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Distribution of Gammaridean Amphipoda (Crustacea) on Georges Bank

John J. Dickinson and Roland L. Wigley

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U.S. DEPARTMENT OF COMMERCE

Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration

National Marine Fisheries Service

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Distribution of Gammaridean Amphipoda (Crustacea) on Georges Bank

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ABSTRACT

The distribution of 97 species of gammaridean amphipods is described for the Georges Bank region, based on 379 samples from 326 stations. A wide variety of sampling gear was used, resulting in representation of both infaunal and epifaunal species. Geographic and bathymetric distributions, and sediment preferences are summarized for each species. The zoogeography of the gammaridean fauna of Georges Bank is discussed, and the most common geographic distribution patterns are described and related to environmental parameters.

INTRODUCTION

This report describes distribution patterns for 97 species of gammaridean amphipoda on Georges Bank. Georges Bank is a submerged coastal plain that extends over 300 km east of Cape Cod, Mass., and encompasses an area of approximately 19,000 km² (Fig. 1). It is one of the most productive fishing grounds in the world yielding thousands of metric tons of finfish and shellfish annually (Gusey 1977). In the future, Georges Bank might also serve as an offshore source of petroleum.

Gammaridean amphipoda are the most numerous group of macroinfaunal organisms inhabiting Georges Bank, composing 49% of the number of specimens in quantitative samples collected there (Wigley and Theroux in prep.). Gammarideans are important food for many juvenile bottom-feeding fish. They often comprise 30% or more of the diet (Bowman³).

The purpose of this report is to provide information useful to both benthic ecologists and fisheries biologists interested in the Georges Bank ecosystem. Since amphipods are known to be sensitive to environmental alteration, the data presented in this report may also be useful as a baseline in the event of petroleum development on Georges Bank.

GEORGES BANK—DESCRIPTION OF ENVIRONMENT

For purposes of this report, we define Georges Bank as that part of the New England continental shelf between Great South Channel (long. 69°W) and Northeast Channel at water depths < 200 m (Fig. 1A). The important physiographic features of Georges Bank include: 1) a steeply sloping northern face; 2) an area of shoals in the north-central part; 3) a gently sloping southern face (Fig. 1B). The bank has been shaped by glacial erosion in the past, and recently by the strong tidal currents that run through the shoals (Stewart and Jordan 1964). The sediments of Georges Bank are dominated by sands (Wigley 1961). The central area of the bank including the shoals is chiefly medi-

um to coarse sand (Fig. 2A). Gravel covers the Northeast Peak, but fine sands occur around most of the perimeter of the bank. Silts, clays, and fine sands are the dominant components in the Western Basin.

Bottom water temperatures on Georges Bank vary a moderate amount during the year usually reaching a maximum in September and a minimum in February (Colton and Stoddard 1973). The greatest seasonal changes occur in the shallow central area of the bank which experiences about a 12°C annual fluctuation ranging from 4°C to 16°C (Fig. 3A, B). The perimeter of the bank has a much smaller annual temperature range fluctuating as little as 2°C in some areas. The coldest year-round bottom waters (6°C–8°C) occur in the Western Basin and on the Northeast Peak.

GEORGES BANK—AMPHIPODA

The gammaridean amphipod fauna of Georges Bank has been little studied previously. Smith and Harger (1874) collected a few samples from the bank and reported the amphipods which they found, but the taxonomy is now outdated and coverage of the bank was incomplete. Some records of occurrence on Georges Bank are given in papers of Shoemaker (1945b) and Bousfield (1965). Whitely (1948) collected 42 species of epibenthic and pelagic gammarideans on Georges Bank, but he gave distributional data for only one species, *Monoculodes edwardsi*.

METHODS

The distribution patterns described in this report are based on samples collected by the Benthic Dynamics Investigation at the Northeast Fisheries Center at Woods Hole, Mass. These collections were obtained as part of a survey, conducted between 1953 and 1965, to obtain an overview of the general composition and distribution of the macrobenthos on the continental shelf between Nova Scotia and Florida.

A total of 379 collections from 326 stations were utilized in charting the distribution of gammarideans on Georges Bank (Fig. 2B). The coverage of the bank was relatively complete except for the Shoals area where fewer samples were taken due to the hazards of navigating there. The samples were collected with a variety of sampling gear, including 1) quantitative grabs (Van Veen, Smith-Mac Intyre, Campbell), 2) epibenthic sled nets (ring and meter), 3) Dobby dredges, 4) otter trawls, and 5) from fish stomachs. The Smith-Mac Intyre grab (160 samples), the ring net (85), and the meter net (50) were the most frequently

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used samplers. Due to the variety of gear used and the large number of samples collected, we feel that a representative species list was obtained of both infaunal and epifaunal amphipods. Estimates of numerical density given in this report were based on samples collected with either the Smith-Mac Intyre (0.1 m²) or the Campbell (0.56 m²) grabs.

Nearly all the gammaridean species that we collected on Georges Bank are described in previous taxonomic works. Bousfield's (1973) excellent systematic monograph on the shallow-water amphipod fauna of New England described about one-half of the species found on the bank. The next most important reference is Sars (1895) classic work on the Crustacea of Norway, which includes about one-third of the species occurring on Georges Bank. Other useful systematic references include Holmes (1905), Shoemaker (1930a, b, 1945a, b), Stephensen (1935, 1938, 1940, 1942), Gurjanova (1951), Barnard (1960, 1969, 1971, 1972, 1979), Bousfield (1965, 1970, 1977, 1978), Mills (1967, 1971), and Laubitz (1977). The species names used in this report primarily follow Bousfield (1973), but recent revisions by Barnard (1969) and Laubitz (1977) have been incorporated. The systematic arrangement of species into families and superfamilies follows the phylogenetic classification proposed by Bousfield (1978).

ANNOTATED LIST OF SPECIES

The following list gives a summary of the geographic and bathymetric ranges and sediment preference for each species based on literature sources. Notes on general ecology are also included when information was available. The distribution of each species on Georges Bank is also characterized based on our collections, and a series of charts (Figs. 4-15) show the patterns of occurrence for each species collected. These charts are arranged alphabetically according to the species names.

Class Crustacea
Subclass Malacostraca
Superorder Peracarida
Order Amphipoda
Suborder Gammaridea

Superfamily Phoxocephaloidea
Family Phoxocephalidae

Harpinia propinqua G.O. Sars, 1895. Arctic-Boreal regions of North Atlantic; in western Atlantic: Arctic south to Cape Hatteras; 10-1,500 m, sand to silt-clay bottoms, burrowing detritivore (Sars 1895; Bousfield 1973; Dickinson et al. 1980).

Perimeter of Georges Bank, 84-196 m, gravel to silt-clay bottoms, 4.5°-7.7°C, densities 10-50/m².

Phoxocephalus holbolli Kroyer, 1842. Arctic-Boreal in North Atlantic; in western Atlantic: Arctic south to Virginia; 0-400 m, sand and silty sand bottoms, burrowing detritivore (Bousfield 1973; Dickinson et al. 1980) m².

Perimeter of Georges Bank, 33-179 m, sand and gravelly sand bottoms, 7.1°-12.3°C, densities 10-100/m².

Paraphoxus epistomus (Shoemaker, 1938). (*Trichophoxus epistomus* in Bousfield 1973. See Barnard 1979 for most recent discussion and proposal to change name to *Rhepoxynus epistomus*.) Boreal regions of North Atlantic and North Pacific; in western Atlantic: Maine south to North Carolina; 0-180 m, sand bottoms, burrowing detritivore (Barnard 1960; Bousfield 1973; Dickinson et al. 1980).

Central Georges Bank, 33-123 m, gravel and sand bottoms, 5.4°-12.3°C, densities 10-150/m².

Family Platyishnopiae.

Platyishnopus sp. A (undescribed species). Southern edge of Georges Bank, 121 m, sand bottom, 7.5°C. This species will be described by E. L. Bousfield of the Canadian National Museum in Ottawa.

Superfamily Lysianassoidea

Family Lysianassidae

Anonyx debruynei Hoek, 1882. Arctic waters of North Atlantic; in western Atlantic: south from Gulf of St. Lawrence to Cape Cod; bathyal depths and cold water (Steele and Brunel 1968).

Western Basin of Georges Bank, 183 m, silt-clay bottoms, 6.6°C.

Anonyx liljeborgi Boeck, 1871. Arctic-Boreal regions of North Atlantic; in western Atlantic: Arctic south to Delaware; 0-200 m, sand and silty sand bottoms, epibenthic scavenger (Steele and Brunel 1968; Bousfield 1973).

Perimeter of Georges Bank, 60-183 m, sand and silt-clay bottoms, 6.6°-11.6°C.

Anonyx sarsi Steele and Brunel, 1968. Circumpolar; in western Atlantic: Arctic south to New Jersey; 0-65 m, sand bottoms, epibenthic scavenger (Steele and Brunel 1968; Bousfield 1973).

Southern edge and Northeast Peak of Georges Bank, 70-97 m, gravel to sand bottoms, 7.4°-7.7°C.

Hippomedon propinquus Sars, 1895. Boreal regions of North Atlantic; in western Atlantic: from Nova Scotia south to Cape Hatteras; 15-250 m, gravelly sand to silt-clay bottoms, epibenthic (Sars 1895; Dickinson et al. 1980).

Western Basin and perimeter of Georges Bank, 73-196 m, sand to silt-clay bottoms, 6.6°-11.6°C.

Hippomedon serratus Holmes, 1905. Western Atlantic: Gulf of St. Lawrence south to North Carolina; 5-90 m, sand and silty sand, epibenthic (Bousfield 1973; Dickinson et al. 1980).

Southern Georges Bank, 35-106 m, sand and gravel bottoms, 7.3°-11.6°C.

Orchomene minuta Krøyer, 1846. Arctic-Boreal regions of North Atlantic; in western Atlantic: south from Baffin Island to New Jersey; 0-100 m, sand bottoms, epibenthic (Bousfield 1973; Dickinson et al. 1980).

Southern Georges Bank and Northeast Peak, 48-179 m, sand and gravelly sand bottoms, 7.4°-11.6°C, densities 10-100/m².

Orchomene pinguis Boeck, 1861. Arctic-Boreal regions of North Atlantic; in western Atlantic: Arctic south to North Carolina; 0-100 m, sand bottoms, epibenthic scavenger (Stephensen 1938; Bousfield 1973).

Perimeter of Georges Bank, 60-168 m, sand and silt-clay bottoms, 6.6°-11.2°C.

Psammonyx nobilis Stimpson, 1853. Western Atlantic: Newfoundland to New Jersey; 0-60 m, sand bottoms, burrower (Scott and Croker 1976; Dickinson et al. 1980).

Northern Georges Bank, 22-128 m, sand and gravelly sand, 6.1°-9.3°C.

Tmetonyx cicada O. Fabricius, 1780. Boreal-Arctic regions of North Atlantic; in western Atlantic: Arctic south to New Jersey; 0-2,000 m, sand and silty sand bottoms, epibenthic scavenger (Sars 1895; Stephensen 1935).

Perimeter of Georges Bank, 91–183 m, sand and silt-clay bottoms, 6.3°–7.6°C.

Tryphosella nanoides Liljeberg, 1865. Eastern North Atlantic; not previously reported from western Atlantic; 100–700 m (Sars 1895; Stephensen 1935).

Northern edge of Georges Bank, 179 m, sand bottom, 7.8°C.

Superfamily Pontoporeioidea

Family Pontoporeiidae

Amphiporeia gigantea Bousfield, 1973. Western Atlantic: Cape Cod south to New Jersey; 10–40 m, sand bottoms, burrowing detritivore (Bousfield 1973; Glennon 1979).

Central Georges Bank, 20–55 m, sand bottom, 7.8°–9.4°C.

Amphiporeia virginiana Shoemaker, 1933. Western Atlantic: Nova Scotia south to South Carolina; 0–15 m, sand bottoms, burrowing detritivore (Bousfield 1973; Hager and Croker 1979).

Central Georges Bank, 33 m, sand bottom, 8.4°C.

Bathyporeia quoddyensis Shoemaker, 1949. Western Atlantic: Nova Scotia south to Virginia; sand bottoms, burrowing detritivore (Bousfield 1973).

Central Georges Bank, 33–66 m, sand bottom, 7.6°C.

Family Haustoriidae

Acanthohaustorius intermedius Bousfield, 1965. Western Atlantic: Cape Cod to Florida; 0–40 m, sand bottoms, burrowing filter feeder (Bousfield 1973; Dickinson et al. 1980).

Central Georges Bank, 33–66 m, sand bottom.

Acanthohaustorius similis Frame, 1980. Western Atlantic: Cape Cod south to Cape Hatteras; 10–74 m, sand bottoms, burrowing filter feeder (Dickinson et al. 1980; Frame 1980).

Central Georges Bank, 33–66 m, sand bottom.

Acanthohaustorius spinosus Bousfield, 1962. Western Atlantic: Nova Scotia to New Jersey; 0–200 m, sand bottoms, burrowing filter feeder (Bousfield 1973).

Central Georges Bank, 64 m, sand bottom.

Acanthohaustorius sp. C (undescribed species). Western Atlantic: Cape Cod to Cape Hatteras; 10–40 m, sand bottoms (Dickinson et al. 1980).

Central Georges Bank, 46–49 m, sand bottom.

Acanthohaustorius sp. D (undescribed species). Central and Southern Georges Bank, 46–82 m, sand bottoms.

Parahaustorius attenuatus Bousfield, 1965. Western Atlantic: Cape Cod south to Virginia; 0–75 m, sand bottoms, burrowing filter feeder (Bousfield 1965, 1973; Dickinson et al. 1980).

Central Georges Bank, 33–66 m, sand bottom.

Parahaustorius holmesi Bousfield, 1965. Western Atlantic: Cape Cod to Virginia; 20–50 m, sand bottoms, burrowing filter feeder (Bousfield 1965, 1973).

Central Georges Bank, 35–42 m, sand bottom, 13.4°C.

Parahaustorius longimerus Bousfield, 1965. Western Atlantic: Cape Cod Bay south to northern Florida; 0–10 m, sand bottoms, burrowing filter feeder (Bousfield 1965, 1973; Croker 1967).

Central Georges Bank, 20–66 m, sand bottom.

Protohaustorius deichmannae Bousfield, 1965. Western Atlantic: Maine to South Carolina; 0–40 m, sand, shelly sand, and silty sand bottoms, burrowing filter feeder (Bousfield 1965, 1973; Dickinson et al. 1980).

Central Georges Bank, 46–60 m, sand bottom.

