FAUNAL AND CHEMICAL CHARACTERISTICS OF SOME STEWART ISLAND STREAMS

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ABSTRACT

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A chemical and faunal survey of several Stewart Island streams was carried out in August 1987 and the summer of 1987-88. Streams had clear to brown waters, pH 6.0 - 7.2, conductivity 11.0 - 38.6 mS m^{-1}, and DOC concentrations ranging from 2.8 to 10.5 g m^{-3}. Eight fish taxa were found, including *Retropinna retropinna* which had not been recorded previously from Stewart Island. Of the 66 invertebrate taxa collected, 41 were not previously known from the island. They include *Pycnocentrella eruensis, Mauiulus luma, Neocurupira tonnoiri, Mischoderus sp.* and *Austridotea benhami*, taxa which have restricted or poorly known distributions within mainland New Zealand. Although benthic invertebrate communities of stony streams were generally similar in composition and species richness to streams on the west coast of the South Island, they differed because species of Hydroptilidae, Conoesucidae, Notonemouridae, *Helicopsyche*, and *Archichauliodes* were absent or rare, and cased caddis in general were poorly represented.

KEYWORDS: brown water - benthic invertebrates - Stewart Island - Westland - streams.

INTRODUCTION

Deforestation, development, and enrichment of lowland catchments, along with the introduction of predatory salmonids has meant that many New Zealand streams have been subjected to varying degrees of modification. Consequently, the composition of aquatic communities and the distributions of various species have been altered. For example, the decline in abundance and range of the freshwater shrimp *Paratya curvirostris* in Canterbury is probably a result of changes to stream catchment land use, although predation by introduced trout may have contributed to the loss of some small isolated populations of this species (Carpenter 1976). Deforestation and/or trout introductions were also implicated by Main (1988) as factors limiting the distribution of large galaxiid fishes in lowland streams of South Westland. Because predatory salmonids appear to be absent and extensive areas of relatively unmodified lowland forest remain, the stream faunas of Stewart Island might be expected to resemble those once common on the southern mainland before anthropogenic disturbances occurred. Surprisingly, few investigations have been made of the freshwater faunas of Stewart Island and the only published work is of a limited survey of sandy-bottomed streams in the lower Freshwater Valley (Cowie *et al.* 1978).

In August 1987 and the following summer (1987/88), faunal and physicochemical surveys were carried out in a number of Stewart Island streams. The results of that study are presented here.

STUDY AREA

Stewart Island is the smallest and southernmost of the three main islands of New Zealand. It has an area of about 1720 km^2 (Wilson 1982), and its landscape is both diverse and complex. The northern half of the island is dominated by the Ruggedy, Anglem, and Paps/Thompson coastal mountain ranges and the large interior

wetlands of Freshwater Valley (Fig. 1). In contrast, the southern half of the island is dominated by Mt Rakeahua and the central Tin Range, with rolling hill country, wetlands and complex river valleys to either side.

Mixed-podocarp forest covers most of Stewart Island below an altitude of about 300 metres. Much of the forest canopy is dominated by a rimu (*Dacrydium cupressinum*), kamahi (*Weinmannia racemosa*) association, although miro (*Prumnopitys ferrugineus*) and rata (*Metrosideros umbellata*) are also common (Wilson 1982). The shorter, yellow silver pine (*Lepidothamnus intermedius*), although uncommon in the north, increases in abundance further south on large areas of poorly drained, infertile soils (Wilson 1982). True wetlands are mainly covered by stands of manuka (*Leptospermum scoparium*) and scrub. The scrub and undergrowth beneath the podocarp and manuka stands are generally dominated by *Blechnum discolor* and to a lesser extent *Coprosma foetidissima, Dicksonia squarousa, Cyathea smithii, Pseudowintera colorata, Ripogonum scandens*, and juvenile canopy trees.

