Canterbury Museum

Records

Volume 30
2016

Records of the
Canterbury Museum
Volume 30
2016

Canterbury Museum gratefully acknowledges a grant from the Mason Foundation for the publication of the Records of the Canterbury Museum.

ISSN 0370 3878 (Print)
ISSN 2881 9707 (Online)

Records of the Canterbury Museum
Volume 30, 2016
Published September 2016

Rolleston Avenue
Christchurch 8013
New Zealand

Contents

New Cretaceous brachiopods from the South Island, New Zealand

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Two new brachiopod taxa of Late Cretaceous age are described from contrasting depositional settings in North Canterbury, South Island, New Zealand. *Gowanella capralis* gen. et sp. nov. lived in a shallow water oyster reef. The second taxon, which cannot be properly diagnosed, is a deep water form from an outer shelf to upper slope environment. Both species are terebratulids; *Gowanella* is placed in the new family Ostreathyridae but the other form cannot be readily placed in an appropriate family.

Keywords: Brachiopods, terebratulids, Late Cretaceous, New Zealand

Introduction

Cretaceous brachiopods are rare and poorly known components of marine faunas in New Zealand; fewer than 30 species can be recognised and of these only a handful have been fully described and formally named (MacFarlan et al. 2009). Lee and Motchurova-Dekova (2008) described a new rhynchonellide from the Kahuitara Tuff on Pitt Island, Chatham Islands, and Hiller (2011) described a new notosariid rhynchonellide and a bizarre new terebratulidine of uncertain affinities from the *Ostrea* Bed, Broken River Formation of North Canterbury. In addition, he mentioned two indeterminate terebratulides from the same stratigraphic unit.

In this paper, additional species from Upper Cretaceous rocks of North Canterbury are described. Further sampling of the Ostrea Bed at the top of the Broken River Formation has produced another species of terebratulidine brachiopod. These shallow water forms are contrasted with similarly aged deep water forms from the Mead Hill Formation on the Kaikoura Peninsula.

The specimens are housed in the collections of Canterbury Museum, Christchurch, New Zealand (CM) and the University of Otago Geology Museum (OU).

South Island Cretaceous stratigraphic horizons with brachiopods

The earliest mention of Cretaceous brachiopods in South Island rocks appears to have been that made by Haast (1879, p.295) who included the three brachiopod genera *Terebratella* d'Orbigny, 1847, *Waldheimia* King, 1850, and *Rhynchonella* Fischer, 1809 in his list of fossils from the oyster beds associated with his 'brown coal formation'. However, it is uncertain whether these genera were actually derived from Cretaceous rather than Cenozoic strata. Unfortunately, the whereabouts of the specimens is unknown.

Warren & Speden (1978, p. 50) listed four brachiopod genera from two Upper Cretaceous stratigraphic units at Haumuri Bluff in South Marlborough. These include a discinid (originally identified as *Patella? amuritica* by Wilckens (1922)), *Rhynchonella* (s.l.) sp. and *Terebratula* (s.l.) sp. from the Okarahia Sandstone, and a linguloid from the slightly

younger Conway Formation. These specimens require further investigation.

Numerous specimens of a linguloid brachiopod were obtained during preparation of a plesiosaur skeleton discovered in a calcareous concretion from the Conway Formation at the Waipara River, North Canterbury (Hiller & Mannering 2005; Hiller et al. 2005). Whether these belong to the same taxon as the linguloid from Haumuri Bluff requires further research. The Conway Formation at the Waipara River has been shown to be somewhat younger than it is at Haumuri Bluff (Roncaglia et al. 1999).

Thomson (1920) mentioned the presence of a rhynchonellide in the *Ostrea* Bed at Weka Creek, North Canterbury. More recently, the discovery of Cretaceous brachiopods from the *Ostrea* Bed among Cenozoic forms in the Robin S Allan collection at Canterbury Museum led Hiller (2011) to investigate that stratigraphic unit, at the top of the Broken River Formation, in Weka Creek and surrounding area (Fig. 1B). This confirmed Thomson's observation and produced the new taxa mentioned above. The specimens that are the subject of this study were recovered from a bulk sample taken at a locality where weathering had made the *Ostrea* Bed quite friable so that fossils were easily separated from the medium-grained sandy matrix.

In 2005, a number of participants in a mid-conference field trip, held during the 50th annual conference of the Geological Society of New Zealand, made the first discovery of invertebrate macrofossils in the Mead Hill Formation, a glauconitic, fine-grained siliceous limestone exposed along the foreshore at Kaikoura, North Canterbury (Fig. 1C). Among the specimens collected at that time and subsequently were sponges, echinoid spines, a possible belemnite and, significantly, articulated brachiopods.

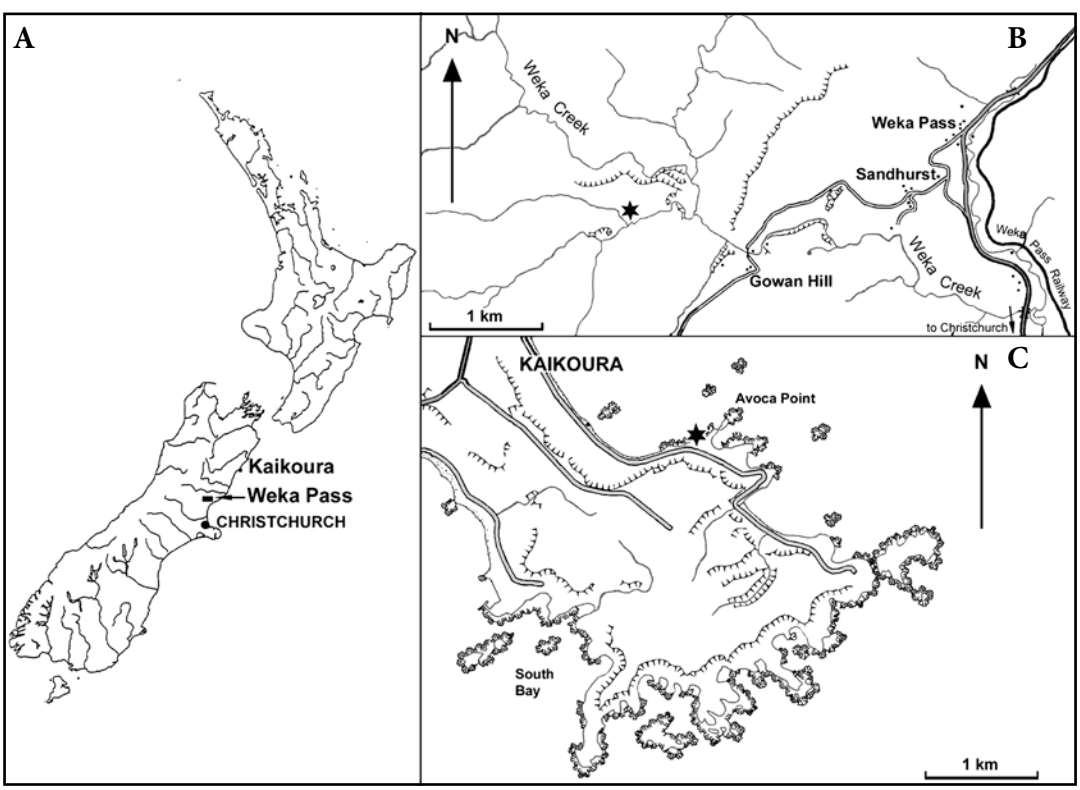

Figure 1. Locality maps. **A**, Positions of the collection sites within the South Island of New Zealand. **B**, Collection site on the farm Gowan Hill in the Weka Pass area. **C**, Kaikoura collection site on the rocky shore near Avoca Point. Collecting sites are indicated by stars.

Systematic Palaeontology

Order Terebratulida Waagen, 1883
Suborder Terebratulidina Waagen, 1883
Superfamily uncertain
Family Ostreathyridae fam. nov.

Diagnosis: Thick-shelled, short-looped brachiopods with ventribiconvex shells of variable outline; anterior commissure plicate; hinge line almost straight; greatest width at or close to hinge line; beak markedly attrite; large foramen permesothyrid.

Age: Late Cretaceous (Maastrichtian).

Included genera: Ostreathyris Hiller, 2011; *Gowanella* gen. nov.

Remarks: The included genera developed their shells without the involvement of any median support structure for the loop. For this reason they are placed within the Suborder Terebratulidina. If this systematic placement is correct, then they differ from most other members of the suborder. Generally, terebratulidines are smooth, elongately ovoid with maximum width well anterior of the hinge line, quite unlike the members of the new family. Although the new family cannot be readily placed within any known superfamily, its erection is warranted by the highly distinctive, somewhat aberrant nature of the genera included in it, even though knowledge of the entire loop is lacking at this stage.

Genus *Gowanella* gen. nov.

Etymology: Named after the farm Gowan Hill on which the specimens were found.

Type species: Gowanella capralis sp. nov.

Horizon: Ostrea Bed Member at the top of the Broken Hill Formation, North Canterbury, South Island, New Zealand.

Age: The Broken River Formation has been dated, on the basis of dinoflagellate cysts, as late Haumurian (late Campanian–early Maastrichtian) by Roncaglia et al. (1999), making the Ostrea Bed probably early Maastrichtian.

Diagnosis: Small to medium sized, ventribiconvex shells with subcircular to roundly hexagonal outline; anterior commissure plicate; shell surface smooth apart from strong growth lines; hinge line almost straight; beak markedly attrite with large permesothyrid foramen. Shell punctate. Dorsal median septum lacking.

Gowanella capralis gen. et sp. nov.
(Figs 2a–r)

Etymology: From the Latin *caprale*, a marsh or swamp fit only for goats, referring to the small marshy gully that is the type locality for the species.

Material: Six complete shells, two dorsal valves and two broken ventral valves from Site 4, Gowan Hill West, of Hiller (2011) (Fig 1B); New Zealand Fossil Record File Number M34/f0928. Holotype: CM 2014.1.1; Paratypes: CM 2014.1.2 and CM 2014.1.3 in Canterbury Museum, Christchurch.

Diagnosis: As for genus.

Description: Ventribiconvex shells with subcircular to roundly hexagonal outline; maximum width about mid-valve. Dorsal valve very gently to gently convex in lateral profile; anterior profile varying from almost flat to gently convex; rounded median fold subdued in early growth stages but becoming higher as shell gets larger and separating flat to concave lateral areas. Ventral valve gently to strongly convex in lateral profile; anterior profile strongly convex apart from narrow flat to concave median portion that coincides with sulcus, which becomes deeper in later growth stages. Beak short, markedly attrite with large permesothyrid foramen. Relatively short, wide deltidial plates disjunct in early growth stages but becoming conjunct or fused in mature shells. Shell surface smooth apart from strongly developed stepped growth lines, becoming crowded near anterior margin. Shell substance thick; punctate.

Ventral valve interior with broad, short, robust teeth; dental plates absent. Rounded median ridge corresponds to sulcus. Dorsal

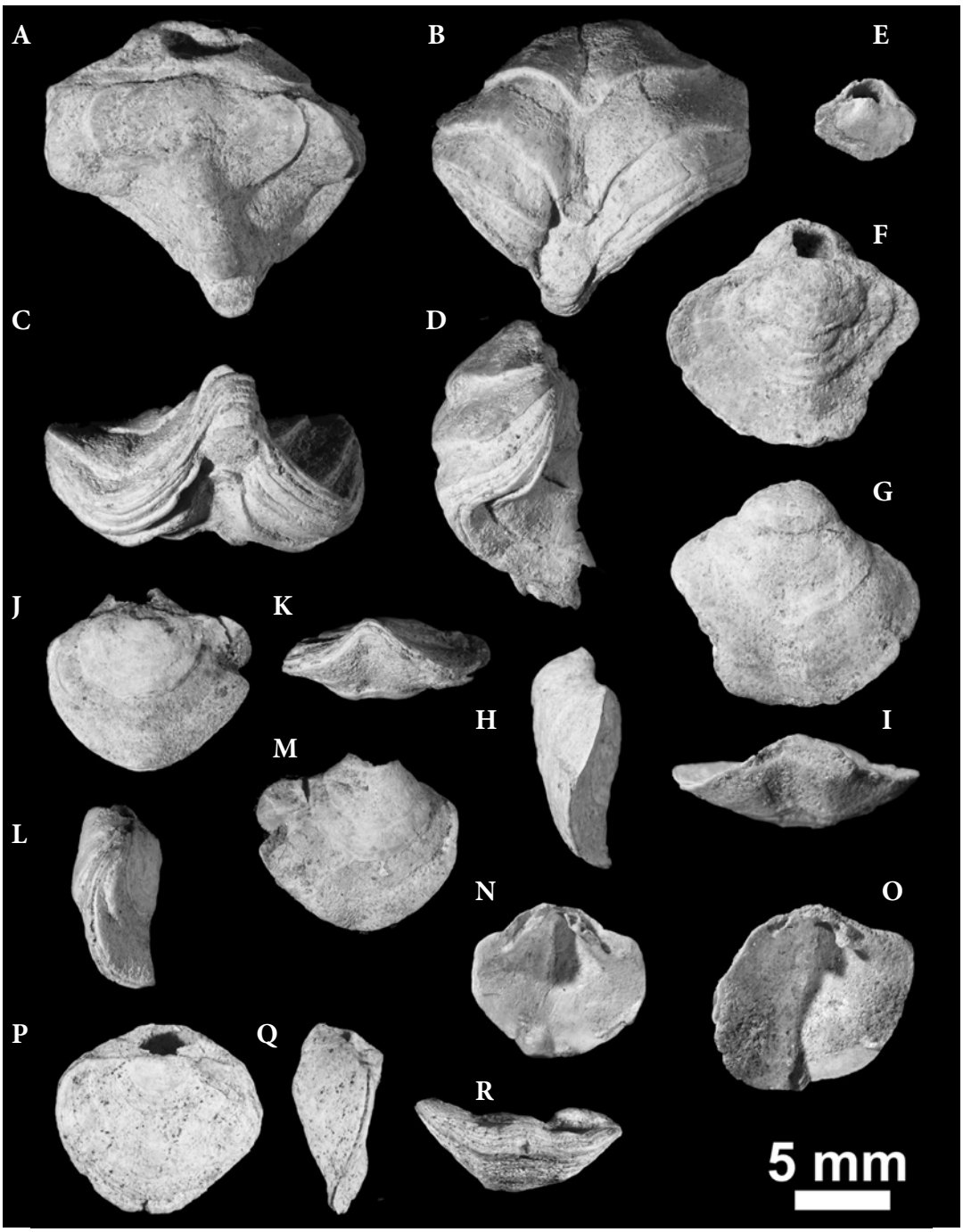

Figure 2. *Gowanella capralis* gen. et sp. nov. **A–D**, Holotype CM 2014.1.1, complete shell in dorsal **A,** ventral **B,** anterior **C,** and lateral **D,** views. **E**, CM 2014.1.6, juvenile complete shell in dorsal view. **F–I**, CM 2010.41.50, complete shell in dorsal **F,** ventral **G,** lateral **H,** and anterior **I,** views. **J–M,** Paratype CM 2014.1.2, complete shell in dorsal **J,** anterior **K,** lateral **L,** and ventral **M,** views. **N,** Paratype CM 2014.1.5, dorsal valve in interior view. **O,** Paratype CM 2014.1.4, dorsal valve in interior view. **P–R,** Paratype CM 2014.1.3, complete shell in dorsal **P,** lateral **Q,** and anterior **R,** views.

interior with broad ovate cardinal process that extends across posterior ends of socket ridges. Broad shallow sockets separated from narrow triangular hinge plates by sharp socket ridges. Crural bases poorly defined; nature of crura and loop unknown.

Discussion: The lack of a dorsal median septum indicates that the loop of *Gowanella capralis* gen. et sp. nov. developed without the involvement of a septal pillar or any other median support for a loop during ontogeny. This precludes placing the genus within the long-looped brachiopods and so it is classified as a short-looped terebratulidine.