Protohaustorius wigleyi Bousfield, 1965. Western Atlantic: Maine to North Carolina; 0–150 m, shell and sand bottoms, burrowing filter feeder (Bousfield 1965, 1973; Dickinson et al. 1980).

Central and southern Georges Bank, 33–95 m, sand and gravelly sand bottoms, 7.6°–12.3°C, densities 10–300/m².

Pseudohaustorius borealis Bousfield, 1965. Western Atlantic: Georges Bank to Virginia; 10–60 m, sand bottoms, burrowing filter feeder (Bousfield 1965, 1973; Dickinson et al. 1980).

Central and northern Georges Bank, 46–88 m, sand bottoms.

Superfamily Gammaroidea

Family Gammaridae

Gammarus annulatus Smith, 1873. Western Atlantic: Nova Scotia to Long Island Sound; 0–200 m, sand bottoms, epibenthic or pelagic, omnivore (Bousfield 1973; Dickinson et al. 1980).

Southwest Georges Bank, 123 m, sand bottom. (It is noteworthy that this species, which reaches densities of 600/m² on Nantucket Shoals (Dickinson et al. 1980), was represented by only a single specimen on Georges Bank.)

Superfamily Eusiroidea

Family Eusiridae

Eusirus cuspidatus Krøyer, 1845. Arctic Atlantic; in western Atlantic: Arctic south to Bay of Fundy; 40–400 m, epibenthic or pelagic, probably carnivorous (Sars 1895; Stephensen 1935).

Western Basin of Georges Bank, 183 m, silt bottom, 6.6°C.

Rhachotropis distincta (Holmes, 1908). Arctic-Boreal regions of North Pacific and North Atlantic; in western Atlantic: Arctic south to Gulf of St. Lawrence, 300–1,200 m, epibenthic carnivore (Barnard 1971; Bousfield 1973).

Western Basin of Georges Bank (southern range extension), 157–196 m, silt-clay bottoms, 6.6°–7.7°C.

Rhachotropis inflata (G. O. Sars, 1882). Boreal regions of North Pacific and North Atlantic; in western Atlantic: Arctic south to Virginia; 20–100 m, epibenthic carnivore (Barnard 1971; Dickinson et al. 1980).

Southern edge of Georges Bank, 72–144 m, sand and gravel bottoms, 7.2°–12.6°C.

Rhachotropis oculata (Hansen, 1887). Pan-Arctic and Arctic-Boreal; in western Atlantic: Greenland south to Cape Cod; 5–100 m, epibenthic and pelagic carnivore (Bousfield 1973).

Southeast Georges Bank, 82–95 m, sand bottom.

Family Pontogeneiidae

Pontogeneia inermis (Krøyer, 1842). Arctic-Boreal in North Atlantic and North Pacific; in western Atlantic: Arctic south to Virginia; 0–80 m, rocky bottoms, epibenthic and pelagic (Bousfield 1973; Dickinson et al. 1980).

Central Georges Bank, 20–179 m, gravel to sand bottoms, 7.0°–11.3°C.

Family Calliopiidae

Calliopiops laeviusculus (Krøyer, 1838). Arctic-Boreal in North Atlantic and North Pacific; in western Atlantic: Labrador south to New Jersey; 0–30 m, rock and gravelly

sand bottoms, 0°–22°C, pelagic and epibenthic carnivore (Bousfield 1973; Steele and Steele 1973).

Central part of Georges Bank, 20–59 m, sand bottom, 7.6°–11.1°C.

Halirages fulvocinctus (M. Sars, 1854). Circumpolar Arctic; in western Atlantic: Arctic south to New England coast; 10–400 m, gravel and clay bottoms, epibenthic (Sars 1895; Stephensen 1938).

Western Basin of Georges Bank, 157–183 m, silt-clay bottom, 6.6°–6.8°C.

Haliragoides inermis (G. O. Sars, 1882). Arctic-Atlantic; in western Atlantic: Arctic south to Gulf of St. Lawrence; 30–2,000 m, silt-clay bottoms, epibenthic (Sars 1895; Stephensen 1938).

Western Basin and Northern Edge of Georges Bank (southern range extension), 152–196 m, gravel to silt-clay bottoms, 6.6°–7.7°C.

Family Paramphithoidea

Epimeria loricata G. O. Sars, 1879. Arctic-Boreal regions of North Atlantic; in western Atlantic: Arctic to New Jersey; 150–1,400 m, mud bottoms (Sars 1895; Stephensen 1938; Watling 1979).

Western Basin and Northern Edge of Georges Bank, 157–183 m, sand and silt-clay bottoms, 6.6°–7.6°C.

Superfamily Oedicerotoidea

Family Oedicerotidae

Bathynedon sausserei (Boeck, 1871). Boreal North Atlantic; not previously recorded in western Atlantic; 100–600 m, burrowing detritivore (Sars 1895; Stephensen 1938).

Western Basin and Northern Edge of Georges Bank (first western Atlantic records), 154–179 m, sand bottoms, 7.6°C.

Monoculodes edwardsi Holmes, 1908. Western Atlantic: Gulf of St. Lawrence south to Florida; 0–80 m, sand bottoms, burrowing detritivore (Bousfield 1973; Dickinson et al. 1980).

Central Georges Bank, 20–179 m, sand and gravel bottoms, 7.1°–12.6°C, most abundant species in epibenthic collections.

Monoculodes intermedius Shoemaker, 1930. Boreal regions of North Atlantic; in western Atlantic: Gulf of St. Lawrence south to Cape Cod Bay; 5–50 m, sand bottoms, burrowing detritivore (Bousfield 1973).

Northeast Peak of Georges Bank, 101 m, gravel bottom, 8.2°C.

Monoculodes latimanus (Goes, 1866). Boreo-Arctic regions of North Atlantic; in western Atlantic: Arctic south to Gulf of St. Lawrence; 5–100 m, burrowing detritivore (Sars 1895; Stephensen 1938; Bousfield 1973).

Southern Georges Bank, 84 m, gravel bottom.

Monoculopsis longicornis (Boeck, 1871). Arctic-Boreal regions of North Atlantic; in western Atlantic: Arctic south to Gulf of St. Lawrence; 0–100 m, sand and mud bottoms, burrowing detritivore (Sars 1895; Stephensen 1938).

Northern Edge of Georges Bank (southern range extension), 156–168 m, sand bottom.

Synchelidium americanum Bousfield, 1973. Western Atlantic: Central Maine to Georgia; 0–40 m, sand bottoms, burrowing detritivore (Bousfield 1973; Dickinson et al. 1980).

Southern Georges Bank, 73–84 m, sand and gravel bottoms, 10.5°C.

Westwoodilla megalops (G. O. Sars, 1882). Arctic-Boreal regions of North Atlantic and Arctic Oceans; in western Atlantic: Arctic south to Gulf of St. Lawrence; 10–90 m, burrowing detritivore (Sars 1895; Stephensen 1938).

Northeast Peak of Georges Bank (southern range extension), 192 m, sand bottom.

Superfamily Leucothoidea

Family Pleustidae

Neopleustes pulchellus Krøyer, 1846. Arctic-Boreal regions of North Atlantic; in western Atlantic: Arctic south to Georges Bank; 40–800 m, rock and gravel bottoms, epibenthic (Sars 1895; Stephensen 1938; Bousfield 1973).

Northeast Peak of Georges Bank, 84–108 m, gravel bottom.

Pleustes panoplus Krøyer, 1838. Circumpolar; in western Atlantic: Arctic south to New England coast; 10–280 m, sand and gravel bottoms, epibenthic (Sars 1895; Stephensen 1938).

Southern Georges Bank and Northeast Peak, 71–103 m, gravel to sand bottoms, 7.2°–7.7°C.

Pleusyntes glaber Boeck, 1861. Boreal regions of North Atlantic; in western Atlantic: Labrador to Chesapeake Bay; 5–120 m, rocky bottoms (Gurjanova 1951; Bousfield 1973).

Great South Channel and Northeast Peak of Georges Bank, 48–146 m, sand and gravel bottoms, 7.4°–8.9°C.

Stenopleustes gracilis Holmes, 1905. Western Atlantic: Cape Cod south to Chesapeake Bay, 5–50 m, sand bottoms (Bousfield 1973; Dickinson et al. 1980).

Great South Channel and Northeast Peak of Georges Bank, 58–103 m, sand and gravel bottoms, 7.1°–8.4°C.

Stenopleustes inermis Shoemaker, 1949. Western Atlantic: Gulf of Maine south to Delaware Bay; 5–100 m, sand and silty sand bottoms, epibenthic (Bousfield 1973; Dickinson et al. 1980).

Southern Georges Bank, 66–95 m, sand bottom.

Family Amphiloichidae

Amphiloichoides odontyx (Boeck, 1871). Boreal regions of North Atlantic; in western Atlantic: Arctic south to New Jersey; 20–120 m, sand to silt-clay bottoms (Sars 1895; Stephensen 1938; Watling 1979).

Southern Georges Bank, 84 m, gravel bottom, 10.4°C.

Gitanopsis arctica G. O. Sars, 1895. Arctic-Boreal regions of North Atlantic; in western Atlantic: Arctic south to Gulf of St. Lawrence; 10–100 m, silt-clay bottoms (Sars 1895; Stephensen 1938).

Northern Edge of Georges Bank (southernmost record in western Atlantic), 64 m.

Family Stenothoidea

Stenothoe minuta Holmes, 1905. Western Atlantic: Cape Cod south to Georgia; 0–40 m, usually associated with hydroids and bryozoans (Bousfield 1973).

Southern Georges Bank, 64–73 m, sand bottom.

Stenothoe peltata (Smith, 1873). Western Atlantic: Arctic to Gulf of St. Lawrence; 50–200 m (Gosner 1971; Bousfield 1973).

Perimeter of Georges Bank, 70–179 m, sand.

Superfamily Stegocephaloidea

Family Stegocephalidae

Andaniopsis nordlandica (Boeck, 1871). Boreal regions of North Atlantic; not previously reported in western Atlantic; 40–600 m, epibenthic (Sars 1895; Stephensen 1935).

Southern Georges Bank, 84 m, gravel bottom, 10.5 °C.

Stegocephalus inflatus Krøyer, 1842. Circumpolar Arctic; in western Atlantic: Arctic south to Rhode Island; 30–600 m, gravel to clay bottoms, epibenthic, predator? (Sars 1895; Stephensen 1935; Bousfield 1973).

Perimeter of Georges Bank, 121–196 m, sand and silt-clay bottoms, 6.6 °–7.6 °C.

Family Acanthonotozomatidae

Acanthonotozoma serratum (Fabricius, 1780). Circumpolar Arctic; in western Atlantic: Arctic south to Bay of Fundy; 10–300 m, gravel to silt-clay bottoms, epibenthic (Sars 1895; Stephensen 1938; Gurjanova 1951).

Northeast Peak of Georges Bank (southern range extension in western Atlantic); 79–198 m, sand and gravel bottoms, 7.8 °–8.2 °C.

Superfamily Synopioidea

Family Synopiidae

Syrhoe crenulata Goes, 1866. Boreal regions of North Atlantic and North Pacific Oceans; in western Atlantic: Arctic south to Cape Cod; 40–200 m, epibenthic detritivore (Sars 1895; Barnard 1972).

Northeast Peak of Georges Bank, 77–101 m, sand bottom, 8.4 °C.

Tiron spiniferum (Stimpson, 1853). Circumboreal; in western Atlantic: Arctic south to New England coast; 30–200 m, epibenthic (Sars 1895; Barnard 1972).

Northeast Peak of Georges Bank, 93–198 m, gravel and gravelly sand, 7.7 °–8.4 °C.

Family Argissidae

Argissa hamatipes (Norman, 1869). Northern Hemisphere, subarctic to warm temperate; in western Atlantic: Labrador south to North Carolina, 4–1,720 m, gravel to silt-clay bottoms (Barnard 1971; Bousfield 1973).

Southeast Part of Georges Bank, 60–82 m, sand bottom.

Superfamily Pardaliscoidea

Family Pardaliscidae

Halice abyssii Boeck, 1871. Arctic-Boreal regions of North Atlantic; not previously recorded in western Atlantic; 200–800 m, mud bottoms (Sars 1895; Stephensen 1938).

Western Basin of Georges Bank, 168–183 m, silt-clay bottom, 6.6 °–7.2 °C.

Pardalisca cuspidata Krøyer, 1842. Arctic-Boreal regions of North Atlantic; in western Atlantic: Arctic south to New England; 10–750 m, sand to silt-clay bottoms (Sars 1895; Gurjanova 1951; Bousfield 1973).

Northeast Peak of Georges Bank, 132 m.

Superfamily Ampeliscoidea

Family Ampeliscidae

Ampelisca agassizi (Judd, 1896). Atlantic and Pacific coasts of North America; in western Atlantic: Nova Scotia south to Caribbean; 5–450 m, coarse sand to silt-clay bottoms, detritivore, tubedweller (Mills 1971; Dickinson et al. 1980).

Southern Georges Bank, 60–170 m, sand bottoms, 6.6 °–12.6 °C, often occurs in high densities (100–10,000/m³).

Ampelisca declivitatis Mills, 1967. Northwestern Atlantic: western Greenland south to North Carolina; 100–1,000 m, sand to silt-clay bottoms, probably a tube-dwelling detritivore (Mills 1971; Dickinson et al. 1980).

Western Basin of Georges Bank, 150–170 m, sand and silty-sand bottoms.

Ampelisca macrocephala Liljeborg, 1852. Arctic-Boreal in North Atlantic, North Pacific, and Arctic Oceans; in western Atlantic: Greenland south to New Jersey; 5–1,700 m, stable sand bottoms, detritus feeding tubedweller (Barnard 1971; Mills 1971; Bousfield 1973).

Perimeter of Georges Bank, 66–168 m, sand bottoms, 7.3 °–12.2 °C.

Ampelisca vadorum Mills, 1963. Western Atlantic: Gulf of St. Lawrence to Gulf of Mexico; 0–100 m, medium to coarse sand, detritus feeding tubedweller (Mills 1967; Bousfield 1973; Dickinson et al. 1980).

North and central Georges Bank, 20–80 m, coarse and medium sand, 7.6 °–8.4 °C.

Byblis gaimardi (Krøyer, 1846). North Atlantic and Arctic Oceans; in western Atlantic: Greenland south to Cape Cod; 5–575 m, sand bottoms, detritus feeding tubedweller (Mills 1971).

Western Basin of Georges Bank, 154 m, sand bottom.

