the canals and, in this habitat at least, cannot be considered rare. The fact that this species was also recorded by the present authors at sites on the lower River Shannon, also dominated by *P. pectinatus*, suggests that it may be far more common in aquatic habitats than was hitherto reported.

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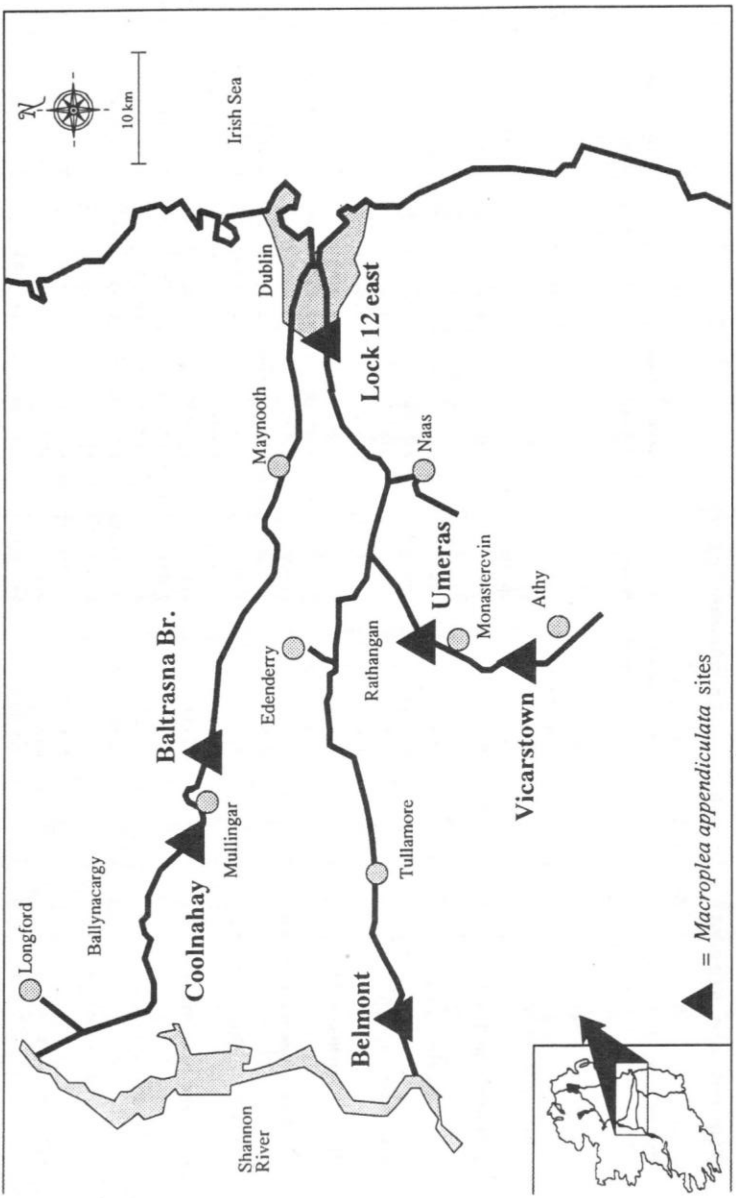
TABLE 1. Physico-chemical analysis of water samples from six sites on the Royal, Grand and Barrow Canals where *Macroplea appendiculata* was recorded during 1992. Figures are presented as means, with ranges below.

Parameters	**Grand Canal**		**Barrow Canal**		**Royal Canal**	
	Lock 12 east	Belmont	Umeras Br.	Vicarstown	Baltrasna Br.	Coolnahay
Conductivity (μS/cm at 20°C)	506	430	567	494	479	435
	472-561	388-517	494-642	392-580	285-637	282-676
Colour (Hazen units)	13	29	32	30	30	20
	10-15	25-40	10-45	15-45	10-45	10-25
Turbidity (N.T.U.)	1.0	17.5	17.1	8.1	2.2	1.7
	0.6-1.4	9.3-30.0	13.0-22.0	1.4-16.0	0.9-3.0	1.2-2.7
Total Hardness (mg/L $CaCO_3$)	279	235	320	268	275	231
	260-315	206-293	280-365	206-320	144-382	106-402
Alkalinity (meq/L)	4.9	4.0	5.6	4.4	4.5	4.1
	4.4-5.6	3.4-4.9	5.0-6.3	3.4-5.4	2.3-6.3	2.5-6.8
Total Phosphorus (mg/L P)	0.015	0.027	0.046	0.028	0.033	0.045
	0.009-0.019	0.011-0.038	0.037-0.054	0.020-0.038	0.025-0.039	0.018-0.073
Molybdate Reactive Phosphorus (mg/L P)	0.002	0.004	0.003	0.001	0.005	0.007
	0.001-0.004	0.002-0.006	0.001-0.006	0.001-0.002	0.002-0.009	0.004-0.011
Total Kjeldahl Nitrogen (mg/L N)	0.391	0.542	0.825	0.069	0.770	0.781
	0.251-0.480	0.433-0.675	0.667-1.030	0.492-0.811	0.700-0.805	0.548-0.899
Oxidised Nitrogen (mg/L N)	1.963	0.980	1.775	1.882	0.541	1.481
	1.403-2.996	0.019-2.865	0.793-2.658	0.715-3.427	0.001-1.411	0.0-4.444
Chlorophyll (μg/L)	2.79	3.29	39.78	19.12	4.19	-
	2.42-3.17	2.34-4.25	37.36-42.20	5.55-32.69	1.96-6.42	-
Dissolved Oxygen (mg/L O_2)	10.8	11.6	11.9	10.1	9.4	10.2
	8.2-13.4	10.3-12.6	11.9-11.9	8.5-11.6	8.6-10.3	10.2-10.2
Calcium (mg/L)	236	196	271	224	234	222
	214-266	170-256	218-329	162-273	87.0-350	138-365
pH	7.9	8.3	8.1	8.1	7.7	7.6
	7.7-8.0	8.2-8.4	8.0-8.2	8.0-8.3	7.6-7.9	7.3-7.9

FIGURE 1: map of the Grand, Barrow and Royal Canals showing the sites where *Macroplea appendiculata* was recorded.