In the overall form of the shell, the new genus resembles *Ostreathyris* Hiller, 2011 with which it occurs. The latter differs from *Gowanella* in being very coarsely ribbed but it also possesses an attrite beak and a large foramen. Internally, the dorsal valve of *Ostreathyris* is characterized by the presence of broad, triangular hinge plates; these are not seen in *Gowanella.*

Suborder Terebratellidina Muir-Wood, 1955

Superfamily uncertain
Family uncertain
Genus and species indeterminate

Horizon: Mead Hill Formation, Kaikoura, South Island, New Zealand.

Age: Haumurian; Late Cretaceous (Maastrichtian), Browne et al. (2005).

Material: Ten pairs of conjoined valves, all deformed by crushing and tectonic distortion, from exposures along the rocky foreshore near the wharf at Kaikoura (Fig. 1C); New Zealand Fossil Record File Number O31/f0617. Holotype: CM 2014.1.38; Paratypes: CM 2014.1.39 in Canterbury Museum, Christchurch and OU 45287 in the Department of Geology, Otago University, Dunedin.

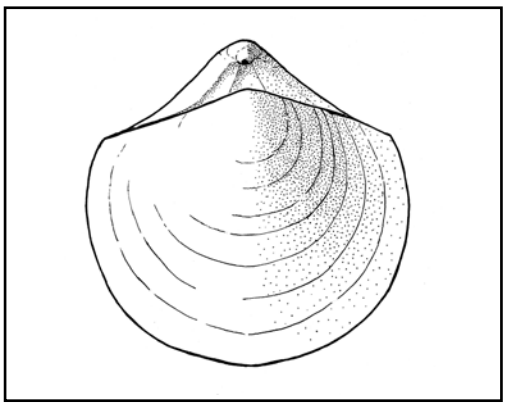

Figure 3. A reconstruction of the indeterminate Mead Hill Formation taxon in dorsal view, based mostly on specimen CM2014.1.39.

Description: Shells with subcircular outlines (Fig. 3); maximum width about midvalve. Anterior commissure rectimarginate to very gently sulcate. Beak narrow, erect to slightly incurved; foramen very small, circular, mesothyrid; beak ridges well developed. Delthyrium closed by fairly high concave symphytium that has developed from conjunct deltidial plates. Ventral valve gently convex in lateral profile; anterior profile more strongly convex medianly. Dorsal valve gently and evenly convex in both profiles. Shell substance thin anteriorly but thickened in posterior regions.

Table 1. Dimensions (in mm)

specimen number	length	width	thickness
CM 2014.1.1 holotype complete shell	16.7	17.5	8.3
CM 2014.1.2 paratype complete shell	10.1	11.0	4.5
CM 2014.1.3 paratype complete shell	10.2	11.0	4.6
CM 2014.1.4 paratype dorsal valve	11.6	11.7	
CM 2014.1.5 paratype dorsal valve	8.8	9.3	
CM 2014.1.6 juvenile complete shell	4.7	5.8	2.6
CM 2014.1.7 juvenile complete shell	3	3	
CM2010.41.50 complete shell	11.6	12.9	4.9

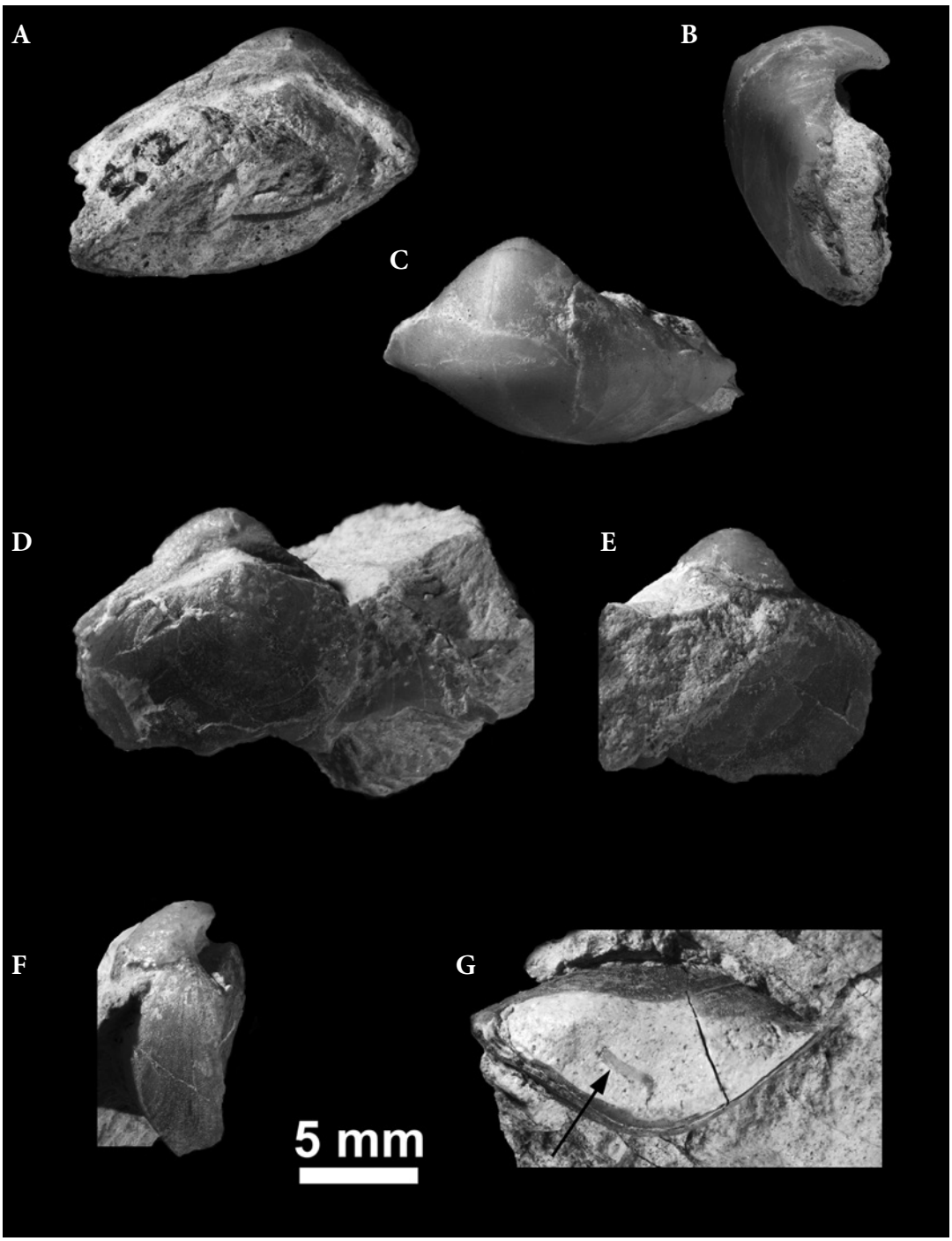

Figure 4. Genus and species indeterminate. **A–C,** CM 2014.1.38, complete shell in dorsal **A,** lateral **B,** and ventral **C,** views. The exaggerated curvature of the ventral valve is due to tectonic distortion. **D–F,** CM 2014.1.39, complete shell in dorsal **D,** ventral **E,** and lateral **F,** views. The thin shell at the growth margins of both these specimens has been broken off. **G,** OU 45287, complete shell in anterior view showing broken anterior end with portion of the loop visible (arrowed).

Details of the interior of the shell are unknown except that one specimen, OU 45287 (Fig. 4g), shows a portion of a long loop, although this appears to have been displaced slightly from its life position.

Discussion: The placement of this genus in the Terebratellidina is based on specimen OU 45287, which shows part of the loop preserved, but placement in a superfamily is not possible without more information about the cardinalia and brachidium. Externally, the species closely resembles *Aliquantula tapirina* (Hutton, 1873), a New Zealand terebratelloid of Oligocene age, but it would be wrong to assume it belongs in the same superfamily.

The hard, very fine sedimentary filling of the shells precludes excavation of the internal structures and tectonic distortion rendered the specimens unsuitable for serial sectioning.

Discussion

Hiller (2011) interpreted the *Ostrea* Bed at the top of the Broken River Formation to represent an oyster reef formed in very shallow water, probably only a few metres deep. In contrast, the Mead Hill Formation was deposited by pelagic sedimentation in an outer shelf to upper slope environment (Hollis et al. 2003a; Hollis et al. 2003b; Browne et al. 2005). The silica content of the Mead Hill Formation, derived from in situ diatoms and radiolarians, is consistent with deposition in a setting analogous to modern biogenic oozes (Hollis 2003; Hollis et al. 2003a; Hollis et al. 2003b). The external morphology of both new taxa reflects the environments in which they lived. The robust shell, attrite beak and large foramen of *Gowanella* attests to a species adapted for living in a high energy environment in which it used a short, thick pedicle to attach closely and firmly to a hard substrate, in this case the large oyster shells among which it lived. The somewhat variable outline of the specimens probably reflects the crowded and cramped conditions in which they grew.

In contrast, the indeterminate form from Kaikoura lived in a very low energy environment lacking current and wave activity. In such a setting, it is likely that each larval brachiopod would have attached, using a very slender pedicle, to a single sedimentary particle that it quickly outgrew to effectively live free on the sea floor. Thickening of the posterior part of the shell served to stabilize the shells in their life positions.

Acknowledgements

I am grateful to my colleagues Al Mannering and the late Natalie Cadenhead for their help in collecting specimen material from the *Ostrea* Bed and the Mead Hill Formation. Richard Murchison, owner of the farm Gowan Hill, is thanked for allowing access to his property. I also thank Daphne Lee (Otago University) for the loan of specimens from Kaikoura, and Kyle Davis (Canterbury Museum) for taking the photographs. The helpful comments of Dr Aleksandra Bitner (Polish Academy of Science) and an anonymous reviewer were much appreciated. The project was supported financially by the Robin S Allan Memorial Fund at Canterbury Museum and this is gratefully acknowledged.

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What can we do? A case study in the conservation of canned wet food in museum collections

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This research report considers the process of conserving canned wet food in museum collections. It details, as a case study, the methods of content removal, sampling procedure and scientific analysis performed in 2014 on part of a collection of canned wet food from Cape Hallett Station, Antarctica, held in the collections of Canterbury Museum. Offering recommendations on storage, analysis and the display of canned wet food collections, the intent of the report is to encourage future, and more detailed, research into the conservation of wet food collections.

Keywords: Conservation, food, collections, cans, tins, Antarctic

Introduction

Canterbury Museum in Christchurch, New Zealand, cares for an estimated 2.3 million collection items including approximately 6,500 objects that represent Antarctic exploration and research activities from the late 1800s to the present day. In 2005, Canterbury Museum acquired a collection of more than 1,000 objects relating to Cape Hallett Station, Antarctica. Among the building components, fuel drums and tools was a collection of 42 cans of wet food from the 1950s – 1960s. Preserved in fluid, these canned foods ranged from fruit in juice or syrup (Fig. 1) and vegetables in water to meat and fish in brine. Although canning foods in fluid is generally a stable, long-term method of preservation, it is not an indefinite one; canned wet food is subject to physical, chemical and biological deterioration as it ages and, if the can is penetrated, oxygen can further affect the contents (Potter & Hotchkiss 1998).

The Cape Hallett Station collection of canned wet food had been stored in the Mammal Attic at Canterbury Museum for more than eight years. Over this time, the cans had been subject to an uncontrolled environment. In 2014, temperatures ranged from 14°C to 26.5°C and humidity fluctuated between 29.3% and 75.4%. When the collection was looked over as part of a routine check in 2014, some of the cans were found to be deteriorating rapidly. The condition of the cans varied greatly; some were in near perfect condition with undisturbed contents, whereas others were severely deteriorated with liquid leaking from the vessels onto surrounding objects. The individual cans had been wrapped in tissue paper and leaking fluid had soaked the tissue, causing it to stick to the metal cans and paper labels. The affected objects were immediately bagged and removed.

An initial examination was carried out by an objects and paper conservator. The cans were then placed inside a fume cabinet on top of cups or polyethylene foam so they could drain. The tissue paper used to wrap the cans for storage (where still wet) was removed and the cans were left for a short period to determine which were leaking and which were just contaminated with fluid. It was clear that conservation treatment

Figure 1. A can of Apricot Jam (2005.151.400) from the Hallett Station collection upon its acquisition in 2005.

would be required to ensure that the cans were, at minimum, cleaned and preserved for the future. As the cans are museum collection items, it was also important that they were treated in such a way that they would be available for future display and interpretation. A treatment plan was devised that included cleaning and removing rust from cans, treating and reattaching labels where possible and, where the cans were leaking, removing the contents. The latter decision ensured that the physical body of the can remained accessible for future exhibition. The actual conservation treatment of the metal cans, while of interest, is not the main subject of this article. Rather, we are interested in exploring the validity of retaining decanted and subsequently frozen contents from leaking cans. In this situation, analysis of the contents of frozen food collections will assist museums who face similar situations to decide on the value of retaining frozen samples in the long term. If chemical analysis of food, which helps us to understand food quality control, research and development, shows significant changes in the frozen samples, the benefit of retaining such samples may be questioned.

Literature review

The care and conservation of wet food in museum collections is challenging and can be problematic; to date, there is no generally accepted methodology for the conservation of wet food collections. Internationally, however, this area is gaining increasing attention. In Switzerland, the Haute Ecole de Conservation-Restauration Arc is examining the conservation of cans containing food in museum collections. The objective of their 'Conservation of cAns in collectioNS' project is to 'develop conservation methodologies respectful of the material authenticity and cultural values of these composite objects' and is due for completion in 2017 (CANS 2014). While it is hoped the CANS project will provide comprehensive information about the conservation of wet food collections in museums, there is still considerable information that can be drawn from a wider existing literature, particularly with regards to the construction of such items, the conservation of other food products and existing examples of decanting and freezing can contents.

Most cans in museum collections are likely three-piece cans constructed out of tinplated steel in order to slow corrosion and sealed with a tin-lead alloy solder (Potter & Hotchkiss 1998). The cans would have been hermetically sealed, meaning they were at one point completely sealed against ingress of micro-organisms, namely bacteria, yeasts, moulds, gases, water vapour, dirt and dust (Potter & Hotchkiss 1998). There are many scholarly food science resources that describe in detail the current and former food canning processes and techniques. These resources are targeted to the food industry and are concerned with the relatively short-term preservation of food through the use of cans (Robertson 1993; Potter & Hotchkiss 1998; Blunden & Wallace 2003). Similarly, there are general guidelines published by food authorities regarding the storage and shelf life of canned goods for consumption (Food Standards Australia New Zealand 2008). The Commonwealth Scientific and Industrial Research Organisation (CSIRO) suggest that canned foods have a shelf life of up to four years. They also advise that, as a general rule, the lower the temperature, the longer the life of the

canned goods (CSIRO 2011). To date, no testing has been completed to conclusively suggest that canned collections should be stored frozen. There are, however, resources that warn of the consequences of having improperly sealed, or defective metal cans, and the subsequent likelihood of contamination of contents with pathogenic bacteria such as *Clostridium botulinum* that can lead to the food-borne disease botulism, which can be fatal (Potter & Hotchkiss 1998).

Research into the storage and conservation of food in museum collections has traditionally focused on the challenges that dry food artefacts pose (Cox 1993; Daniels & Lohneis 1997; Wharton et al. 2011) and the preservation of food in contemporary art (Temkin 1999; Gilman et al. 2011). The relevance of these to collections of wet canned food in museum collections is limited due to the composite nature of cans containing wet food, specifically, the interaction between the metal can and food contents. In contrast, significant conservation work has been completed on cans containing wet food encountered in Antarctica (Bickersteth et al. 2008; Natural History Museum 2006, 2007, 2013). The Antarctic Heritage Trust, which cares for buildings and their contents on the Antarctic continent, has over the last 10 years undertaken conservation on canned wet food in various conditions. In order to perform metal stabilisation treatments, and to preserve the collection on open display, these cans are defrosted and, if leaking, opened using a rotary tool cutting wheel, and emptied. Following a sampling methodology developed with assistance from the University of Otago (Department of Food Science), representative samples of the contents are stored either in a small plastic container or a large plastic bag then refrozen (Meek, Fryer pers. comm. 2014). To date, no scientific testing has been undertaken to examine the chemical impact, and therefore consequent value of, freezing contents and questions exist as to whether the amounts currently being saved would be enough for standard food analysis tests.