The climate of Stewart Island is characterised by frequent rainfalls with precipitation distributed evenly throughout the year. Mean

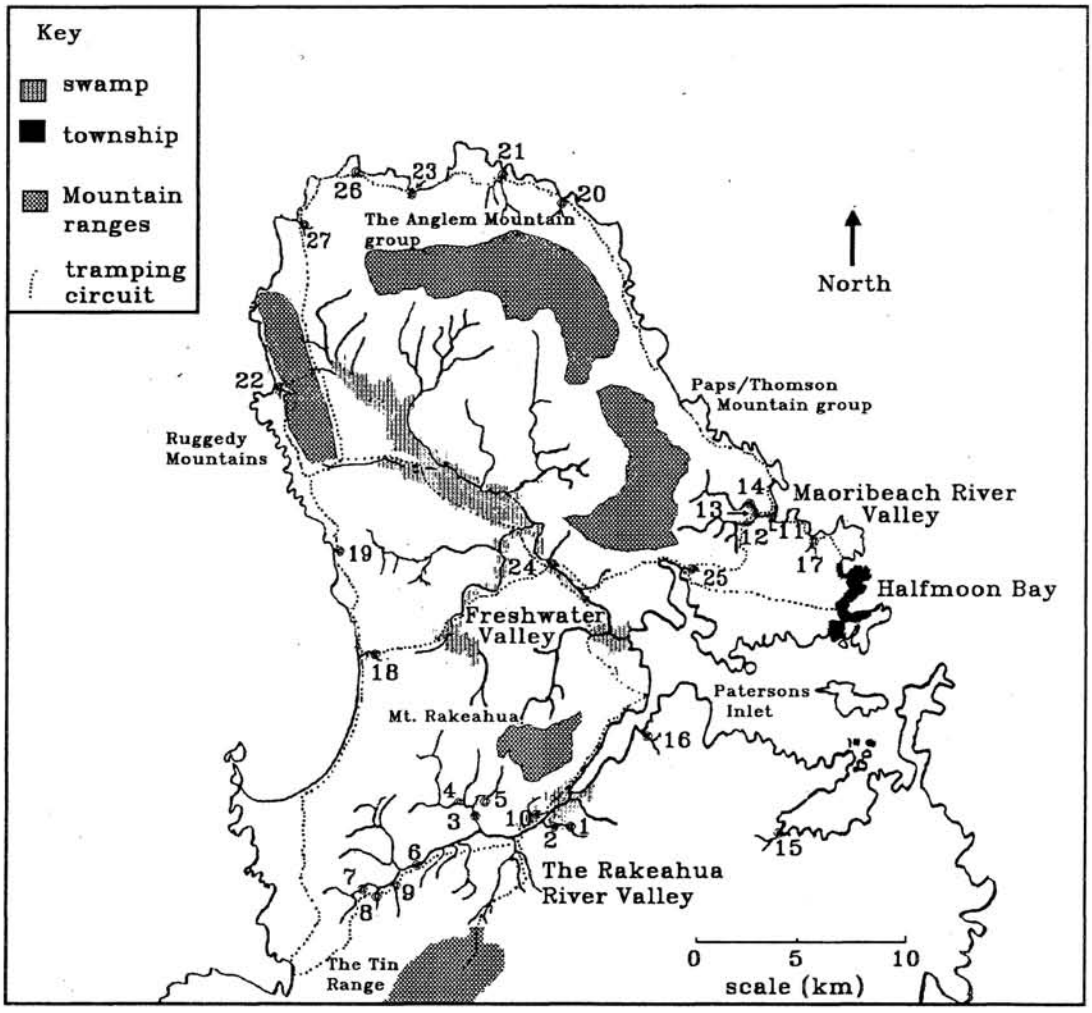

Figure 1. Stewart Island; site locations and streams sampled, August 1987 and December to February 1988.

annual rainfall at Halfmoon Bay is 1455 mm with an average of 216.5 raindays (Slater 1983). Air temperatures are cool to mild (1986 monthly means range from 6.2 to 13.9 °C, excluding July and January for which data were not available) (The New Zealand Gazette, climatological tables, 1986). Frosts and snow occur infrequently (Slater 1983).