Bull. Ir. biogeog. Soc. No. 19 (1996)

FIRST RECORD OF SMELT *OSMERUS EPERLANUS* L. FROM THE RIVER SUIR, TOGETHER WITH A REVIEW OF IRISH RECORDS

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There are several references to the occurrence of 'smelt' or smelt-like fish in Irish waters dating back to the late 17th century (Smith, 1750; Rutty, 1772; Browne, 1774; O'Flaherty, 1846). However, for many years it was generally accepted that many of these anecdotal accounts probably referred to the atherine or sand smelt *Atherina presbyter* Valenciennes rather than the true smelt *Osmerus eperlanus* L. (Day, 1880-84; Farran, 1946; Kennedy, 1948; Thompson, 1856; Bracken and Kennedy, 1967). While in most cases this may have been true, it is clear that Templeton (1837), for example, was aware of the existence of both species of 'smelt' in Irish waters. Indeed, he specifically referred to the occurrence of *O. eperlanus* remarking that it 'is sometimes taken on our coasts in considerable abundance; but, often, several years intervene during which they are rarely to be met with.' Likewise, he remarked about the distribution of *A. presbyter* as follows: 'On the coast of Ireland it is caught in abundance during the spring months. It is brought from Portaferry into Belfast market.' It is interesting to note that Dubourdieu (1802) and Thompson (1856) also referred to the occurrence of 'smelt' at Portaferry. Thompson (1856) identified the species as *A. presbyter* and noted that they were known locally as 'Portaferry Chicken.' Although *A. presbyter* was recorded at Portaferry again during January 1953 (Williams, 1954), it was not reported during a survey of Strangford Lough and neighbouring bays in August 1963 and 1964 (Corlett, 1967).

In 1684, Roderick O'Flaherty (1846) stated: 'Here (in Lough Corrib) is another kind of fish which hath recourse to the sea as the salmon (*Salmo salar* L.) yearly to and fro, they are called *Chops*, and in Irish (Gaelic) *Trascáin*, very like herrings (*Clupea harengus* L.) only that herrings come not into freshwater.' Farran (1946) stated that the fish in question was almost certainly a shad (*Alosa* sp.) but he also acknowledged that it might have been a type of 'smelt', either *O. eperlanus* or *A. presbyter*. He noted that the Gaelic name *Trosgán*, which is phonetically similar to *Trascáin*, was used in some parts of Ireland to describe 'smelt'.

However, more specifically, he noted that the Gaelic name *Traslán*, which is also phonetically similar to *Trascáin*, was used to describe *A. presbyter* in Co. Kerry. While *A. presbyter* is known to occur in Galway Bay (O'Connell *et al.*, 1992), and is commonly found in estuarine areas (Wheeler, 1978), it is not known to penetrate into freshwater. On the other hand, *O. eperlanus* has never been positively identified from Galway Bay or indeed, the Corrib.

Nevertheless, it is possible that *O. eperlanus* may have frequented the Corrib during the 17th century, long before the present flood control weir was constructed in Galway City. Indeed, is it possible that the weir may have caused *O. eperlanus* to abandon the Corrib?

Thompson (1856) was of the opinion that *O. eperlanus* did not occur in Irish waters and this appears to have been the general consensus of opinion up until the mid 1940's when Farran (1946) remarked that *O. eperlanus* was still 'very doubtful native to Ireland.' However, two years later, the occurrence of the species in Irish waters was finally confirmed (Kennedy, 1948).

Today, *O. eperlanus* is regarded as an indigenous euryhaline fish (Quigley and Flannery, 1996). However, its distribution in Irish waters still appears to be very localised (Went and Kennedy, 1976). Indeed, until recently the species had been recorded only from the estuary of the River Shannon (Kennedy, 1948), River Fergus (Bracken and Kennedy, 1967; Anon, 1970) and River Foyle (Vickers, 1974; Vickers and Watson, 1974; Minchin and Molloy, 1978), as well as inshore waters at Larne, Co. Antrim and Belfast Lough, Co. Down (Moorehead and Service, 1992). Breeding populations are known to occur only in the Shannon, Fergus and Foyle.

Prior to 1995, circumstantial evidence suggested that *O. eperlanus* might also occur in some rivers along the south coast of Ireland. For example, during June 1969, a specimen of *O. eperlanus* was recovered from a cormorant *Phalacrocorax carbo* (L.) stomach on Little Saltee Island (X9799), Co. Wexford (West *et al.*, 1975). This was followed by unconfirmed reports in 1988 that *O. eperlanus* might be present in the rivers Suir and Nore and possibly other rivers along the south coast of Ireland (Whilde, 1993).

