FOOD, FEEDING AND BEHAVIOUR OF *NOTOTHENIA ROSSII* NEARSHORE AT SOUTH GEORGIA

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Abstract. Blue phase (pelagic) fingerlings of *Notothenia rossii* sampled nearshore were feeding primarily on small planktonic organisms such as copepods, amphipods, fish larvae and decapod larvae. Sixty-two percent of the stomachs contained one major prey item. At the juvenile demersal stage of the life-cycle, the diet of the fish had changed considerably and the most abundant components of the stomach contents were amphipods, algae, isopods and small fish. Although amphipods were most important by numbers (55%), fish made up the bulk of the diet by weight (43%), followed by amphipods (20%) and algae (9%). Only two dietary components, amphipods and algae, were eaten in quantity throughout the year. The regularity and amount of algae consumed confirms that it is a specific food item and not ingested by accident. Although there was much local movement of juvenile *N. rossii* within King Edward Cove, the prime habitats chosen by the fish were areas of dense macroalgal cover. *Notothenia rossii* dispersed from open areas of sparse macroalgal cover and aggregated in places affording greater protection.

Introduction

The life-cycle of *Notothenia rossii* includes an inshore migration of pelagic fingerlings, a nearshore demersal juvenile and an offshore adult (Burchett, 1983*a*). Major changes in the life-cycle of the fish were accompanied by changes in diet, distribution and growth. Seasonal variations in the condition of the fish are related to quality and quantity of prey (Burchett, 1983*b*).

Although there are some quantitative data on the diet of young *N. rossii* (Hoshiai, 1979; Burchett, 1982), a detailed study had not been undertaken and the behaviour of *N. rossii* in relation to habitat and food availability was not known.

This paper describes the diet of the early stages of *N. rossii* and behavioural patterns of the species in the nearshore waters at South Georgia. Stomach contents are analysed at two stages in the early life-history of the fish: the blue phase (pelagic 0-group) fingerling and nearshore juvenile (age classes II–V) stages. Stomach components of offshore adult *N. rossii* have been described by Tarverdiyeva (1972).

Materials and Methods

Fish were sampled nearshore in Cumberland East Bay and King Edward Cove, South Georgia (54° 17′ S, 36° 30′ W), between January 1978 and January 1980. Six sites were regularly sampled within King Edward Cove (Fig. 1) and two deep water sites in Cumberland East Bay were sampled occasionally. King Edward Cove was divided into sectors, based upon bottom substrate and habitat (Fig. 1). A variety of sampling techniques were employed appropriate for the size ranges of specimens occurring in the nearshore fish communities. This and the variety of sampling techniques used to obtain the *N. rossii* have been described by Burchett (1983*a*).

Approximately 100 juvenile *N. rossii* were caught each month as part of routine sampling and the stomach contents examined. Specimens were killed immediately on arrival at the laboratory. Gut examination and analysis was conducted soon after

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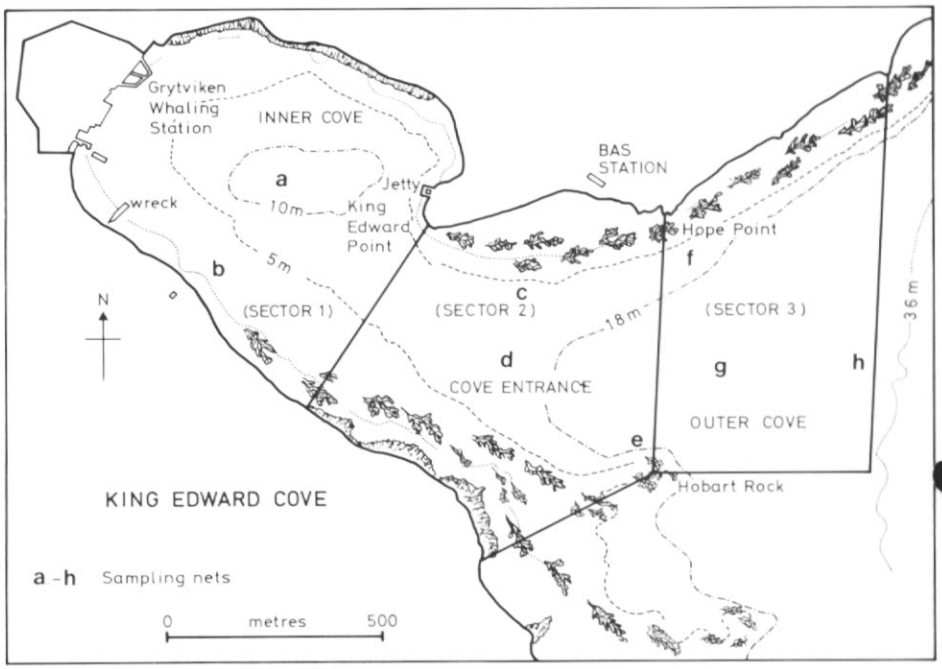