Streams on Stewart Island flood frequently and the steep terrain and water-saturated, boggy soils appear to be incapable of retaining much additional water. Debris inputs are probably high in forested streams, and although log jams are common, long term retention of course particulate matter seems to be poor.

MATERIALS AND METHODS

Benthic invertebrate collections were made at 23 sites on 16 streams. Most sampling effort was concentrated on the Rakeahua and Maoribeach river systems, although a number of short coastal streams flowing into Patersons Inlet, and others on the northern tramping circuit (Fig. 1) were included in the survey. Most streams were shallow (less than 35 cm deep), with stony beds and flowed through coastal scrub, manuka scrub or mixed podocarp forest.

Benthic invertebrates were collected with a 0.5 mm mesh net held downstream of stony substrata which were disturbed by foot or turned over and scrubbed by hand. Samples were stored in 70% alcohol and sorted later in the laboratory.

Fish were collected with mini-Fyke nets, hand nets, and Gee minnow traps set mainly in streams on the northern tramping circuit (Fig. 1, Table 3). Most of the fish were collected by R. Allibone who later identified them at the Zoology Department, University of Otago.

Water samples were taken from most streams at the same time that invertebrates were collected. They were stored in 350 ml polyethylene containers and returned to the University of Canterbury for analysis.

Conductivity was measured with a Radiometer CD2e meter and is expressed as mS m^{-1} at 25°C (Golterman & Clymo 1969).

Hydrogen ion concentration (pH) was measured with a Metrohm Herisau E512 meter and dissolved organic carbon (DOC) concentration was estimated using a spectrophotometric technique. Absorbance at 360 nm was used to cal-

Sites	pH	Conductivity (mS m^{-1})	DOC (Spect) (g m^{-3})	DOC (Dichr)
4	6.3	19.44	7.2	8.5
6	6.5	17.28	9.3	9.8
7	6.3	17.06	10.5	11.3
9	6.2	13.28	4.5	6.7
10	6.0	15.23	7.4	8.4
11	6.7	29.32	3.9	--
12	6.5	13.39	7.3	10.5
13	6.2	12.53	8.1	11.5
15	6.7	13.52	5.2	--
16	7.2	23.28	2.8	--
17	6.8	16.5	4.1	--
18	6.1	38.59	6.0	--
20	7.1	11.0	4.9	--

Table 1. Physicochemical characteristics of Stewart Island streams sampled in August 1987 and December to February 1988. Site locations are shown in Fig. 1. Spect = spectrophotometric determinations, and Dichr = dichromate wet oxidation determinations.

culate DOC (g m^{-3}) with the regression equation, DOC (g m^{-3}) = 59.6 $Abs._{1cm}$ + 1.9 (Collier 1987). DOC in samples collected in August 1987 was also measured by the dichromate wet oxidation procedure used by Collier and Winterbourn (1987).

RESULTS AND DISCUSSION

WATER CHEMISTRY

Results of chemical analyses are shown in Table 1. Conductivity and pH of water samples ranged from 11.0 to 38.6 mS m^{-1} at 25°C and 6.0 - 7.2, respectively. These are higher than values reported by Collier and Winterbourn (1987) for acid brown water streams with similar concentrations of DOC in South Westland, South Island and in the case of conductivity at least, they suggest a (saline) coastal influence. Stewart Island DOC values ranged from 2.8 to 10.5 g m^{-3}, which corresponds to the lower part of the range reported by Collier and Winterbourn (1987).

BENTHIC INVERTEBRATE FAUNA

Of the 66 invertebrate taxa collected (Table 2), 41 had not been recorded previously from Stewart Island. The most abundant taxa were larvae of the mayflies, *Deleatidium* spp., and *Coloburiscus humeralis*, the stoneflies, *Zelandobius confusus, Zelandoperla fenestrata*, and *Austroperla cyrene*, and beetles of the family Elmidae. Where aquatic plants were present, the amphipods *Paraleptamphopus caeruleus*, and/or *Chiltonia rivertonensis*, were sometimes common. The isopod *Austridotea benhami* was often very common in the lower reaches of streams and their estuaries.

