

FAUNA OF THE SALT-MARSH, NORTH BULL ISLAND, DUBLIN

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ABSTRACT

An investigation of the invertebrate fauna of the salt-marsh, North Bull Island, Dublin, was made during 1961–1963. 332 species are listed with notes on zonation, seasonal occurrence and abundance. The aquatic fauna of pans and channels is brackish in character and shows zonation according to a salinity gradient with the greatest number of species and highest faunal density in the lower zones. The fauna of the soil surface is influenced by tidal frequency but species occurring below a depth of 1cm are the same in all zones of the marsh. The great majority of aerial and vegetative species are found near the upper limits of the tidal zone and are not typical of salt-marshes.

Introduction

The North Bull Island lies about four miles from the centre of Dublin city. It is a narrow spit of land, about three miles long and half a mile broad at its widest point and is separated from the mainland by a channel, called the "Blue Lagoon". The island developed from accumulated sand and silt as a result of changes in the currents of Dublin Bay, following the building of the North and South Walls of the River Liffey. It reached its present size less than a hundred years ago. Descriptions of the island and historical accounts of its growth are given by Kennedy (1935) and Farrington and Haughton (1947).

The island may be divided into three zones: (i) sand dunes which form its seaward edge; (ii) a central region occupied by rough grassland; and (iii) a salt-marsh on its landward side. At the narrow north-east tip of the island the dunes meet the salt-marsh and in this region members of the dune fauna may be found on the marsh.

The salt-marsh is about 400 metres wide at its widest point. Certain areas have undergone considerable change in recent years but at the time of this survey the marsh showed no signs of increase in area. Its lower border is marked by a miniature cliff, 30–50cm high which shows signs of erosion. In one area land subsidence had caused tidal encroachment. The marsh is drained by sinuous channels which become more numerous in its lower half. Here salt pans are found. There is also a number of artificial dykes constructed for the purpose of draining one of the two golf courses present. They are deeper than the channels and quite straight.

The vegetation, the chemical and physical properties of the soil and soil

profiles have been described by O'Reilly and Pantin (1957) who recognised four vegetational types :

1. *Festucetum*: *Festuca rubra* L. dominant.
At the upper edge of the marsh within the limits of tidal influence but also extending above the upper tidal limit. Soil relatively dry and sandy.
2. *Juncetum*: *Juncus maritimus* Lamarck dominant with, occasionally, *Juncus gerardii* Loiseleur. Soil generally moist, with a high organic matter content.
3. "General salt-marsh": This area forms the widest zone. *Plantago maritima* L. and *Armeria maritima* Willdenow are dominant. The roots of these plants form a spongy, water retaining mass. Clumps of *Spartina townsendi* Groves have been planted in a linear fashion along the centre.
4. *Puccinellietum*: *Puccinellia maritima* (Hudson), the dominant plant, forms a narrow zone at the seaward edge of the marsh. It is also found in patches in the wetter areas of the "general salt-marsh". In some places *Salicornia ramosissima* Woods is co-dominant.

In the faunal list, zonal distribution is given for each species as follows :—

Zone A—*Festucetum* and *Juncetum*. The upper edge of this zone corresponds to the level of H.W.S. Covered by 5% of tides.

Zone B—Upper half of the "general salt-marsh". Channels present and a few salt pans. Covered by 18% of tides.

Zone C—Lower half of the "general salt-marsh", contains many pans and channels. The limit between zones B and C is marked by *Spartina* clumps. Covered by 30% of tides.

Zone D—*Puccinellietum* area, also with pans and channels. Covered by 43% of tides.

Water salinity in pans and channels is varied and depends on the degree of tidal influence. In the channels salinity undergoes both daily fluctuations due to tides and seasonal variation due to rainfall. Generally, it lies between 28 and 34 parts per thousand in zone D, falling to 8‰ in zone A. In the pans salinity ranges are 24–33‰ in zone D and 8.6–27‰ in zone A.

Since the period during which the faunal list was compiled (1961–63), the island has been connected to the mainland by a causeway which now obstructs tidal currents within the "Blue Lagoon" and is causing rapid silting of the north-eastern half of the channel (Fig. 1). The salt-marsh on this side of the causeway is extending towards the mainland and in many places the cliff, which marked the edge of the marsh, has disappeared.

Faunal List

The faunal list consists mainly of species collected during the three year period of investigation but other records are included. Protozoa, Nematoda, Crustacea (Ostracoda), Annelida (Enchytraeidae), many insect larvae and some adult Diptera, e.g. Muscidae, have not been identified.