During June 1995, Mr Peter Walsh (Mooncoin) captured 15 specimens of *O. eperlanus* while snap-netting for Atlantic salmon *Salmo salar* in the River Suir near Mooncoin (S5116), Co. Waterford. The following lengths and weights were recorded:

T.L. (cm)	F.L. (cm)	Wt. (g)	T.L. (cm)	F.L. (cm)	Wt. (g)
14.9	13.9	25	23.3	-	100
16.0	15.0	50	24.2	22.0	75
19.4	18.0	50	24.5	22.0	100
-	19.5	75	25.0	23.0	100
21.8	-	100	26.0	24.0	100
22.5	20.5	75	26.0	24.0	110
22.5	21.0	75	26.3	24.2	100
23.0	21.2	85			

Although these specimens represent the first authenticated records of *O. eperlanus* from the Suir, there is, as yet, no firm evidence to suggest that the river actually supports a breeding population. *O. eperlanus* usually spawns during March/April just above the estuarine limits before returning to sea (Maitland and Campbell, 1992). Potential spawning sites on the rivers Suir (Carrick-on-Suir), Barrow (St Mullins), and Nore (Inistioge) should be investigated during March/April in order to confirm whether or not the species breeds in these rivers. Mooncoin is situated on the Suir estuary c.20km upstream of its confluence with the Barrow/Nore estuary at Cheekpoint (S6814), and c.15km south of the upper tidal limit at Carrick-on-Suir (S4022).

Apart from some basic artificial rearing experiments carried out by the Inland Fisheries Trust during the early 1970's (Anon, 1971, 1972), as well as some data on age determinations (Bracken and Kennedy, 1967), very little has been published on the biology of *O. eperlanus* in Irish waters.

Whilde (1993) remarked that 'although there were no recent records of smelt (*O. eperlanus*), it was likely that it still occurred in the Shannon.' On 8 March 1994 smelt were observed during their upstream spawning migration in the lower Shannon. Three specimens (T.L. 16.5, 18.7 and 19.7cm) were presented to the National Museum of Ireland, Dublin (N.M.I. 25:1994). Meanwhile, the species was observed spawning again in the lower Shannon during March 1996 (O'Connor, pers. comm.).

Wheeler (1978) described *O. eperlanus* as 'an inshore migratory fish which is most common close to river mouths and in the estuaries themselves. Isolated populations live in freshwater lakes in Scandinavia and European USSR (and formerly inhabited Rostherne Mere in the U.K., where it is now extinct c.f. Ellison and Chubb, 1968). These populations are relicts from migratory stocks in the immediate post-glacial period.' McAllister (1984) outlined the species distribution as follows: 'White Sea and its drainage (rare), Baltic and its drainage (including lakes of Finland, Sweden, Denmark, Germany and Poland), southern North Sea, southern Norway, British Isles, Scotland, England, Wales, western Ireland, and northern and western coasts of France.'

During the late 19th century the smelt supported valuable commercial fisheries in Britain. However, since then, several populations have been lost due to overexploitation and estuarine pollution. Nevertheless, it is encouraging to note that, following a major improvement in water quality, smelt have recently recolonized the rivers Thames and Trent (Hutchinson and Mills, 1987; Howes and Kirk, 1991; Maitland and Lyle, 1991; Wheeler, 1979).

Although there is no evidence to indicate that *O. eperlanus* was ever the subject of a commercial fishery in Ireland, the species is currently regarded as 'vulnerable' (Whilde, 1993; Quigley and Flannery, 1996) for the following reasons: there are only three known spawning populations; there are no management plans for existing populations; very little is known about its biology; and the species is not afforded protection by any specific national legislation. It is clear that much more information is required about the distribution and biology of *O. eperlanus* in Irish waters.

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RECORDS OF CHIRONOMIDAE (DIPTERA) IN IRELAND: TWENTY-NINE SPECIES NEW TO THE IRISH FAUNA

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Introduction

Continuing investigations on the Irish Chironomidae in the Department of Zoology, University College Dublin, have yielded material, collected personally or during undergraduate or postgraduate student projects, which contains representative specimens of species or genera whose records of occurrence in Ireland have hitherto not been published. This paper presents summary information on twenty nine such new species records from twenty one genera, four of which are also recorded for the first time. Most of the records reported here date from 1981 (one is from 1966). The determinations of pupal exuviae in the 1980's were mostly based on Langton (1984). Since then revisionary taxonomic work has yielded updated and more comprehensive keys e.g. Langton (1991), Wiederholm (1986, 1989). The collected material has been re-examined using modern keys to give satisfactory species determination. The bulk of the records stem from the works of Heneghan (1986), Morgan (1989) and Hayes (1991). Additional records are from personal collections. The material is predominantly pupal exuviae (Pe) and/or adult males which had been slide mounted shortly after collection, and then, in many cases, not assigned to species. The value of retaining such preparations, which even if at the time of collection are not identifiable to species level, is shown in the confirmed additions to the Irish faunal list presented here. Voucher material remains in the author's personal collection.

In the following list, information is given on the life stage morphotype collected, the location (including six-figure grid reference for the majority of records) and date of collection. New generic records are denoted by an asterisk *.

New Irish Records

Subfamily Orthocladiinae

***Chaetocladius dissipatus* Edwards**

Co. Kerry: Caragh River, adult male, leg. C. Dowling, ?.?.75. No data on location or date of collection.