Fig. 1. Map of King Edward Cove, South Georgia showing sectors and sampling sites: a. mid-inner cove; b. old radio house; c. King Edward Point; d. mid-cove entrance; e. Hobart Rock; f. Hope Point; g. mid-outer cove; h. break of slope.

death to facilitate identification of the contents. Initial analysis of stomach contents was achieved by direct observation and the prey items noted. Dietary changes were recorded during different stages in the life-cycle of *N. rossii*. Stomach content analysis was carried out on 146 blue phase fingerlings having a length range of 47–59 mm and 1302 juvenile specimens having a length range of 257–349 mm.

Local movements among the nearshore population of *N. rossii* were investigated using a mark and recapture technique as described by Burchett (1983*a*).

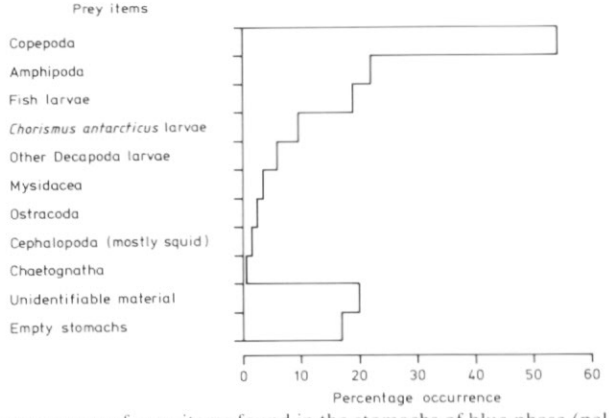

Fig. 2. Percentage occurrence of prey items found in the stomachs of blue phase (pelagic) fingerlings of *Notothenia rossii* sampled nearshore at South Georgia.

Table I. Number of different prey items found in each stomach of *Notothenia rossii* sampled nearshore at South Georgia during 1978 and 1979.

No. of different prey items	*Blue fingerlings*		*Nearshore juveniles*	
	n	*%*	*n*	*%*
1	75	62	467	46
2	35	29	326	33
3	10	8	160	16
4+	1	1	49	5
Total	121	100	1005	100

Results

Blue phase fingerlings

Blue phase fingerlings swim freely in the water column, mostly in the 0–15 m depth zone (Burchett and others, 1983). The percentage occurrence of prey items found in the stomachs of blue phase (pelagic) fingerlings is presented in Fig. 2 and the number of different prey items observed in each stomach is shown in Table I. Most of the fingerling diet consisted of copepods, amphipods and fish larvae and 62% of stomachs contained one major prey item. Seventeen percent of the stomachs were empty.

Juvenile Notothenia rossii

Juvenile specimens were mostly found in shallow waters less than 90 m deep nearshore at South Georgia. Fig. 3 shows percentage occurrence and percentage by weight of major prey items found in the stomachs of *N. rossii* juveniles. The number of different prey items observed in each stomach is given in Table I. The stomach contents represented about 2% of the fish body weight and 10% of the stomachs