As in the Freshwater Valley (Cowie *et al.* 1978), very few caddisfly larvae were found, and only *Aoteapsyche* (?)*tepoka*, and *Zelolessica cheira* were common locally. Cased caddisflies were particularly poorly represented and a number of trichopteran families and genera common on the mainland were rare or not collected. Notable amongst the absentees were, the Hydroptilidae and Conoesucidae, while *Helicopsyche* (Helicopsychidae) was only collected from one site in very low numbers. *Pycnocentrella eruensis* (Calocidae), and an unidentified species of Oeconesidae (two cased caddisflies with limited or irregular distributions) were collected however, and knowledge of their presence on Stewart Island increases the known southern distribution limits of both families.

In contrast to the cased caddisflies, members of the family Hydrobiosidae (six species) and Philopotamidae (*Hydrobiosella stenocerca*) were present in most faunal collections, although they were rarely abundant.

Two further taxa which are often common in stony streams elsewhere in New Zealand (Winterbourn *et al.* 1981), but were rare or absent from Stewart Island collections, were the Megaloptera and Notonemouridae (Plecoptera). The latter was represented by only a single species, *Cristaperla fimbria*, found at a single site (Site 18), while *Archichauliodes diversus*, the only New Zealand megalopteran, was not collected.

On the other hand, the known distributions of the leptophlebiid mayfly *Mauiulus luma* is extended substantially from a previous southernmost record of Franz Joseph Glacier (Collier 1988).

Of the Diptera found on Stewart Island (Table 2), the records of *Neocurupira tonnoiri* (Blephariceridae) and the tanyderid, *Mischoderus* sp. are probably most noteworthy.

N. tonnoiri had previously been collected only from the west coast of the South Island in steep, forested streams and swift open rivers between 150 and 800 metres a.s.l., (Craig 1969). In contrast, larvae taken on Stewart Island were in forested streams between sea level and 60 metres a.s.l.

Members of the Tanyderidae are regarded as the most primitive of all living Diptera. About 36 species are known throughout the world, half of them from Australasia alone (Exner & Craig 1976). Although rarely collected, tanyderids appear to be widely distributed in stony and soft bottomed streams in New Zealand (Winterbourn & Gregson 1981), and although recorded previously from Fiordland, this is the first record of the family from Stewart Island.

Finally, the discovery of the isopod *Austridotea benhami* is particularly interesting. The distribution and ecology of the two known *Austridotea* species are very poorly understood