***Cricotopus* (*Cricotopus*) *cylindraceus* (Kieffer)**

Recorded as pupal exuviae by Hayes (*loc. cit.*) from **Co. Cork**: River Blackwater, Ballymacquirk Bridge (W382989), 1.9.81 and at Keale Bridge (W294936), 2.9.81; River Ilen, Madore Bridge (W103419) and near Hollybrook (W117363), both on 24.8.83; River Owvane, Piersons Bridge (W023454); **Co. Donegal**: River Oily, Claggan Bridge (G751803), 8.8.82; River Leannan, upstream of Kilnacrennan (C145200) and at a bridge west of Claragh (C197210), 13.8.82; **Co. Kerry**: River Inny, Scarriff Bridge (V504696) and upstream of Waterville (V525704), 24.8.83; **Co. Sligo**: River Moy, Cloonacool (G493168), 30.8.82; **Co. Wicklow**: River Avonmore, bridge near Castle Howard (T190833) and downstream of the confluence with the Avonbeg (T198821), 4.8.83.

***Cricotopus* (*Isocladius*) *intersectus* Staeger**

Co. Donegal: adult male, Glenveagh National Park (C039230), 16.8.85, leg. P. Dwyer.

***Cricotopus* (*Isocladius*) *pilitarsus* (Zetterstedt)**

Co. Donegal: present in collections of pupal exuviae by Hayes (*loc. cit.*), River Eany downstream of its confluence with River Eanybeg (G842815), 10.8.82 and by Heneghan (*loc. cit.*) in foam on shore of Lough Veagh, Glenveagh National Park (C038233), 24.7.85. Also recorded by Hayes (*loc. cit.*) from **Co. Galway**: River Tirur, Newbridge (M492699), 16.8.81; **Co. Meath**: River Dee, East of Drumconrath (N910894); **Co. Offaly**: River Little Brosna, New Bridge (N016088), Sharavogue (S056953), Brosna Bridge (S077938), Milltown Park (S068907) and upstream of bridge west of Ryan's cross roads (S053882), all on 2.9.82; **Co. Wicklow**: River Slaney, Stratford Bridge (S895930), 28.7.81.

***Gymnometriocnemus subnudus* Edwards**

Recorded by Heneghan (*loc. cit.*) from **Co. Donegal**: Glenveagh National Park, adult male over vegetation near Owenveagh River (C003188), 25.5.86.

***Metriocnemus beringiensis* (Cranston and Oliver)**

Recorded by Heneghan (*loc. cit.*) from **Co. Donegal**: adult male, Glenveagh National Park, on the wing at bank of Owencarrow River (C035241), 28.5.86.

***Orthocladius (Orthocladius) pedestris* Kieffer**

Recorded as *Orthocladius* Pe10 (*sensu* Langton, 1984) by Hayes (*loc. cit.*) from **Co. Kerry**: River Annascaul, downstream of Annascaul (Q593017), 2.7.81 and by Morgan (*loc. cit.*) from **Co. Wicklow**: Glencullen River, Knocksink (O175215), March to July 1987.

***Orthocladius (Orthocladius) rivinus* Kieffer**

Recorded as *Orthocladius* Pe3 (*sensu* Langton, 1984) by Hayes (*loc. cit.*) from **Co. Wexford**: River Slaney, Clohamon (S933534) and Ballycarney Bridge (S967488), both 29.7.81 and by Morgan (*loc. cit.*) from **Co. Wicklow**: Glencullen River, Knocksink (O175215), 26.3.87 and 17.5.87.

***Orthocladius (Orthocladius) wetterensis* Brundin**

Recorded as *Orthocladius* Pe8 (*sensu* Langton, 1984) by Morgan (*loc. cit.*) from **Co. Wicklow**: Glencullen River, Knocksink (O175215), 17.5.87.

***Paraphaenocladius penerasus* (Edwards)**

Recorded by Hayes (*loc. cit.*) as *Paraphaenocladius* Pe3 (*sensu* Langton, 1984) from **Co. Donegal**: Crana River, Ballymagan (C379344), 15.8.82, pupal exuviae in drift and by the author from **Co. Meath**: River Boyne, below Bellinter Bridge (N894625), 4.8.83.

***Paraphaenocladius exagitans monticola* Strenzke**

Recorded as *Paraphaenocladius sp "a"* (*sensu* Pinder, 1978) by Heneghan (*loc. cit.*) as an adult male from **Co. Donegal**: Glenveagh National Park, roadside near Glenveagh Castle (C022211), 23.5.86.

***Psectrocladius (Psectrocladius) octomaculatus* Wülker**

Recorded by Heneghan (*loc. cit.*) from **Co. Donegal**: Glenveagh National Park (C040203), reared from a larva from a bog pool pH 6.0, 30.5.86.

***Psectrocladius (Psectrocladius) oligosetus* Wülker**

Recorded by Heneghan (*loc. cit.*) from **Co. Donegal**: Glenveagh National Park, pupa and adult female, pond near Castle (C022212), 19.8.85.

***Pseudorthocladius* (*Pseudorthocladius*) *rectangilobus* Caspers and Siebert**

Recorded by Heneghan (*loc. cit.* as *P. sp ? rectangularis)* from **Co. Donegal**: Glenveagh National Park, adult male, upper glen (B998175), 4.6.86; adult male, Glenlack stream, in overnight drift (C003193), 14-15.5.86; adult male near Owencarrow River (C035241), 28.5.86.

***Pseudosmittia recta* Edwards**

Recorded by Heneghan (*loc. cit.*) from **Co. Donegal**: Glenveagh National Park, adult male, Glenlack (C035210), 13.5.86.