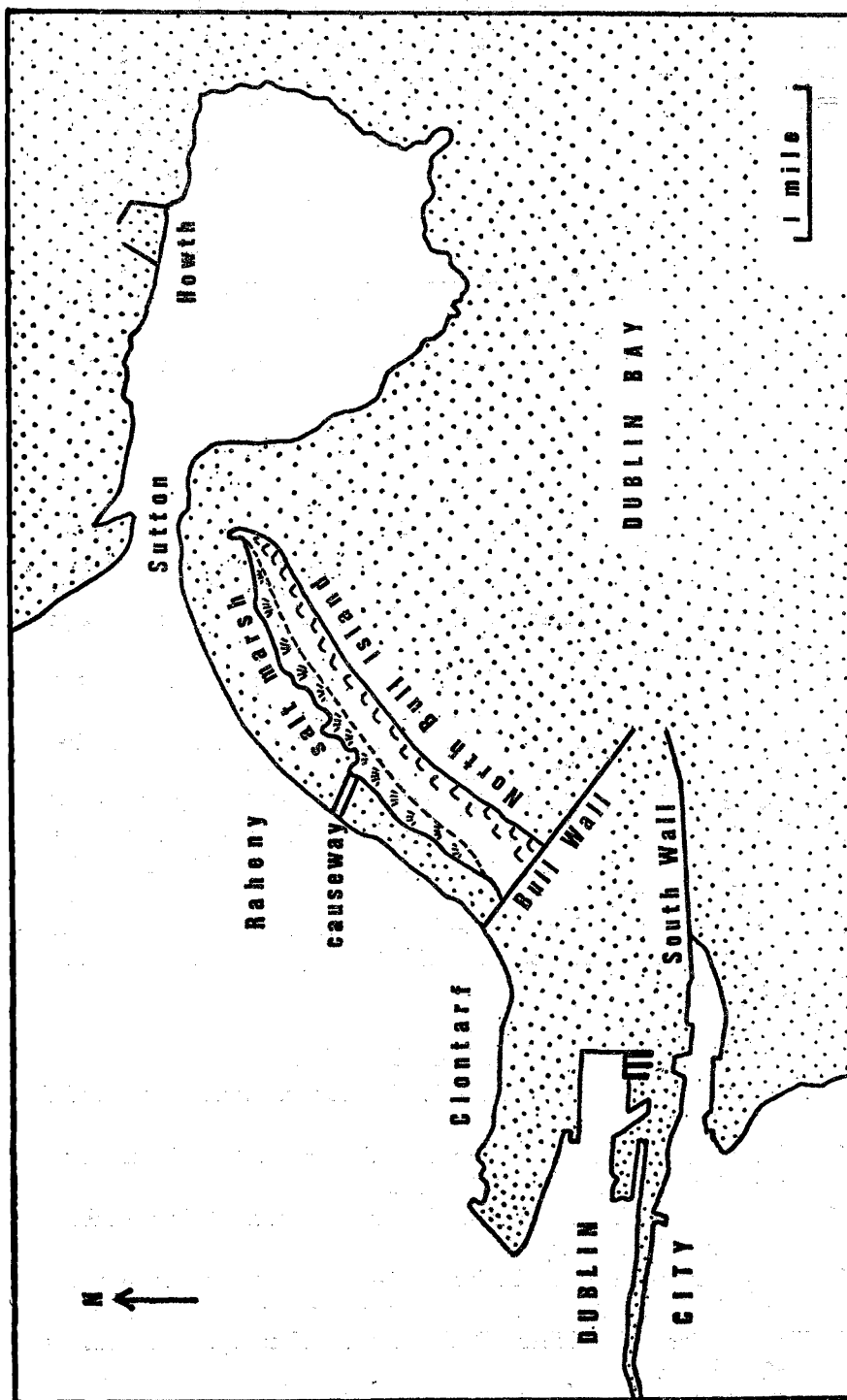


FIG. 1.—Map of Dublin Bay, showing the salt-marsh on North Bull Island.

In the list the species name is followed by zonal distribution, A, B, C and D. The months in which the species was found (I–XII) are given, when this is of interest. Frequency is indicated by a status figure (1–5) where 5 = abundant, 4 = common, 3 = frequent, 2 = occasional and 1 = rare. In the last case only one or two specimens have been taken. Where marked fluctuations in numbers occurred this is noted.

New Irish records are marked with an asterisk.

PHYLUM PLATYHELMINTHES

Class TURBELLARIA

Uteriporus vulgaris Bergendal A–D. 4. On the surface of wet soil and mud.

PHYLUM ANNELIDA

Class POLYCHAETA

Eteone longa (Fabricius) B–D. 3. Only juveniles taken. In pans and channels, in the surface layer of mud or swimming freely.

Nereis diversicolor O. F. Müller A–D. 4. In mud of pans and channels; depth 0–20cm. Juveniles often found among filamentous algae or swimming freely.

Pygospio elegans Claparède B–D. 3. In the water and surface of the substratum of pans and channels.

Capitella capitata (Fabricius) B–D. 3. In the surface layer of the substratum of pans and the lower reaches of channels.

Arenicola marina (L.) B–D. 4. In the substratum of channels; depth 0–20cm.

Fabricia sabella (Ehrenberg) B–D, pans; A–D, channels. 4–5. On the substratum and generally taken without tubes. Wide fluctuations in numbers occur.

Manyunkia aestuarina (Bourne) B–D, pans and D, channels. 2–5. In the surface layer of the substratum of both pans and channels and sometimes abundant.

Class OLIGOCHAETA

Tubifex costatus Claparède A–D. 2–5. In the substratum of pans and channels; depth 0–25cm.

Limnodrilus hoffmeisteri Claparède B–D. 5. Amongst algal filaments or in the substratum of pans and channels.

Peloscolex benedeni (Udekem) B–D. 5. Amongst algae or in the substratum of pans and channels.

Monopylephorus rubroniveus Levinson A–C. 2–3. In the surface layer of the substratum of pans and occasionally of channels.

Clitellio arenarius O. F. Müller D. 3. In the surface layer of the substratum of channels.

Stylodrilus heringianus Claparède D. 1. In a pan.

PHYLUM ARTHROPODA

Class CRUSTACEA

Order COPEPODA

- Harpacticus littoralis* (T. and A. Scott) D. 1. Taken by net sweep in a channel.
- Parathalestris intermedia* Gurney C-D. 2. Taken by net sweeps in channels and pans.
- Stenhelia palustris* Brady D. 2-5. In pans.
- Mesochra lilljeborgi* Boeck C. 3. In channels.
- M. heldti* Monard In a channel (O'Riordan 1971).
- Enhydrosoma buchholtzi* (Boeck) In a channel (O'Riordan 1971).
- Nannopus palustris* Brady In mud and muddy sand in a channel (O'Riordan 1971).
- Heterolaophonte littoralis* (T. and A. Scott) C. 1. Taken by net sweep in a pan.
- H. minuta* (Boeck) One female and a juvenile in the substratum of a channel (O'Riordan 1971).
- Paranychocamptus curticaudatus* Boeck Collected by O'Gorman in 1956 (pers. comm.). In low numbers in a channel (O'Riordan 1971).
- Platychelipes littoralis* Brady The dominant harpacticid in samples from the substratum of a channel (O'Riordan 1971).
- Tachidius discipes* Giesbrecht C-D. 3. In the substratum of pans and channels.
- Itunella muelleri* Gagern C. 3. On the surface of the soil.

Order ISOPODA

- Paragnathia formica* (Hesse) C-D. 3. Colonies found in galleries in the banks of channels.
- Furidice pulchra* Leach B-D. 2. In pans and channels, often swimming with the flowing tide.
- Eluma purpurascens* Budde-Lund A. 3. In pitfall traps. The only other Irish localities known are Howth and Portmarnock, both in Co. Dublin (Bagnall 1908; Pack-Beresford 1908). The species has not yet been recorded for Britain.
- Armadillidium vulgare* Latreille A. 4. In pitfall traps.
- Porcellio scaber* Latreille A. 1. In a pitfall trap.
- Philoscia muscorum* Scopoli A. 2. In a pitfall trap.

Order AMPHIPODA

- Gammarus zaddachi* Sexton C-D. 3. In pans and channels.
- Orchestia gammarella* (Pallas) A-D. 4. Burrows in damp soil and in the banks of channels; swims in both pans and channels at high tide.
- Corophium volutator* Pallas A-D. 5. Burrows in pans and channels.

Order DECAPODA

- Palaemonetes varians* (Leach) A-D. 2. In channels.
Crangon vulgaris Fabricius A-D. 3-5. In pans and channels. Numbers high but are subject to fluctuations. Rare in winter; absent in spring and early summer.
Garcinus maenas (L.) A-D. 5. Immature specimens only and usually less than 3cm in width. Burrow in the banks of pans and channels, or in the substratum of them.