Foods spoil over a period of time due to chemical and physical changes and microbial growth. The literature on food freezing processes is generally concerned with preventing food poisoning and maintaining optimum food taste and texture (Grout et al. 1991). Freezing does not stop degradation of food entirely but slows physical and chemical changes and microbial growth considerably. As such it is the only reliable method for storing wet food long-term (Zaritzky 2008). The standard temperature for most food being stored and transported is around -18°C as yeasts and moulds cannot multiply below -12°C and -18°C respectively (Zaritzky 2008). As a general rule, the lower the temperature at which a food is stored above freezing, the slower the deterioration (Ranken et al. 1997).

The rate of freezing, storage temperature and temperature fluctuations during storage play a major role in preventing degradation of frozen foods (Brown 1991). It can be difficult to maintain food products in a consistent, optimum frozen state. The Collaborative Crystallisation Centre, part of the CSIRO, deals with frozen food samples for analysis and recommends ensuring that each sample only goes through one freeze/thaw cycle if necessary. They also recommend that the freezing process is as rapid as possible, to reduce the chance of crystalline ice forming and that the crystals formed are as tiny as possible (slow freezing produces large crystals). They advise that freezing and thawing samples that contain protein almost certainly results in some level of degradation in the sample, however accept that there are very few other long-term, feasible options for storage of food samples (CSIRO 2013). Changes in the temperature, as minimal as those from opening the freezer door, can cause thawing. This thaw/freeze cycling can adversely affect the food through changes brought about by the formation and reformation of ice crystals. Other effects of freeze/thaw cycles are protein denaturation and microbial growth (Ranken et al. 1997). There is a need for a constant and systematic control and careful monitoring to ensure the ideal temperature is maintained.

Figure 2. A selection of cans after opening with a rotary tool (L Yeats, 2014).

Some museums have collected wet food items solely for the packaging. Durham Museum in Omaha, Nebraska, for instance drains and disposes of the content of soda and beer cans. This approach was developed from experience that an unopened can ultimately leaked after a few years, causing potential damage to other collection items. By puncturing the bottom end of the can, the objects can still be displayed with no visible damage (Stober 2011). Decanting can contents provides an opportunity to establish a baseline of the chemical composition of the contents. By undertaking scientific analysis of a sample of these decanted contents, a reference point can be established against which future tests of retained samples can be measured in order to understand the impact freezing contents has on these types of materials. That said, sampling protocol needs to be given significant consideration in order to obtain useful samples and meaningful data. No literature could be located that addresses the sampling techniques of aged canned food samples in preparation for laboratory analysis specifically. There are references that explain the sampling procedure used by food scientists and archaeologists prior to carrying out analytical tests (Peters 1996; Curren & King 2002; Ihnat 2003; Lourdes 2012). The general consensus is that samples should be collected in a sterile environment, stored for the shortest time possible and remain unaltered during transportation and storage until the moment of analysis. All stress the importance of taking representative and replicable samples for testing purposes. A sample must also be large enough to be able to measure the materials of interest. The leaking canned wet food collections from Cape Hallett Station provided an ideal opportunity to undertake baseline analysis in order to measure any deterioration that occurs in freezing samples over a period of years.

Methods

Once it had been confirmed that multiple individual cans were leaking the curator and

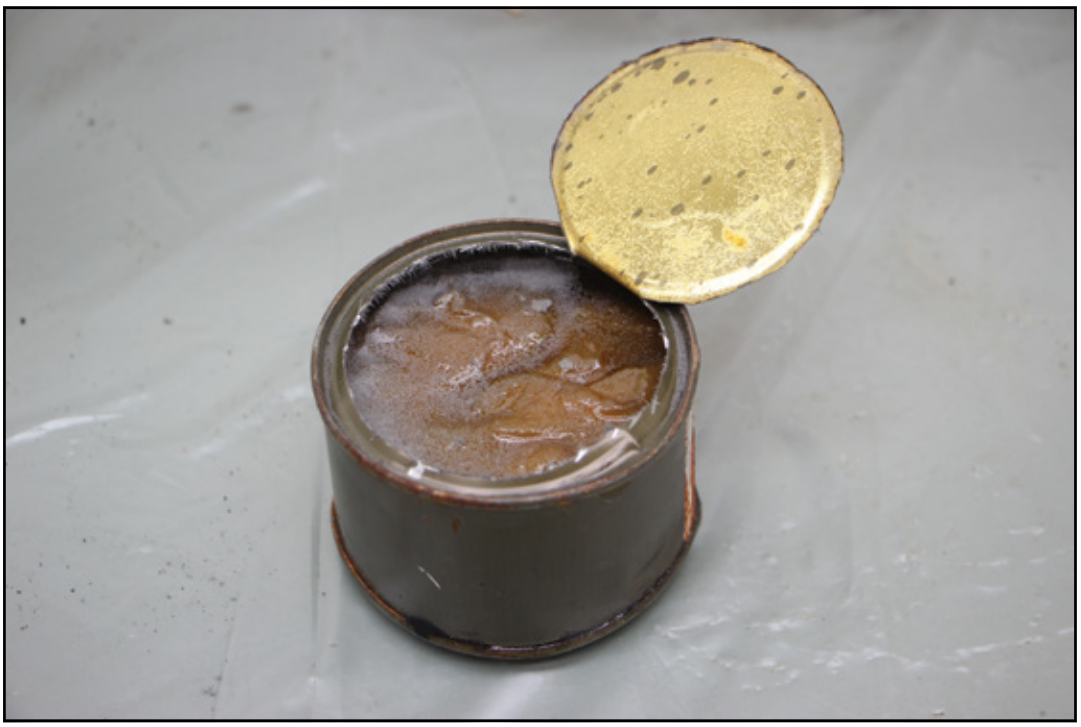


Figure 3. Open can showing fine metal filings (L Yeats, 2014).

conservator recommended that the contents of the leaking cans be removed to prevent further contamination. In order to leave the can displayable, a rotary tool was used to open the can around the rim of the base leaving a hinge of around 20mm (Fig. 2). While different methods of opening were considered, including commercial can openers, punches and drilling, the rotary tool method used by the Antarctic Heritage Trust was chosen for the minimal physical impact on the can itself and the ability to allow effective cleaning (Meek, Fryer pers. comm. 2014). This method of opening caused fine metal filings to deposit on the surface of the food contents (Fig. 3). The metal filings were scraped and syringed off the food as much as possible while it was still in the can, using sterile instruments, in order to reduce potential contamination. The contents were then transferred to sterile glass and plastic containers using a clean stainless steel instrument.

Samples were collected as soon as possible after the cans had been opened to deter further oxidation and contamination from microbes. The sterile containers were clearly marked with the can's accession number using a permanent marker (Fig. 4). The bulk of the samples were placed inside clearly marked plastic zipped lock

Figure 4. Samples of decanted can contents including apricot jam, kidney beans, apricots, apple sauce and white turkey.

bags and put into the freezer for permanent storage at Canterbury Museum. Five samples were not frozen, but instead placed in a plastic zipped lock bag and sent via post to Eurofins Laboratory in Auckland, New Zealand, for further analysis. The samples, while in transit and at Eurofins Laboratory, were in an uncontrolled environment for a maximum of two weeks. Future research may wish to consider ways of controlling the environment for such samples.

As the cans had been accessioned prior to the labels deteriorating, cross-referencing with the museum database allowed identification of the cans and their contents. Analytical tests were then carried out on the selected samples to provide an idea of any deterioration that had already occurred and to establish a baseline against which any further deterioration of the samples over time could be measured. The most worthwhile tests to carry out on the samples were determined by discussion with Eurofins Laboratory. As the metal filings could be present in the sample due to the opening method, and metal corrosion product could bind the vitamins in a sample, vitamin analysis was not carried out due to concern over unreliable results (Szparagowska, Fryer pers. comm. 2014). A series of tests to measure levels of nutrients, peroxide and anisidine values and tests that picked up the presence of mould and sulphite-reducing bacteria were completed.

Due to the relatively small size of the cans and consequently the small amount of sample (150 g) that could be provided, the samples were ultimately destroyed and results were based on one test (multiple tests are standard to ensure samples are not compromised; it is possible, despite measures undertaken to prevent this, that contaminants entered the samples and affected results). The amount of sample retained for future testing varied depending on the size of the tin and the amount that had already leaked out. In all cases, all that remained of the food, once the 150g sample had been removed, was retained and frozen. The samples chosen to submit for testing were selected to provide a representative range of fruits, vegetables and meats least contaminated by metal fillings and allow sufficient remaining contents for future testing. The analysis that was carried out was under the guidance and advice of food scientists who had not encountered aged samples such as this before. There was no published precedent for the testing of aged food samples to gauge degradation.

Tests and results

Upon the advice of Eurofins Laboratory a range of nutritional, chemical and microbiological tests were carried out. Nutritional panel tests recorded levels of specific nutrients. If the same tests were carried out in the future, any change in the levels of nutrients would be apparent, letting researchers know the sample has degraded. Similarly, oxidation which progresses at different rates depending on factors such as temperature, light, availability of oxygen and the presence of moisture and metals, can indicate a product has spoilt. High peroxide (primary breakdown product) and high anisidine (secondary breakdown product) values are an indication of oxidation (Szparagowska, Fryer pers. comm. 2014). Some samples were also tested for mould and sulphite reducing bacteria. If colonies of sulphite reducing bacteria are present, Eurofins sends the sample to North Shore Hospital, Auckland for further identification. The results are shown in Table 1.

Despite an expectation, drawn from the understanding that botulism frequently occurs in opened canned food, scientific testing revealed no significant amounts of botulism on any of the samples, even though they had been open for some time in room temperature conditions. Mould levels on the beans were high which was unsurprising as mould was visible prior to sending the sample for testing. The other samples had fairly low levels of mould. The mould on the beans increased in amount very quickly once emptied from the can. Original nutritional information was only available on the label of the can of white turkey (Fig. 5). Comparison of this against measured amounts

Table 1. Results of scientific testing undertaken on samples of wet canned food contents from Cape Hallett Station collection.

Test	**Reporting Units**	**White Turkey** (2005.151.454)	**Apricot Jam** (2005.151.400)	**Kidney Beans** (2005.151.450)	**Apple Sauce** (2005.151.451)	**Apricots** (2005.151.550)
Ash Leo TGA701	**%m/m**	1.00	0.15	1.41		
Carbohydrate 1.2.8	**g/100g**	0.9	71.6	17.0		
Energy 1.2.8	**kJ/100g**	510	1230	413		
Moisture AOAC 920.151 AOAC 945.43	**g/100g**		27.7			
Moisture Leco TGA701	**%m/m**	72.9		74.7		
Protein AOAR 981.10	**g/100g**	21.8	0.25	6.53		
Fat AOAC 922.06	**g/100g**		0.30	0.34		
Fat AOAC 960.39	**g/100g**	3.31				
Saturated Fat AOAC 991.39/ 1969.33/1963.22	**g/100g**	1.14				
Unsaturated Fat AOAC 991.39/ 1969.33/1963.22	**g/100g**	2.17				
Monounsaturated Fat AOAC 991.39/ 1969.33/1963.22	**g/100g**	1.28				
Polyunsaturated Fat AOAC 991.39/ 1969.33/1963.22	**g/100g**	0.89				
Trans Fat AOAC 991.39/ 1969.33/1963.22	**g/100g**	<0.10				
Sodium AOAC 984.27	**mg/100g**	217	10.9	166		
Total Fat	**g/100g**					
Total Sugars AOAC 980.13/JAOAC 75:1992	**%m/m**	<0.05	64.3	0.32		
Peroxide Value AOCS Cd8.53	**Meq/kg**	34.31				
Anisidine Value AOCS Cd 18-90	**Meq/kg**	12				
Yeasts and/or Moulds APHA	**Cfu/g**	<10		600	<10	<10
Sulphite Reducing Bacteria ISO 15213:2003 (E)	**Cfu/g**	<1		<1	<1	<1

Measuring units g/100 = grams per 100 grams, meq/kg = milliequivalents per kilogram, cfu/g = colony forming units per gram, %m/m = percentage by mass. Abbreviations: AOAC (Association of Analytical Communities); TGA701 (Thermogravimetric Analyser); AOCS (American Oil Chemists' Society); APHA (American Public Health Association); ISO (a horizontal method for the enumeration of sulphite-reducing bacteria growing under anaerobic conditions)

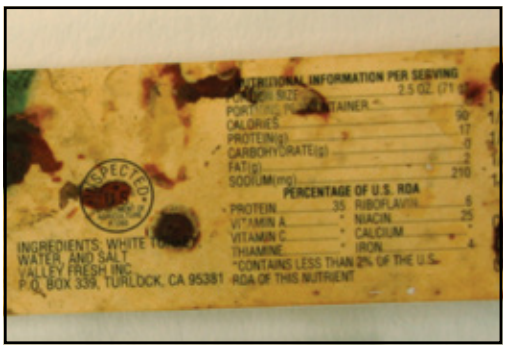


Figure 5. White turkey can label showing nutritional information (note there is a margin of error on this)

from the can in Table 2 show, as expected, that these figures are a guide only and the tin label cannot be taken to be exact. The results of this analysis will be linked to the database record of each object for comparison with future tests. These results suggest that museum staff can follow a clear staged approach in relation to the storage, display and conservation of canned wet food (Figs 6–8).

Conclusions

As this was the first project of its kind that the researchers and scientists involved had undertaken, few expectations were placed on the results; rather this information is intended to act as a base point for further sampling or analysis and to provide ideas for consideration in the storage, display and conservation of canned wet food. It is hoped that the results can act as a reference point for future analysis of canned wet food contents in Canterbury Museum's collection and, potentially, provide useful information for the care, storage and conservation of wet food collections held elsewhere.

This case study has highlighted a number of areas that require further thought in future research and practice. A different can opening method is required in order to obtain uncontaminated food samples specifically to prevent metal filings from contaminating the samples. This may have implications for museums in making the can less displayable. It should be noted that botulism was not detected in the samples although this was thought to be a high risk in this type of food collection. Care still needs to be taken in dealing with such samples, although this may be a lower risk than previously thought. Going forward the contribution of food scientists to interpret these results further and discuss different testing options will be invaluable. Key indicators of deterioration that can be easily analysed and work for a number of food groups require identification. Similarly, we need to be very clear about the ethical considerations of discarding contents as well as separating them from their can. As discussed, there are a number of costs, and logistical challenges in decanting cans, analysing the contents and retaining their frozen contents. Although the comparison of information on can labels versus scientific test results is interesting, due to the margin of error on the former and the (possible) unrepresentative sampling on the latter they may not be statistically significant. Of greater significance will be the analysis taken of the samples from the same can in several years' time which will provide comparison with the

Table 2. Nutritional information on the label of White Turkey compared to nutritional information from scientific testing. Units changed to be as on label (per serving of 71g rather than per 100g)

Nutritional Information	On label	By scientific testing (in units the same as on the Turkey label)
Calories	90	87
Protein	17	15.48
Carbohydrates	0	0.64
Fat	2	2.35
Sodium	210	154.07

baseline testing undertaken here to consider the value of retaining frozen food samples in museum collections.