****Thienemannia gracilis* Kieffer**

Recorded by Heneghan (*loc. cit.*) from **Co. Donegal**: Glenveagh National Park, adult male, stream on main glen (B998175), 4.6.86. First record of genus from Ireland.

****Trissocladius brevipalpis* Kieffer**

Recorded by Heneghan (*loc. cit.*) from **Co. Donegal**: Glenveagh National Park, Pe, overnight drift from stream near Park Administration Centre (C041227), 14.5.86. First record of the genus from Ireland.

Subfamily Chironominae

***Chironomus* (*Chironomus*) *commutatus* Keyl**

Recorded as Pe by Hayes (*loc. cit.*) from **Co. Donegal**: River Keenagh, Umgall (C454543), 16.8.82; **Co. Galway**: River Owentouey, Tullywee Bridge (L973474), 18.8.81; **Co. Offaly**: River Shannon, Shannon Bridge (M967254), 15.8.81.

***Cryptochironomus albofasciatus* (Staeger)**

Co. Kerry: adult male and associated exuviae collected by the author from floating emergence trap, Dundag Bay, Muckross Lake, Killarney (V964858), 3.8.73.

***Parachironomus biannulatus* (Staeger)**

Pupal exuviae recorded by Hayes (*loc. cit.*) from **Co. Meath**: River Dee, near Drumconrath (N910894), 7.7.83.

***Paracladopelma camptolabis* Kieffer**

Recorded by Hayes (*loc. cit.*), unless otherwise stated, as pupal exuviae from **Co. Carlow**: River Derreen, Acann Bridge (S900780), 29.7.81; **Co. Cavan**: River Erne, west of Drumbarry (N462951), 17.8.81; **Co. Cork**: River Owvane, Pierson's Bridge (W023454), 24.8.83; River Blackwater, Knocknagree (W159975), 2.9.81; **Co. Donegal**: River Eany, below confluence with River Eanybeg (G842815), 10.8.82; River Lennan above lake at Drumaboden (C165218), 12.8.82; adult male also collected by Heneghan (*loc. cit.*) from Glenveagh National Park, taken on the wing over vegetation near Misty Lough (C041228), 3.6.86; **Co. Galway**: River Loughkip, bridge on Oughtarard road (M224313), 17.8.81; River Owentouhey, Tullywee Bridge (L873474), 18.8.81; **Co. Kildare**: River Liffey, Sallins (N881245), 15.7.83; **Co. Laois**: River Nore, upstream of Castletown Bridge (S326930), 27.8.81; **Co. Mayo**: River Moy, Bellanacurra (G403047), 29.8.82, Cloongullaun Bridge (M277992), 30.8.82; **Co. Offaly**: River Little Brosna, Brosna Bridge (S077938) and Milltown Park (S068907), both on 2.9.82; **Co. Roscommon**: River Suck at Castlecoote (M809627) and Ballyforan (M817464), both on 16.7.81 and at Newtown Bridge (M844346), 15.8.81; **Co Sligo**: River Moy, Cloonacool (G530205) and at Metal Bridge (G493168), both on 30.8.82; **Co. Tipperary**: River Nore at Quaker Bridge (S211868), Shanahoe Bridge (S407858) and Athanagh (S423763), all on 28.8.81; **Co. Wicklow**: River Slaney, Stratford Bridge (S895930), 28.8.81; River Derry, Balisland (S978645), 28.7.81.

***Phaenopsectra (Phaenopsectra)* Pe F Bala**, (*sensu* Langton 1984, 1991)

This characteristic pupal exuviae, which as yet is not assigned to species but which does not belong to any *Phaenopsectra* species currently known from Ireland, was collected by Hayes (*loc. cit.*) from **Co. Cork**: River Ilen, bridge near Hollybrook (W117363), 24.8.83; River Owvane, Pierson's Bridge (W023454), 24.8.83; **Co. Donegal**: River Leannan, upstream of lake north of Drumaboden (C165218), 12.8.82 and at Bridge north-west of Clara (C197210), 13.8.82.

***Saetheria reissi* Jackson**

Pupal exuviae collected by Hayes (*loc. cit.*) from **Co. Laois**: River Nore, Shanahoe Bridge (S407858), 27.8.81 and provisionally identified as *Paracladopelma* sp. Examination of this material has shown it to be *S. reissi*. This is the first record of the genus from Ireland.

***Paratanytarsus penicillatus* Goetghebuer**

Co. Cork: Lough Gouganebarra (W009660), 7.4.66, adult male recorded from insect emergence trap. Male genitalia slide mounted and previously undetermined were recently discovered in the author's personal collection.

Rheotanytarsus curtistylus **(Goetghebuer)**

Recorded by Hayes (*loc. cit.*) as pupal exuviae from **Co. Galway**: River Cregg, Addergsole Bridge (M324350), 16.8.81; **Co. Kildare**: River Boyne, Ballyboggan Bridge (N639402), 9.7.81; **Co. Meath**: Scarrif Bridge (N734527), 9.7.81 and at Trim (N815571), 9.7.81.

Rheotanytarsus nigricauda **Fittkau**

Pupal exuviae recorded by Hayes (*loc. cit.*) from **Co. Carlow**: River Slaney, New Bridge Kildavin (S899597), 29.7.81; **Co. Kilkenny**: River Nore, Threecastles (S458626), 27.8.81; **Co. Wexford**: River Slaney, Edderline Bridge (S977345), 29.7.81; **Co. Wicklow**: River Slaney, Glen of Imaal (S987948), 28.7.81 and west of Knockgarrigan (S936937), 28.7.81.