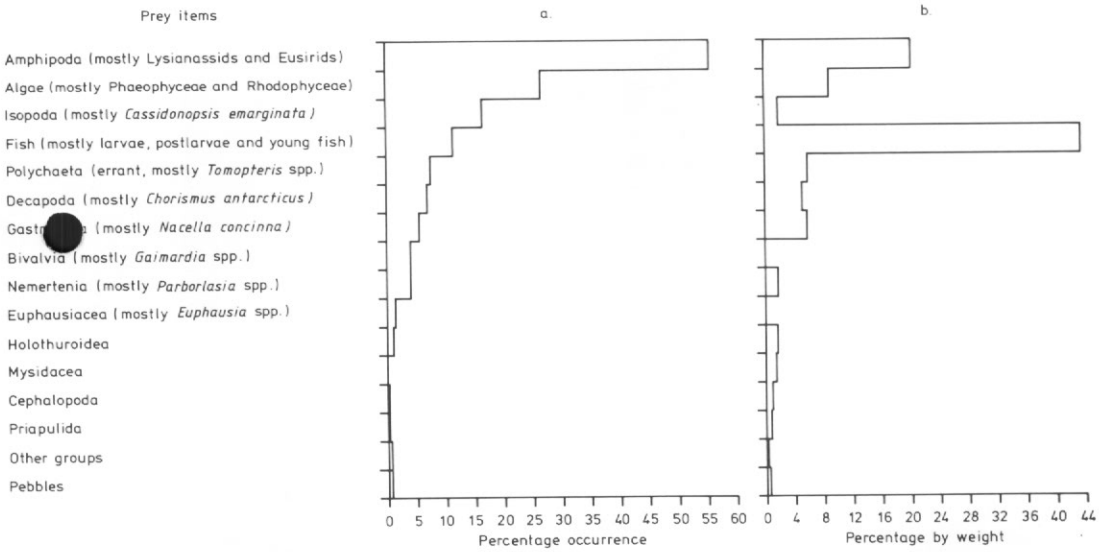

Fig. 3. Percentage occurrence and percentage by weight of major prey items found in the stomachs of 1302 juvenile *Notothenia rossii* sampled over a 12-month period nearshore at South Georgia during 1978.

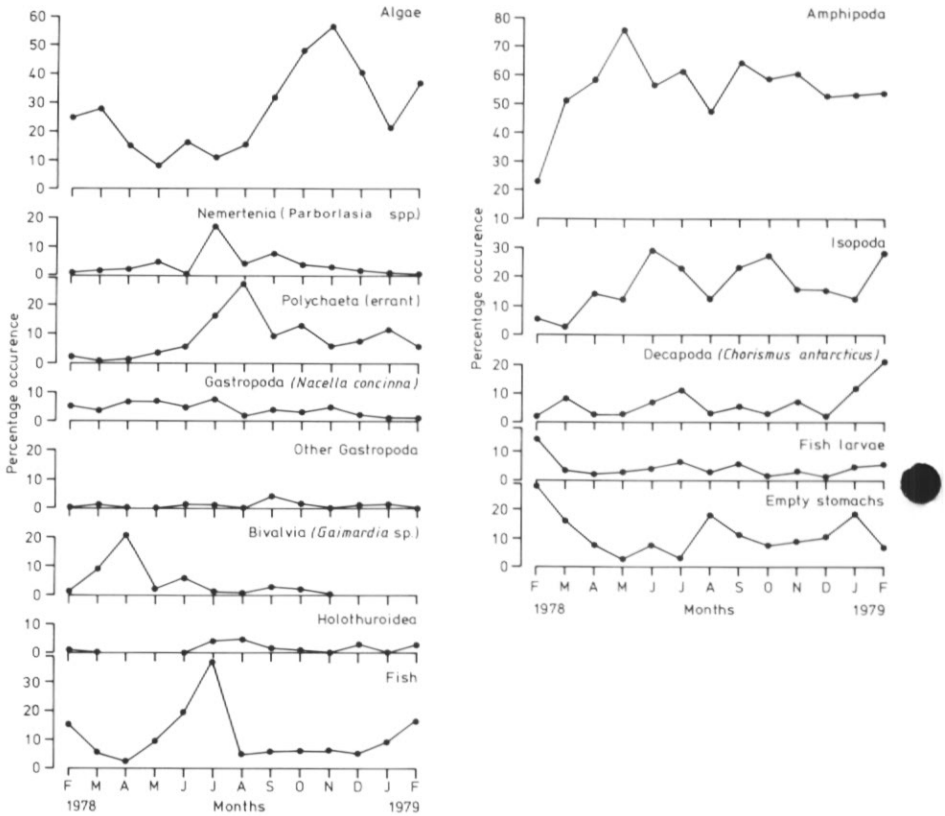

Fig. 4. Seasonal variations in the frequency occurrence of selected stomach components of juvenile *Notothenia rossii* sampled nearshore at South Georgia.