INSECTA
- Ephemeroptera
  - Leptophlebiidae
    - *Deleatidium* spp. (C/B)
    - *Mauiulus luma* (C/B)
    - *Zephlebia versicolor* (C/B)
    - *Zephlebia* sp. (C/B)
    - *Austroclima* sp. (C/B)
    - *Ameletopsis perscitus* (P)
  - Oligoneuriidae
    - *Coloburiscus humeralis* (F/C)
  - Siphlonuridae
    - *Nesameletus* sp. (C/B)
- Plecoptera
  - Eustheniidae
    - *Stenoperla prasina* (P)
  - Austroperlidae
    - *Austroperla cyrene* (S/G/C)
  - Gripopterygidae
    - *Megaleptoperla grandis* (P)
    - *Zelandoperla* (?)*fenestrata* (C/B)
    - *Zelandoperla decorata* (C/B)
    - *Zelandobius confusus* (C/B)
    - *Zelandobius* sp. (C/B)
    - *Acroperla trivacuata* (C/B)
  - Notonemouridae
    - *Cristaperla fimbria* (C/B)
- Odonata
  - Coenagrionidae
    - *Xanthonemis zealandica* (P)
  - Lestidae
    - *Austrolestes colensonis* (P)
  - Corduliidae
    - *Procordulia smithi* (P)
- Trichoptera
  - Hydrobiosidae
    - *Hydrobiosis parumbripennis* (P)
    - *Costachorema psaroptera* (P)
    - *Costachorema callista* (P)
    - *Costachorema* sp. (P)
    - *Psilochorema nemorale* (P)
    - *Hydrochorema tenuicaudatum* (P)
  - Philopotamidae
    - *Hydrobiosella stenocerca* (F)
  - Leptoceridae
    - *Hudsonema aliena* (O)
    - *Triplectides dolichos* (S)
  - Helicopsyche
    - *Helicopsyche* sp (G)
    - *Rakiuru vernale* (G)
  - (?)Ecnomidae/Psychomyiidae
    - (?)*Ecnomina zelandica*
    - */Zelandoptila moselyi* (P?)
  - Calocidae
    - *Pycnocentrella eruensis* (C/B)
  - Hydropsychidae
    - *Aoteapsyche* (?)*tepoka* (FP)
  - Oeconesidae
    - Unidentified species (S/C)
  - Polycentropodidae
    - *Polyplectropus* sp. (P)
- Diptera
  - Ceratopogonidae
    - Unidentified species (P)
  - Chironomidae
    - Tanypodinae sp. (C/P)
  - Chironominae
    - Tanytarsini sp. (C)
    - *Chironomus* sp. (C)
  - Tipulidae
    - Hexatomini sp. (C/B)
    - *Aphrophila neozelandica* (P)
    - *Aphrophila* sp. (P)
    - *Paralimnophila skusei* (C)
    - Eriopterini sp. (C)
  - Simuliidae
    - *Austrosimulium* sp. (F)
  - Empididae
    - Unidentified species.
  - Blephariceridae
    - *Neocurupira tonnoiri* (G)
  - Tanyderidae
    - *Mischoderus* sp. (C/B)
- Coleoptera
  - Elmidae
    - Unidentified species.(C/B)
  - Helodidae
    - Unidentified species. (C/B)
  - Hydraenidae
    - *Orchymontia bidentata* (C/B)
  - Hydrophilidae
    - Unidentified species. (P)
  - Staphylinidae
    - Unidentified species.

CRUSTACEA
- Amphipoda
  - Eusiridae
    - *Paraleptamphopus caeruleus* (C/B)
    - *P. subterraneus* (C/B)
  - Hyalellidae
    - *Chiltonia rivertonensis* (C/B)
- Isopoda
  - Idoteidae
    - *Austridotea benhami*
  - Flabellifera
    - *Paravireia* (?)*typica*
- Decapoda
  - Atyidae
    - *Paratya curvirostris* (F)
  - Parastacidae
    - *Paranephrops zealandicus* (O)

MOLLUSCA
- Gastropoda
  - Hydrobiidae
    - *Potamopyrgus antipodarum* (G)
    - *Potamopyrgus estuarinus* (G)
- Bivalvia
  - Sphaeriidae
    - *Sphaerium noveazealandiae* (F)

ANNELIDA
- Oligochaeta (C)

Table 2. Benthic invertebrates collected from Stewart Island streams and rivers, August 1987, and December 1987 to February 1988. (Functional feeding groups, C. = collector, B = browser, P = predator, F = filter feeder, S = shredder, O = omnivore, and G = grazer).

and only a few populations have been reported from mainland New Zealand (Nicholls 1937, Marshall 1974). Nevertheless, a species of *Austridotea* had been reported previously from Stewart Island (Nicholls 1937) but, this *was A. annectens* not *A. benhami*. Despite extensive searching the former species was not found in the present survey, whereas *A. benhami* was widespread and common in the lower reaches of most of the stony bedded streams sampled. It is worth noting that the only specimen of *A. benhami* collected by Nicholls (1937) came from a mud filled hollow in Ross Creek Gorge, Dunedin, a situation which contrasts markedly with its Stewart Island habitat.

