The Feeding Ecology of Larval Fish in an Antarctic Fjord, with Emphasis on *Champsocephalus gunnari*

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Summary. The vertical distribution of five species of fish larvae and their prey species was studied in late winter and summer at Cumberland East Bay, South Georgia. Prey type varied between fish species but was dominated by the copepod *Drepanopus forcipatus* and copepod eggs. Prey numbers increased with fish size. In summer, fish larvae and copepods were most abundant in the upper 120 m of the 265-m-deep fjord, whereas in late winter, both groups were more evenly dispersed throughout the water column.

1 Introduction

South Georgia is a very important finfish fishery area in the Antarctic and is mainly dependant on the mackerel icefish *Champsocephalus gunnari*. In the 1986/87 season 71 141 tonnes of the grand total of 90 872 tonnes of fish taken in Antarctic waters was *C. gunnari* from South Georgia (CCAMLR 1988). Other exploited species include two more icefish, *Chaenocephalus aceratus* and *Pseudochaenichthys georgianus*, and the rock-cods *Notothenia gibberifrons* and *Patagonotothen brevicauda guntheri*. Recruitment to the *C. gunnari* population is very variable (Cooke 1987) and largely controls the value of the commercial fishery. Indications of year-class success and future recruitment derived from estimates of the abundance of the early stages will be important for managing the fishery.

Adult *C. gunnari* feed offshore on krill (*Euphausia superba*). They spawn nearshore during April to June in the fjords around South Georgia (Olsen 1955). Larvae with a yolk-sac hatch in June to August (winter) and begin to feed in August–September before all their yolk reserves have been depleted (North 1988; North and Ward 1989). Early juvenile *C. gunnari* (60–100 mm long) fed on mysids at South Georgia (Kock 1981). Juvenile *C. gunnari* are most abundant in shallow waters 100 to 200 m deep around the island (Kock 1981; Boronin et al. 1987). The nearshore ecosystem, especially in the fjords, is therefore an important area where biological and physical factors affect recruitment and year-class success (North 1988). These factors, apart from the status of the adult spawning stock, are mostly those which determine survival of the larval to the juvenile stages and include feeding success and the effects of water movements on their distribution in relation to feeding grounds (Hunter 1981; Cushing 1975).

To date relatively few studies have investigated the feeding ecology of the larval stages of Antarctic fish. There has been little seasonal coverage and, with the notable exception of Kellermann (1986, 1987), few species have received attention. This chapter is a preliminary report on the feeding ecology of the most abundant larval stages of fish in Cumberland East Bay, South Georgia, including three species important to the fishery, *Champsocephalus gunnari, Chaenocephalus aceratus,* and *Notothenia gibberifrons,* and two others *Nototheniops nudifrons* and *Nototheniops larseni.*

2 Materials and Methods

Zooplankton including fish larvae and copepods were sampled from the fjord of Cumberland East Bay, South Georgia (54° 16′ S, 36° 25′ W). The fjord is 11 km long, 3 km wide and has a maximum depth of 265 m, and although mostly enclosed has a wide, deep entrance to Cumberland West Bay and the open sea (Fig. 1).

Samples were obtained using an acoustically controlled multiple rectangular midwater trawl (RMT 1 + 8 M) towed at 2.5 knots along set transects (Fig. 1). Fish and copepods were taken simultaneously using the 8 m^2 net of 4.5 mm mesh and the 1 m^2 net of 0.33 mm mesh respectively. Fish were also sampled in the upper 2-m water layer using a Foredeck Frame net (FNET) of 1 m^2 with mesh of 4.5 mm deployed at the same time as the RMT 1 + 8 M. The FNET was