Byblis serrata (Smith, 1873). Western Atlantic: Cape Cod to Cape Hatteras; 0–200 m, medium to coarse sand, detritus feeding tubedweller (Mills 1971; Dickinson et al. 1980).

Southern Georges Bank, 44–123 m, sand bottom, 7.3 °–11.6 °C, moderately abundant (10–500/m³).

Haploops tubicola Liljeborg, 1856. Circumpolar Boreo-Arctic species; in western Atlantic: Arctic south to Gulf of Maine; 10–400 m, sand to silt-clay bottoms, detritus feeding tubedweller (Sars 1895; Stephensen 1935; Mills 1971).

Western Basin and perimeter of Georges Bank, 79–179 m, sand to silt-clay bottoms, 6.3 °–7.4 °C.

Superfamily Melphidippoidea

Family Melphidippidae

Melphidippa goesi Stebbing, 1899. Boreal regions of North Atlantic; in western Atlantic: Labrador south to Gulf of Maine; 30–300 m, filter feeder (Sars 1895; Stephensen 1938; Enequist 1949).

Western Basin and Northern Edge of Georges Bank, 157–183 m, sand and silt-clay bottoms, 6.6 °–7.6 °C.

Family Hornelia—Cheirocratus group

Casco bigelowi (Blake, 1929). Western Atlantic: Gulf of St. Lawrence south to Maryland; 0–400 m, sand to silt-clay bottoms, epibenthic, omnivore (Bousfield 1973; Dickinson et al. 1980).

Perimeter of Georges Bank, 68–179 m, sand and silt-clay bottoms, 5.3 °–12.8 °C.

Superfamily Melitoidea

Family Melitidae

Eriopisa elongata (Bruzellius, 1859). Arctic-Boreal regions of North Atlantic and North Pacific; in western Atlantic: Cape Cod south to New Jersey; 60–1,200 m, sand to silt-clay bottoms, burrowing deposit feeder (Sars 1895; Enequist 1949; Barnard 1971; Dickinson et al. 1980).

Southwest Georges Bank, 92 m, sand bottom.

Maera danae Stimpson, 1853. Western Atlantic: Gulf of St. Lawrence south to New Jersey; 0–50 m, gravel and silt-clay bottoms, epibenthic omnivore (Bousfield 1973).

Northern Edge of Georges Bank, 103 m, sand bottom.

Melita dentata Krøyer, 1842. Arctic-Boreal regions of North Atlantic and Arctic Oceans; in western Atlantic: Arctic south to Maryland; 0–300 m, gravel and sand bottoms, epibenthic omnivore (Bousfield 1973).

Perimeter of Georges Bank, 46–183 m, gravel and sand bottoms, 7.1°–11.6°C.

Melita sp. A. (undescribed species). Western Atlantic: Cape Cod south to New Jersey; 70–100 m, sand and silty sand bottoms (Dickinson et al. 1980).

Southern edge of Georges Bank, 92–114 m, sand bottom.

Melita sp. B. (undescribed species). Northeast Peak of Georges Bank, 86–194 m, gravel and gravelly sand.

Superfamily Corophioidea

Family Photidae

Gammaropsis maculatus (Johnston, 1827). Boreal regions of North Atlantic; in western Atlantic: Arctic south to North Carolina; 20–200 m, gravel and gravelly sand, detritus feeders (Sars 1895; Bousfield 1973; Fox and Bynum 1975).

Northeast Peak of Georges Bank; 79–93 m, gravel bottoms.

Photis dentata Shoemaker, 1945. Western Atlantic: Maine south to Florida; 49–92 m, sand bottom, probably a tube-dwelling detritivore (Shoemaker 1945a; Dickinson et al. 1980).

Western portion of Georges Bank, 35–124 m, sand and gravelly sand bottoms.

Photis macrocoxa Shoemaker, 1945. Western Atlantic: Gulf of St. Lawrence south to Virginia; 0–100 m, sand and silt bottoms, probably a tube-dwelling detritivore (Bousfield 1973).

Central and southern Georges Bank; 33–93 m, sand bottom.

Podocerosopsis nitida (Stimpson, 1853). Boreal regions of North Atlantic; in western Atlantic: Gulf of St. Lawrence south to New Jersey; 0–50 m, primarily on rocky bottoms, probably a detritivore (Bousfield 1973; Watling 1979).

Perimeter of Georges Bank, 35–179 m, gravel and sand bottoms, 4.9°–12.3°C.

Protomedea fasciata Krøyer, 1842. Arctic-Boreal regions of North Atlantic; in western Atlantic: Arctic south to New Jersey; 15–115 m, sand and gravelly sand, burrowing detritivore (Sars 1895; Enequist 1949).

Perimeter of Georges Bank, 62–146 m, gravel to sand bottoms.

Family Ischyroceridae

Ericthonius rubricornis Smith, 1873. Boreal regions of North Atlantic; in western Atlantic: Labrador south to Cape Hatteras; 0–400 m, gravel to silt-clay bottoms, filter-feeding tubedweller (Enequist 1949; Bousfield 1973; Dickinson et al. 1980).

Perimeter of Georges Bank, 46–192 m, gravelly sand and sand bottoms, moderately abundant along southern edge of Georges Bank reaching densities of 500/m².

Ischyrocerus anguipes Krøyer, 1838. Subarctic and Boreal regions of North Atlantic; in western Atlantic: Hudson Strait south to Cape Hatteras; 0–60 m, primarily on hard substratum, tubedweller (Bousfield 1973).

Perimeter of Georges Bank, 35–94 m, sand and gravel bottoms.

Ischyrocerus megacheir (Boeck, 1871). Arctic-Boreal regions of the North Atlantic; in western Atlantic: Arctic south to Gulf of St. Lawrence; 80–1,400 m, gravel and silt-clay bottoms, tube-dwelling detritivore (Sars 1895; Stephensen 1942; Enequist 1949).

Northeast Peak and Western Basin of Georges Bank (southernmost records), 112–196 m, gravel and gravelly sand bottoms.

Family Amphithoidae

Amphithoe rubricata (Montagu, 1808). Amphiatlantic; in western Atlantic: Arctic south to Long Island Sound; 0–40 m, algae bottoms, tubedweller, herbivore (Stephensen 1942; Enequist 1949; Bousfield 1973).

Southeastern Georges Bank (unusual record, normally confined to nearshore area), 62 m.

Family Aoridae

Leptocheirus pinguis (Stimpson, 1853). Western Atlantic: Labrador south to North Carolina; 0–250 m, sand to silt-clay bottoms, tubedweller, filter-feeding detritivore (Bousfield 1973; Dickinson et al. 1980).

Perimeter of Georges Bank, 44–179 m, sand and gravelly sand bottoms, 7.1°–12.2°C, moderately abundant on Georges Bank often reaching densities of 400/m².

Pseudunciola obliquua (Shoemaker, 1949). Western Atlantic: Bay of Fundy south to Virginia; 0–100 m, sand-gravel to silty sand, tubedweller, detritivore (Bousfield 1973; Dickinson et al. 1980).

Southern Georges Bank, 64–103 m, sand and shelly sand.

Unciola dissimilis Shoemaker, 1945. Western Atlantic: Massachusetts to North Carolina; 0–1,000 m, sand and silty sand bottoms, tube-dwelling detritivore (Shoemaker 1945b; Bousfield 1973).

Western Georges Bank, 20–135 m, sand bottoms, 4.4°–11.6°C.

Unciola inermis Shoemaker, 1945. Western Atlantic: Bay of Fundy south to North Carolina, 0–200 m, sand and silty-sand bottoms, tube-dwelling detritivore (Shoemaker 1945b; Dickinson et al. 1980).

Perimeter of Georges Bank, 57–192 m, sand and gravelly sand bottoms, 7.1°–11.2°C, high densities between 10 and 2,000/m².

Unciola irrorata Say, 1818. Western Atlantic: Gulf of St. Lawrence south to South Carolina; 6–500 m, sand-gravel to silt-clay bottoms, tube-dwelling detritivore (Shoemaker 1945b; Bousfield 1973; Dickinson et al. 1980).

Central Georges Bank, 35–168 m, gravel and sand bottoms, 7.1°–12.6°C, moderate densities 10–500/m².

Unciola spicata Shoemaker, 1945. Western Atlantic: Long Island south to Florida; 40–800 m, sand and silty sand bottoms (Shoemaker 1945b; Dickinson et al. 1980).

Southern edge of Georges Bank, 114–124 m, sand bottoms.

Family Corophiidae

Corophium crassicorne Bruzelius, 1859. Arctic-Boreal regions of North Atlantic and North Pacific; in western Atlantic: Arctic south to Virginia, 0–200 m, gravel to silty sand, tubedweller, filter-feeding detritivore (Bousfield 1973; Dickinson et al. 1980).

Perimeter of Georges Bank, 35–146 m, gravel and sand bottoms, 8.3°–12.3°C.

Siphonocetes smithianus Rathbun, 1908. Western Atlantic: Cape Cod south to Maryland, 10–90 m, sand bottoms, tube-dwelling detritivore (Bousfield 1973; Dickinson et al. 1980).

Southwest Georges Bank, 66 m, sand bottom.

Family Podoceridae

Dyopedos arcticus (Murdoch, 1884). Boreo-Arctic regions of North Atlantic and North Pacific; in western Atlantic: Arctic south to Cape Cod; 10–75 m, filter feeder (Laubitz 1977).

Northeast Peak of Georges Bank, 99 m, sand bottom, 8.9°C.

Dyopedos monacantha (Metzger, 1875). Boreal regions of North Atlantic; in western Atlantic: Arctic south to Virginia; 20–300 m, gravel to silt-clay bottoms, filter feeder (Laubitz 1977; Dickinson et al. 1980).

Perimeter of Georges Bank, 35–187 m, sand and gravel bottoms, 6.8°–11.3°C.

Dulichia tuberculata Boeck, 1870. Boreo-Arctic regions of North Atlantic; in western Atlantic: Arctic south to Cape Cod; 10–600 m, rock and gravel bottoms, filter feeder (Stephensen 1935; Laubitz 1977).

Northern Edge of Georges Bank, 156 m, sand bottom.

Paradulichia typica Boeck, 1870. Arctic-Boreal regions of North Atlantic; in western Atlantic: Arctic south to Cape Cod; 60–1,100 m, silt-clay bottoms, filter feeder (Gurjanova 1951; Laubitz 1977).

Western Basin of Georges Bank, 157–187 m, sand and silt-clay bottoms, 6.6°–6.8°C.

DISCUSSION

Zoogeography

Georges Bank lies in the latitudes where the Boreal (cold-temperate) and Virginian (warm-temperate) faunal provinces overlap (Bousfield 1973; Briggs 1974). In his study of the inshore gammaridean fauna of the Cape Cod region, Bousfield (1973) found the Virginian forms composed two-thirds of his species list. In contrast, we found that two-thirds of the species on Georges Bank were Boreal forms having their centers of distribution in the cold waters north of Cape Cod. However, it should be noted that the shallow central portions of the bank are chiefly inhabited by Virginian species, and that nearly all the Boreal forms are restricted to the perimeter of the bank. Therefore, our results are in agreement with Bousfield's findings.

Briggs (1974), in his discussion of the zoogeography of the northwest Atlantic, summarized data for both fish and invertebrates which showed a clear trend for cold-temperate forms to be amphi-Atlantic while most warm-temperate species are endemic to the western Atlantic. The data presented in Bousfield (1973), Dickinson et al. (1980), and this report indicate that this distributional pattern is also true for gammarideans.

Species Distribution Patterns

None of the 97 species collected were ubiquitous over the entire Georges Bank region, all of them were restricted in their distribution to some degree. In comparing the spatial patterns of gammarideans on the bank, it became apparent that many species had similar patterns. One of six patterns could be used to characterize nearly all the species (Fig. 16). Although these patterns are idealized and not followed exactly by each species, they were useful in simplifying the data and in providing insights into which environmental factors may be important in controlling gammaridean distributions on Georges Bank. A discussion of each of these patterns and the species described by it follows.

Northeast Peak

A group of six species (Table 1) showed a strong association with gravel sediments and cold year-round temperatures (6°–8°C) of the Northeast Peak. This group of species showed a high fidelity to the Northeast Peak with only *Anonyx sarsi*

Table 1.—Six patterns of gammaridean distribution on Georges Bank. Species in parentheses occurred in only one or two collections.

| | |
|----------------------------------|--------------------------------------|
| Northeast Peak | <i>Monoculopsis longicornis</i> |
| <i>Acanthonotozoma serratum</i> | <i>Paradulichia typica</i> |
| <i>Anonyx sarsi</i> | <i>Rhachotropis distincta</i> |
| (<i>Dyopedos arcticus</i>) | <i>Stegocephalus inflatus</i> |
| <i>Gammaropsis muculatus</i> | <i>Tmetonyx cicada</i> |
| <i>Mehta</i> sp. B | |
| <i>Neopleustes pulchellus</i> | Shoals |
| (<i>Pardalsca cuspidata</i>) | <i>Ampelisca vadorum</i> |
| <i>Tiron spiniferum</i> | <i>Amphiporea gigantea</i> |
| (<i>Tryphosella nanoides</i>) | <i>Pontogeneia inermis</i> |
| (<i>Westwoodilla magulops</i>) | <i>Psammonyx nobilis</i> |
| Perimeter | Southern Edge |
| <i>Ampelisca macrocephala</i> | <i>Ampelisca agassizi</i> |
| <i>Anonyx lalgeborgi</i> | <i>Aræssa hamatipes</i> |
| <i>Casco bigelowi</i> | (<i>Eriopsis elongata</i>) |
| <i>Corophium crassicorne</i> | (<i>Gammarus annulatus</i>) |
| <i>Dyopedos monacantha</i> | <i>Mehta</i> sp. A |
| <i>Erichthonius rubricornis</i> | <i>Orchomene minuta</i> |
| <i>Harpinia propinqua</i> | <i>Pleustes panophis</i> |
| <i>Hippomedon propinquus</i> | <i>Rhachotropis inflata</i> |
| <i>Leptocheirus pinguis</i> | <i>Rhachotropis oculata</i> |
| <i>Mehta dentata</i> | <i>Stenopleustes inermis</i> |
| <i>Orchomene pinguis</i> | (<i>Synchelidium americanum</i>) |
| <i>Photis dentata</i> | Central |
| <i>Phoxocephalus holbolli</i> | <i>Acanthohaustorius intermedius</i> |
| <i>Pleusymtes glaber</i> | <i>Acanthohaustorius similis</i> |
| <i>Podocerosopsis nitida</i> | <i>Acanthohaustorius spinosus</i> |
| <i>Protomedea fasciata</i> | <i>Acanthohaustorius</i> sp. C. |
| <i>Stenopleustes gracilis</i> | <i>Acanthohaustorius</i> sp. D. |
| Western Basin | <i>Bathyporeia quoddyensis</i> |
| <i>Ampelisca declivitatis</i> | <i>Byblis serrata</i> |
| (<i>Anonyx debrayni</i>) | <i>Hippomedon serratus</i> |
| <i>Bathymedon saussurei</i> | <i>Monoculodes edwardsi</i> |
| (<i>Byblis gannardi</i>) | <i>Parahaustorius holmesi</i> |
| (<i>Dulichia tuberculata</i>) | <i>Parahaustorius longimerus</i> |
| <i>Epimeria loricata</i> | <i>Paraphoxus epistomus</i> |
| (<i>Eusirus cuspidatus</i>) | <i>Photis macrocoxa</i> |
| <i>Halice abyssis</i> | <i>Protohaustorius deichmannae</i> |
| <i>Halirages fulvocinctus</i> | <i>Protohaustorius wigleyi</i> |
| <i>Haliragoides inermis</i> | <i>Pseudohaustorius borealis</i> |
| <i>Haploops tubicola</i> | <i>Pseudunciola obliquua</i> |
| <i>Ischyrocerus megacheir</i> | <i>Stenothoe minuta</i> |
| <i>Melphidippa goesi</i> | <i>Unciola irrorata</i> |

occurring outside this area. These species are all Arctic-Boreal and probably limited to the perimeter by their temperature tolerance, but their preference for gravelly sediments probably accounts for their further restriction to the Northeast Peak. A group of four species represented by single occurrences on the Northeast Peak are also listed in Table 1 as other species which might show this distribution pattern if more data were available.