Class ARACHNIDA

Order ACARI

Division *Oribatei*

- Hermannia subglabra* Berlese A-D. 5. In soil; depth 0-12cm, also on vegetation.
Hermannia reticulata Thorell B. 1. On soil surface.
Punctoribates quadrivertex Halbert A-D. 5. In soil; depth 0-20cm and on vegetation, especially *Festuca rubra* and *Puccinellia maritima*. C-D, in same habitats but more abundant.
Trichoribates incisellus (Kramer) A-D. 2-4. Common in the inflorescences of *Festuca rubra* and *Juncus* spp. C-D, scarce, on the surface of the marsh.
Ameronothrus bilineatus (Michael) A-D. 3-4. In soil; depth 0-6cm and on vegetation. Prefers moist soil. Less common at A.
A. lineatus s.sp. *brevipes* Willman A-B. 3. On the soil surface.
Hygroribates spoofti (Oudmans) A-D. 3. In wet soil; depth 0-6cm. On vegetation at D.
H. bilineatus Bostock A-D. 3. On the soil surface and on vegetation. Also in tidal refuse at A.
H. nigrofemoratus (L. Koch) A-C. 3. In wet soil; depth 0-6cm.
Scheloribates laevigatus (C. L. Koch) A. 3. On the surface of dry soil and in the inflorescences of *Festuca rubra* and *Juncus* spp.
Liebstadia similis (Michael) A. 2. On dry soil and on *Festuca rubra*.
Oppia clavipectinata (Michael) A. 3. On dry soil and on *Festuca rubra* and *Juncus* spp.
Platynothrus peltifer (C. L. Koch) A. 2. On dry soil and on *Festuca rubra*.
Eupelops torulosus (C. L. Koch) A. 2. On dry soil and on *Festuca rubra*.

Division *Mesostigmata*

- Phaulodinychus minor* (Halbert) A-D. 5. In soil, depth 0-6cm and on vegetation.
P. orchestidarum (Barrois) A-D. 3. In the soil; depth 0-6cm and on vegetation.
Pergamasus longicornis Berlese A-C. 3. In the soil; depth 0-6cm.
Digamasellus halophilus Willman D. 1. In the soil; depth 8-18cm.
Leioseius salinus Halbert B-C. 2. On vegetation.
Blattisocius dentriticus (Berlese) A. 1. In tidal refuse.

Rhodacarus pallidus Hull A-D. 3. In the soil; depth 0–20cm. More frequent in the deep layers.

Macrocheles scutatus (Berlese) A-D. 2. In the soil; depth 0–6cm and on vegetation.

Cheiroseius necorniger (Oudmans) B. 1. On the surface of moist soil.

Division Prostigmata

Cheylestigmaeus salinus Evans A-C. 2–3. On wet soil. Occasionally on vegetation at C-D.

C. scutatus (Halbert) B-D. 2–3. In wet soil; depth 0–6cm. Occasionally on vegetation at B-C.

Bdella longicornis (L.) A-D. 3. In soil; depth 0–12cm and on vegetation, especially *Festuca rubra*.

Eupodes halophilus Halbert A-D. 2. On soil surface.

Order ARANEAE

Argenna subnigra (O.P.—Cambridge) A. VI. 1. One male among *Festuca rubra*.

Segestria senoculata (L.) B. IV. 1. One female on channel bank.

Clubiona stagnalis Kulczynski A. IX. 1. A female on *Juncus maritimus*, at night.

Xysticus cristatus (Clerck) A. VI, IX. 1. Two females in a pitfall trap.

Tibellus oblongus Walckenaer A. IX. 1. One female on vegetation, at night.

Thanatus striatus C. L. Koch A. IX. 1. Immature specimen in a pitfall trap.

Lycosa purbeckensis (F.O.P.—Cambridge) A. II, X. A-C. V-IX. 5. Seasonally abundant, especially where the ground surface is dry.

L. pullata (Clerck) A. VI. 1. A male among *Festuca rubra*.

Trochosa terricola Thorell A. VI. 1. A male among *Festuca rubra*.

Pirata piratica Clerck A. VII. 2. Four males among *Juncus maritimus*.

Robertus lividus (Blackwall) A. IX. 1. One female on *Juncus maritimus*, at night.

Tetragnatha extensa (L.) A. VII. 3. Frequent on *Juncus maritimus*. Nymphs frequent IX-X.

Pachygnatha clercki Sundevall A. V-VII. 3. On the ground and in pitfall traps.

P. degeeri Sundevall A. VI, IX. 2. In pitfall traps and on *Juncus maritimus*, at night.

Araneus cornutus Clerck A-C. 3 and 2. Frequent throughout the year at A. Occasionally at B-C, in summer. Males found infrequently in late summer. In winter remains within inflorescences of *Juncus* spp.

A. diadematus Clerck A. IX. 3. On *Juncus* spp.

A. quadratus Clerck A. IX. 2. On *Juncus maritimus*.

Hypomma tuberculatum (Wider) A. V. VII. 2. Females among *Festuca rubra*.

Oedothorax fuscus (Blackwall) A. II. 1. One female on *Juncus maritimus*.

- Savignia frontata* (Blackwall) A. XI. 1. One female on *Juncus*, at night.
Erigone longipalpis (Sundevall) A-D. I-XII. 5. The commonest spider on the marsh.
Bathyphanes gracilis (Blackwall) B. VIII. 1. One female on the ground.
Leptyphanes tenuis (Blackwall) A. VII. 1. One female among *Festuca rubra*.
Mengea scopigera (Grube) A. IX. 1. One male on *Juncus maritimus*, at night.

Order PHALANGIDA

- Phalangium opilio* (L.) A. IX. 1. One female among vegetation.

Class DIPLOPODA

- Cylindroiulus latestriatus* Curtis A. I-XII. 4. Common in dry sandy soil; depth 0-6cm.

Class INSECTA

Order COLLEMBOLA

- Xenylla maritima* (Fabricius) A-D. 4. Common in the surface layer of soil and in all tidal refuse. Also on vegetation at A.
Friesia mirabilis (Tullberg) A-D. 4. In the soil; depth 0-12cm. More common at C-D.
Anurida maritima Laboulbène C-D. V-X. 2-5. Occurs sporadically on the banks of channels.
Onychiurus debilis (Moniez) A-D. 5. In the soil; depth 0-20cm.
Tullbergia krausbaueri Börner A-D. 5. In the soil; depth 0-20cm.
Isotoma maritima Tullberg A-D. 2-5. In soil. Occasionally on vegetation at A.
I. viridis Bourlet A. 4. In the surface layer of soil. A-D, on vegetation in summer.
Isotomiella minor Schäffer A. 2. In surface soil.
Folsomia sexoculata Tullberg A. 1. In the surface layer of soil and on vegetation.