examined were empty. At the juvenile stage, amphipods and algae were the most frequent components in the stomach. However fish and amphipods were the predominant dietary components by weight.

Seasonal variation in the percentage occurrence of selected stomach components over a 12-month period are presented in Fig. 4. Some dietary items were eaten more frequently at certain times of the year. Only two items, amphipods and algae, were consumed in quantity throughout the year. In the natural habitat *N. rossii* are thought to feed opportunistically on prey that is most readily available and easily caught at any one time.

Local movement and migration

A mark and recapture method was used both to investigate local movements amongst the nearshore population of juvenile *N. rossii* at South Georgia and to demonstrate an offshore migration. Fig. 5 shows local fish movements within King Edward Cove based upon recapture data. The locations of sampling sites are shown in Fig. 1.

Within the experimental area of King Edward Cove, wherever there were suitable macroalgae (notably *Macrocystis pyrifera* and *Himanotothallus grandifolius*) there were high levels of fish activity. Both types of macroalgae provide suitable habitat

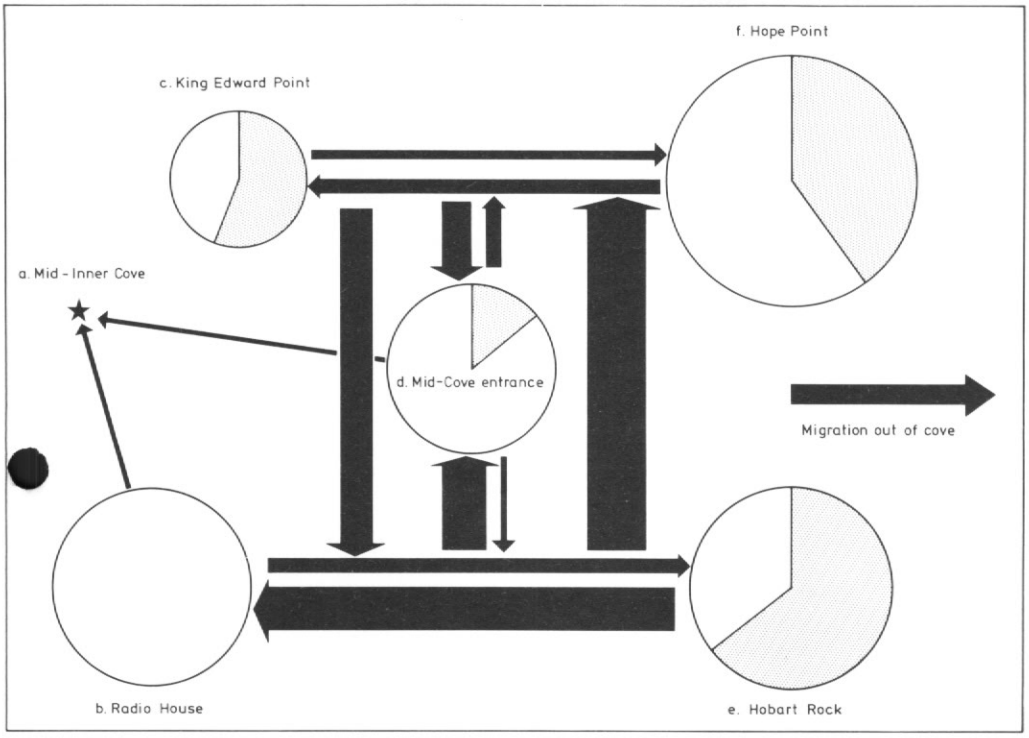

Fig. 5. A diagram representing local movement of *Notothenia rossii* juveniles within King Edward Cove, South Georgia. Thickness of arrows indicates degree of movement between sites. Shaded part of circle: proportion of marked fish recaptured at release site. Blank part of circle: proportion of marked fish recaptured at a different site from the release site. Circle size is proportional to the number of marked fish recaptured at the site as a percentage of the total number of marked fish released to that site.