It is important for staff to consider both the reality and feasibility of freezing removed contents long-term before making a decision regarding keeping or discarding contents. Until the results of the CANS project are published in 2017, the authors recommend no decision is taken on emptying non-leaking cans. Should cans be leaking, current research recommends that wet food contents be removed from metal cans in museum collections as this is currently the only way to responsibly conserve all the

Figure 6. Flowchart of steps for storage of canned wet food collections

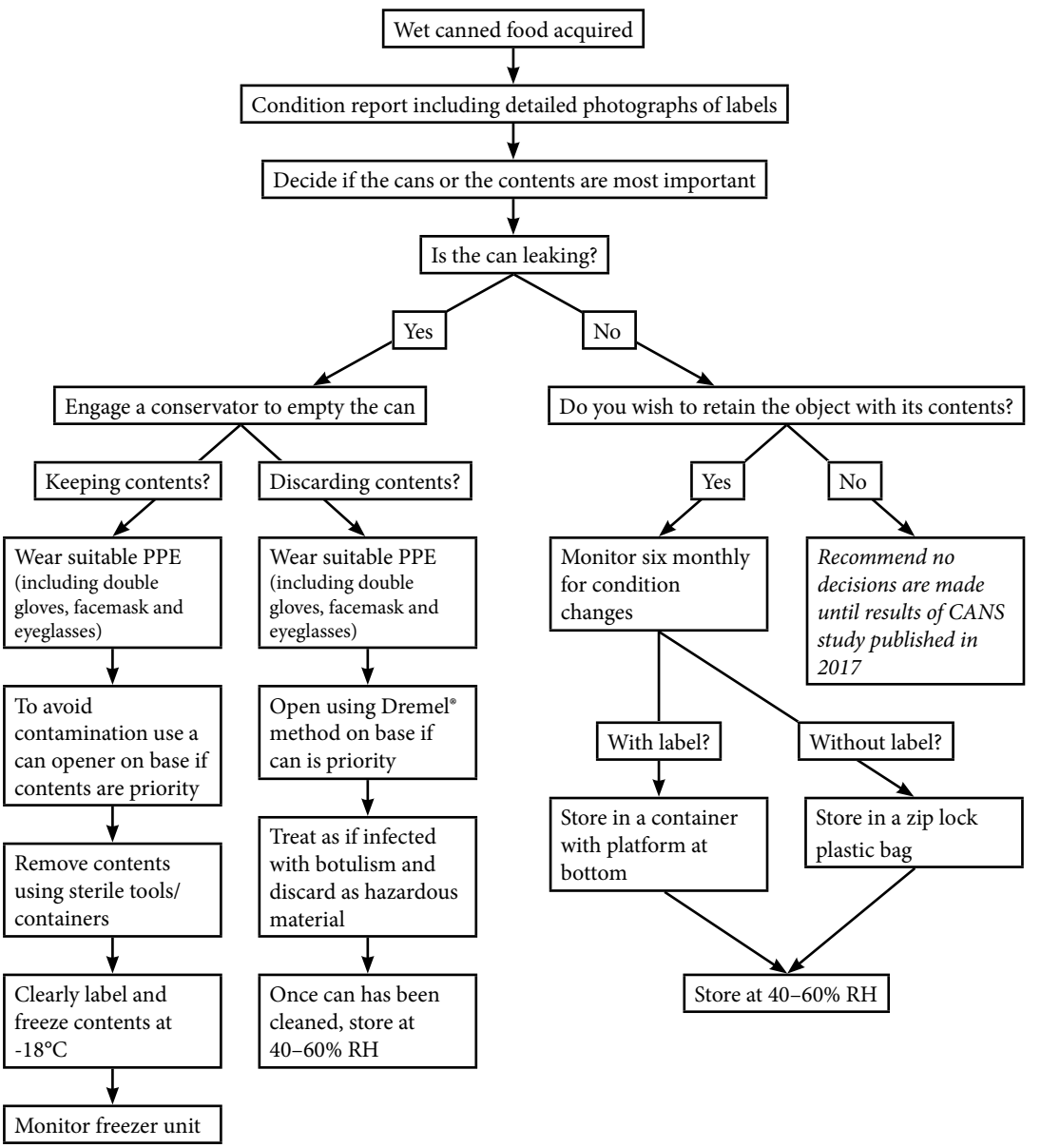


Figure 7. Flowchart of steps for analysis of canned wet food collections

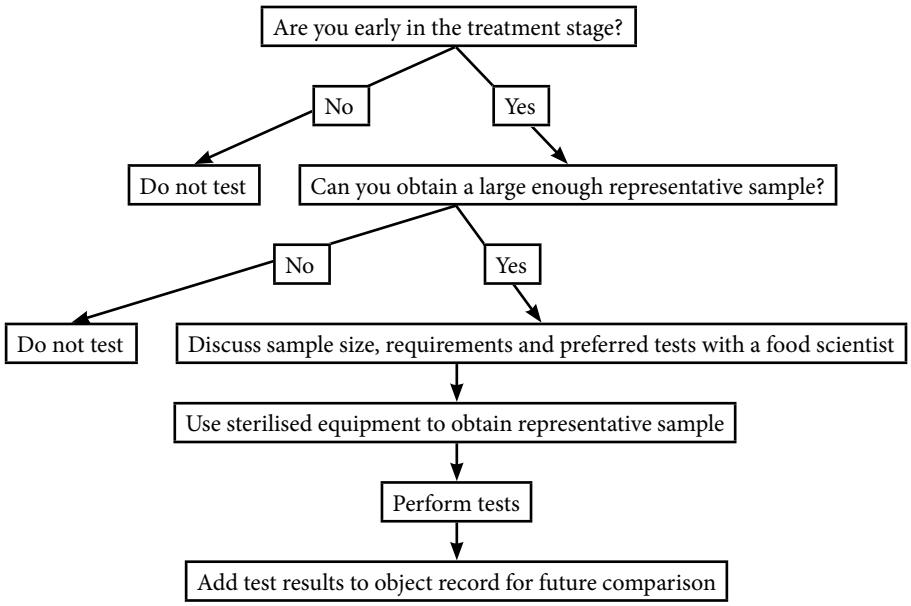
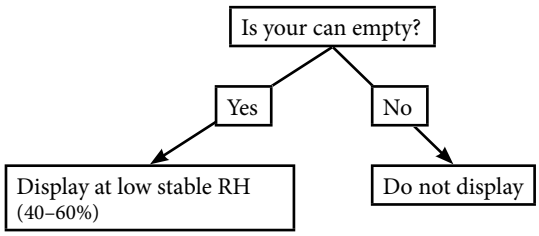


Figure 8. Flowchart of steps for display of canned wet food collections



components - cans, labels and contents - long term. While museums may consider freezing the leaking tin until such a time as a better treatment option is presented, this does not allow for access or display and requires suitable monitored freezer space which may be prohibitively expensive or impractical. There are also implications to be considered should the cans thaw at any point in future as condensation can affect any paper based labels. In Christchurch, the recent series of seismic events demonstrated just how unreliable freezer storage can be for long periods of disrupted power supply (even with generator back up).

How to successfully conserve cans containing food in museum collections is a difficult task and one that requires special consideration. On the one hand, wet canned food items are inherently unstable over a long period of time and pose a potential hazard to other collections. On the other hand, it is evident that once removed from the cans (even compromised ones) that degradation of the food element occurs at a greatly increased rate. This project reveals a lack of knowledge regarding the conservation of cans containing food in collections and the subsequent treatment of the removed contents. The project also emphasises the research potential in this area and the applicability of nutritional, chemical and microbiological analysis to the contents of canned food in museum collections. The results obtained through analytical testing

provide a useful baseline to gauge degradation (for the tested cans only) and from which to continue with research into the best methods of emptying, storing and testing canned wet food collections.

Acknowledgements

The authors acknowledge the help and assistance of the following parties in this research: staff at Canterbury Museum; Eurofins Auckland, specifically Michael Hodgson and Aimee Szparagowska; Anthony Mitchell at the University of Otago, Christchurch; Joanne Winter for sharing the findings of her minor thesis and Lizzie Meek of the Antarctic Heritage Trust.

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Types of Charles Chilton's Crustacea with comments on his collections in the Canterbury Museum

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The life of the New Zealand biologist, Charles Chilton (1860–1929), is briefly outlined, a description of his collection of Crustacea at the Canterbury Museum given, and the types catalogued. The species described by Chilton, 52 amphipods, 51 isopods, five tanaidaceans and three decapods, are listed alphabetically in their original combinations. The present-day name, family placement, type locality and a listing of available type material in alcohol and on microslides are given. Rediscovery of previously unrecognised types has led to the setting aside of two recent neotype designations: *Platyischnopus neozelanicus* Chilton, 1897 (Amphipoda: Otagiidae) by Hughes and Lörz (2013) and *Paratanais ignotus* Chilton, 1885 (Tanaidacea: Paratanaidae) by Edgar (2012). *Glycerina affinis* Chilton, 1885 is a member of *Ichnopus* Costa, 1853 (Amphipoda: Uristidae). *Ichnopus affinis* (Chilton, 1885) is a subjective junior homonym of a Mediterranean species and here replaced by *Ichnopus parriwi* Lowry & Stoddart, 1992.

Keywords: Amphipoda, Decapoda, holotype, Isopoda, syntypes, Tanaidacea, Triassic fossil

Introduction

Charles (Chas) Chilton (1860–1929) was born in Herefordshire, England, and came to New Zealand with his family as a very young child. His family settled at a farm at East Eyreton, Canterbury. This family farm later became the type locality for Chilton's first 'well-shrimps' as described in an important early paper (Chilton 1882e). Owing to hip problems, Chilton had had his leg amputated and this was said to be the reason he did not practice farming like his brothers. He took up pupil teaching as a way of entering university. He went to Canterbury College in 1875 as a non-matriculated student and gained a Master of Arts, with first class honours in zoology. The Professor of Biology was then Captain Frederick Hutton who is said to have initiated Chilton's interest in Crustacea (as well as that of his lifelong colleague G M Thomson). In 1888, Chilton gained New Zealand's first Bachelor of Science degree, one of several 'firsts' and many notable academic achievements. He moved into teaching, quickly becoming headmaster of a district school. In 1895, he trained and then practised as a surgeon in Edinburgh and returned to Christchurch as an ophthalmic surgeon in 1901. However, soon after, Chilton became a temporary, and then by 1903 a permanent Professor of Biology at Canterbury College. Later, Chilton became Acting Director, Canterbury Museum (March 1905–April 1906) (Johns & Pollard 2002). Chilton's mostly dry taxonomic descriptions perhaps belie related interests in biogeography (Hurley 1990) and evolution (Chilton 1894). These scant biographical details omit many other activities. The information above is from an obituary by Thomson (1930), as well as from an interesting sketch by Hurley (1990), which

also lists many other sources.

An extensive archive of 655 Chilton papers and letters is held at the Canterbury Museum (1896–1930, C323, Canterbury Museum records). The contents concern scientific correspondence and also records of several associations in which Chilton was involved: The Australasian Association for the Advancement of Science, the Christchurch Beautifying Association, the Summit Road Association and the West Christchurch High School Committee. In addition there is correspondence, reports and newspaper cuttings concerning a debate over the Christchurch water supply in the 1920s.

The Chilton collection of Crustacea

The collection at Canterbury Museum comprises numerous identified whole specimens stored wet in alcohol plus many hundreds of permanent microslides. Towards the latter part of Chilton's life it appears he systematically documented his collection. It is uncertain when exactly this was done, however, two notes on microslide cards show that he was making extra catalogue entries in 1917 and c. April 1918. An annotation on the card for *Orchomenopsis chiliensis* (Heller, 1868) states 'This should probably be considered a distinct species [signed] Chas. C. 1917.' Another on the card for *Phreatogammarus helmsi* Chilton, 1918 has pencilled 'See paper posted 29 iv 1918 to Journal. Zool. Res.' This would have happened while the collection was in the Department of Zoology at the University of Canterbury. The collection was moved to Canterbury Museum in May 1959 (Johns & Pollard 2002). Much of the documentation is in his own hand.

Chilton actively acquired representative species of Crustacea for his own collection, sometimes by exchange from contemporary crustacean workers. Notable among these are K H Barnard in Cape Town, South Africa, H Richardson in Washington, USA, D Giambigi in Buenos Aires, Argentina, T R R Stebbing and others in the United Kingdom, S W Fulton and O A Sayce in Melbourne, W E Nicholls in Perth, and T Whitelegge in Sydney, Australia. A O Walker exchanged part of the British Antarctic Terra Nova expedition. A few of the specimens donated may be syntype specimens and some are labelled as 'cotypes'. Some specimens described by other authors were identified by him as part of the large surveys on which he reported. Notable among these are those from Talé Sap, Thailand (Chilton 1926a, 1926b), Chilka Lake, India (Chilton 1916a, 1921a, 1924), New Zealand's subantarctic islands (Chilton 1909a, 1909b) and the Kermadec Islands (Chilton 1911a). Others are examples of relatively well known species that he appears to have acquired for comparative purposes and dissected by him and mounted on permanent microslides. In the case of the extensive Chilka Lake survey, Chilton identified his material by station number. Annandale and Kemp (1915) noted the existence of a log of station numbers for this survey but provided no details.

Chilton Jar Collection

The alcohol collection is arranged in 423 jars (called 'bottles' in the card catalogue). Jars are in a largely continuous series. Jar numbers 1 to 224 are Isopoda and 500 to 731 are Amphipoda. A large gap between 225 and 500 is not represented by either jars or catalogue cards. However, a few smaller gaps in the otherwise continuous series represent jars that were originally present but cannot be located currently. Chilton's original 'jars' were discarded and replaced by Agee® glass jars with sealed metal lids sometime in the latter half of the twentieth century and the original jar labels destroyed and replaced. Unfortunately the replacement jar labels, hand-written in ink, were supplied by someone who had difficulty reading the original labels and who was not familiar with crustacean nomenclature. Importantly, many of these newer jar labels include the word 'TYPE' when in fact the contents cannot be types. Most of these jar labels have now been supplemented with new jar labels.

Each of Chilton's jars contains one or more species almost always from a single genus. Rarely up to three confamilial genera were stored in the

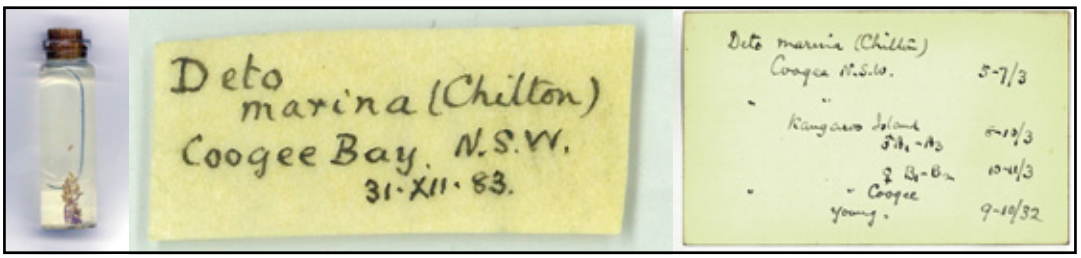

Figure 1. *Deto marina* (Chilton, 1884), syntypes. From left to right; vial, label from vial, relevant catalogue card.

same jar. Most vial labels are in his own hand with a name, brief locality and sometimes a date of collection (Fig. 1). Potential types and non-type vials were found in the same jar. Types and non-types have now been placed in separate jars (along with a record of their original Chilton Jar Number) to avoid future confusion. Rarely, on the vial labels, the word 'Type!' is added, even though the relevant publication does not indicate the existence of a holotype (see section on Chilton types below). Several vials of terrestrial isopods have species names that do not appear in the literature and are therefore *nomina nuda*.

Chilton microslides

Microslides appear to be mounted in Canada balsam and most are in excellent condition. Most are stained with what is presumed to be carmine red (Fig. 2). A small number are stained black with osmic acid and these slides are mostly annotated 'osmic'.

The microslides prepared by Chilton over 47 years of publications were organised by him in four microslide cabinets of over 170 trays storing the microslides flat. The cabinets in use today do not appear to be the ones used by Chilton. Each tray originally held 20 microslides exactly. Type specimens, examples of the same species collected later, and dissections of species described by others were mixed on the one tray. Representatives of a single species may range across more than one tray. The genus and species names on microslide and vial labels were frequently updated by Chilton. This includes type specimens, and it is common for microslides to bear both genus and species in their original combination but also an updated classification. Some vial labels of potential types are also likely to be replacement labels rewritten to reflect changed classification e.g. '*Chiltonia mihiwaka* (Chilton) Mt Mihiwaka, Port Chalmers'.