Order DERMAPTERA

- Forficula auricularia* L. A. 2. Colonies under *Festuca rubra*.

Order PSOCOPTERA

- Caecilius burmeisteri* Bauer A. IX. 1. By a net sweep.
Ectopsocus briggsi (McLacklan) A. IX. 1. By a net sweep.

Order THYSANOPTERA

- Chirothrips manicatus* Haliday A. VIII. 1. A male and a female on *Festuca rubra*.
Aptinothrips nitidulus Haliday A-D. II-XI. 3. Females only. Light forms on *Festuca rubra* and *Juncus maritimus*; dark forms more frequent on *Cochlearia maritima*, *Sueda maritima*, *Puccinellia maritima* and *Spartina townsendi*.

- A. stylifer* Trybom A-C. VII-IX. 3. On *Aster tripolium*, *Festuca rubra*, *Halimione portulacoides* and *Juncus* spp. (Second instars, VII-VIII, females, VIII-IX).
- Thrips tabaci* Lindeman A-C. VIII. 2. On *Aster tripolium*.
- Taeniothrips atratus* Haliday A-C. IX. 1. A female on *Aster tripolium*.
- Haplothrips statices* Haliday A-D. I-XII. 5. On *Armeria maritima*, almost all the older plants infested. In the inflorescences in summer; between leaf bases in winter. All specimens micropterous.
- H. juncorum* Bagnall A. VII-X. 2. On *Juncus gerardii* and *Aster tripolium*.

Order HEMIPTERA

Sub-order HETEROPTERA

- Stygnocoris rusticus* (Fallén) A. IX. 1. By net sweep.
- Anthocoris nemorum* (L.) A. VIII. 1. By net sweep.
- Calocoris norvegicus* (Gmelin) A. VI-VIII. 3. By net sweeps. Nymphal instars appear on the ground in June; adults on vegetation from the beginning of July.
- Trigonotylus ruficornis* (Geoffroy) A. VII-VIII. 5. On *Festuca rubra*.
- Leptoterna ferrugata* (Fallén) A. VII-VIII. 3. By net sweeps.
- Fieberocapsus flaveolus* (Reuter) A. VII. 1. By net sweep.
- Salda littoralis* (L.) A-B. VI-VIII. 3. By net sweeps.
- S. orthochila* (Fieber) Recorded by Halbert (1935). Details of distribution not given.
- S. pilosus* (Fallén) Recorded by Halbert (1935). Details of distribution not given.
- Saldula palustris* (Douglas and Scott) B-D. VI-IX. 5. Particularly abundant on the banks of channels.
- Chiloxanthus pilosus* (Fallén) Recorded by Halbert (1935).

Sub-order HOMOPTERA

- Neophilaenus lineatus* (L.) A. VII-I. 3. By net sweeps.
- Aphrodes bicinctus* s. sp. *aestuarinus* (Edwards) A-B. VII-VIII. 4. By net sweeps.
- Arthaldeus pascuellus* (Fallén) A. VIII. 1. By net sweep.
- Euscelis obsoletus* (Kirschbaum) A-D. VII-X. 5. On vegetation.
- Macrosteles horvathi* (Wagner) A-D. VI-X. 5. On vegetation.
- Delphacodes dubia* (Kirschbaum) A. VII. 1. By net sweep.

Family Aphididae

- Macrosiphum euphorbiae* (Thomas) A-B. VII-VIII. 3. On *Plantago maritima*.
- M. fragariae* (Walker) A. V. 2. On *Juncus maritimus*.
- M. avenae* (Fabricius) A. VII-IX. 1. By net sweep.
- Staticobium limonii* (Contarini) A-C. VII-IX. 3. On *Limonium humile*.
- Macrosiphoniella asteris* (Walker) A-C. VII-IX. 4. On *Aster tripolium*.
- Metalophium dirhodum* (Walker) C. VIII. 1. On *Halimione portulacoides*.

- Myzus cerasi* (Fabricius) A. VII. 1. On *Plantago maritima*.
Ropalosiphum padi (Schrank) A. X. 1. By net sweep.
Aphis tripolii (Laing) A-C. IX. 5. On *Festuca rubra*, *Juncus* spp., *Sueda maritima* and *Aster tripolium*.
Brachycaudus helichrysi (Kaltenbach) A. VIII. 1. On *Aster tripolium*.
Juncobium leegei (Börner) A. VIII. 4. On *Juncus* spp.
Aploneura lentisci Passerini B. IX. 1. By net sweep.

Order TRICHOPTERA

- Limnephilus affinis* Curtis A. IX. 1: By net sweep.

Order LEPIDOPTERA

(Taken in net sweeps unless otherwise stated)

(Taken in net sweeps unless otherwise stated).

- Hydraecia lucens* Freyer A. XI. 1.
Leucania impura Hübner A. VII. 1.
Hadena suasa Schiffermüller A. VII. 1. Bred from a larva found on *Plantago maritima*.
Pieris brassicae (L.) A-D. V-IX. 2.
Crambus hortuellus (Hübner) A. VI-VII. 1.
C. perlellus (Scopoli) A. VII. 1.
Zygaena filipendulae (L.) A. VII-VIII. 4. Pupae frequent on *Festuca rubra*, where the dunes border the marsh.
Phalonia affinitana Douglas A. VI. 1. Bred from a pupa taken in soil.
Agriphila coluellus L. A. VIII. 1.
Scrobipalpa plantaginella (Stainton) A. VII. 2.
 **Coleophora obtusella* Stainton A-C. VI-VII. 5. Larvae feed on the seeds of *Juncus maritimus*; practically every plant infested.
C. alticollella (Zeller) A. VII. 2. Larvae feed on the seeds of *Juncus gerardii*.

Order COLEOPTERA

- Dyschirius globosus* (Herbst) A. II-VII. 2.
Dichirotrichus gustavii Crotch A-D. I-XII. 5. The commonest beetle on the marsh. Both larvae and adults found in the soil; depth 0-20cm. Adults found on vegetation during the night.
Amara aenea (Degeer) A. VII. 1. On the surface of the marsh.
Dromius linearis (Olivier) A. VII. 1. In tidal refuse (plant detritus).
Pterostichus strenua (Panzer) A. VII. 1. On the surface of the marsh.
Poecilus coerulescens L. A. VI. 2. In pitfall traps.
Calathus cisteloides (Panzer) A. VI-VII. 2. In pitfall traps.
C. melanocephalus (L.) A. XI. 1. In a pitfall trap.
Ochthebius punctatus Stephens A-B. I-XII. 4. Common on wet ground. Larvae conspicuous in early summer; pupate under algal filaments; imagines emerge from the end of June to the beginning of July.
O. impressicollis Castelnau A. IX. 1. On the surface of a dry pan.
O. marinus Paykull B. VIII. 2. On the surface of moist soil.
Helophorus affinis Marsham B. VII. 1. Under algal filaments.