and have a variety of associated invertebrate fauna upon which the fish prey. Fish tended to move along the *M. pyrifera* beds fringing the coastline and there was much local exploration amongst the benthic macroalgal beds of *H. grandifolius*. Some recapture of fish outside King Edward Cove suggests that there was a slow, continual migration away from the study area and these fish will eventually join the offshore adult population.

Areas of suitable habitat had the highest proportion of marked fish recaptured at the same site as that at which they were released (represented by the shaded portions of the circles in Fig. 5). This suggests that there was less movement away from areas of suitable macroalgal cover. In contrast, open areas that afforded little macroalgal habitat were not favoured by fish and there was a positive movement away from exposed sites.

Discussion

The diet of *N. rossii* varies considerably during its life-cycle. The transitional stages during which major dietary changes occurred were from post-larva to fingerling, fingerling to demersal juvenile and nearshore juvenile to offshore adult.

The diet of post-larvae and young fingerlings consists mostly of larval stages of large crustacea and other small components of the zooplankton.

Blue phase fingerlings sampled nearshore were feeding primarily on small planktonic organisms of the surface zone (1–50 m). Four prey items dominated the diet and in order of weight included copepods, amphipods, fish larvae and decapod larvae (mostly of the Antarctic prawn *Chorismus antarcticus* larvae; Fig. 2).

Most stomachs contained fewer than four different prey items and normally one item was predominant (Table I). By the demersal juvenile stage of the life-cycle, the diet had changed considerably. The most frequently occurring stomach components were amphipods (mostly Lysianassids and Eusirids), algae (mostly Phaeophyceae and Rhodophyceae), isopoda (mostly *Cassidonopsis emarginata*) and young fish (Fig. 3a). Juvenile *N. rossii* prefer to inhabit the shallow macroalgal beds that also provide shelter and suitable habitat for a large number of organisms that the fish prey upon. Although amphipods were the most important dietary component in terms of numbers (55%), fish made up the bulk of the diet by weight (43%) followed by amphipods (20%) and algae (9%) (Fig. 3b).

Frequency of dietary components found in the stomachs of *N. rossii* varied during the year (Fig. 4). Only two items, amphipods and algae, were eaten in quantity throughout the year. Algae consumed was frequently not associated with the ingestion of any other prey items. The amount of algae consumed therefore confirms that it is not ingested by accident but is a specific food item. However, the value of the algae to the fish is not clear. During summer months from January to April, the standard diet was augmented by fish larvae and decapod larvae which were present in large numbers in the nearshore plankton.

Offshore, prey items of adults (age classes VI–XV) were less varied than those found in the diet of the nearshore fish. Major prey items in abundance on the shelf areas of South Georgia include krill (*Euphausia superba*), salps, a variety of scyphozoans, ctenophores, tunicates and hyperiids. Tarverdiyeva (1972) stated that offshore, the main food of *N. rossii* was krill and to a lesser extent, mysidaceae. Hyperiidae were discovered only in small quantities in the diet. The adult fish feed intensively during March and May but less in April just prior to spawning (Tarverdiyeva, 1972).

Fig. 5 shows that juvenile *N. rossii* moved along the *Macrocystis* beds fringing the shoreline and across to adjacent algal beds on the opposite side of King Edward Cove. There was also movement to and from the *Himantothallus* beds at the mid cove entrance. In suitable areas with macroalgal habitat, a large proportion of marked specimens were recaptured from the sites at which they had been released. However, in more exposed areas such as the inner cove where the macroalgae cover was sparse or absent, there was a large amount of local movement away to areas of preferred habitat. Thus the prime habitats for juvenile *N. rossii* nearshore were the areas of dense macroalgae. This was supported by the evidence that these areas also had the highest rates of capture per net.

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