Chilton's microslides are accessed by two sets of documentation. The first is a set of three similar black-covered notebooks with blue-lined pages and embossed covers, one for Isopoda and two for Amphipoda. Each page is devoted to a single tray and lists microslides numbered from 1 to 20. Forty trays of Isopoda and 138 trays of Amphipoda are documented in the first book and 32 trays (140–171) in the second. A more recent type index to genera follows in the second

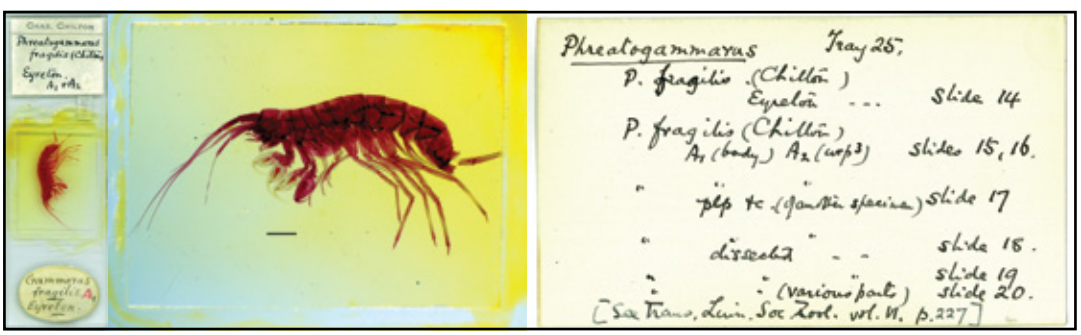

Figure 2. *Gammarus fragilis* Chilton, 1882, syntype (CMNZ 2015.149.26). From left to right; slide 15 of 20, coverslip and syntype in detail (scale = 2 mm), relevant species catalogue card.

Amphipoda book, after which is a further listing of apparently uncatalogued material added by M M Darby, in March 1967. These pages and cards are marked with Box III or Chilton III. D E Hurley may have had a hand in these additions.

The second is an index of 3" x 5" cards, alphabetical by genus and species, prepared in Chilton's hand. Some Isopoda and Amphipoda are in two separate card drawers. Following the species name is a description of each microslide that indicates how many microslides were prepared from each specimen. He used upper-case letters (A, B etc.) to indicate specimens and subscripts to denote microslides prepared (A_1, A_2 etc.). These data sometimes enabled decisions on what could be type material and what could not. Often, the microslides were labelled and indexed with a genus name other than that by which the species had been initially described. Additional lined cards have been more recently added to the microslide card catalogue. The contents and handwriting on these cards match the notebook entries attributed to M M Darby.

Chilton types

Chilton rarely designated types so for many species where he indicated more than one specimen or he described both males and females we assume these to be syntypes. Occasionally he reported a single specimen, which we take to be the holotype. Rarely he described more than one specimen and used the phrase 'Type in Canterbury Museum, New Zealand', which, following ICZN Article 73.1.1., constitutes a fixation of a holotype. This article applies, even when considering the recommendation 73F to avoid assuming the existence of holotypes. Unfortunately Chilton failed to indicate in the collection which of the several he had at hand was the type.

The list of primary types previously given by Johns and Pollard (2002) listed only 24 of the species named by Chilton. The status of several of these is amended. Some specimens of the notable Middle Triassic fossil *Protamphisopus wianamattensis* (Chilton, 1918) were located; some of these had been earlier reported as missing by Wilson and Edgecombe (2003).

Regrettably, some material is listed as missing and searches for this material revealed that most are unreturned loans. It would be appreciated if curators and collection managers that find or know of Chilton material from Canterbury Museum in their collections could contact Canterbury Museum to establish appropriate tenure and documentation for specimens currently in their care. For a few of these specimens it is unlikely that their type status can be firmly established except by comparing label data to Canterbury Museum catalogues.

Methods

The following taxonomic listing is alphabetical by genus within the four orders Amphipoda, Isopoda, Tanaidacea and Decapoda on which Chilton published. We append the currently accepted species name of his taxa (if different). We used current family names that were often different from those given originally.

For each species is given:

- Chilton's genus and species name
- Combination in current usage, if different, with the current family name used by the World Register of Species Names (WoRMS) (WoRMS Editorial Board 2016) or by another catalogue of accepted names which is cited
- The type locality from the original publication, usually given as 'Hab. [habitat]' or 'Localities' with any evidence of material used followed by citation of Chilton's paper describing the species and the most recent reference to the species' present-day classification. Unless otherwise stated here all type localities are in New Zealand.
- The museum acronym followed by a listing of the type material located in alcohol and on microslides; label data are given in quotation marks for some.
- Comments on the material or type locality.

Most of the material comes from the Canterbury Museum, Christchurch (CMNZ)

but all known types from the Australian Museum, Sydney (AM) and Museum Victoria, Melbourne (NMV) are included. Incidental data was discovered from the Western Australian Museum (WAM), South Australian Museum (SAM) and from the Natural History Museum, London (BMNH). Chilton type material from CMNZ is now registered with accession numbers starting 2015.149.1. Comments on the taxonomic placement of some species refer to the Australian Faunal Directory (AFD, http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/home). The abbreviations gn and prp are those used by Chilton and refer to gnathopod and pereopod, respectively.

Taxonomic list of type material

Amphipoda

Acanthonotozoma australis Chilton, 1912

Acanthonotozomatidae

Southern Ocean. 'Scotia', 18th March 1904. Lat. 71°22'S., long. 16°34'W.; 1410 fathoms. Station 417. One female specimen; length of body (head to base of telson), 35 mm (Chilton 1912).

CMNZ. Holotype not located or catalogued.

The deposition of the specimen was not mentioned. Likely depositories include Scottish museums.

Alicella scotiae Chilton, 1912

= *Eurythenes obesus* (Chevreux, 1905) Eurytheneidae

Southern Ocean. Station 468, South Atlantic, lat. 39°48'S., long. 2°33'E.; 2645 fathoms. 29th April 1904. One specimen, 20 mm long (Chilton 1912, De Broyer et al. 2007).

CMNZ. Holotype not located or catalogued.

The deposition of the specimen was not mentioned. Likely depositories include Scottish museums.

Atyloides calceolata Chilton, 1912

= *Schraderia gracilis* Pfeffer, 1888 Pontogeneiidae

South Atlantic. South Orkneys, Scotia Bay, Station 395; 10 fathoms. A few specimens, mostly imperfect, about 5 mm long (Chilton 1912, De Broyer et al. 2007).

CMNZ. Syntypes: 1 specimen on 4 microslides '*Atyloides calceolata* sp. nov, A_1–A_4, South Orkneys' (2015.149.1); 1 specimen in alcohol, South Orkneys, 'Scotia', March 1903 (2015.149.21).

According to the microslide card catalogue these were 'Mounted in Plymouth, 1912'.

Bircenna fulvus Chilton, 1884

= *Bircenna fulva* Chilton, 1884 Eophliantidae

Lyttelton Harbour, very few specimens (Chilton 1884a).

CMNZ. Syntypes: Lyttleton. gn and prp of type. 'Portions of the specimen described in 1884, other parts not preserved' (2015.149.22); a very small specimen mounted whole (2015.149.23); syntype ♀ on 6 microslides (2015.149.24) catalogued as Canterbury Museum AQ 3661 and bearing replacement SAM labels. No material in alcohol located or catalogued.

Calliope subterranea Chilton, 1882

= *Paraleptamphopus subterraneus* (Chilton, 1882) Paraleptamphopidae

Pump at Eyreton, North Canterbury (Chilton 1882d) (February 1882); later described in detail (Chilton 1882e) (May 1882).

CMNZ. Syntypes: 4 syntypes on 11 microslides (2015.149.90–93); 7 syntypes (label states 8) 'Eyreton, Type, b' in alcohol (2015.149.94–100).

Another male specimen on 4 slides (C_1-C_4; 2015.149.1762) is here considered to be a later collection. See remarks by Fenwick (2006) on the difficulties in species identification of syntypes, especially those in alcohol. Male specimens in the syntype series in ethanol are likely to include misidentified specimens of *Ringanui toonuiiti* Fenwick, 2006, or *R. koonuiroa* Fenwick, 2006. One non-type male, illustrated by Chilton (1894: pl. 23 fig. 1; 2015.149.101) was identified as *R. toonuiiti* by Fenwick (2006). A holotype was incorrectly listed by Johns & Pollard (2002).

Corophium lendenfeldi Chilton, 1884

= *Haplocheira barbimana barbimana* (Thomson, 1879) Corophiidae

Lyttelton Harbour (Chilton 1884a, Thomson 1879).

CMNZ. Syntypes: 1 microslide (2015.149.8) with circular label, dissected specimen '*Corophium barbimanum* = *lendenfeldi* Chilton, Lyttleton'; 1 microslide with whole animal (2015.149.9) with circular label '*Corophium* ~~*barbimanum*~~ [*barbimanum* crossed out] *lendenfeldi*, Lyttelton'. No specimens in alcohol located or catalogued.

Crangonyx compactus Chilton, 1882

= *Paracrangonyx compactus* (Chilton, 1882) Paracrangonyctidae

Pump at Eyreton, North Canterbury (Chilton 1882d) (February 1882); later described in detail (Chilton 1882e) (May 1882); transferred to *Paracrangonyx* by Stebbing (1899).

CMNZ. Syntypes: 4–6 specimens on 16 microslides (2015.149.10–16); 5 specimens in alcohol (2015.149.102–106).

The exact number of specimens mounted on microslides is impossible to determine. A holotype was incorrectly listed by Johns & Pollard (2002).

Cyproidia (?) *crassa* Chilton, 1883

= *Tetradeion crassum* (Chilton, 1883) Stegocephalidae

Lyttelton Harbour, '2 specimens ....The details (fig. 1 a–d) were taken from a small specimen ...' (Chilton 1883b).

CMNZ. Syntype: 1 specimen dissected in part on 1 microslide (2015.149.17) 'part of type, *Cyproidea* (?) *crassa*, portions of body and abdomen'. No types in alcohol located.

The card catalogue states 'portion of the small specimen used for description of "*Cyproidia* (?) *crassa*"'. Two other microslides are potential syntypes, both from Lyttelton: 1 specimen on 4 microslides (Microslides 15–18, B_1-B_4, Tray 148); 1 specimen on 1 microslide (Microslide 19 Tray 148). Three vials of non-types exist in alcohol plus another specimen on 3 microslides from Lyttelton collected by H(enry) Suter that cannot be considered part of the original series because of its apparent later collection date. The generic name *Cyproidea* Haswell, 1879 was misspelled by Chilton (1883b).

Cyproidia otakensis Chilton, 1900

= *Neocyproidea otakensis* (Chilton, 1900) Cyproideidae

Otago Harbour, New Zealand. A few specimens obtained by surface-netting (Chilton 1900, Hurley 1955).

CMNZ. Syntypes: 1 specimen on 3 microslides '*Cyproidia otakensis*, Port Chalmers, N.Z.' (2015.149.18); 1 or more syntypes missing from empty vial of alcohol '*Cyproidea otakensis* Lightship (surface), Port Chalmers' from 'Bottle 691'.

Chilton misspelled the generic name *Cyproidea* Haswell, 1879.

Elasmopus bollonsi Chilton, 1915

Maeridae

Dredged off the Three Kings Islands, north of New Zealand, at a depth of 60 fathoms, one male and two small females (Chilton 1915a).

CMNZ. Syntype: 1 male on 6 microslides, 'Type' (2015.149.19). No specimens in alcohol, however, a missing jar is mentioned in catalogue as 'spec. from New Zealand. Bottle 703'.

Elasmopus neglectus Chilton, 1915

Maeridae

Blueskin Bay, Otago (G M Thomson); Moko Hinou (C R Gow) (Chilton 1915a).

CMNZ. Syntypes; 1 syntype female on 4 microslides '♀ described in T.N.Z.J. v 47 p. 328' (2015.149.20); 'type male' Moko Hinou C R Gow 1914 (in alcohol) and also with parts on microslide 'type ♂ gn & prp' (microslide mentioned on label but not in card catalogue) (2015.149.49); 34 syntypes in alcohol, Moko Hinou N.Z (2015.149.107–140).

Eurystheus persetosus Chilton, 1921

= *Gammaropsis persetosa* (Chilton, 1921) Photidae

Australia. 40 miles [64 km] west of Kingston,

South Australia, 30 fathoms. Four specimens, about 12 mm. (Reg. No. E. 4862) (Chilton 1921b).

AM. Syntypes: E.6561.001 (microslide); P.5933 (2 syntypes from E.4862).

CMNZ. No type specimens in alcohol or on microslides. One non-type microslide from Kangaroo Is, South Australia, E R Waite.

Eusirus splendidus Chilton, 1912

= *Eusirus perdentatus* Chevreux, 1912 Eusiridae

South Atlantic. South Orkneys, Scotia Bay, Station 325. 15th August 1903. 54 fathoms. Two specimens, both males: No. 1, 30 mm, No. 2, 35 mm. in length of the body (Chilton 1912).

CMNZ. No material on microslides or in alcohol located or catalogued.

The deposition of the specimens was not mentioned.

Gammarus barringtonensis Chilton, 1917

= *Austrocrangonyx barringtonensis* (Chilton, 1917) Paramelitidae

Australia. Barrington Tops, 4,600 ft., NSW (C. Hedley). (Barnard & Karaman 1983, Chilton 1917d)

CMNZ. 1 paralectotype on 4 microslides (2015.149.25); 1 paralectotype [urp 3 abnormal] Barrington Tops, 4,600 ft., NSW (C Hedley). xii.15 (in alcohol; 2015.149.141).

AM. P.4083.001 (female 'i' lectotype on microslide); P.4080 (4 paralectotypes) selected by Barnard & Karaman (1983).

Gammarus fragilis Chilton, 1882

= *Phreatogammarus fragilis* (Chilton, 1882) Phreatogammaridae

From a pump at Eyreton, North Canterbury (Chilton 1882d) [March 1882]; described in detail (Chilton 1882e) [May 1882].

CMNZ. Syntypes: 2–6 specimens on 7 microslides with original circular labels (2015.149.26–31). Non-type collection, May 1921 C. Chilton, illustrated by Hurley (1954). 'Bottle 590' and other material not located.

Johns & Pollard (2002) incorrectly catalogued a holotype.

Glycerina affinis Chilton, 1885

= *Ichnopus parriwi* Lowry & Stoddard, 1992. Uristidae

Australia. Two specimens from Sydney Harbour (Chilton 1885c).

CMNZ. No material located or catalogued.

Ichnopus affinis (Chilton, 1885) is a subjective junior homonym of the Mediterranean species, *Ichnopus affinis* Heller, 1866, itself a subjective junior synonym of *I. taurus* Costa, 1853 (J K Lowry, pers. comm. 13 Dec 2015). Chilton's name is here replaced by *Ichnopus parriwi* Lowry & Stoddard, 1992 (ICZN Article 60.2).

Grandidierella gilesi Chilton, 1921

Aoridae

India, Chilka Lake. Off Samal Island, 8–15 ft. One male, two females. Off Satpara, 4–5 ft., 17.ix.13, five females. / 8 miles W. by S. of Breakfast Island, two males, one female. / off north shore of Samal Island, three females. Barkul Point, one male. / Satpara Bay, one male and one female (Chilton 1921a).

CMNZ. 2 potential syntypes on 4 microslides, 'Chilka Lake Sta. 9' and 'Chilka Lake, Sta. 19' (2015.149.32–33); 4 syntypes in alcohol 'Off Samal Is, Chilka Lake' (2015.149.142–145).

The microslide card catalogue states 'Syntypes, see Mem. Indian Mus. V. P.'