- Necrophorus vespillo* (L.) A. VI. 1. In a pitfall trap.
- Silpha rugosa* (L.) A. VI–VIII. 3. In pitfall traps.
- S. tristis* Illiger A. VI–VIII. 4. Larvae and adults in pitfall traps.
- Megarathrus depressus* (Paykull) A. VII. 1. On soil under *Juncus maritimus*.
- Omalium laeviusculum* Gyllenhal A. VI. 1. Among debris of *Enteromorpha* sp.
- Acidota crenata* (Fabricius) A. VIII. 1. On the surface of the marsh.
- Bledius spectabilis* Kraatz D. VIII. 1. In the bank of a channel.
- Stenus clavicornis* (Scopoli) A. VII–IX. 3. On vegetation, at night, and among dry plant refuse.
- Philonthus fuscipennis* (Mannerheim) C. VIII. 1. In the bank of a channel.
- P. marginatus* (Fabricius) A. VIII. 1. In soil around *Juncus maritimus*.
- P. varians* (Paykull) A. VII. 1. Among *Juncus maritimus*.
- Staphilinus ater* Gravenhorst A. IX. 4. Found on vegetation, at night.
- Heterothops binotatus* (Gravenhorst) A. VII. 1. In the soil under *Festuca rubra*.
- Tachyporus chrysomelinus* (L.) A. IX. 1. Found on vegetation, at night.
- T. hypnorum* (Fabricius) A. XI. 1. Found on vegetation, at night.
- T. nitidulus* (Fabricius) A. IX. 2. Found on vegetation, at night.
- T. pusillus* Gravenhorst A–B. VIII–IX. 2. On the ground and on vegetation, at night.
- Tachinus rufipes* (Degeer) A. VII. 1. Among *Juncus maritimus*.
- Halobrecta flavipes* (Thomson) C–D. VI–VIII. 2. On the surface of the marsh and among debris of *Enteromorpha* sp.
- Atheta hypnorum* (Kiesenwetter) A. IX. 1. Found on vegetation, at night.
- A. atramentaria* (Gyllenhal) B. VII. 1. On the surface of the marsh.
- A. fungi* (Gravenhorst) A–C. II–VII. 3. In tidal refuse.
- A. vestita* (Gravenhorst) A–C. II–VII. 3. In tidal refuse.
- Lamprinodes saginatus* (Gravenhorst) A. VI. 1. On the surface soil.
- Mycetoporus splendidus* (Gravenhorst) A. VI. 1. On the surface soil.
- Cantharis bicolor* Herbst A. VI–VII. 3. On vegetation.
- C. darwiniana* (Sharp) A. VI–IX. 2. On vegetation, particularly *Juncus* spp.
- C. fulvicollis* var. *flavilabris* Fallén A. VI–VIII. 2. On *Juncus maritimus*.
- Rhagonycha fulva* (Scopoli) A. VII–VIII. 4. On vegetation.
- Psilothrix cyaneus* (Olivier) A. VI. 1. On vegetation.
- Agriotes lineatus* (L.) A. I–XII. 3. In dry sandy areas. Larvae frequent in the soil, under *Festuca rubra*.
- Heterocerus flexuosus* Stephens A–C. VIII–IX. 2. On wet ground and in temporary pools after rainfall or tidal flooding.
- Omosita discoidea* (Fabricius) Recorded by O'Mahoney (1924). Details of habitat not given.
- Coccinella septempunctata* L. B. VII. 1. On *Spartina townsendi*.
- Chaetocnema concinna* (Marsham) A. VII. 1. In a pitfall trap.
- Apium flavipes* (Paykull) A–B. IX. 3. On the surface of the marsh.
- Otiorhyncus ligneus* (Olivier) A. IX. 3. Found at night on vegetation.

- Erirrhinus bimaculatus* (Fabricius) B-C. I-XII. 3. Larvae and adults among the roots of *Spartina townsendi*.
Polydrusus chrysomela (Olivier) B. VII. 1. On the surface of the marsh.

Order HYMENOPTERA

(The following species were caught by net sweeps.)

Superfamily ICHNEUMONOIDEA

- Bracon anthracinus* Nees A. VII. 1.
Apanteles triangulator (Wesmael) A. VIII. 1.
Microgaster globata Nees A. VII. 1.
Microplitis xanthopus (Ruthe) A. VI. 1.
Aphaerata minuta var. *cephalota* (Haliday) A. V. 1.
Aspilota concolor (Nees) A. IX. 1.
Dacnusa anasella Stelfox A-D. VII-IX. 4.
D. senilis (Nees) A. VII. 1.
Rhizarcha areolaris (Nees) A. V-VII. 1.
Aphidius matricariae Haliday A-C. VII-VII. 2.
Ichneumon extensorius L. A. IX. 1.
Phaeogenes fuscicornis Wesmael A. IX. 1.
P. planifrons Wesmael A. IX. 1.
Hemiteles pedestris (Fabricius) A. IX. 1.
Gelis anthracina (Foerster) A. VII. 1.
Attractodes tenebriodes Gravenhorst A-C. VII-VIII. 1.
Pimpla turionellae (L.) A. VII-VIII. 1.
Ephialtes brevicornis (Gravenhorst) A. VIII-IX. 2.
Lissonota bellator (Gravenhorst) A. IX. 1.
Zootrephas rufiventris Thomson A. VIII-IX. 2.
Diplazon laetatorius (Fabricius) A. VIII. 1.
D. signatus (Gravenhorst) A. VIII. 1.
Angitia exareolata (Gravenhorst) A. VIII. 1.
A. cerophaga (Gravenhorst) A-C. VI-IX. 3.

Superfamily CHALCIDOIDEA

- Eurytoma tibialis* (Boheman) B. VII. 1.
Copidosoma filicorne (Dalman) A. VIII. 1.
C. dius (Walker) A. VI. 1.
Microterys tessellatus (Dalman) A. VII. 1.
Dicyclus circulus Walker C. VII. 1. Hatched from a pupa found among debris of *Enteromorpha* sp.
Habrocytis sp. A. VIII-IX. 3. As yet an undescribed species (Graham, pers. comm.).
Mesopolobus incultum (Walker) A. IX. 1.
Meraporus graminicola (Walker) C. VIII. 1.
Asaphes vulgaris Walker A. VII. 1.
Cyrtogaster vulgaris Walker B. VIII. 1.
Hemiptarsenus unguicellus (Zetterstedt) A. VII. 1.