NATIVE FISH

Six species of native fish were collected from 12 Stewart Island streams (Table 3), and of these, only the common smelt (*Retropinna retropinna*) had not been recorded from the island previously (McDowall 1987). *Galaxias brevipinnis* (koaro), *G. fasciatus* (banded kokopu) and the red finned bully *Gobiomorphus huttoni* were the most common and frequently taken fish. Although not mentioned by McDowall (1987) as occurring on Stewart Island, a distribution record for *G. argenteus* (giant kokopu) is shown for the island in his book (McDowall 1978). It is likely that this species is more widespread than this survey indicates.

Eels and a lamprey were also observed in Stewart Island streams although they were not collected in the trapping programme.

BENTHIC INVERTEBRATE COMMUNITIES

Many New Zealand streams have very similar benthic faunas, characterised by the presence of a nucleus of common invertebrate genera and species. Of the genera listed by Winterbourn *et al.* (1981), *Deleatidium, Coloburiscus, Nesameletus*, (Ephemeroptera); *Stenoperla, Zelandoperla, Zelandobius*,(Plecoptera); *Hydrobiosis, Psilochorema, Aoteapsyche,* (Trichoptera) and *Potamopyrgus*, (Gastropoda); were taken in this survey, while *Olinga* and *Pycnocentria* (Trichoptera) and *Archichauliodes* (Megaloptera) were not.

In terms of the functional feeding groups, the invertebrate fauna also conformed to the general New Zealand pattern with a preponderance of predators and collector/browsers, and a paucity of shredders.

Numbers of taxa collected at individual sites ranged from 5 to 36, the same range found in acid brown water streams on the West Coast, South Island by Winterbourn and Collier (1987).

Both the composition and richness of the invertebrate fauna and to a lesser extent the chemical data currently available, suggest that Stewart Island streams are very similar in nature to the brown water streams on the west coast of

	Sites										
Species	7	10	15	18	20	21	22	23	24	26	27
Galaxias fasciatus			+	+	+	+			+	+	+
G. brevipinnis	+			+	+			+		+	
G. maculatus			+			+			+		
G. argenteus		+									
Gobiomorphus huttoni	+	+	+			+	+		+		
Retropinna retropinna									+		

Eels *Anguilla* spp. and the lamprey *Geotria australis* were also observed but were not collected.

Table 3. Fish species collected at 12 sites on Stewart Island streams in August 1987 and December to February 1988. See Fig. 1 for site locations.

the South Island.

Nevertheless, the stream faunas are distinctive due to the absence or relative rarity of several important mainland families, notably the Conoesucidae, Hydroptilidae and Notonemouridae. *Pycnocentria sylvestris* is the only conoesucid reported from Stewart Island (Cowie *et al.* 1978), and *Cristaperla fimbria* is the only Notonemourid. One might also expect to find the hydroptilid, *Oxyethira albiceps* which is known from the Snares, Campbell and Antipodes Islands (Wise 1978).

McFarlane (cited in Cowie *et al.* 1978) collected several trichopteran species from Stewart Island with morphological characteristics consistently different from those of mainland species. This suggests that little gene flow occurs between the South and Stewart Islands, and that Foveaux Strait represents a significant barrier to migration. The absence of many species may therefore be the result of their failing to colonise the Stewart Island land mass following its glaciation in the Ice Age (20,000 - 14,000 years ago) either before or after its subsequent separation from the mainland. This is suggested as the reason for *Nothofagus* (a plant with poor dispersal abilities) not re-establishing itself on Stewart Island following its extinction there during the Ice Age (Stevens 1980).

Several New Zealand studies (eg. Rounick and Winterbourn 1982, Collier and Winterbourn 1987) have shown that substratum stability is correlated with invertebrate density and diversity, and although, stability was not measured in the present survey, my observations over three consecutive summers indicate that many of the streams are very unstable. Therefore the physically harsh nature of the streams combined with the short period of recent colonisation (14,000 years) may also have prevented successful colonisation by some of the absentees.

Finally, anthropogenic disturbances may increase habitat diversity, possibly favouring certain species to the detriment of others. The low levels of anthropogenic disturbances on Stewart Island may result in low habitat diversity which may likewise explain, at least in part, the rarity of some common mainland species.

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