Haliragoides australis Chilton, 1912

Calliopiidae

South Atlantic. South Orkneys, Scotia Bay, Station 32; 9–10 fathoms. May 1903. A few small specimens, about 3 mm. long; all very delicate and fragile (Chilton 1912).

CMNZ. Syntypes: 3 specimens on 3 microslides. 2015.149.36 states '*Haliragoides australis* sp. nov., Bay A, Sth. Orkneys, 9-10 fath., 'Scotia', Apr. 1903'. 2015.149.34 & 2015.149.35 ibid. plus 'Sta 325, May 1903'. No material in alcohol located or catalogued.

Hyale grenfelli Chilton, 1916

= *Protohyale* (*Boreohyale*) *grenfelli* (Chilton, 1916) Hyalidae

Cuvier Island, off the coast of Auckland, New Zealand; between tide-marks, male specimen, (Bousfield & Hendrycks 2002, Chilton 1916c).

CMNZ. Holotype male on 3 microslides, 'Type ♂, Cuvier Island, P.W. Grenfell, 1916' (2015.149.37). Non-types: Moko Hinou C R Gow 26.xi.16 (C.C. determ.) (on slides).

Johns & Pollard (2002) incorrectly listed syntypes.

Hyale saldanha Chilton, 1912

Hyalidae

South Africa, entrance to Saldanha Bay, Station 483; 25 fathoms. 21st May 1905. Several specimens, males and females, the largest about 9 mm long. (Chilton 1912)

CMNZ. Syntype: 1 female on 5 microslides (2015.149.38), '*Hyale saldanha* sp. nov. Entrance to Saldanha Bay, 25 fathoms 'Scotia' 21.v.04'. Non-types: vial of many specimens from Cape Town collected by K H Barnard in 1914.

Hyalella mihiwaka Chilton, 1898

= *Chiltonia mihiwaka* (Chilton, 1898) Chiltoniidae

Mountain streams near Port Chalmers, up to about 1500 feet above sea-level (Chilton). In hillside stream at Rast [sic] Taieri; from spongy moss at top of Mount Cargill, 2200 feet, and on Swampy Hill, 2400 feet (G M Thomson) (Chilton 1898, Stebbing 1899).

CMNZ. Syntypes: 3 specimens on 10 microslides '*Hyalella mihiwaka*' (2015.149.39–45); 103 specimens in alcohol, '*Chiltonia mihiwaka*, Mt Miniwaka, Port Chalmers' (2015.149.440–542); 17 specimens in alcohol, '*Chiltonia mihiwaka*, Creek at Hope Hill, East Taieri, G.M. T[homson]' (2015.149.543–559); 15 specimens in alcohol, '*Chiltonia mihiwaka*, Mt Cargill (2400 ft) and Flagstaff Hill (2000 ft), G.M. T[homson]' (2015.149.560–574).

Idunella chilkensis Chilton, 1921

Liljeborgiidae

India, Chilka Lake. 1 mile E. by N. of Patsahanipur. Five males, one female. / 2–6 miles E. by S. ½ S. of Patsahanipur. One male, one female (Chilton 1921a).

CMNZ. Syntypes: 1 male specimen on 1 microslide, Chilka Lake (2015.149.46); 3 specimens in alcohol (male and female) Chilka Lake Sta. 61 (2015.149.146–148).

This species has been cited in WoRMS as *Listriella chilkensis* Chilton, 1921.

Moera incerta Chilton, 1883

= *Quadrimaera incerta* (Chilton, 1883) Maeridae

Listed but not diagnosed, without locality (Chilton 1882c). Lyttelton Harbour (Chilton 1883b).

CMNZ. Syntypes: 5 specimens in alcohol in vial, stored with algal frond (Catalogue AQ 3278; 2015.149.149–153). No microslides located or catalogued.

Johns & Pollard (2002) incorrectly listed a holotype for *Maera* (sic) *incerta*. The genus name *Maera* Leach, 1814 misspelled by Chilton (1883b), (Krapp-Schickel & Ruffo 2000).

Moera festiva Chilton, 1885

= *Melita festiva* (Chilton, 1885) Melitidae

Australia. Sydney Harbour, several specimens (Chilton 1885c).

CMNZ. Syntypes: 2 specimens on 2 microslides '♂ + ♀ Type, Sydney' catalogued but currently missing; '*Melita festiva* (Chilton) cotypes ♂ + ♀ Sydney Harbour 1 .1.84' in alcohol (2015.149.154–155).

It is possible that an unreturned loan may contain other syntypes.

Neoniphargus westralis Chilton, 1925

= *Uroctena westralis* (Chilton, 1925) Paramelitidae

Australia. Darlington, Western Australia (Chilton 1925a, Williams & Barnard 1988).

WAM. Lectotype: WAM 10661 male, Darlington, Darling Ranges, WA. Paralectotypes: WAM 10661 7 specimens, Darlington, Darling Ranges,

WA, selected by Williams & Barnard (1988).

CMNZ. Paralectotypes: 14 microslides from 5 specimens variously labelled (2015.149.50–54); 3 specimens in alcohol, Western Australia (from G.E. Nicholls; 2015.149.156–158); 7 specimens, Darlington, W A Brook 'A' / L Glauert 15.ix.23 (2015.149.159–165); 4 specimens, Darlington, W A Brook 'B' / L Glauert 15.9.23 (2015.149.166–169).

Nicea egregia Chilton, 1882

= ? *Ceina egregia* (Chilton, 1882) Ceinidae

Described briefly from 'Lyttelton Harbour' ?material (Chilton 1882c). Described in detail later from material at 'Lyttelton Harbour. On seaweed, usually at roots of *Macrocystis*' (Chilton 1883b).

CMNZ. Syntype: 1 microslide. '~~*Nicea*~~ *Ceina egregia*, Lyttleton ...of original specimen' (2015.149.47). Non-type. '~~*Nicea*~~ *Ceina egregia*, Lyttleton ... of young male of specimen described in 1883' (2015.149.48).

The original genus name is crossed out on both microslides. The microslide card catalogue makes it clear that 2015.149.47 is a type specimen.

Niphargus australiensis Chilton, 1923

= *Victoriopisa australiensis* (Chilton, 1923) Eriopisidae

Australia. South-West Rocks, Trial Bay, New South Wales (Chilton 1923b, Karaman & Barnard 1979).

AM. Holotype: P.5852 (in alcohol); P.5852.001 (microslide).

CMNZ. No material located or catalogued.

Niphargus chilkensis Chilton, 1921

= *Victoriopisa chilkensis* (Chilton, 1921) Eriopisidae

India, Chilka Lake. Off Samal Island, 3–15 ft., 22-ix-13. One. / Off Barkul, 21-vii-13. Two. / One mile S. of Kalidai. Several. 4 to 9 miles E.½S. of Barkul bungalow. Several. / 3 to 2 miles S.E. by E.½S. of Patsahanipur. Four. 1 mile E. by N. of Patsahanipur. Five. / 2 miles E. by S.½S. of Patsahanipur. Several. / 1 to 9 miles N.E. by E. of Kalidai. Several (Chilton 1921a, Karaman & Barnard 1979).

CMNZ. Syntypes: male K (5 microslides, 2015.149.55); ?male P (5 microslides, 2015.149.56); male H (3 microslides, 2015.149.57); fragments (1 microslide, 2015.149.58); 4 specimens in alcohol, Chilka Lake (2015.149.170–173).

Niphargus indicus Chilton, 1923

= *Indoniphargus indicus* (Chilton, 1923) Mesogammaridae

India. In Jamuria Colliery, 300 ft. deep, Asansol, Bengal (Chilton 1923a).

CMNZ. Syntypes: 5–7 syntypes on 7 microslides (2015.149.59–65), '*Niphargus indicus* Chilton sp nov. Jamuria Colliery, Asansol, Bengal.'; 35 syntypes in alcohol (2015.149.174–208).

Niphargus philippensis Chilton, 1920

= *Flagitopisa philippensis* (Chilton, 1920) Eriopisidae

Philippines. From a well at Los Baños, Luzon. Collected by S. Lantican (Chilton 1920a, Sawicki et al. 2005).

CMNZ. Syntypes: female A (4 microslides, 2015.149.66); female B (4 microslides; 2015.149.67); various appendages (1 microslide, 2015.149.68); various appendages 'of cliff event specimens' (1 microslide, 2015.149.69); 12 specimens 'From a well at Los Banos, Luzon. Collected by S. Lantican sent by C.F. Bauer' (in alcohol; 2015.149.424–435).

Orchestia chiliensis gracilis Chilton, 1921

= *Transorchestia gracilis* (Chilton, 1921) Talitridae

Chile, Juan Fernandez Archipelago, Masatierra, Portezuelo, under stones 3.XII.16. S.P.E. No. 32. One male specimen only (Bousfield 1982, Chilton 1921c).

CMNZ. Holotype not located. Non-types: 9 slides from Masatierra with similar but non-identical data. One vial from Chile was found amongst 5 jars of *O. chiliensis* but this has very different data.

Orchestia bollonsi Chilton, 1909

= *Transorchestia bollonsi* (Chilton, 1909) Talitridae

Bounty Islands, under guano (Dr L Cockayne, July 1903); Snares (Chilton, 11th November 1907) Type in the Canterbury Museum, Christchurch (Bousfield 1982, Chilton 1909b).

CMNZ. 4 potential holotypes in alcohol: '♂ and ♀, Bounty Islands, Type! D.L. Cockayne 1903' (2015.149.436–439). Also abundant non-type material in alcohol and on microslides.

Although Chilton cited a 'type' he did not separate a single specimen from the vial of four specimens.

Orchestia miranda Chilton, 1916

= *Transorchestia miranda* (Chilton, 1916) Talitridae

Mr. T. B. Smith, of the Stephen Island Lighthouse, a large number of specimens (Bousfield 1982, Chilton 1916b).

CMNZ. 2 syntypes on 14 slides A_1-A_{10} (2015.149.605), B_1-B_4 (2015.149.606); Syntypes in alcohol: 5 large males (2015.149.607–611); 29 medium-sized males (2015.149.612–640); 64 medium-sized females '? or *O. chiliensis*' (2015.149.641–704); 31 medium-sized males and females (2015.149.705–731).

Orchestia parva Chilton, 1909

= *Makawe parva* (Chilton, 1909) Talitridae

Several specimens from Norman's Inlet taken in company with *P. maynei* (J B Mayne); others under logs on Auckland Island (Professor W B Benham). Type in the Canterbury Museum. (Chilton 1909b, Duncan 1994).

CMNZ. Holotype: '*Parorchestia parva* Chilton, Auckland Island, C.P.I. expedition 1907, Type!' (in alcohol, abdomen missing; 2015.149.209). 5 microslides, A_1 to A_5, apparently from the holotype are currently missing.

Orchomenopsis (?) *coatsi* Chilton, 1912

= *Pseudorchomene coatsi* (Chilton, 1912) Lysianassidae

Antarctica. Scottish National Antarctic Expedition station 411, Coats Land, lat. 71°S, long, 22°W: 161 fathoms. 12th Mar 1904. Many specimens, about 13 mm long (Chilton 1912, De Broyeret al. 2007).

Royal Scottish Museum. Lectotype: 1921.143.938 (Lowry & Stoddart 1983)

AM. Paralectotype: P.32402.001 (microslide).

CMNZ. Paralectotypes: 2 specimens on 10 microslides (2015.149.70–71); specimens in alcohol 'Bottle 660' missing.

Panoplaea translucens Chilton, 1884

= *Whangarusa translucens* (Chilton, 1884) Calliopiidae

Lyttelton Harbour. Three specimens taken in company with numerous specimens of *P. debilis* (Barnard & Karaman 1987, Chilton 1884a).

CMNZ. Syntypes: entire specimen labelled *Panoploea translucens* on 1 microslide (2015.149.74); 2 possible syntypes labelled *Apherusa translucens* male and female on 7 microslides (2015.149.72–73).

Paranaenia longimanus Chilton, 1884

= *Gammaropsis longimana* (Chilton, 1884) Photidae

Lyttelton Harbour (Chilton 1884a).

CMNZ. No material located or catalogued.

Paranaenia typica Chilton, 1884

Photidae

Lyttelton Harbour (Chilton 1884a).

CMNZ. Syntypes: 2 specimens on 1 microslide (2015.149.75–76). No specimens in alcohol located or catalogued.

Parorchestia improvisa Chilton, 1909

= *Kanikania improvisa* (Chilton, 1909) Talitridae

Snares, five female specimens (G R Marriner). Also found in Stewart Island. Type in Canterbury Museum (Chilton 1909b, Duncan 1994).

CMNZ. Potential holotype: in alcohol 'Type!, The Snares, C.P.I. Exped. 1907' (2015.149.210). 1 potential holotype on six microslides A_1-A_6 but not located.

The six microslides from one specimen have not been located [according to Duncan (1994) this specimen most closely resembles the original description]. The Snares and Stewart Island specimens have not been located either. Duncan (1994) described various specimens not from the original series as paratypes which they cannot be.

Parorchestia insularis Chilton, 1909

= *Makawe insularis* (Chilton, 1909) Talitridae

Campbell Island (Mr G R Marriner and Messers Des Barnes and Chambers), only a comparatively small number of specimens were actually secured. Type in the Canterbury Museum (Chilton 1909b, Duncan 1994).

CMNZ. Holotype: 'Type!, Campbell Island, C.P.I. Exped. 1907' in alcohol (2015.149.211); 1 microslide, 'Type, ♂, gn1 & gn2' (Tray 39, Microslide 7) from the same specimen is missing.

Hurley (1957) listed 'microslides CM1, CM2' as syntypes. He and Johns & Pollard (2002) were incorrect when they stated that there are syntypes.

Parorchestia maynei Chilton, 1909

= *Makawe maynei* (Chilton, 1909) Talitridae

Several specimens, both male and female. From Norman Inlet, Auckland Island (J B Mayne), and one male and two females from Disappointment Island (Professor W B Benham). To this species I refer also some female specimens collected on Adams Island at a height of 2000 ft. by Mr R Speight, and also others collected by myself on Auckland Island. Type in the Canterbury Museum (Chilton 1909b, Duncan 1994).

CMNZ. Holotype (male) and paratype (female) in alcohol (2015.149.212–213). Parts of holotype on 7 microslides currently missing.

The designation of the male as holotype is based on its slide catalogue card which states 'type ♂ A_1 to A_7'. Duncan (1994) stated that a holotype is present but did not label it, and implied that Hurley (1957) mentioned syntypes. Johns & Pollard (2002) incorrectly stated that a lectotype is present.

Phreatogammarus helmsi Chilton, 1918

Phreatogammaridae

Rona Bay, Wellington Harbour; Waikawa and Torea Bays, Queen Charlotte Sound; Kenepuru Sound (C Chilton); Greymouth (R Helms); Akaroa (C. Chilton). At the mouths of fresh-water streams near high water mark (Chilton 1918b).

CMNZ. Syntypes: 7 specimens on 9 microslides (2015.149.77–83). Material in alcohol 'Bottle 590' not located. For redescriptions of this species see Hurley (1954) and Chapman (2003).

Phreatogammarus propinquus Chilton, 1907

Phreatogammaridae

A small pool near the top of Mount Anglem, 2800 feet above sea-level, Stewart Island, New Zealand (J Crosby Smith), only one specimen (Chilton 1907).

CMNZ. Holotype: 1 microslide (2015.149.87), 'Type, ii.07', seen by Hurley (1954). Non-type: 'May 1921 C. Chilton', illustrated by Hurley (1954).

Podoceropsis insignis Chilton, 1926

= *Gammaropsis insignis* (Chilton, 1926) Photidae

Thailand. Talé Sap, Station 27. Four specimens (Chilton 1926a).

CMNZ. Syntypes not located. 2 non-types on 2 microslides from other stations: male *Podoceropsis insignis* n.s. Tale Sap. Sta. 35; young male *Podoceropsis insignis* n.s. Tale Sap. Sta. 36, 30.1.(19)16. No specimens in alcohol located or catalogued.