- Diglyphus isaca* (Walker) A. VII. 1.
Euderus viridis Thomson A. IX. 2.
Chrysocharis pubicornis (Zetterstedt) A. VII. 1.
Entedon diotimis Walker A. VI. 1.
Aprostocetus canon Walker A. VI-VII. 1.
Pediobius epigonus (Walker) A. VII. 1.
Tetramesa linearis (Walker) A. VII. 1.

AGULEATA

- Bethylus fuscicornis* (Jurine) A. VII. 1.
Myrmica laevinodes Nylander A. IV-IX. 3.
Apis mellifera L. A-D. IV-IX. 4.
Bombus lucorum (L.) B-D. VI-IX. 3.

Order DIPTERA

(When only imagines are recorded, they were taken in net sweeps.)

NEMATOCERA

- Symplecta stictica* (Meigen) A-D. IV-IX. 5. Larvae in the substratum of channels and pans in all zones. Also found in soil A-D; depth 0-12cm.
Tipula paludosa Meigen A-D. VII-IX. 5.
Dicranomyia sera (Walker) A-D. V-X. 5. Larvae common in the soil.
Cricotopus vitripennis var. *halophilus* (Kieffer) A-D. IV-X. 5. B-D, larvae in pans and channels during summer and winter. Pupation during April.
Smittia thalassophilus (Goetghebuer) C-D. VII-IX. 5. Swarms over the lower reaches of channels in September.
Dasyhelia flavoscutellata (Zetterstedt) A-D. VII-VIII. 3.
Bibio johannis (L.) A. IV-VII. 3.
Philia febrilis (L.) A. V-VI. VIII. 3.
P. femorata (Meigen) A. VI. 2.
Sciara carbonaria Meigen A. VIII. 1.

BRACHYCERA

- Nemoteles uliginosus* (L.) A-D. VI-IX. 5. Swarms over *Juncus* at the end of June and beginning of July. C-D, larvae found on the surface of the marsh and among debris of *Enteromorpha* sp.
Bombilius minor L. A. IX. 1.
Thereva nobilitata (Fabricius) A. VII. 1.
Drapetis curvipes (Meigen) A. VI-VIII. 2.
Tachydromia notatus (Meigen) A. VIII. 1.
T. pallidiventris (Meigen) A. VI. 1.
Empis femorata Fabricius A. VI. 2.
Rhamphomyia tarsata Meigen A-D. V-VI. 4.
Dolichopus plumipes (Scopoli) A-D. VI-VIII. 5.

- D. urbanus* Meigen A. VI. 1.
D. nubilus Meigen A. V-VIII. 4.
D. brevipennis Meigen A. VI-VIII. 2.
Macroloichopus diadema (Haliday) A-D. VII-VIII. 3.
Hydrophorus oceanus (Macquart) A-D. VI-IX. 5. Larvae in the soil surface layer.
Syntormon pallipes (Fabricius) A-D. V-IX. 4.
S. pallipes var. *pseudospicatus* Strobl A-D. V-IX. 4.
Machaerium maritimae Haliday A-D. VII-VIII. 3.
Campsicnemus armatus (Zetterstedt) A. IX. 2.
Sympycnus annulipes (Meigen) A-D. VI-IX. 4.
Pyrophaena granditarsa (Forster) A. IX. 1.
Platychirus manicatus (Meigen) A. V. 1.
P. clypeatus (Meigen) A. VIII-IX. 3.
Sphaerophoria menthastri (L.) A. IX. 1.
Scaeva pyrastris (L.) A. IX. 1.
Metasyrphus latifasciatus (Macquart) A. VIII. 1.
Syrphus balteatus Degeer A. VIII-IX. 2.
Paroxyna plantaginis (Haliday) A. VII-IX. 4. Larvae in inflorescences of *Aster tripolium*.
Sepsis violacea Meigen A. V-VII. 3.
Salticella fasciata (Meigen) A. VI. 1.
Chamaemyia herbarum (Robineau-Desvoidy) A. VI-VIII. 3.
Coelopa frigida Meigen A. IX. 1.
Morpholeria kerteszi (Czerny) A. IX. 1.
Tethina grisea (Fallén) A. VI. 1.
T. illota Haliday A. VI. 1.
Glenanthe ripicola Haliday C. VII. 1. Hatched from a pupa collected from refuse of *Enteromorpha* sp.
Hyadina humeralis Becker A. VI. 1.
**Copromyza unicata* (Duda) D. VII. 1.
Tricimba cincta (Meigen) A. VII. 1.
Oscinella frit (L.) A. IX. 1.
O. pusilla (Meigen) A. VII. 1.
O. vastator Curt B. VII. 1.
Melanum lateralis Haliday A. VI-VII. 3.
Chlorops troglodytes (Zetterstedt) A. VI-IX. 2.
Chloropisca glabra (Meigen) A. VI. 1.
Thaumatomyia notata (Meigen) A-C. VIII-IX. 3. One adult hatched from a pupa taken from soil at D.
Scopeuma stercorarium (L.) A-D. IV-X. 3.
Scatophaga litorea (Fallén) A-D. IV-X. 5. Large numbers of larvae in debris of *Enteromorpha* sp.
Calliphora erythrocephala (Meigen) A. VII. 1.
Phaonia incana (Wiedemann) A. VII. 1.
Dexiopsis minutalis (Zetterstedt) A-D. VI-VIII. 4. B-C, larvae in the soil.

- Coenosia tigrina* Fabricius A. VI. 1.
C. salinarum Stein A. VI. 1.
C. geniculata (Fallén) A. VI. 1.
C. pulicaria (Zetterstedt) A. VI. 2.
C. descipiens Meigen A. VI. 1.

PHYLUM MOLLUSCA

Class GASTROPODA

- Acmaea testudinalis* Müller B. VIII. 1. In a pan.
Littorina littoralis (L.) C. 1. In a pan.
L. littorea (L.) C-D. 4. In pans and channels.
L. saxatilis (Olivi) A-D. 5. Pans, channels and damp soil. Aggregate in burrows in the sides of pans, in the banks of channels and in the soil; depth 0-10cm. Dark, tessellated, red, pale and banded forms present.
Hydrobia ulvae (Pennant) A-D. 5. In pans and channels. Particularly abundant on wet mud in zones C-D. Densities of 21,000/sq.m. recorded. At A, restricted to pans and wet soil.
H. ventrosa (Montagu) C-D. 2. Pans and channels; mainly in the surface.
Akera bullata Müller D. VII. 1. In a channel.
Limapontia nigra Johnson C-D. X-IV. 1-5. In pans, channels and in standing water on the marsh. Rare in spring and summer; often abundant during autumn and winter. Populations undergo rapid variation in number. Highest densities recorded in pans, at D.
Alderia modesta (Loren) D. III. 1. In a pan.
Bythinia tentaculata (L.) B. X. 4. In a pan but disappeared a week later. It is not known how this species reached the marsh.
Phytia myosotis Draparnaud A-D. 5. On damp ground.