Perimeter

A group of 17 species (Table 1) was distributed around the perimeter of the bank. The bottom temperatures around the perimeter generally have an annual range between 4° and 13°C, being warmer in the Great South Channel and cooler along the Northern Edge. The sediments of the perimeter are fine sands except for gravel on the Northeast Peak and medium to coarse sand in the Great South Channel. It is noteworthy that all 17, although having boreal distributions, are reported south of Georges Bank (Dickinson et al. 1980) in contrast to the species restricted to the Northern Edge and Western Basin. It seems likely that this group of species is excluded from the central parts of Georges Bank by the warmer summer temperatures (14°-18°C) and greater annual temperature range (3°-18°C) found there. It is clear that sediment type may also play a role in restricting the distribution of some of these species since they are absent from the Northeast Peak or Great South Channel portions of the perimeter.

Western Basin

A group of 14 species (Table 1) was restricted to the Western Basin and Northern Edge. This area is characterized by the coldest year-round temperatures (4°-6°C) and the finest sediments on the bank. Three species in the group (*Haploops tubicola*, *Stegocephalus inflatus*, and *Tmetonyx cicada*) had single records on the Southern Edge of the bank, but their distributions seemed to be better described by a "Western Basin" pattern than a "Perimeter" pattern. Only 2 of the 14 species occurred south of Georges Bank, and they (*Ampelisca declivata* and *Tmetonyx cicada*) were reported only from bathyal depths (Dickinson et al. 1980). Since these records constitute the southern limit for most of these species, we suspect that temperature limits their distribution on the bank to this area of cold year-round bottom temperatures. An additional group of four species are also listed in Table 1 as other species which might show this pattern if more data were available.

Shoals

Only a small group of species (Table 1) occurs in the gravelly sands of the northern shoals. This area of the bank is characterized by strong currents that continually rework the sediments. The shoals also experience the greatest annual temperature range (4°-16°C). Three of the four species found in the shoals are known to be associated with coarse sands, and they are usually found in shallow turbulent sand communities of the open coast. *Pontogeneia inermis* is a pelagic-epibenthic species which is ubiquitous over the central parts of Georges Bank. It is probable that other gammarideans may be associated with the shoals, but we may have missed them in our limited collections from this part of the bank.

Southern Edge

A group of eight species (Table 1) was restricted in their distribution to the Southern Edge of the bank. This area is characterized by fine sands and a narrow annual temperature range fluctuating between 8° and 11°C. Since these species are all cold-water forms, it seems likely that distribution around the perimeter of Georges Bank is limited by their preference for fine sands. Three additional species are listed in Table 1 since we suspect they might show this pattern if more data were available.

Central

A group of 19 species (Table 1) is associated with the medium sand sediments and warmer summer temperatures (12°-14°C) of the central portions of the bank. However, this group of species seems to avoid the northern shoals area of the bank. These species all have Virginian distributions and are endemic to the western Atlantic. Some species in this group such as members of the family Haustoriidae have limited distributions on the bank, probably reflecting their need for special sediment characteristics. Other species in this group such as *Unciola irrorata* and *Monoculodes edwardsi* are broadly distributed in the central region of the bank. In general, we suspect that this species group is restricted from the perimeter of the bank by the cold year-round temperatures and from the shoals by the turbulence.

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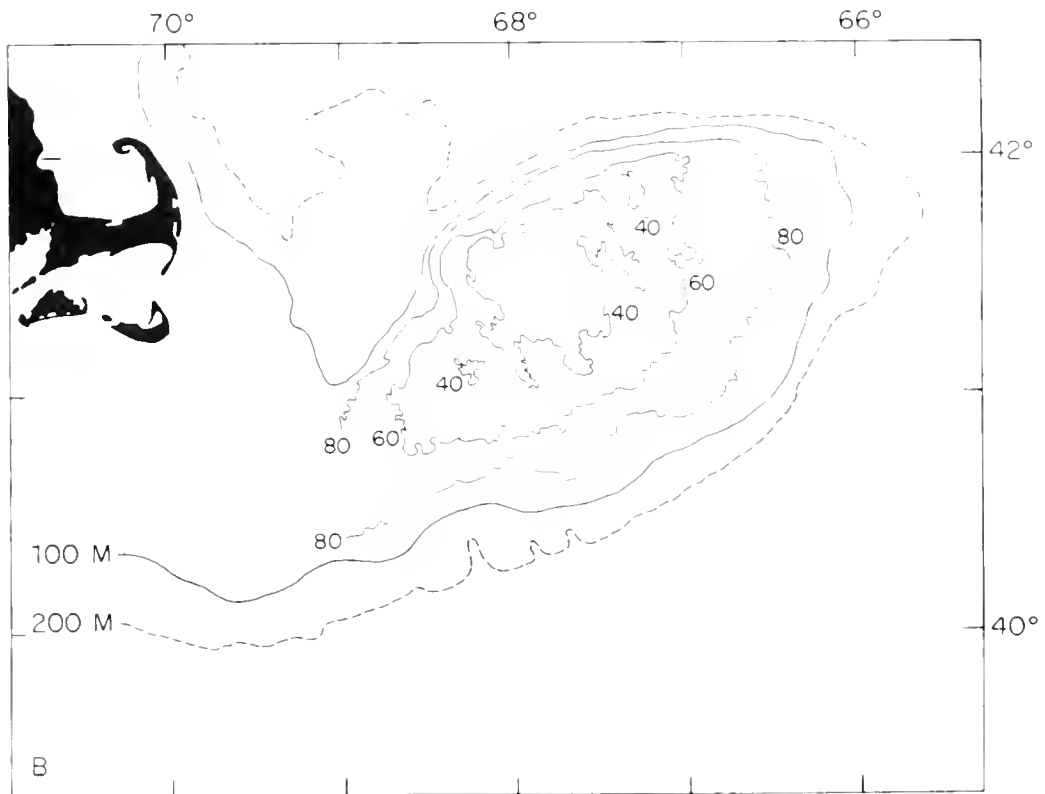
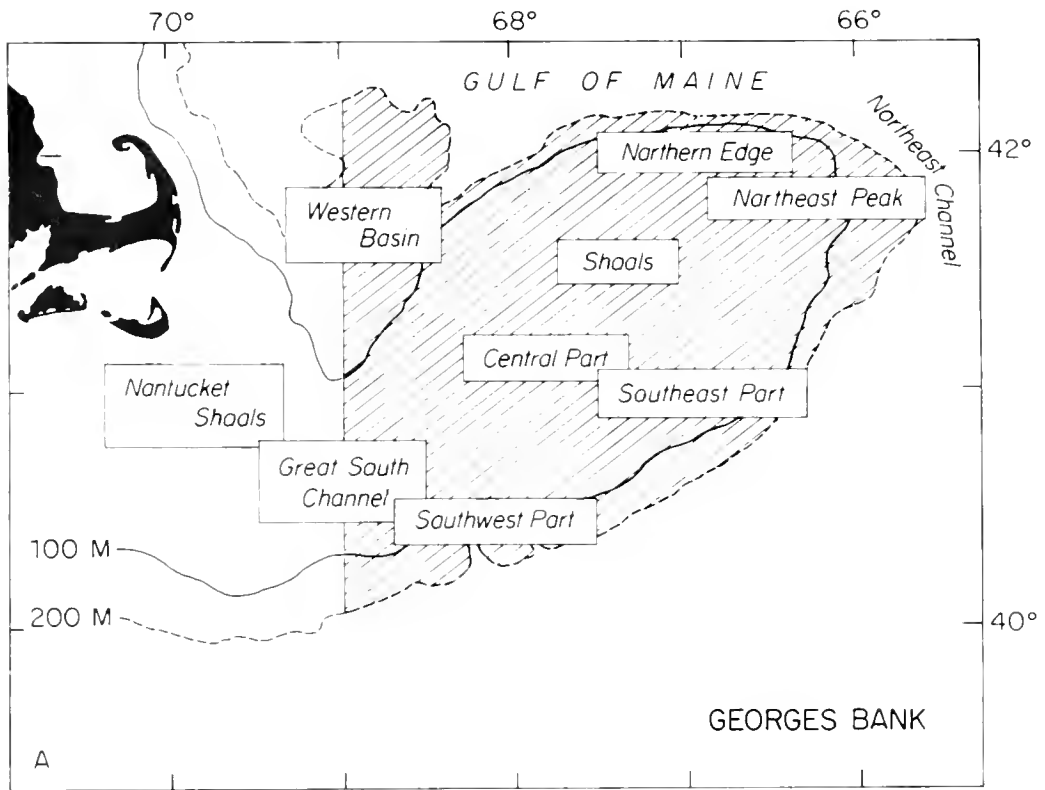


Figure 1.—A. Geographical features of Georges Bank region. The study area is defined by hatching. B. Bathymetry of Georges Bank in meters.

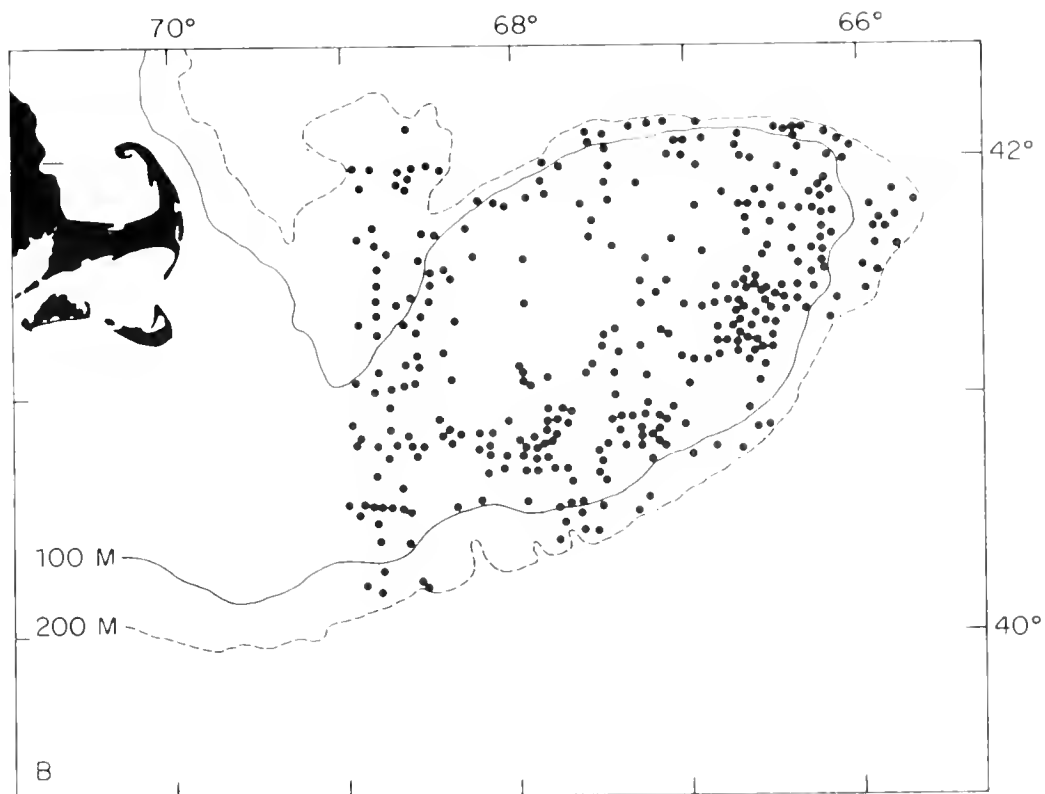
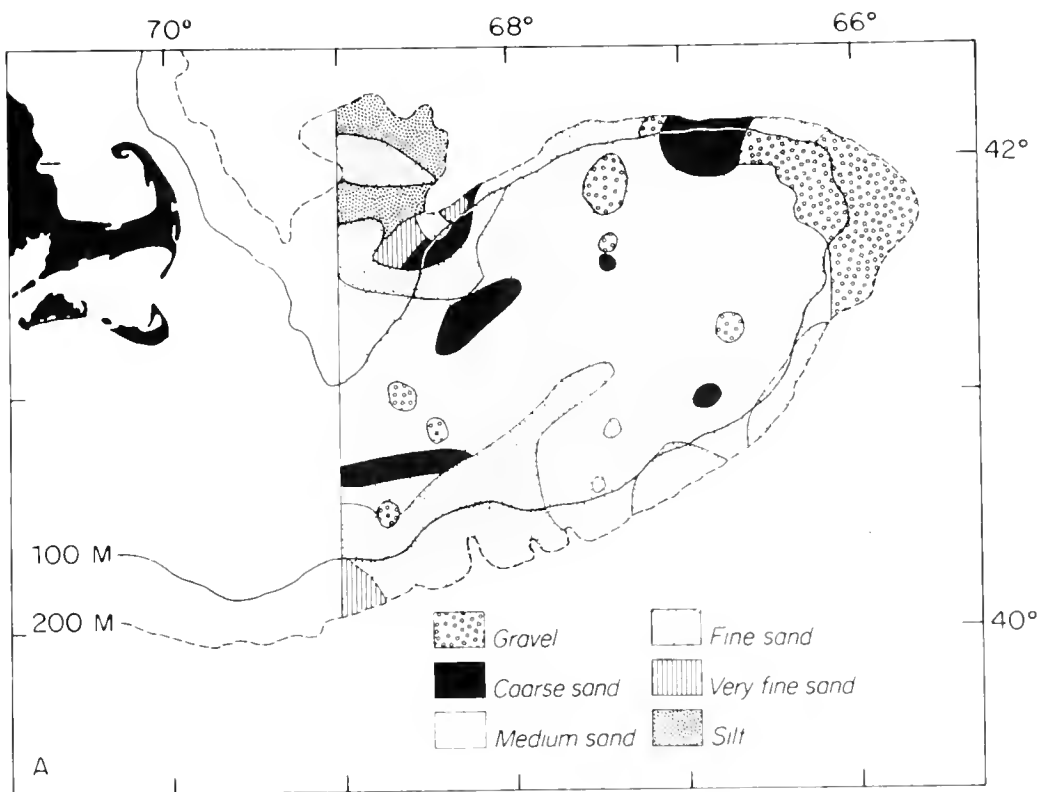


Figure 2.—A. Geographic distribution of bottom sediment types on Georges Bank (after Wigley 1961). B. Station locations on Georges Bank where samples were collected.