Podocerus frequens Chilton, 1883

= *Ventojassa frequens* (Chilton, 1883) Ischyroceridae

Listed but not diagnosed, without locality (Chilton 1882c). Lyttelton Harbour (Barnard 1970, Chilton 1883b).

CMNZ. Syntypes: 1 male on microslide (2015.149.84); 1 female on microslide (2015.149.85); 1 sex unstated on microslide (2015.149.86). Non-types: The vial mentioned

in the entry for Podocerus latipes (see next) is considered to be a later collection and not part of the syntype series for P. frequens.

Podocerus latipes Chilton, 1884

= *Ventojassa frequens* (Chilton, 1883) Ischyroceridae

Lyttelton Harbour (Barnard 1970, Chilton 1884a).

CMNZ. Possible syntypes. The only mention of this name found in catalogues or labels is a vial with a mix of *Podocerus frequens* and putative male *P. latipes*, 30 specimens in alcohol labelled '*Jassa frequens* (Chilton), ♂ *Podocerus latipes* Chilton, Lyttleton Harbour' (2015.149. 575–604) (also see previous entry).

Platyischnopus neozelanicus Chilton, 1897

= *Otagia neozelanicus* (Chilton, 1897) Otagiidae

Otago Harbour, New Zealand, only a single specimen taken by surface-netting on the night of September 19th, 1891 (Barnard & Karaman 1991, Chilton 1897, Hughes & Lörz 2013).

CMNZ. Holotype: 1 specimen on 2 microslides, both labelled 'Type!' (2015.149.88).

NIWA. Neotype [set aside]: NIWA 85992, South Taranaki Bight, south of Hawera, New Zealand.

Hughes & Lörz (2013) assumed that Chilton's type material was lost and erected a neotype from South Taranaki, New Zealand. Following ICZN Article 75.8 this neotype designation must be set aside.

Syndexamine carinata Chilton, 1914

Dexaminidae

Oamaru, on East Coast of South Island of New Zealand, four specimens; one small immature specimen from Lyttelton Harbour (Chilton 1914).

CMNZ. Syntype: 1 specimen on 6 microslides, 'Type!' (2015.149.89). Potential syntypes (in alcohol) 'Oamaru, N.Z' missing from empty Chilton jar 601.

Talorchestia sinensis Chilton, 1925

= *Sinorchestia sinensis* (Chilton, 1925) Talitridae

China. 'Recently received from Professor S. F. Light, University of Amoy ... both specimens were males' (Chilton 1925c, Hisashi & Hiroshi 1999).

CMNZ. Syntype: male on 2 microslides, '*Talorchestia sinensis* n.s.', catalogued in microslides as 'ant, gn, prp' (2015.149.1862). Potential syntype specimens in alcohol missing, empty vial labelled 'Kulangsu Is. Amoy, China. S F Light [Type – see microslides]'.

Chilton (1925c) did not specify a type locality, only from whom he received the two specimens.

Teraticum typicum Chilton, 1884

= *Seba typica* (Chilton, 1884) Sebidae

Lyttelton Harbour. Three specimens only (Chilton 1884a).

CMNZ. Syntypes: 2 specimens on microslides 11 (2015.149.1868) and 12 (2015.149.1869), the former 'type'. The microslide catalogue states 'These are the two specimens originally described as *Teraticum typicum* Chilton. Microslide 12 was sent to M. Chevreux about 1898 for comparison with *S. armata*, was damaged in transit and remounted in Edinburgh'.

Thaumatelson inermis Chilton, 1912

= *Prothaumatelson nasutum* (Chevreux, 1912) Stenothoidae

South Atlantic. South Orkneys, Scotia Bay. Station 325; 9–10 fathoms. April and May 1903. Several specimens, the largest 3 mm. long (Chilton 1912, Krapp-Schickel 2006).

CMNZ. No material located or catalogued.

The deposition of the specimen was not mentioned. Likely depositories include Scottish museums.

Thaumatelson walkeri Chilton, 1912

= *Antatelson walkeri* (Chilton, 1912) Stenothoidae

South Atlantic. South Orkneys, Scotia Bay. Station 325. April and May 1903. Several specimens, the largest 3 mm. long (Chilton 1912, Krapp-Schickel 2006).

CMNZ. No material located or catalogued.

The deposition of the specimen was not mentioned. Likely depositories include Scottish museums.

Isopoda

Actaecia opihensis Chilton, 1901

Scyphacidae

Timaru, under seaweed at high water mark (Chilton 1901, Schmidt 2002).

CMNZ. Syntypes: 3 specimens on microslides, '*Actoecia* [sic] *opihensis* Chilton, Timaru N.Z.'(2015.149.1773–1775). No material in alcohol located or catalogued.

Anthura affinis Chilton, 1883

= *Mesanthura affinis* (Chilton, 1883) Anthuridae

Listed without description from Lyttelton Harbour (Chilton 1882c). Lyttelton Harbour. Found on seaweed at low tide (Chilton 1883b).

CMNZ. Syntypes: 1 specimen '*Anthura affinis* Chilton Lyttelton, N.Z. C.C.' illustrated by Poore & Lew Ton (1986) (in alcohol; 2015.149.214); 1 specimen on 2 microslides, Lyttelton (2015.149.1776).

Barnard (1925) reported seeing 'two of Chilton's cotypes of *A. affinis*', sent to him in Cape Town and his label '=*Haliophasma maculata* Has. [undecipherable] K.H.B.' is in the tube. Johns & Pollard (2002) incorrectly listed a holotype.

Anthura (?) *flagellata* Chilton, 1882

= *Paranthura flagellata* (Chilton, 1882) Paranthuridae

Lyttelton, single specimen (Chilton 1882b) [February 1882]; (Chilton 1882b) [May 1882] (Barnard 1925).

CMNZ. Holotype: entire specimen on 1 microslide (2015.149.1777). Non-type in alcohol: Lyttleton Harbour, C(has) C(hilton), figured by DCH (2015.149.370).

Barnard (1925) reported seeing 'male cotypes from Chilton' who sent him material. These cannot be types since a single specimen was reported in the first, albeit brief, description. Barnard (1925) incorrectly synonymised this with *Paranthura ciliata* Whitelegge, 1901 (Poore 1984).

Armadillo hamiltoni Chilton, 1901

= *Coronadillo hamiltoni* (Chilton, 1901) Armadillidae

Petane, near Napier (A Hamilton), only the dried specimen originally described and figured, but not named, by Mr Thomson (Chilton 1901, Vandel 1977)

CMNZ. Holotype: 1 microslide, 'Petane Napier A. Hamilton' (2015.149.1778).

Armadillo macmahoni Chilton, 1901

= *Sphaerilloides macmahoni* (Chilton, 1901) Armadillidae

Kenepuru, Malborough, in the bush (MacMahon) (Chilton 1901, Vandel 1977).

CMNZ. Syntypes: 22 specimens in alcohol, '*Cubaris macmahoni* Chilton, Kenepuru, J. Macmahon, [Co-types]' (2015.149.215–236). No microslides located or catalogued.

Cassidina pulchra Chilton, 1924

Sphaeromatidae

India. Chilka Lake. Eight miles W. by S. of Breakfast Island. One specimen. / Off Samal Island, 8-15 ft. Several specimens (Chilton 1924).

CMNZ. Syntypes: 1 specimen on 3 microslides '*Cassidina pulchra* Chilton n.s. Chilka Lake' (2015.149.1779); 'ser. No. 4 – 4 specimens' in alcohol (2015.149.2–5).

Cirolana nigra Chilton, 1924

= *Anopsilana willeyi* (Stebbing, 1904)

India, Chilka Lake. Chirriya lsland, 2 specimens. / Maludai Kuda Island, several. / Barkul Point, 4 specimens. / Found along with the terrestrial isopod, *Alloniscus pigmentatus*, B. L., under stones at the edge of the lake (Bruce 1986, Chilton 1924).

CMNZ. 4 syntypes Chilka Lake sta. 5 (in alcohol; 2015.149. 243–246); 1 potential syntype on microslide 'dissection' catalogued as tray 29 not located. No details of localities of stations given in this paper nor in introduction to Chilka Lake

survey by Annandale & Kemp (1915).

Cruregens fontanus Chilton, 1882

Paranthuridae

Pump at Eyreton, North Canterbury (Chilton 1882d) [February 1882]; later described in detail (Chilton 1882e) [May 1882].

CMNZ. Syntypes: 3 or more syntypes on 10 microslides (2015.149.1780–1789). 45 syntypes in 3 vials in alcohol 'Eyreton (in wells)' 2015.149.736–739; 2015.149.740–749; 2015.149.750–780). Non-types: One specimen, Waddington, in well 18 feet deep W Deans Aug 1922 (2015.149.781).

Johns & Pollard (2002) incorrectly referred to a holotype from Eyreton.

Cubaris claytonensis Chilton, 1917

Armadillidae

Australia, South Australia: Clayton Creek, 2 specimens; Higgins Dam, 1 specimen (Chilton 1917c).

CMNZ. No material located or catalogued.

Cubaris helmsianus Chilton, 1917

= *Merulana helmsiana* (Chilton, 1917) Armadillidae

Australia. Barrington Tops, (4,600 feet), NSW (C Hedly); Mount Kosciusko, (R Helms). (Chilton 1917d, Green et al. 2002)

CMNZ. Syntypes: 2 specimens in alcohol, 'Mt Kosciusko, R. Helms, 1889' (2015.149.6–7). 1 syntype on microslide '*Cubaris helmsianus* ♂, Kosciusko, p^1 p^2 p^7' catalogued as 'prp of type of Haploph. h(elmsii)'(2015.149.1820)

AM. Syntypes: Mount Kosciusko, P.4077; Mount Kosciusko, P.4084.001 (microslide); Barrington Tops: P.4078 (3 syntypes).

Cubaris milleri Chilton, 1917

= *Coronadillo milleri* (Chilton, 1917) Armadillidae

Under the bark of fallen logs in the bush, Levin, Wellington, 8 specimens (Chilton 1917a, Taiti et al. 1998, Vandel 1977).

CMNZ. Syntype: 1 microslide 'D. Miller 1916 Levin' (2015.149.1791); 6 syntypes in alcohol (2015.149.237–242).

Cubaris suteri Chilton, 1915

= *Coronadillo suteri* (Chilton, 1915) Armadillidae

Henderson, Auckland, a single specimen (H. Suter) (Chilton 1915b, Taiti, Paoli & Ferrara 1998, Vandel 1977).

CMNZ. Holotype: 'H. Suter Henderson Auckland', 1 microslide [antenna of holotype] and in alcohol 'Type!' [left antenna missing] (2015.149.258).

Cymodocea cordiforaminalis Chilton, 1883

= *Dynamenella cordiforaminalis* (Chilton, 1883) Sphaeromatidae

Lyttleton Harbour (Chilton 1883d, Hurley & Jansen 1977).

CMNZ. Syntypes: 1 syntype, abdomen only, on 1 microslide, 'Lyttleton, pleon of type' (2015.149.805); 23 specimens in alcohol, Lyttleton (2015.149.782–804).

Johns & Pollard (2002) incorrectly listed a holotype.

Exosphaeroma parva Chilton, 1924

Sphaeromatidae

India, Chilka Lake. Maludai Kuda Island, 2 specimens. / off Samal Island, 8–15 ft. Several specimens. / Rambha. 22-9-13, several specimens (Chilton 1924).

CMNZ. Syntypes: 1 specimen on 3 microslides 'Chilka Lake'; 5 specimens in alcohol 'Chilka Lake ser. No. 5' (2015.149.247–251).

Haloniscus searlei Chilton, 1920

Oniscidea Chrinocheata incertae sedis

Australia. Lake Corangamite, Victoria (in salt water), March April 1918, eight in number (Chilton 1920b, Schmalfuss 2003).

CMNZ. Syntypes: male 'a' on 6 microslides (2015.149.1793); 5 specimens in alcohol [AFD reported these 'could not be located by Williams (1970)'] jar 47 (2015.149.252–256).

NMV. Syntypes: Lake Corangamite, Victoria,

04/1918, J1650 (2 syntypes); J1651 (3 syntypes).

Together, the material from the two museums totals more than the eight specimens cited by Chilton (1920b).

Haplophthalmus australis Chilton, 1909

= *Notoniscus australis* (Chilton, 1909) Styloniscidae

Campbell Island, on decaying wood and at roots of plants. Type in Canterbury Museum, New Zealand (Chilton 1909b, Chilton 1915b, Vandel 1952).

CMNZ. Holotype: specimen A, body and dissected limbs, on 3 microslides labelled '*Notoniscus australis* (Chilton) cotype! female Campbell Island Nov 1907' (2015.149.1794). Other material: entire specimen on microslide labelled '*Notoniscus australis* (Chilton) Campbell Island N.Z. 1907' (2015.149.1795).6 specimens in alcohol labelled '*Notoniscus australis* Campbell Island 1907' (2015.149.259–264); 2 specimens in alcohol labelled '*Haplophthalmus australis* Campbell Island C.P.I. [Canterbury Philosophical Expedition] Exped 1907' (2015.149.265–266).

Haplophthalmus helmsii Chilton, 1901

= *Notoniscus helmsii* (Chilton, 1901) Styloniscidae

Greymouth. A single specimen collected by R Helms (Chilton 1901, Chilton 1915b, Vandel 1952).

CMNZ. Holotype: '*Notoniscus helmsii* (Chilton) [=*Haplophthalmus helmsii* Chilton] Greymouth (R. Helms) Type! ix.1888" in alcohol with pereopods on 1 microslide (2015.149.257).

Haplophthalmus tasmanicus Chilton, 1915

= *Notoniscus tasmanicus* (Chilton, 1915) Styloniscidae

Australia. Under rotten logs, Fern Tree Gully, Hobart, Tasmania; collected by Dr Dendy in 1889, only a single specimen (Chilton 1915b, Green 1961).

CMNZ. Holotype: specimen in alcohol and microslide labelled '*Haplophthalmus tasmicus* [sic] Chilton ant prp of Type!' (2015.149.258).

Hemiporcellio strzelecki Chilton, 1917

= *Agnara strzelecki* (Chilton, 1917) Agnaridae

Australia, South Australia. Strzelecki Creek, 2 specimens (Chilton 1917c, Schmalfuss 2003).

CMNZ. No material located or catalogued.

SAM. Syntype: male, Strzelecki Creek, South Australia

Idotea festiva Chilton, 1885

= *Takearana festiva* (Chilton, 1885) Idoteidae

Sumner, Canterbury, New Zealand. A single specimen, taken on the under surface of a boulder exposed at low tide (Chilton 1885a). (Poore & Hurley 2015)

CMNZ. Holotype: Sumner (2015.2.267; was dry on microslide but transferred to alcohol in the past). Non-type: New Brighton E W Bennett 2 Jul 1927 (2015.149.268)

Jaera novae-zelandiae Chilton, 1883

= *Jaera novaezelandiae* Chilton, 1883 Janiridae

Lyttleton Harbour (Chilton 1883d)

CMNZ. No type material located or catalogued. Two vials of unidentified *Jaera* sp. from Akaroa and Port Chalmers cannot be types.

Jaeropsis neo-zelanica Chilton, 1892

= *Joeropsis neozelanica* Chilton, 1892 Joeropsididae

Akaroa: a single specimen on the under-surface of a stone exposed at low tide. Lyttelton: a single imperfect specimen forwarded by Mr R M Laing (Chilton 1892b).

CMNZ. Syntype: 1 entire specimen on microslide '*Jaeropsis curvicornis* (Nicolet) Akaroa = *Jaeropsis neozelanica* Type' on oval and square Chas. Chilton labels (2015.149.1797).

Chilton (1892b) misspelled the genus name.

Janira longicauda Chilton, 1884

= *Iathrippa longicauda* (Chilton, 1884) Janiridae

Lyttelton Harbour. A single specimen (Chilton 1884a).

CMNZ. Non-type: specimen B (4 microslides labelled *Iathrippa longicauda*; 2015.149.1798). Other specimens missing from empty Jar 177 (in alcohol).