Class LAMELLIBRANCHIA

- Mytilus edulis* L. D. IX. 1. In a pan.
Cardium edule L. B-D. 2. In channels.
Scrobicularia plana (da Costa) B-D. 3. In the substratum of channels; depth 0-10cm.

PHYLUM CHORDATA

Class PISCES

- Anguilla anguilla* (L.) A and C. V-VIII. 2. Pans, A, and channels, C.
Pomatoschistus microps Krøyer A-D. 2-5. In pans and channels. The fish is abundant in the channels at A in winter; in spring, migration takes place to the channels of the lower regions and then to the sea for spawning. In summer the new generation appears sporadically in both pans and channels at B-D. Movements have been shown to be due to salinity tolerance (Kunz 1969).
Mugil labrosus Risso A and C. IX-X. 2. Small shoals of juveniles in pans.

The faunal list comprises five phyla, ten classes, twenty-seven orders and three hundred and thirty-two species. While by no means a complete list, as species of a certain phyla have not been identified, it must be of interest in view of the faunal changes which are bound to occur on the marsh due to reclamation and the building of the causeway. Of the species found, two are new Irish records. Many insect species, i.e. Hymenoptera and the majority of Diptera, do not breed on the marsh. Only eleven larvae have been identified in the case of Diptera.

In reviewing the fauna it is noted that the Phylum Arthropoda comprises the greatest number of species, i.e. Crustacea 27, Arachnida 52, Insecta 221 (Diptera 64, Coleoptera 51, Hymenoptera 45, Hemiptera 29, Lepidoptera 13, Thysanoptera 7, Collembola 9, Psocoptera 2, Demaptera 1, Trichoptera 1) and Diplopoda 1. The total number amounts to 91% of all species identified. The most typical denizens are those which are recorded as abundant, common or frequent and which are, also, widely distributed on the marsh. Of the insect Orders recorded, the Collembola, Hemiptera and Coleoptera are the most typical denizens. For example, six species of Collembola are recorded from all zones and are either abundant or common. Only two species, *Isotomiella minor* and *Folsomia sexoculata* appear to be confined to zone A. Of the twenty-nine hemipteran species, three were recorded by Halbert (1935) who gives no details of zonation; four were collected in all zones, one in three zones and six in two zones. The remaining fourteen species were taken chiefly in zone A. The most typical salt-marsh species is *Salduda palustris* which is common on channel banks in zones B, C and D. Thirty-four species of beetle were found in zone A and twenty-one of them are noted as rare. The number of species recorded from two or more zones is seven. Only one species, *Dichirotrichus gustavii*, the commonest beetle, is found in all zones. It is described as abundant—obviously a salt-marsh form.

Among the Arachnida, the Acarina are more typical of this marsh than the Araneae. Of the twenty-one species recorded, nine are present in all zones and four of them are noted as abundant or common. Three species are found in three zones, two in two zones and seven in one zone, notably A. The Araneae are mainly restricted to zone A but *Erigone longipalpis*, the commonest spider on the marsh, is present in all zones. This order cannot be regarded as typical of the marsh.

Finally, one hundred and twenty-four species may be regarded as typical of the marsh. These are: Turbellaria 1, Polychaeta 7, Oligochaeta 5, Crustacea 11 (Harpacticoidea 4, Isopoda 3, Amphipoda 3, Decapoda 1), Acarina 17, Araneae 7, Diplopoda 1, Insecta 68 (Collembola 8, Thysanoptera 3, Hemiptera 14, Lepidoptera 1, Coleoptera 14, Hymenoptera—imagines—4, Diptera 24—including 11 larval/pupal types), Mollusca 6 and Pisces 1.

Discussion

A salt-marsh may be defined as a mosaic of aquatic and terrestrial habitats occupied by marine, brackish, freshwater and terrestrial forms. The relative

importance of each type of fauna depends on the type of marsh: estuarine (usually wet and muddy) or coastal (sandy and well drained). A third type of salt-marsh which develops on peat is frequent in the south and west of Ireland. The North Bull Island marsh belongs to the coastal type. A well aerated layer of the substratum, about 12cm deep, persists throughout the tidal cycle (Chapman 1938) and supports a large terrestrial fauna, chiefly arthropods. The aquatic habits are less stable than on estuarine marshes because they tend to dry out more rapidly and salinities are usually higher.

Aquatic fauna of the North Bull marsh

The fauna is essentially brackish in character, and species typical of brackish habitats such as *Carcinus maenas*, *Nereis diversicolor*, *Eteone longa*, *Arenicola marina* and *Tubifex costatus* are dominant. Freshwater seepage from the grassland above the marsh is slight so there are no freshwater species present. The pans and channels are subject to salinity, temperature and water level fluctuations which often require special adaptations on the part of the denizens, e.g. burrowing habit and osmoregulation.

Thirty-four species are recorded from pans and channels and some 50% of these are rare. Most occur in both habitats but are more abundant in the channels which are seldom without water. The pans are frequently dry but usually hold some water after tidal flooding or heavy rain, i.e. for some days in winter and for shorter periods in summer. Faunal density is lower here and subject to greater fluctuations than in the channels. The banks of the channels and the edges of the pans are riddled with galleries made by crustacean and molluscan species.

A salinity gradient is evident in the channels with lowest and highest readings in zones A and D respectively. The number of species and faunal density are lowest at A and highest at D where species with limited osmoregulatory powers are able to survive. A similar salinity and faunal expression are seen in the pans. In zones A and B species capable of tolerating weaker salinity such as *Anguilla anguilla*, *Heterocerus flexosus* and *Ochthebius punctatus* occur.

Terrestrial and semi-terrestrial fauna of the marsh

These faunas may be considered under five headings: (1) aerial; (2) vegetative; (3) ground-surface and top layer of soil (1cm depth); (4) soil; (5) tidal debris. The main difference between members of (1) and (2) is degree of mobility. The term aerial may be taken to include species which can move freely over the marsh; the term vegetative implies species living in close proximity to or on a particular plant or plants. Here, movement is usually limited.

Adult Lepidoptera, Hymenoptera and Diptera are generally regarded as aerial, while some Arachnida and all Collembola, Hemiptera and Coleoptera species are generally vegetative. Both aerial and vegetative forms display a marked zonation, with the greatest species number and density in zone A (Fig. 1). Factors influencing this zonation are: (1) infrequent tidal incursions;

(2) greater height of the vegetation and the proximity of the grassland. The great majority of aerial and vegetative species are not considered to be typical marsh denizens and may be regarded as visitors. Their presence, however, gives zone A its character. Another interesting feature of the terrestrial fauna is nocturnal periodicity. For example, 23% of the Arachnida and 32% of the Coleoptera were taken at night. Both the surface (3) and soil (4) layers resemble corresponding zones in grassland habitats. The only exception appears to be the complete absence of members of the Lumbricidae in (4). Insects and arachnids make up 90% of the fauna of these layers but species such as *Orchestia gammarella* and *Littorina saxatilis*, typical marine species, are also present.