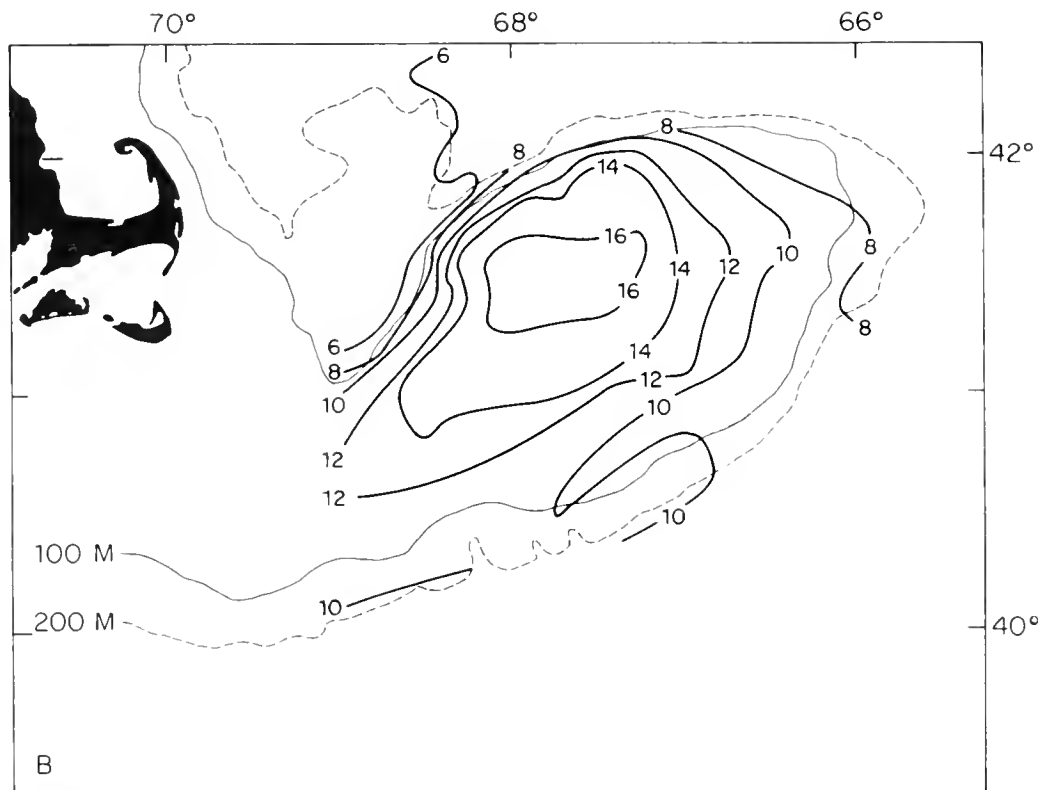
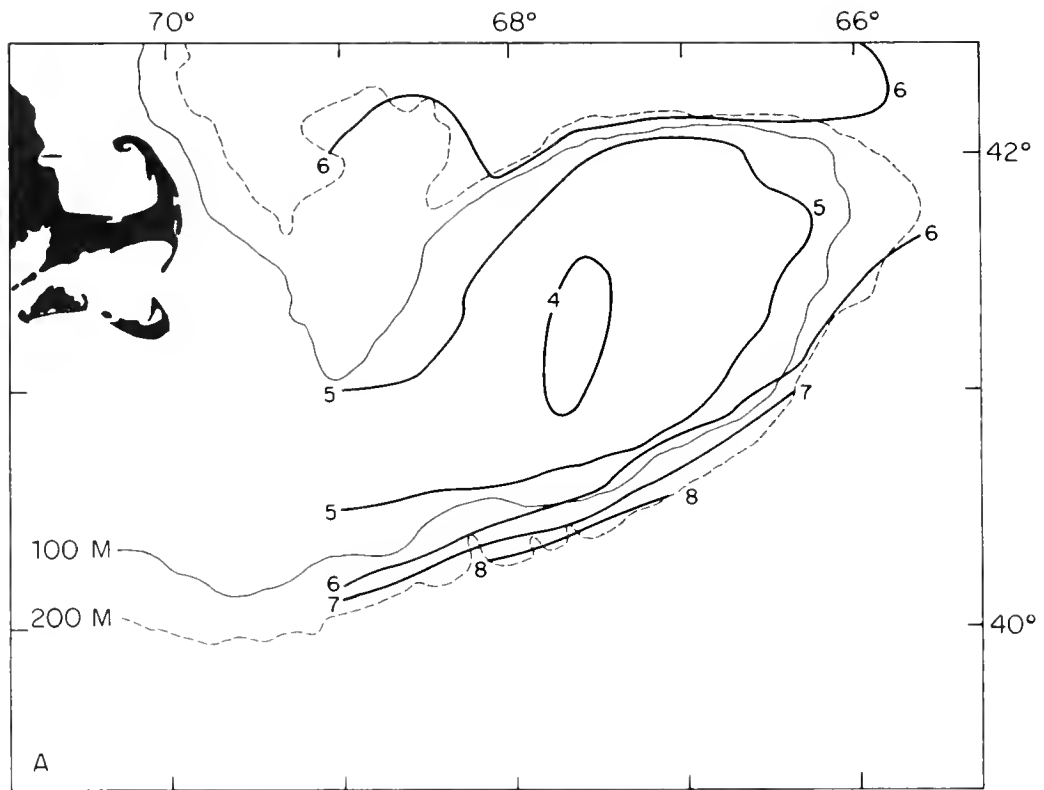


Figure 3.—A. Distribution of average bottom-water temperatures (°C) during February on Georges Bank (after Colton and Stoddard 1973). B. Distribution of average bottom-water temperatures (°C) during September on Georges Bank (after Colton and Stoddard 1973).

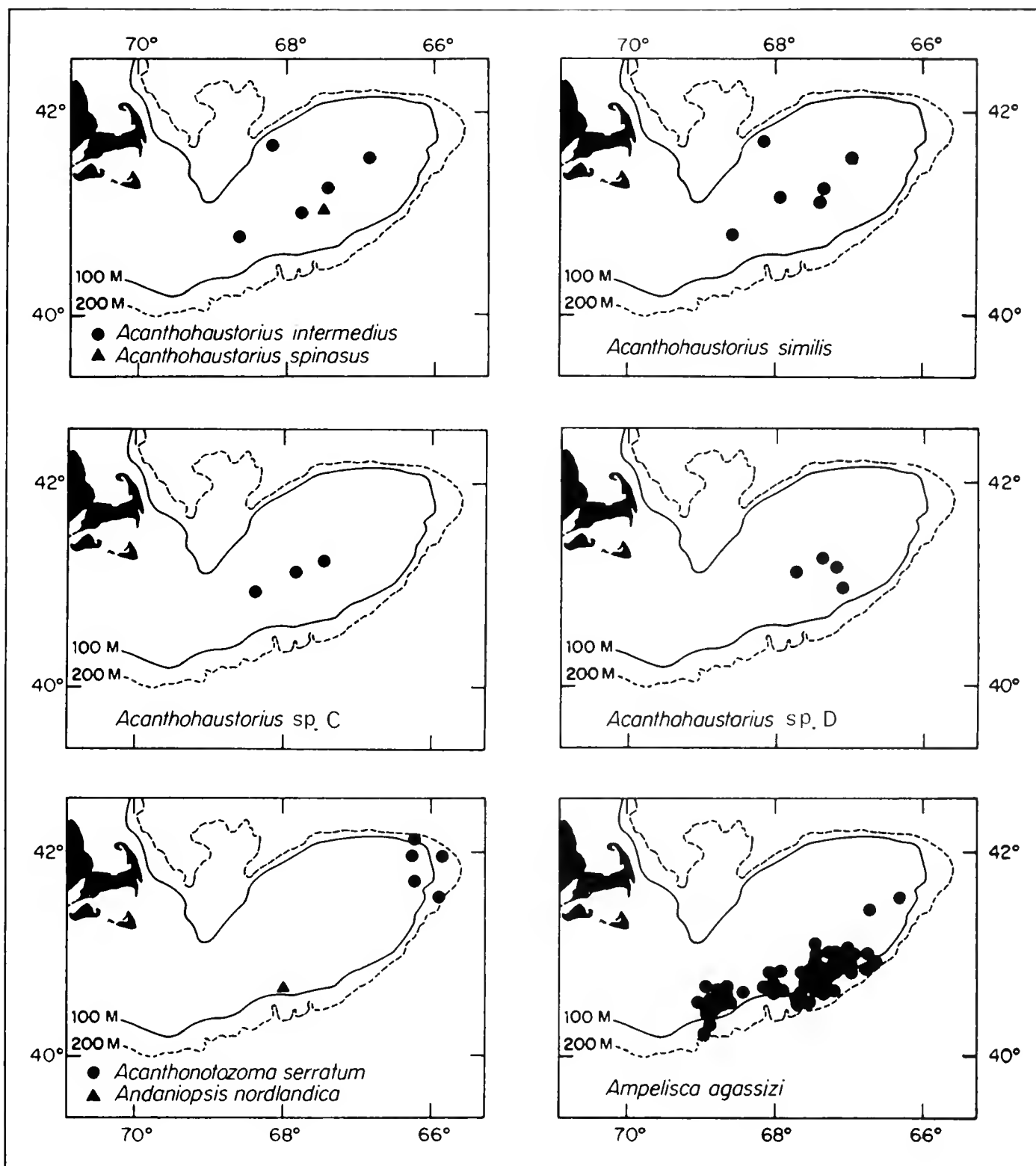


Figure 4.—Geographic distribution of species of gammaridean Amphipoda on Georges Bank.

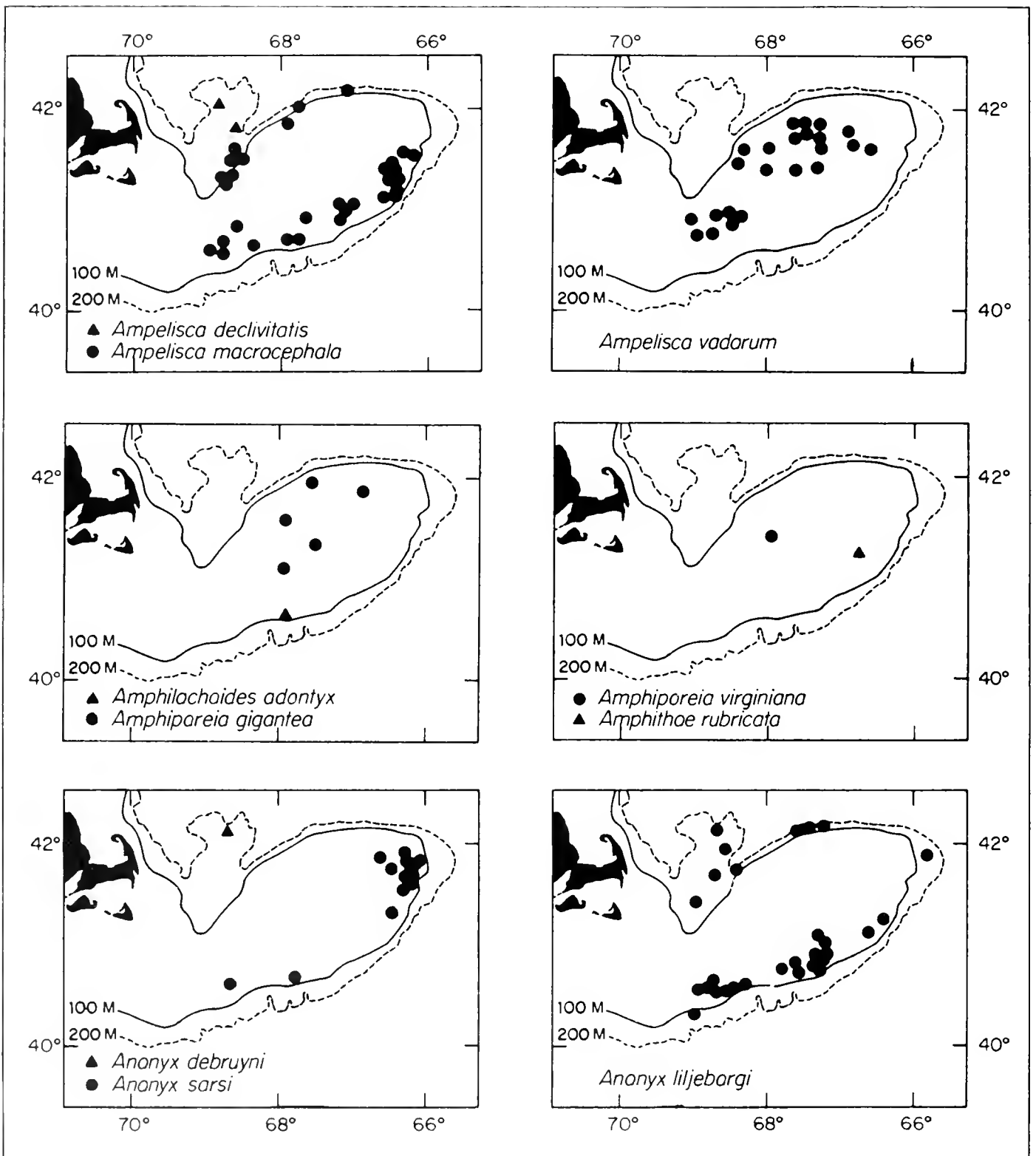


Figure 5.—Geographic distribution of species of gammaridean Amphipoda on Georges Bank.—Continued.