Rheotanytarsus rheanus **Klink**

Pupal exuviae recorded by Hayes (*loc. cit.*) from **Co. Galway**: River Tirur, Newbridge (M492699), 16.8.81; **Co. Kilkenny**: River Nore, Ballyragget (S445707), 28.8.81; **Co. Offaly**: Little Brosna River, Myrtlegrove (S051852), 2.9.82.

Tanytarsus excavatus **Edwards**

Co. Galway: Lower Lough Corrib (M258310), 8.5.80, adult male leg. B. Connolly.

******Zavrelia pentatoma*** **Kieffer**

Recorded by Hayes (*loc. cit.*) from **Co. Donegal**: River Eany downstream of its confluence with Eanybeg (G842815), 10.8.82. First record of the genus from Ireland.

Acknowledgements

I am indebted to former students of the Zoology Department at University College Dublin, Brian Hayes, Liam Heneghan and Declan Morgan for collecting and making slide preparations of Chironomidae cited in this paper and to C. Dowling, P. Dwyer and B. Connolly who kindly donated some specimens.

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REVIEWS

PONDWEEDS OF GREAT BRITAIN AND IRELAND by C. D. Preston. BSBI Handbook No. 8. pp. 352. Botanical Society of the British Isles, London. 1995. Price £16.50 Sterling (Europe £17.50 Sterling). ISBN 0-901158-24-0.

This, the latest in the series of Handbooks from the BSBI on 'difficult' or 'critical' species, is a most welcome aid for the field botanist who wishes to make a serious effort to become proficient in the identification of this group of quite variable aquatic plants. Contrasting with the previous Handbook in the series on Roses, full account has been taken of available data from Ireland. The author's enthusiasm and thoroughness of approach are very evident from the text. He implicitly challenges us not only to identify the commoner species that occur, but also to seek out some of the hybrids that have not yet been reported in these islands.

The book covers *Potamogeton* and *Groenlandia*, both of which are in the Potamogetonaceae, together with the two species of *Ruppia*. While clearly there might have been difficulties in including all the members of order Najadales, a case could be made for the inclusion of *Zannichellia palustris* L. which sometimes may confuse the unwary or even quite experienced botanist. The twenty one species and twenty five hybrids Potamogetons that are treated in Stace's *New Flora* (1991) are fully described here. These include very rare or extinct taxa. One additional hybrid *Potamogeton* x *schreberi* G. Fisch. (*P. natans* x *P. nodosus* Poir.), first found in Britain in 1992, is also described. Appended is a guide to the literature, an extensive bibliography and glossary of specialised terminology.

We are supplied with two keys. The first is to the species and the commonest hybrids. The second is to all species and all hybrids. While clearly a final verdict on the keys must await their application to fresh material (a number of characters may be lost through pressing and desiccation and are difficult or impossible to detect after rehydration) the quality of the illustration of leaves, seeds etc. bode well. I was pleased to discover that the accompanying distribution maps are included with the description of each species and not as an "after-thought" at the end of the book. Additional maps summarise the occurrence and frequency of *Potamogeton* species and hybrids and give an indication of the extent of the field work done and of the large number of specimens determined.

The book contains sections on: the history of pondweeds in Britain and Ireland, nomenclature, classification and evolution, hybridisation, chromosome numbers, structure, life history, ecology, habitats, distribution, cultivation and the collection and preservation of material.

The sections on classification and hybridisation are especially interesting and should be read by all who wish to gain a deeper understanding of *Potamogeton* species and known information on the pollination processes and the occurrence of hybrids. Figure 1 and Map 1, showing the number of hybrids record in each 10km square, are an excellent summary of the current knowledge of classification and hybridisation of the genus. Clearly there is plenty of scope for further field, and for laboratory work on chromosome counts. The value of herbarium specimens in untangling the taxonomy of Potamogetons is very apparent. Chris Preston takes us through the history of the botany of pondweeds from the Sixteenth Century to the present day. He includes the contributions of people such as Gerard, Ray, Babington, Fryer and the more recent Dandy and Taylor *versus* Heslop Harrison controversy. He give us a very lucid account of, for example, how the unnecessary *P. berchtoldii* and *P. pusillus* nomenclature confusion arose. The sections on Structure and Collection and Preservation of Materials are essential pre-fieldwork reading. The reader is urged to make an investment in a dissecting microscope rather than squandering funds on more frivolous purchases of cameras and accessories for photography!

Sources of rather minor irritation are the author's deviation from the recent Kent (1992) and Stace (1991) order for the species and their hybrids and the lack of scales on illustrations - both deliberate decisions. Fruits in the illustrations of individual taxa are drawn to a somewhat eccentric scale of x5.2 and to a larger scale in the section on fruits. It might have been worthwhile considering a waterproof edition of this handbook on Pondweeds.

Overall, this is a superb and well presented production that makes for very informative and stimulating reading. So during your winter hibernation, please (i) read the text, (ii) upgrade your optical equipment - at least to a x20 instrument, (iii) train your retriever or commission the construction of a suitable instrument for grabbing pondweeds and, finally, (iv) give the key a good trial. You should not be disappointed.