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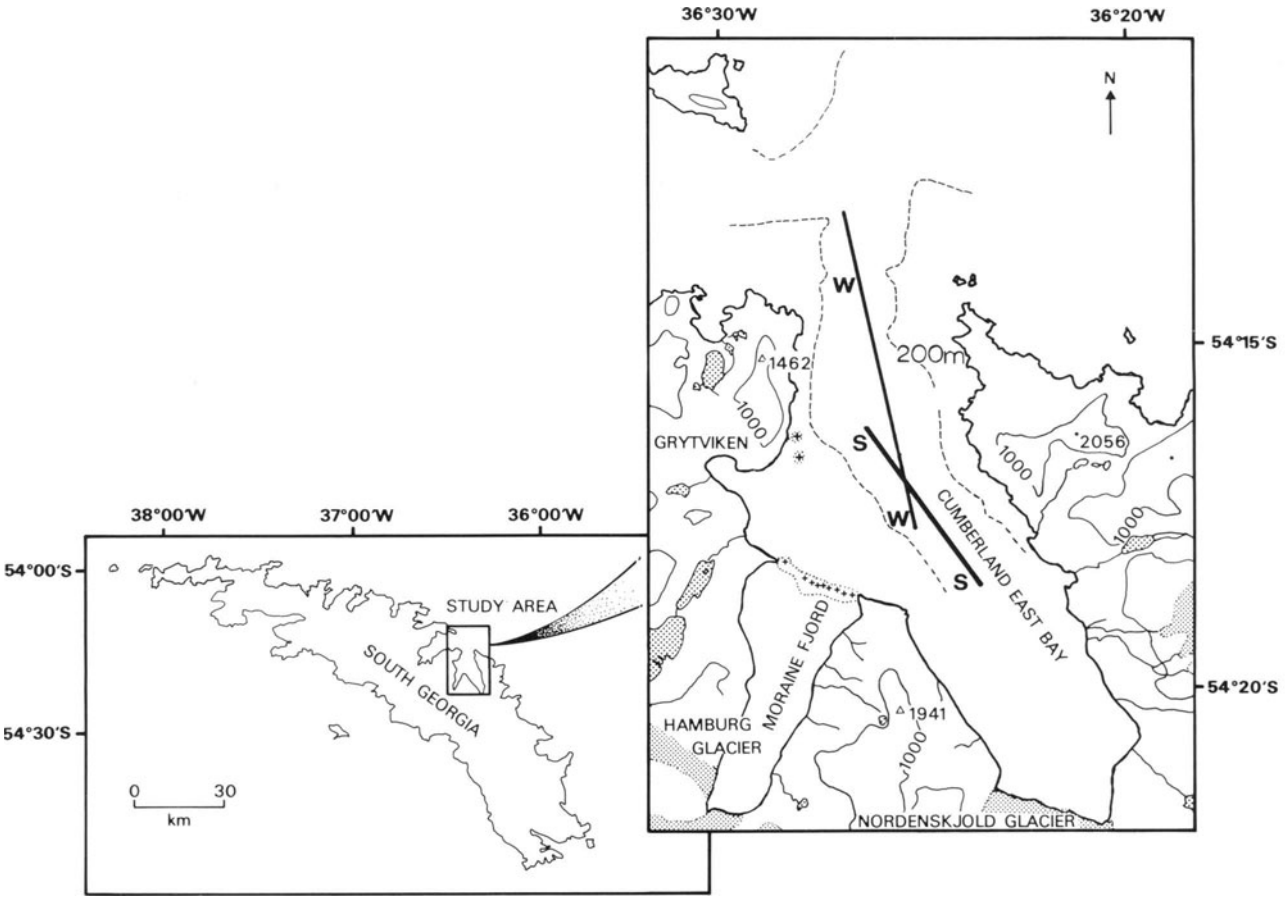

Fig. 1. The study area showing summer (*S*) and winter (*W*) transects

towed alongside the foredeck of the ship and so avoided the disturbance and mixing effect of the propeller wash on the upper water layer.

Late winter/early spring samples were taken during 20–26 September 1983 by upward oblique hauls of 30-min duration at mean depths of 203 – 152, 152 – 75, and 75 – 0 m. Samples were taken at four times of day: pre-dawn, post-dawn, pre-dusk and post-dusk. Summer samples were taken during 4–14 January 1987 by downward oblique hauls of 20-min duration at 0–20, 20–60, 60–100, 100–140, 140–180, 180–220 m depths. These depths were sampled at six times of day: the aforementioned four times plus, midday and midnight. Distance travelled by the nets was calculated from a flowmeter mounted on the net monitor and volume swept then calculated from the equations of Pommeranz et al. (1983). Filtration was assumed to be 100% efficient.

Fish and zooplankton were preserved in 10% formalin solution and were later transferred to Steedmann's solution. Specimens were generally fixed within 3 h of capture and within 1.5 hours of the net returning on-board. Fish and copepods were viewed with binocular microscopes at × 6–60 magnification. Fish standard lengths (preserved) were measured to the nearest 0.1 mm. Other fish and copepod dimensions (preserved) were measured using an eyepiece graticule. Fish internal mouth width (gape width) is similar to internal mouth height (North unpubl. data), therefore, gape width was used as a measure of the potential maximum size of food particles that could be consumed. Copepod dimensions were measured using undigested, preserved material.

Larval fish alimentary tracts were simple, consisting of a pharynx, stomach and a tubular hindgut leading to the anus. Gut content of larval fish was assessed by dissection of preserved specimens, the whole gut was removed intact using fine needles and the gut content separated. Prey items were identified, assigned to developmental stage, and counted.

The possibility of codend feeding is felt to be unlikely since the RMT 8 from which the fish were analyzed has a mesh of 4.5 mm and most zooplankton retained by the net were larger than the fish could ingest. An