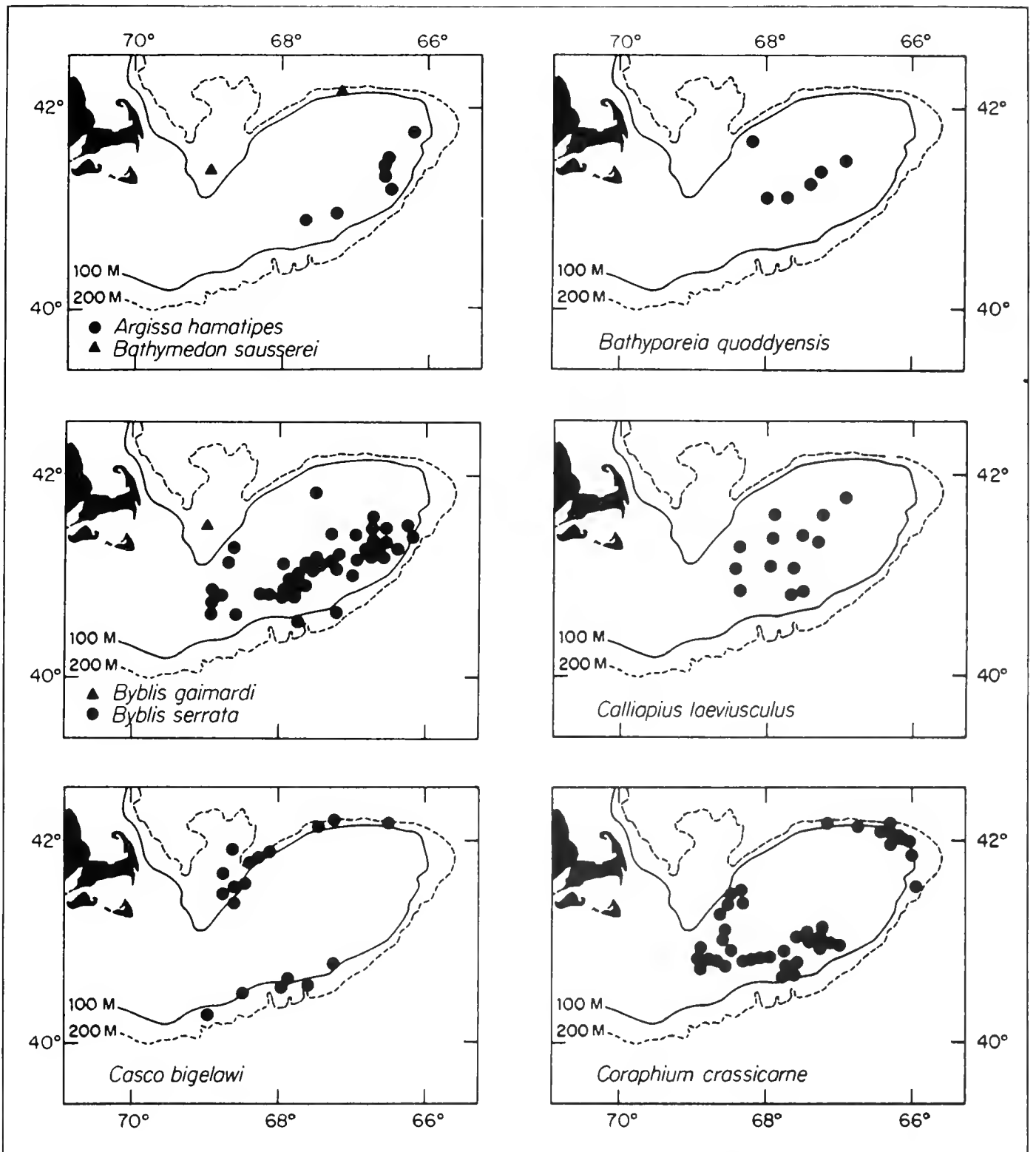


Figure 6.—Geographic distribution of species of gammaridean Amphipoda on Georges Bank.—Continued.

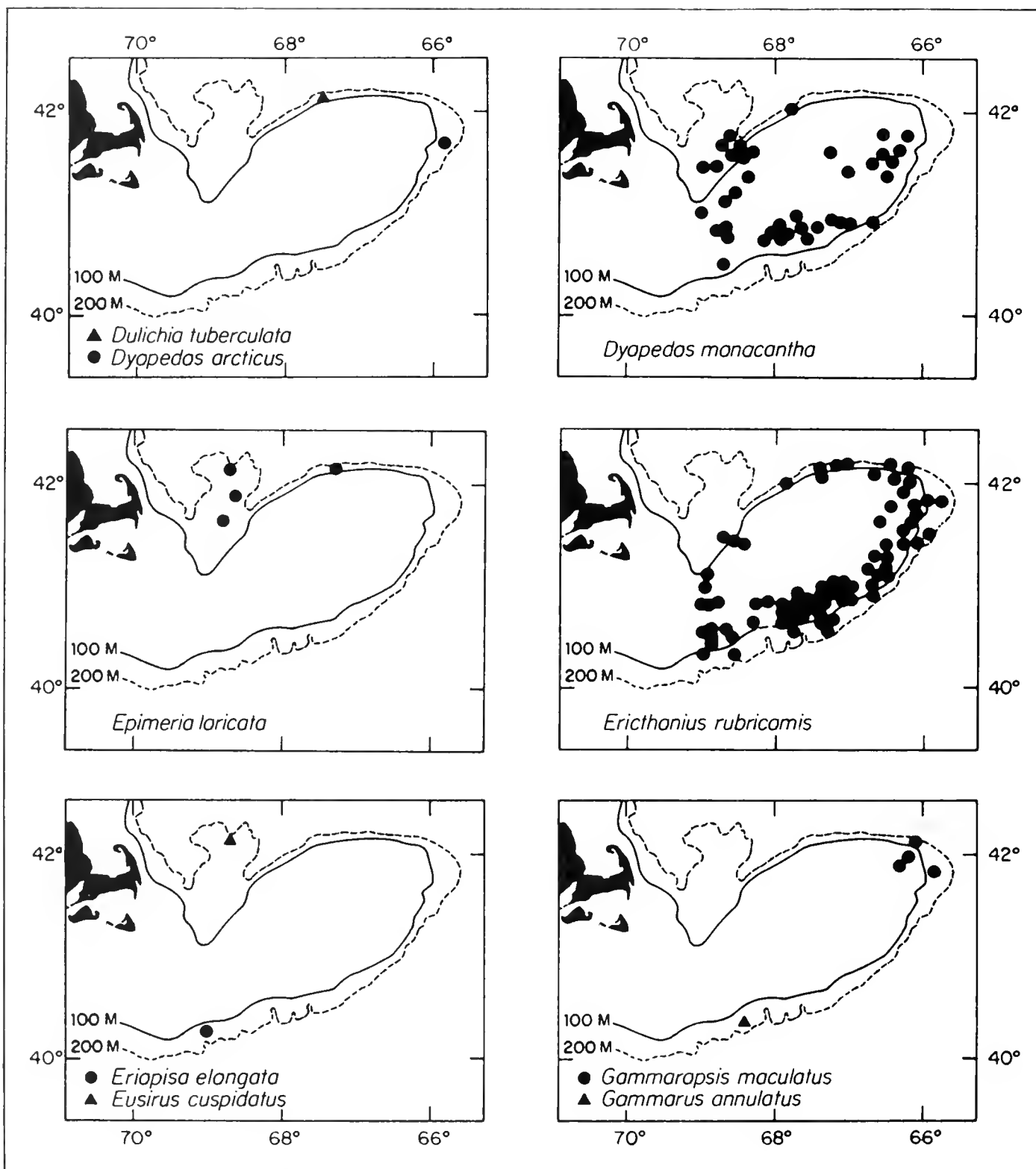


Figure 7.—Geographic distribution of species of gammaridean Amphipoda on Georges Bank.—Continued.

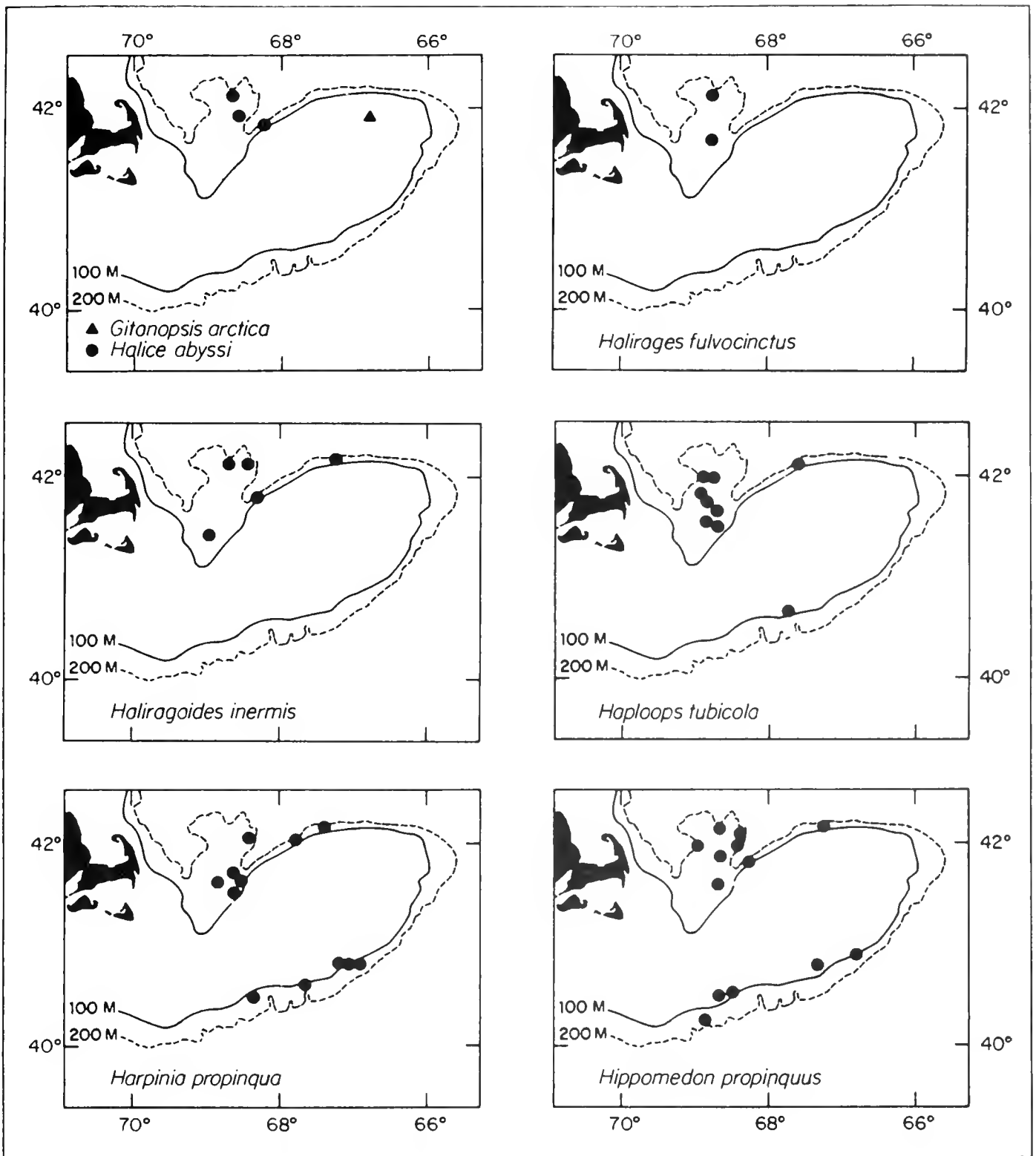


Figure 8.—Geographic distribution of species of gammaridean Amphipoda on Georges Bank.—Continued.

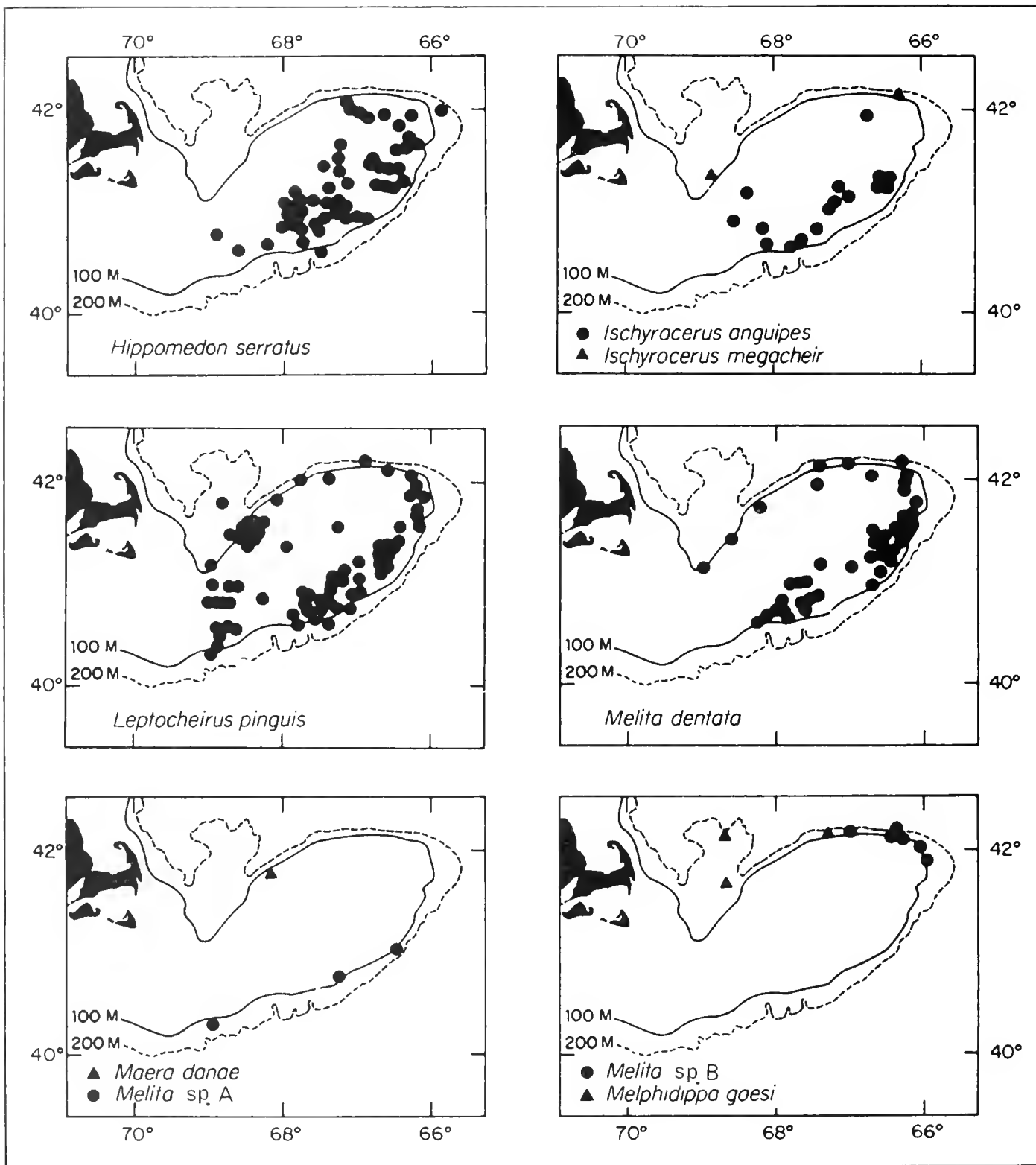


Figure 9.—Geographic distribution of species of gammaridean Amphipoda on Georges Bank.—Continued.