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DAVID W. NASH

ALIEN PLANTS OF THE BRITISH ISLES. A PROVISIONAL CATALOGUE OF VASCULAR PLANTS (EXCLUDING GRASSES) by E. J. Clement and M. C. Foster. pp. [4], xviii, 590, [1]. Botanical Society of the British Isles, London. 1994. ISBN 0-901158-23-2.

The flora of Ireland, like that of every other island and continent, is no longer pristine, uncontaminated by plants from other places. *Alien plants of the British Isles. A provisional catalogue of vascular plants (excluding grasses)* is an invaluable index of the success non-indigenous plants have had in infiltrating our archipelago.

Robert Lloyd Praeger, in a memorable contribution to the Clare Island Survey at the beginning of this century, following in other's footsteps, defined a *native* plant as one that grew in a natural habitat having arrived there by natural means from a natural source (Praeger, 1911). When interference with the habitat, the source or the means of transport can be adduced, a plant cannot be a true native. The ultimate aliens are the countless garden plants that throng Ireland's richly embellished gardens and, as we all know, garden plants can 'escape' into the wild and some have become well-established in wild places. Who has not seen *Epilobium brunnescens*, New Zealand willowherb, in the most remote spot on an Irish mountain, or *Gunnera tinctoria*, the so-called giant rhubarb, happily nestled in sheltered nooks on the western coast? What about the pestilential *Rhododendron ponticum* that two centuries years ago was so much admired by John Templeton that he sprinkled seeds of it over The Cavehill near Belfast, or the montbretia, *Crocosmia* x *crocosmiiflora*, which is a nursery-made hybrid but is now rampant along roadways from Dingle to Derry (see e.g. Nelson, 1994)?

Clement and Foster's catalogue is the first attempt for almost a century to document the alien plants that have been reported in Britain and Ireland. The grasses have been omitted from this volume because they are so numerous. but they will be treated in a forthcoming, companion book. The entries are simplified to a comment on the plant's origin, with invaluable references to descriptions and illustrations, and synonymy. There is a summary of the range within the British Isles of each interloper.

Coverage of Ireland is as good as the published records; Clement and Foster did not search Irish herbaria, but the work of Sylvia Reynolds (cf Reynolds, 1996) on Irish aliens will rectify this deficiency. Be that as it may, this book is an important reference work, a key to botanical literature and thus essential for everyone working on Irish botany, be they county recorders for the BSBI or environmental consultants.

Alien plants are part of our natural world - we may try with varying success to purge our island of some pests such as giant hogweeds and *Rhododendron ponticum*, and contrariwise we may admire and even transplant extraordinary adventurers like the pitcher plant, *Sarracenia purpurea*. We certainly cannot ignore them. Cars and trucks carrying seed in the mud stuck to their tyres, travellers from distant lands with seeds attached to their socks, and gardeners importing new plants from a neighbour, are contributing every day to the inventory of aliens. The aliens are here, and becoming more numerous. For example, *Cardamine corymbosa*, New Zealand bittercress (syn. *C. uniflora*; see Braithwaite, 1991), has reached Ireland although Clement and Foster were not aware of this. This little thug, which will soon be as plentiful perhaps as its fellow New Zealander. the willowherb, is now being spread around, unwittingly, by keen gardeners. I have seen it in County Offaly and it arrived there from the Royal Botanic Garden, Edinburgh, *via* an Ulster garden. Thus Clement and Foster's work is already out of date, but that is not a criticism, merely a statement of fact. Their work records the state of affair before 1995, and it makes fascinating reading. The future holds great prospects for alien hunters!

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E. CHARLES NELSON

INSECTS, PLANTS AND SET-ASIDE edited by Adrian Colston and Franklyn Perring. pp. 55. Botanical Society of the British Isles (Conference Report no. 23), London. 1995. Paperback. £6.50 Sterling. ISBN 0-901158-26-7.

Set-aside of arable land (growing COPs - Cereals, Oilseeds and Protein crops) was introduced as part of the reform of the EC Common Agricultural Policy in 1988, and became compulsory for growers with over 15.13ha receiving arable aid payments from 1993. There are two types of arable set-aside: rotational, where land is set aside for only one or two years; and non-rotational, where land is set aside for 5 years (Department of Agriculture, Food and Forestry, 1995). (A further, more restricted, set-aside option exists for Irish farmers in the Rural Environmental Protection Scheme, where 10-30m width of the banks of listed rivers must be set aside for 20 years (Department of Agriculture, Food and Forestry, 1994)). The aim of the arable scheme is to reduce surplus production, and it is used in conjunction with direct area payments to compensate for an expected fall in prices for COP produce. This is an important point: set-aside is about production control not about environmental benefit. If, for instance, there is a decline in cereal surpluses, then the area under set-aside will be reduced, as has happened for 1996, when the percentage of land required to be set aside was reduced from 15% to 10%. However, there is potential benefit for farmland wildlife and beneficial insect populations where mowing of set-aside cover can be delayed until late July, and the interest and focus of the conference on which Colston and Perring's book reports is how optimum environmental benefits may be obtained on set-aside land. The contributors all refer to set-aside in Great Britain and particularly England, where both the types of scheme available and the ecology of the more intensive agricultural landscapes differ considerably from that in Ireland.