Finally, the fauna recorded from tidal debris is mainly arthropod. Two types of debris are present: (1) decaying marsh plants and (2) decomposing masses of *Enteromorpha* derived from algae present in the channels and on the mud flat below the marsh. Plant debris (1) which is carried by the tides is found chiefly in zones A and B and here the chief denizens are acarines, collembolans and small coleopterans. *Enteromorpha* (2) is often present in large masses and is found in all zones. Moisture is retained for long periods and the material appears to be nutritious as it supports a large number of forms such as Coleoptera and dipteran larvae. The most characteristic species of the *Enteromorpha* is the dipteran, *Scatophaga litorea*, whose larval and pupal duration is short (about one month). This short life cycle allows the fly time to emerge before the *Enteromorpha* mass dries out.

Tidal influence is the most important limiting factor in the vertical distribution of marsh fauna. In zones B, C and D even neap (non-flooding) tides raise the level of the water table to within 20cm of the surface. The effect of this rise is to force the fauna to concentrate in the surface layer. However, in zone A a greater depth of soil remains aerated at all times yet the fauna does not appear to penetrate to greater depths than in other zones. The number of species found between 0 and 20cm in zones A-D at neap tides has been estimated (Table 1). Ninety species were found in the surface 0-1cm layer in

TABLE 1
Number of ground and soil species occurring at different depths in zones A-D of the marsh

| | Depth | Zone A | Zone B | Zone C | Zone D | All Zones |
|---------|---------|--------|--------|--------|--------|-----------|
| Ground— | 0- 1cm | 90 | 45 | 41 | 34 | 104 |
| Soil— | 2- 6cm | 23 | 22 | 22 | 20 | 28 |
| | 7-12cm | 12 | 13 | 13 | 13 | 15 |
| | 13-20cm | 7 | 8 | 8 | 8 | 8 |
| | Total | 92 | 49 | 44 | 36 | 117 |

zone A while in the deeper layers a marked decrease in species numbers becomes apparent. The same pattern is seen in the remaining zones B, C and D but the number of species in the 0–1cm layer is significantly lower. The three lowest layers (2–20cm) are similar in all zones, at least in faunal diversity.

Observations by laboratory experimentation indicate that many of the surface layer species which are typical of the wetter areas (*Ochthebius punctatus*, *Hygroribates bilineatus*, *H. spoofi* and *Ameronothrus nigrofemoratus*)

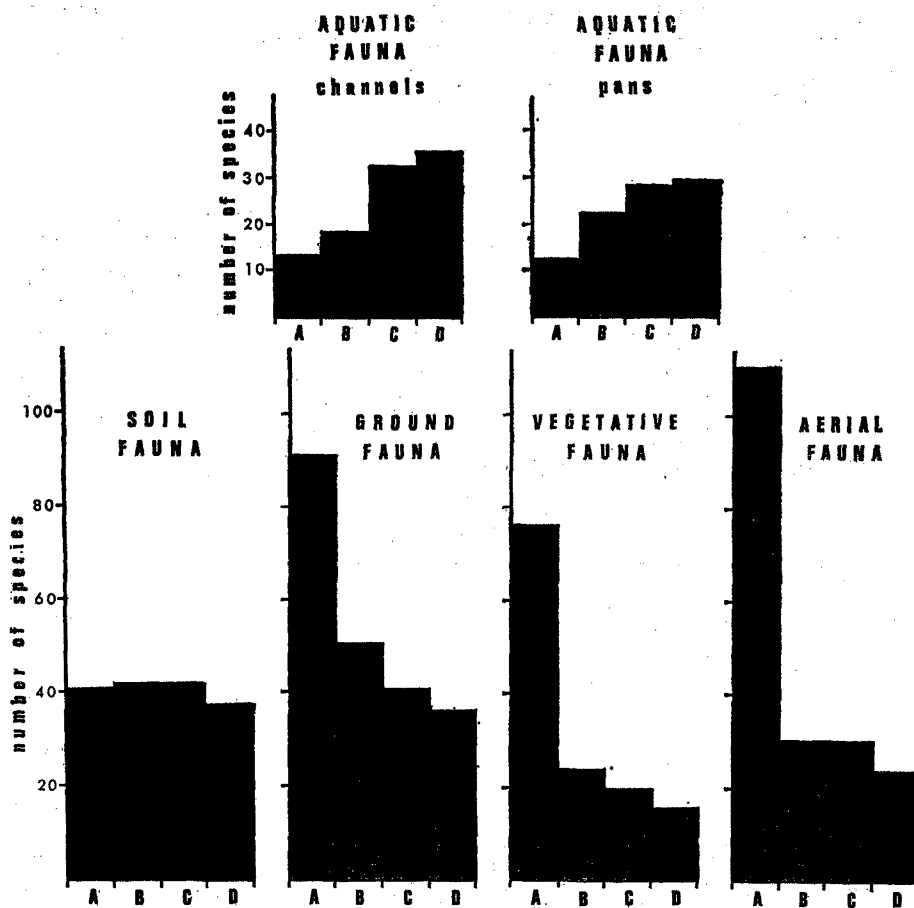


FIG. 2.—The number of species occurring in the four zones of the marsh (A, B, C and D)

survive immersion in sea water for periods of several days to three weeks during which time they continue to move. They may be considered semi-aquatic types. The greater majority of species survive immersion by entering a state of torpor. Brown (1948) has shown that members of the Saldidae survive in this way. Luxton (1964) has demonstrated the ability of many species of acarines to tolerate long periods of immersion and in the case of two species this survival period reached seventy days. During this survey, several species of mites and beetles (adults and larvae) and the pulmonate gastropod *Phytia*

myosotis survived more than twenty-four hours' immersion under experimental conditions.

Despite periodic tidal influence, desiccation is a hazard for many surface dwelling species. Most of the permanent terrestrial ground fauna take refuge in the soil, at least during the day, if conditions become dry. Some of the semi-aquatic Coleoptera (*Ochthebius* spp. *Bledius spectabilis*, *Heterocerus flexuosus* and *Helophorus affinis*), burrow into the soft mud bordering pans and channels or take refuge under algae. *Phytia myosotis* and *Littorina saxatilis* are often found in groups of ten or less individuals of varying sizes at 1cm below the surface. Burrows reaching 10cm depth are common for *Orchestia gammarella* under such conditions.

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