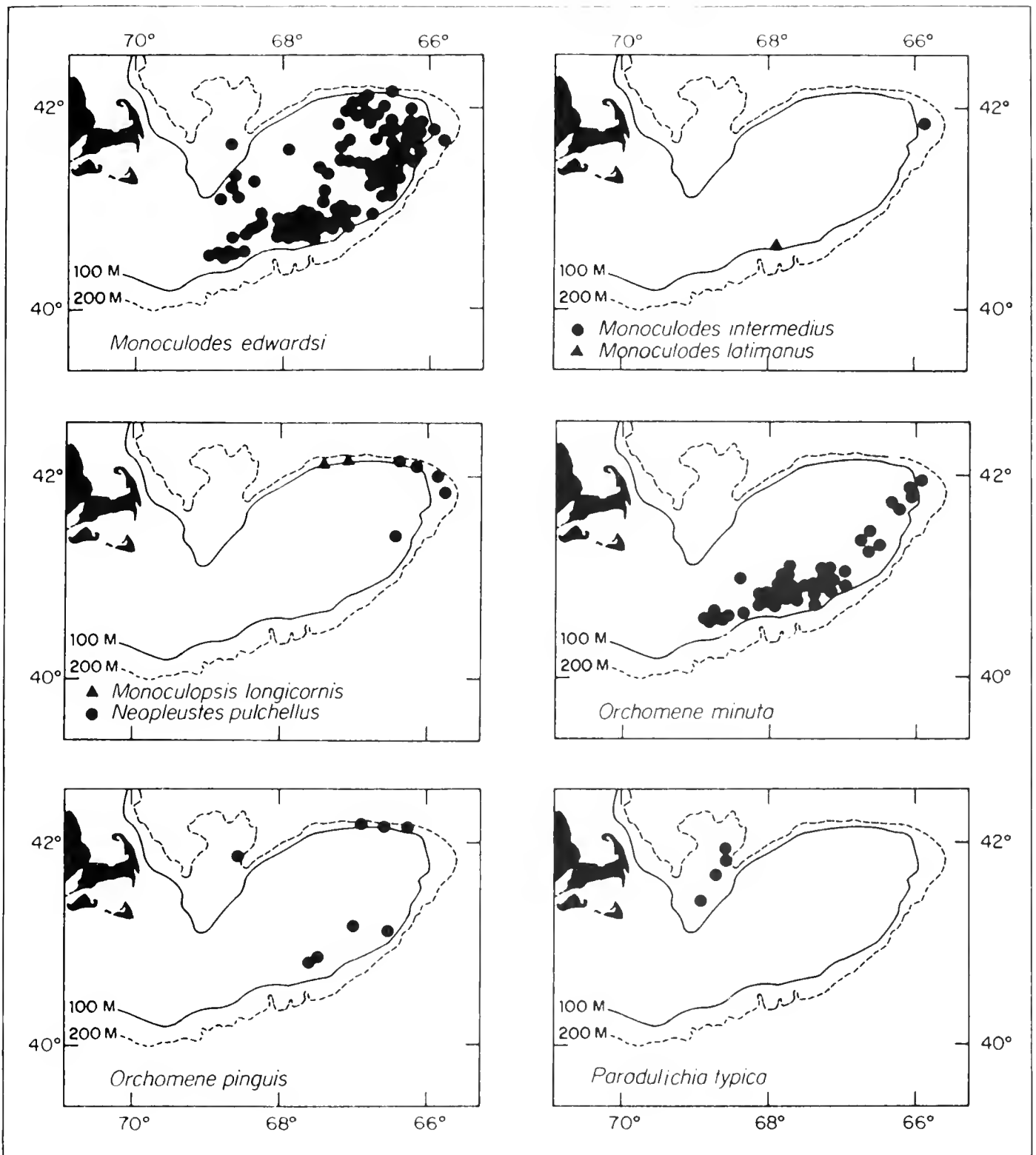


Figure 10.—Geographic distribution of species of gammaridean Amphipoda on Georges Bank.—Continued.

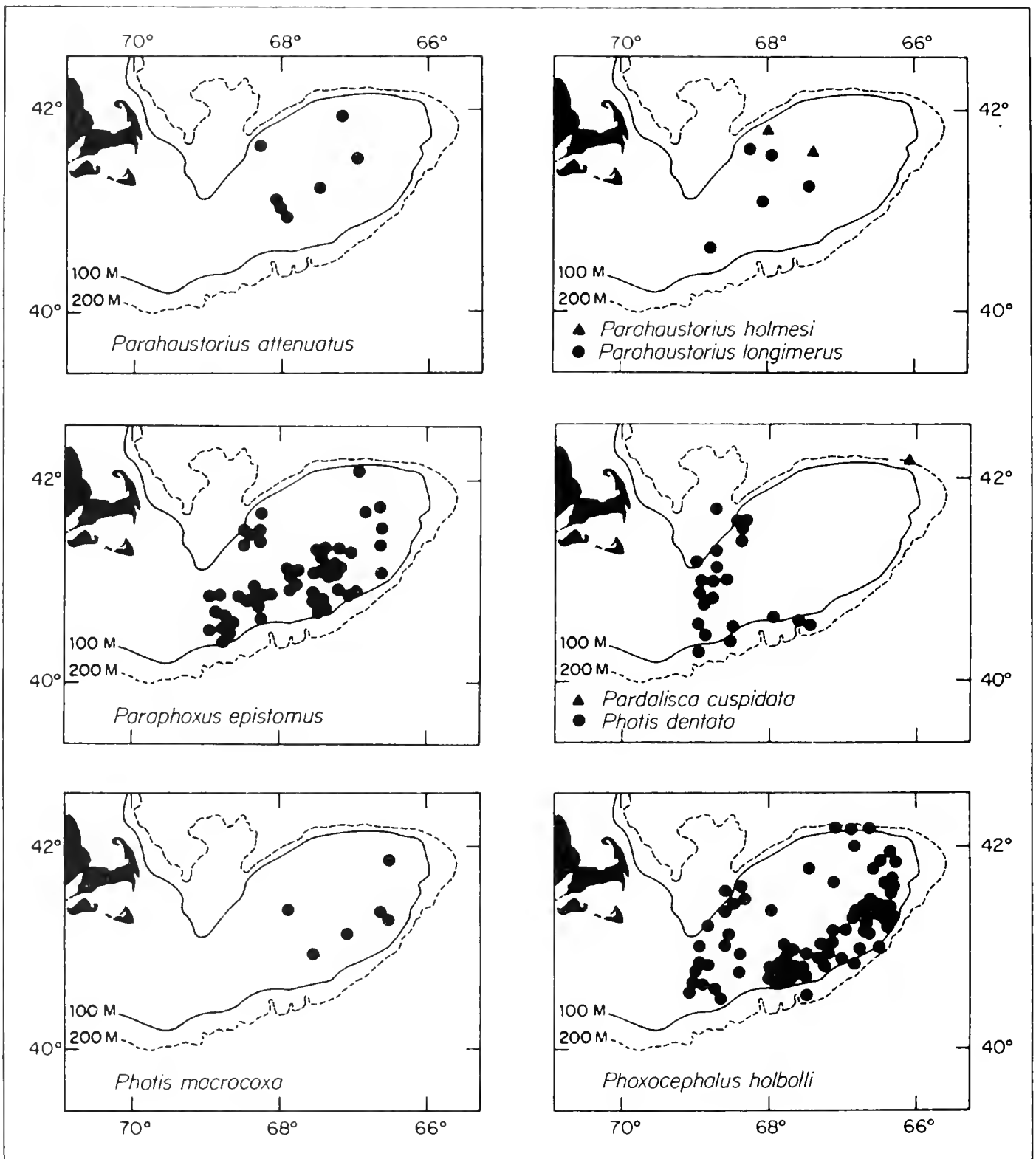


Figure 11.—Geographic distribution of species of gammaridean Amphipoda on Georges Bank.—Continued.

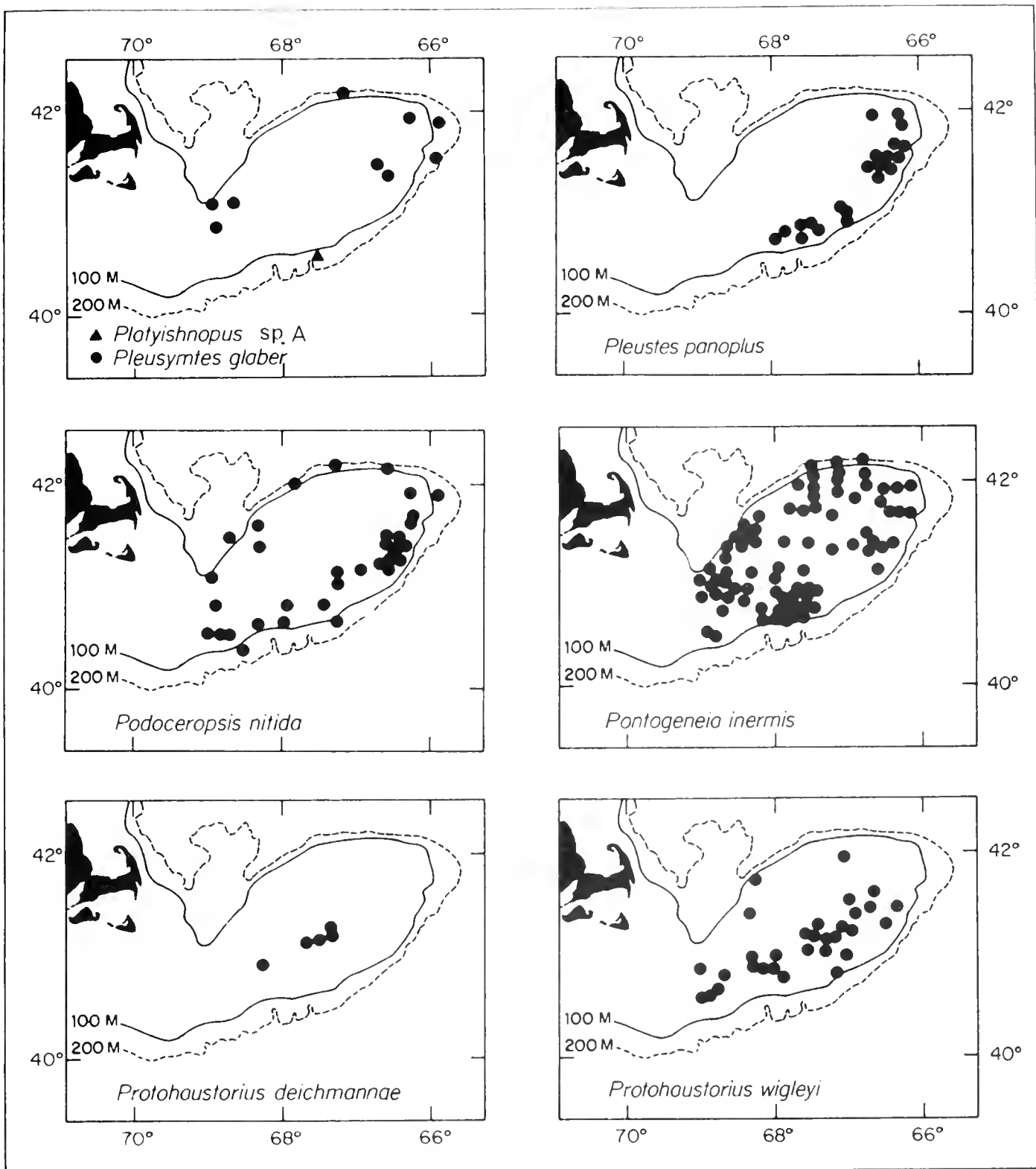


Figure 12.—Geographic distribution of species of gammaridean Amphipoda on Georges Bank.—Continued.