This book reports the proceedings of a conference held at the Royal Entomological Society in April 1994, including six papers, plus short commentaries by representatives of the Countryside Commission, MAFF and the DoE (UK). Given that 'Insects' leads the title, the entomological reader may be disappointed to find that there is only one named insect *(Calocoris norvegicus* (Gmelin), p. 42) in the whole book! The emphasis of the book is primarily botanical, but to be fair, set-aside land as an insect habitat is covered in papers by Moreby and Sotherton (concentrating on insects as food for partridge chicks), and especially by Corbet who discusses succession and insect populations.

The usefulness of this book has to be considered in the light of the proceedings of a much larger conference on set-aside published in 1992 (Clarke, 1992), and, in comparison, the former provides a valuable and more contemporary discourse on specific aspects of set-aside, rather than being a wide-ranging review. The paper by Lane on the current set-aside options provides a very clear, up-to-date and valuable outline of the scheme in operation in England. Wells presents the results of an experiment establishing wildflower grassland on set-aside land, a topic not extensively covered in the contributions to the 1992 conference, which were mainly concerned with natural regeneration. The genetic consequences of set-aside for plant populations is thoroughly discussed by Kay, who warns against the consequences of the use of 'wild-flower seed' from non-native sources, especially where alien species or genotypes could invade areas of semi-natural grassland close to the set-aside land. Moreby and Sotherton present data on differences in selected insect families, preferred by partridge chicks as food, between a large number of wheat and set-aside fields, updating a previous paper in Clarke (1992). Corbet provides an interesting review of ecological aspects of succession, although some generalisations appear unjustified. It is incorrect to state that 1st year set-aside will have few predators, and many predatory species which can colonise crops rapidly will originate from fields in early succession rather than late succession. The commentary by Allen of the Countryside Commission adds to the book considerably, exposing the gap between research results and the requirements of managers and policy makers.

The book is well-bound, but the small single-spaced print makes for tiring reading, and the text could have benefitted from a rigorous proof-reading. Tables 1 and 2 on page 17 take some time to make sense, since the column headings are not correctly justified, and the total numbers of species at the base of the columns do not tally with those marked in the individual columns as being included in the seed mixtures sown.

Although this publication is more relevant to English than Irish farmland conservation, it can be recommended to the reader interested in agricultural ecology, ecological succession or the changing environmental implications of EU agri-environmental policy, especially when it is read with Clarke (1992).

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JERVIS A. GOOD

MARINE ALGAE OF NORTHERN IRELAND by Osborne Morton. 123 pp. Published by the Ulster Museum, 1994. £6.95 Sterling. Available from Ulster Museum, Botanic Gardens, Belfast BT9 5AB, Northern Ireland. ISBN 0 900761 28 8.

This is the first book on the marine algal flora of any part of Ireland's coastline to appear since the 1970s. An attractively produced book, with 16 colour photographs with one more on the cover, this is a definitive and authoritive treatment of the seaweeds of Northern Ireland, and fills a considerable void in the Irish Natural History literature. This book treats 356 benthic seaweeds and the microscopic pelagic or planktonic marine algae and the algae symbiotic in marine and maritime lichens are not covered. In Irish phycology, this book will quickly and deservedly become an essential reference.

As a progress report on the study of seaweeds in Northern Ireland, the sheer bulk of floristic literature from when scientific studies began that was reviewed by the author in preparing this book is impressive. The phytogeographical analysis on species distribution ranges is testimony to the fact that a great deal is known. Some 77 species of seaweeds are considered very rare and this fact is worrying, and ought to focus attention on the need for many more trawls, swims, dives and surveys, if at least only for statutory conservation purposes.

For every student of seaweeds, notes describing the habitat preferences and abundance of each species will be very useful, not only in Northern Ireland, but on every coastline throughout the North Atlantic, from Foynes to the Faeroes. The decision to include many real place names, such as Strangford Lough, Coney Island, Larne Lough, Rathlin Island, Carrickarade, Giant's Causeway, Port Stewart *etc.*, instead of lists of grid references, in the species list, is welcome. Images of these places on Northern Ireland's coastline spring to mind, and with the carefully written ecological descriptions in this book, readers can begin to identify precisely with the habitats for most seaweeds. For divers preparing for littoral and sub-littoral surveys, this is an essential introduction to the seaweeds down there. For the bibliographer researching local seaweed records, most references of significance in Irish marine phycology are mentioned either in this book or are kept with the Marine Algae collections at the Ulster Museum in Belfast, and the existence of this evidently well organised resource in Belfast for visitors should not be missed. My only regret is that the recently agreed Brummitt and Powell (1992) standard forms of abbreviation for marine algal authors were not used, and this should be noted by users and corrected in later or computerised editions.

An essay on the history of recording seaweeds in Northern Ireland makes fascinating reading, and between the lines provides vignettes of hardy, determined 19th century Natural Historians, braving all weathers and tides making records of local sub-littoral seaweeds. In contrast to 19th century observers, most modern day seaweed experts seem to have a negative attitude to records from the tidal drift. While some drift records are mentioned in this book, I would have thought that there would be many more included. Wrack lines can be safely sampled by novices without getting their feet wet, and clearly can demonstrate seaweed diversity on the coastline. I was quite surprised to learn of the species richness among tiny species that grow attached to common and more familiar seaweeds.

My review copy is now accommodated in the Komarov Botanical Institute by the Baltic Sea, and I expect that for any botanist travelling abroad, I am sure this Irish book would be graciously received in any herbarium in the world. For a detailed understanding of the surprising wealth of seaweeds that grow around Ireland's shores, the next generation of enthusiasts must not baulk at braving Irish waters with swimming togs, a mask and snorkel.

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Fodhla Printing