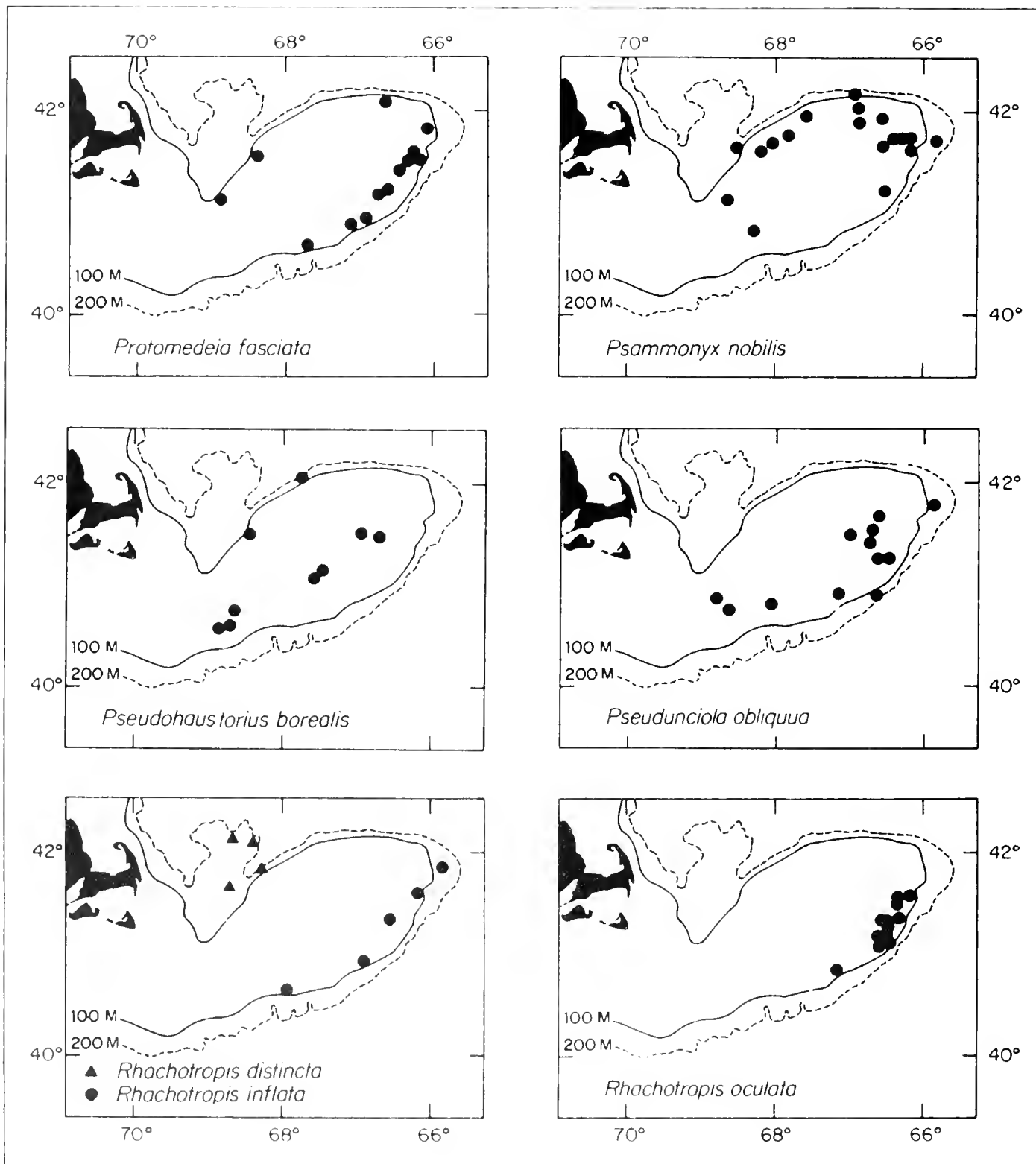


Figure 13.—Geographic distribution of species of gammaridean Amphipoda on Georges Bank.—Continued.

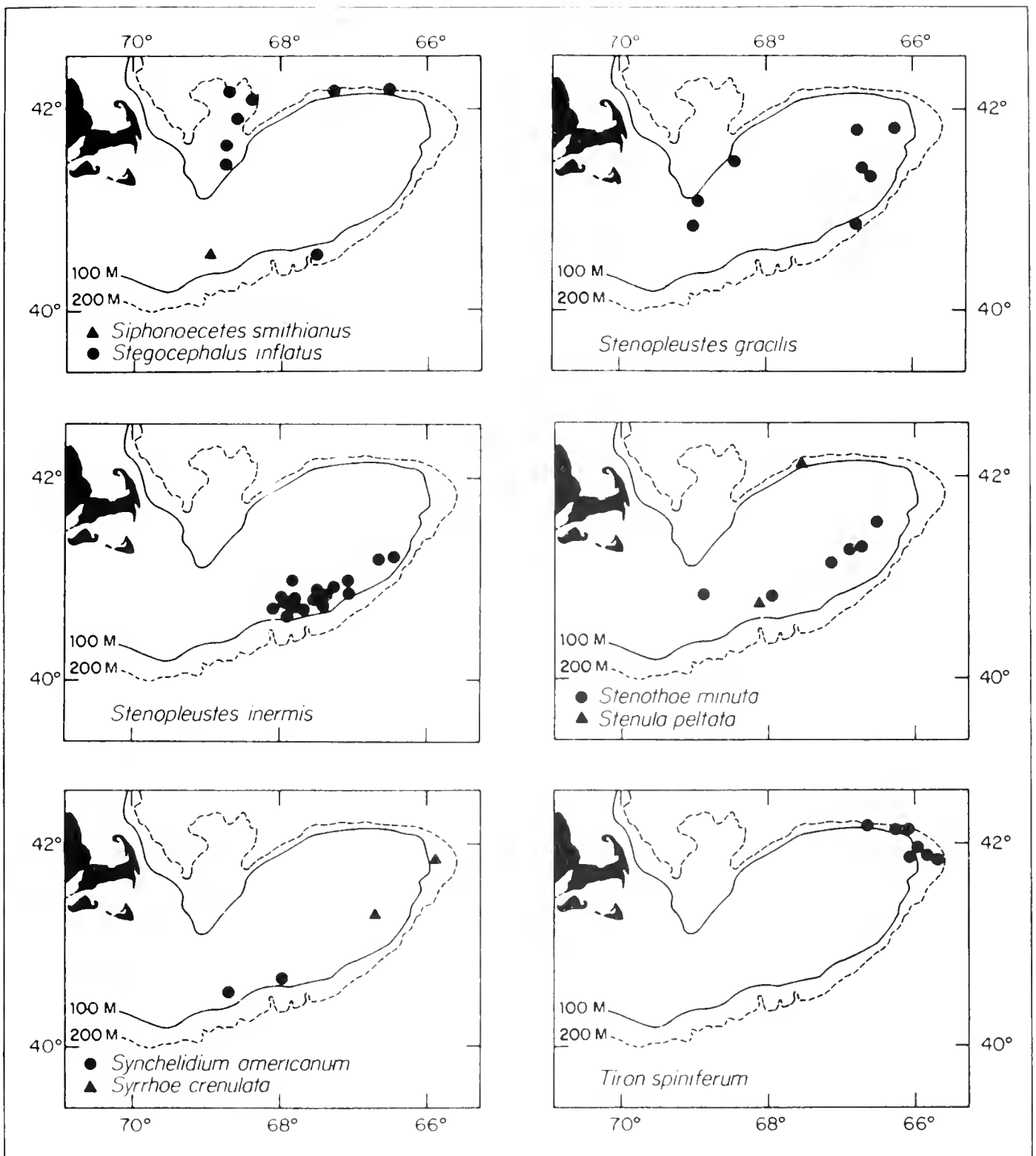


Figure 14.—Geographic distribution of species of gammaridean Amphipoda on Georges Bank.—Continued.

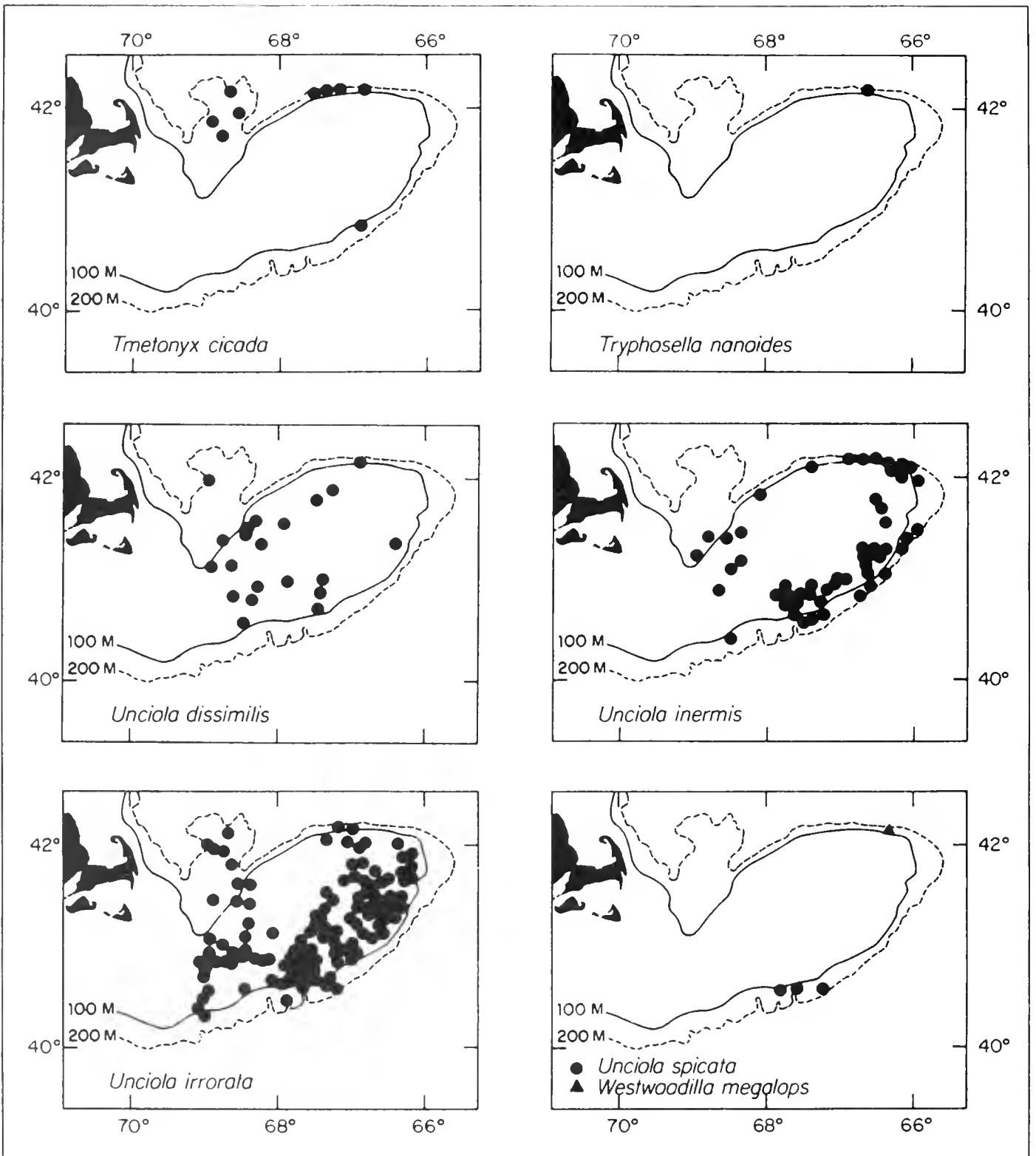


Figure 15.—Geographic distribution of species of gammaridean Amphipoda on Georges Bank.—Continued.

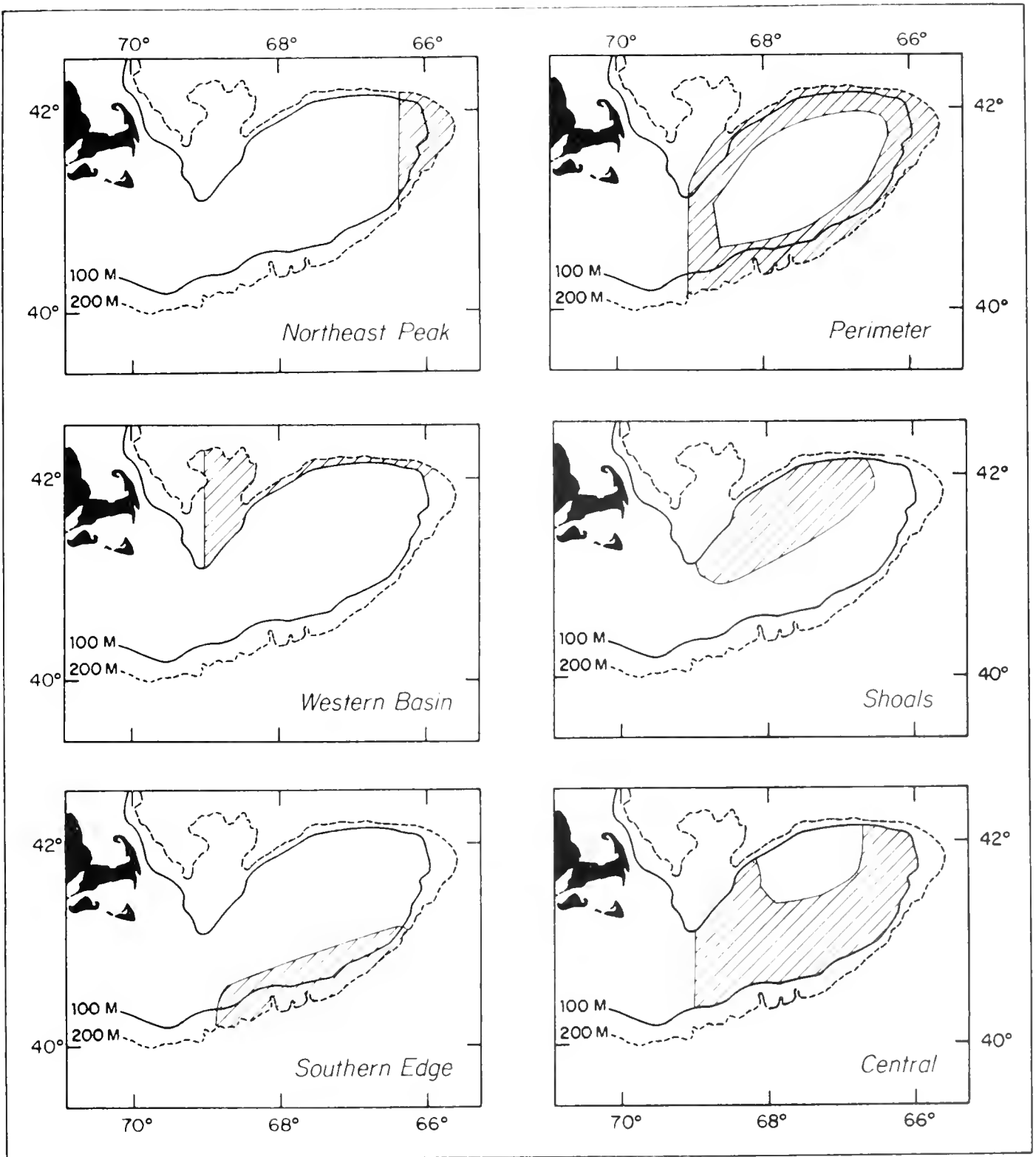


Figure 16.—Most common distribution patterns of gammarideans on Georges Bank.



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