The fact that the only material in the collection is labelled 'specimen B' indicates that it is not the holotype.

Janira neglecta Chilton, 1909

= *Ianiropsis neglecta* (Chilton, 1909) Janiridae

Carnley Harbour, Auckland Islands, 2 fathoms (Professor W B Benham) ; also known from Port Chalmers, and from Lyall Bay, Wellington, New Zealand (Chilton 1909b).

CMNZ. Syntypes: 1 specimen on 1 microslide, Carnley Harbour (2015.149.1799); 1 specimen on 1 microslide, Port Chalmers (2015.149.1800); 1 specimen on 2 microslides (2015.149.1801), Port Chalmers; 1 specimen in alcohol, Port Chalmers (2015.149.269)

Limnoria segnis Chilton, 1883

Limnoriidae

Listed but not diagnosed as 'Found on seaweed, Lyttelton Harbour' (Chilton 1882c). Described from material 'On seaweed, Lyttelton Harbour' (Chilton 1883b).

CMNZ. Syntypes: 105 specimens in 3 vials; 3 specimens in microvial 'Co-types' (2015.149.806–808); 13 specimens, Telson and parts of one ♀ figured RJ Menzies 1950 (2015.149.898–910); 89 specimens in alcohol; (2015.149.809–897); whole specimen mounted under circular coverslip on microslide with round label (2015.149.911); dissected specimen 'A' mounted under round coverslip (2015.149.912). 3 non-types on microslides with square white 'Chas. Chilton' labels labelled '*Limnoria segnis* Chilton / Lyttelton Hr' with no date, ii.03 or iii.03 respectively (2015.149. 913–915).

Munna neozelanica Chilton, 1892

Munnidae

Port Chalmers and Brighton, New Zealand, between tide-marks (Chilton 1892a) [Jan 1892]. Redescribed as *Munna neo-zelanica* citing type locality as 'Port Chalmers and Brighton, near Dunedin, between tide-marks' (Chilton 1892b) [May 1892].

CMNZ. Syntypes: 7–8 syntypes on 16 microslides with circular labels 'Port Chalmers' (2015.149.916–923); many specimens in alcohol 'Port Chalmers, N.Z. C.C. 11.xi.89' (2015.149.924–1015).

Oniscus kenepurensis Chilton, 1901

= *Phalloniscus kenepurensis* (Chilton, 1901) ?Oniscidae

Kenepuru (J. McMahon) (Bowley 1935, Chilton 1901, Schmalfuss 2003, Wahrberg 1922).

CMNZ. Syntypes: ant prp on microslides (2015.149.1802); male dissection on microslides 'Marlborough' (2015.149.1803). No type material in alcohol.

Paravireia typicus Chilton, 1925

Sphaeromatoidea incertae sedis

In freshwater, The Horns, Waipurua Creek, Chatham Islands, G E Archey 25 Jan 1924, 5 specimens (Chilton 1925b). Systematic position discussed by Brökeland et al. (2001).

CMNZ. Syntypes: 1 male on 6 microslides (2015.149.804); 1 syntype of unknown sex in alcohol (many appendages removed; 2015.149.270).

Johns & Pollard (2002) incorrectly listed a holotype.

Philougria otakensis Chilton, 1901

= *Styloniscus otakensis* (Chilton, 1901) Styloniscidae

Widely distributed throughout the South Island, New Zealand, in damp situations (Chilton 1901, Green 1971, Vandel 1952).

CMNZ. Syntypes: female on 3 microslides, '*Trichoniscus otakensis* Chilton. Mihiwaka, N.Z. 26.v.90' (2015.149.1805); 3 microslides, 'Dunedin, N.Z.' (2015.149.1806–1808); female and young on 4 microslides, 'Flagstaff Hill, Dunedin, 30.xi.87' (2015.149.1809). 7 specimens in alcohol '*Styloniscus otakensis* Heathcote Estuary' (2015.149.271–277); 36 specimens in alcohol 'Flagstaff Hill Dunedin

N.Z.' (2015.149.278–313); 3 specimens in alcohol 'Hooker Valley Suter' (2015.149.314–316); 14 specimens 'Keneperu J. McMahon" (2015.149.317–330).

Philougria marina Chilton, 1884

= *Deto marina* (Chilton, 1884) Detonidae

Australia. In rock-pools at Coogee, NSW, considerable numbers (Budde-Lund 1904, Chilton 1884b).

CMNZ. Syntypes: 3 microslides, 'Deto marina (Chilton) Coogee Bay, Sydney 1884' (2015.149.1810); '?immature 1.1.84' (2015.149.1811); 'female with eggs 31.xii.83' (2015.149.1812); 39 syntypes in alcohol 'Coogee Bay, 31.xii.83' 2015.149.331–369).

Philougria thomsoni Chilton, 1885

= *Styloniscus thomsoni* (Chilton, 1885) Styloniscidae

Spar bush, Southland (Chilton 1885b) redescribed as *Philygria thomsoni* by Chilton (1886); (Green 1971, Vandel 1952).

CMNZ. Syntype [labelled as such on card catalogue]: whole specimen on 1 microslide; prp on microslide, '*Trichoniscus thomsoni* Chilton Spar Bush, Southland (2015.149.1813).' Abundant non-type material determined as *T. thomsoni* by Chilton from other localities in New Zealand in alcohol and on microslides.

Philoscia oliveri Chilton, 1911

= *Okeaninoscia oliveri* (Chilton, 1911) Philosciidae

Expedition Hill and Mount Junction, Sunday Island; several specimens from each locality (Chilton 1911a, Vandel 1977).

CMNZ. Syntype: 1 syntype on 4 microslides 'Kermadecs, W.R.B. Oliver, 1908' (2015.149.1814). No type specimens in alcohol located or catalogued.

Phreatoicus assimilis Chilton, 1894

= *Neophreatoicus assimilis* (Chilton, 1894) Phreatoicidae

Winchester, South Canterbury, in wells (D L Inwood) (Chilton 1894, Nicholls 1944).

CMNZ. Syntypes: male A on 16 microslides (3 microslides located 2015.149.1815, 13 slides missing), Winchester; female on 1 microslide missing. No material in alcohol located or catalogued.

Phreatoicus australis Chilton, 1891

= *Metaphreatoicus australis* (Chilton, 1891) Phreatoicidae

Australia. Mount Kosciusko Plateau – at Piper's Creek, about 5,700 feet above sea-level (Chilton 1891, Nicholls 1944).

CMNZ. Syntypes: Mt. Kosciusko, Australia, dried specimen on 1 microslide (2015.149.1816); mouthparts on 1 microslide (2015.149.1817); male γ, 1 of 3 microslides (2015.149.1818); male α, 7 microslides (not located); female δ, 3 microslides (not located).

AM. Syntypes, all from Mount Kosciusko National Park, upper Pipers Creek: G.5407 (5 specimens with 1 microslide); P.682 (5 specimens); P.683.001 (specimen on 11 microslides); P.3347 (110 specimens, some sent to Western Australian Museum and to South Australian Museum in 1936); P.3347.001 (SEM stub). Possible syntypes: P.7930 (117 specimens), Thompsons Plain.

NMV. Syntypes: J212 (3 syntypes) Mt K[osciusko], New South Wales.

Phreatoicus kirkii Chilton, 1906

= *Notamphisopus kirkii* (Chilton, 1906) Phreatoicidae

Fresh-water lagoon on Ruapuke Island (Chilton 1906, Nicholls 1944).

CMNZ. Syntype: Ruapuke Is., 1 microslide missing . Label in empty jar.

Phreatoicus kirkii var. *dunedinensis* Chilton, 1906

= *Notamphisopus dunedinensis* (Chilton, 1906) Phreatoicidae

Streams at Mosgiel and Woodhaugh, near Dunedin (Chilton 1906, Nicholls 1944).

CMNZ. Syntype: Dunedin, 1 microslide missing. Potential syntypes in alcohol missing from empty jar 40.

Phreatoicus latipes Chilton, 1922

= *Phreatomerus latipes* (Chilton, 1922) Amphisopidae

Australia. In hot water from Marree (Hergott) bore, and in springs and streams near Coward, Central Australia. Collected by Professor F Wood Jones, Adelaide University (Chilton 1922, Sheppard 1927).

CMNZ. Syntypes: Marree Bore, Central Australia, young on 2 microslides (2015.149.1819–1820); male A on 4 microslides not located; female B on 3 microslides not located. Label in empty jar.

Phreatoicus typicus Chilton, 1883

Phreatoicidae

Pump at Eyreton, single specimen, then six other specimens (Chilton 1883c)

CMNZ. Lectotype: specimen in alcohol (CMNZ catalogue IZ 3550; 2015.149.371). 2 paralectotypes in alcohol (CMNZ catalogue IZ 3549; 2015.149.372–373); designated by Wilson & Fenwick (1999). Other paralectotypes not seen by Wilson and Fenwick (1999): Eyreton, dried whole female, 1 microslide (2015.149.1821); females A and B on 10 microslides currently missing.

Phreatoicus wianamattensis Chilton, 1918†

= *Protamphisopus wianamattensis* (Chilton, 1918) Phreatoicidae (fossil species)

Australia. Wianamatta Shale of St. Peter's Brickworks, Newtown, Sydney, New South Wales, 14 specimens figured (Chilton 1918a, Nicholls 1943).

AM. Lectotype: block 236a, F.16970, specimen "a", CN#6 designated by Wilson & Edgecombe (2003). Paralectotypes: F.16970.

BMNH. Lectotype: block 235a, IN34996, counterpart of 236, specimen "a". Paralectotypes: IN34993, IN18485, IN34996, IN34991, IN34995, IN34994, IN34992.

CMNZ. Paralectotypes on 5 blocks not listed by Wilson and Edgecombe (2003). All blocks are catalogued as Ffc 265. Chilton (1918b) numbered four blocks in red ink: 241a and 241b (2015.149.1863), 211 (2015.149.1864), and 215 (? difficult to read; 2015.149.1865). The fifth block (2015.149.1866) does not have a red number. Figures 2 and 3 in Chilton (1918a) are from Block 241a. These numbers include ones that were reported as missing by Wilson & Edgecombe (2003). Wilson & Edgecombe (2003) designated a lectotype and paralectotypes from the same series and mentioned other material. Canterbury Museum specimens were not listed in Bradshaw et al. (1992), possibly because these specimens seem to have been previously stored with non-fossil invertebrates.

Plakarthrium typicum Chilton, 1882

Plakarthriidae

Found on brown seaweed at Lyttelton (Chilton 1882c). Described later in detail from 'Lyttelton Harbour. On stems of a brown seaweed, probably Ecklonia radiata' (Chilton 1883b).

CMNZ. Syntype: 1 specimen on 2 microslides, body (dried) and antennae (mounted) (2015.149.1822). Non-types: Various specimens in alcohol, none confirmable as syntypes.

Pseudosphaeroma campbellense Chilton, 1909

Sphaeromatidae

Perseverance Harbour, Campbell Island (November, 1907). Numerous specimens taken on the shore, at the mouth of a small fresh-water stream, in company with *Exosphaeroma gigas*; Auckland Island (Dr L Cockayne, 1903). Type in Canterbury Museum, New Zealand (Chilton 1909b).

CMNZ. Potential holotypes: 1 specimen in alcohol, Campbell Island; 'Type presumed, dissected by Chilton, from Cm but probably from Campbell Is series, no label in tube, Drawn by N L Bruce' (2015.149.1016); Campbell Island xi 07, 2 tubes, 1 with one specimen, (2015.149.1018), other with 205 (2015.149.1019–1223); 5 specimens in alcohol, Campbell Is, New Zealand on shore at mouth of small freshwater stream, coll. by C Chilton Canterbury Museum Nov 1907, 2 males, 2 females, 1 juvenile [label written by G C B Poore, ?1990, presumably transcribed from original] (2015.149.1224–1228); 10 specimens, Campbell Island, Perseverance Harbour, C, P. I. Exped. 1907 'Genosyntypes) (2015.149.1229–1238); 11 specimens, Auckland

Is, L Cockayne, vii.03 (2015.149.1762–1772); Male potential holotype on 3 slides, A_1-A_3 plus female co-collected specimen on 2 slides currently missing.

Rocinela simplex Chilton, 1926

= *Alitropus typus* H. Milne Edwards, 1840 Aegidae

Thailand. Talé Sap, Stations 23 (1 female 16 mm long, 1 male, 13 mm and several immature), 6 (1 female 14 long), 8 (1 immature), 31 (several, all immature, the smallest 5 mm long, the largest 11 mm), 25 (3 immature), 9 (one immature, 4.5 mm long, 2 mm broad) (Bruce 1983, Chilton 1926b).

CMNZ. Syntypes not located or catalogued.

Scyphoniscus magnus Chilton, 1909

Detonidae

Campbell Island, abundant on the shore of Perseverance Harbour about high-water mark; Ewing Island, Dr L. Cockayne). Type in Canterbury Museum, New Zealand (Chilton 1909b, Schmidt 2002).

CMNZ. Potential holotypes in alcohol: Ewing Island Dr Cockayne vii.03 4 specimens (2015.149.1720–1724); Campbell Island C.P.I. Exped. 1907 'syntypes' on large paper label, 4 specimens (2015.149.1725–1728); Campbell Island xi.07 33 specimens (2015.149.1729–1761); male, Campbell Is 'A' on 2 microslides (2015.149.1823); female 'A', Campbell Island xi.07, on 3 microslides (2015.149.1824); male, Campbell Island (appendages on microslide) (2015.149.1825).

Scyphoniscus waitatensis Chilton, 1901

Detonidae

Blueskin Bay, Otago, under seaweed, &c. at high-water mark, a few small specimens (Chilton 1901, Schmidt 2002).

CMNZ. Syntypes: 4 microslides '*Scyphoniscus waitatensis* Chilton Waitati, N.Z.' The exact number of specimens mounted on microslides is impossible to determine (2015.149.1826–1829); 9 specimens labelled '*Scyphoniscus waitensis* [sic] Chilton Type! Waitate, Otago' in alcohol (2015.149.374–382).

Serolis bakeri Chilton, 1917

= *Serolina bakeri* (Chilton, 1917) Serolidae

Australia. Encounter Bay, 20–30 fathoms, 2 males, 3 females with eggs (Dr J. C. Verco) (Chilton 1917b, Poore 1987).

CMNZ. Syntype: Encounter Bay, 20–30 f. South Australia, prp on 1 microslide (2015.149.1830); 1 syntype in alcohol, ovigerous female, 'co-type', Encounter Bay, 20–30 fathoms, Dr J C Verco (2015.149.383).

SAM. Syntypes: C383–384 1 male, 2 females, Encounter Bay, South Australia.

Scutuloidea maculata Chilton, 1882

Sphaeromatidae

Timaru and at Lyttelton (Chilton 1882c) and described in detail from 'Timaru, among seaweed at north side of the breakwater; Lyttelton Harbour' (Chilton 1883b).

CMNZ. Syntypes: 13 specimens in alcohol, '*Scutuloidea maculata* Lyttelton – Type' (2015.149.384–396). Non-type: 1 specimen on 3 microslides, Lyttelton 1906 (2015.149.1831).

Johns & Pollard (2002) incorrectly stated there was a holotype for this species and reported the locality as Timaru.

Sphaeroma (?) *egregia* Chilton, 1892

= *Cymodocella egregia* (Chilton, 1893) Sphaeromatidae

Akaroa: two or three specimens only (Chilton 1892b, Hurley & Jansen 1977).

CMNZ. Syntype: 1 syntype on 2 microslides '*Dexamine* (?) *egregria*, Akaroa' including whole body (dried); 2015.149.1832). The corresponding slide catalogue entry states '*Cymodocella*, Akaroa, Type of *Dexamine*(?) *egregia*, Chilton (slides) 15 & 16'.

Hurley & Jansen (1977) followed Hutton (1904) who placed this species in *Cymodocella* Pfeffer, 1887; they erroneously listed Island Bay as type locality. Johns & Pollard (2002) listed this as a primary type but they may not have sighted specimens at that time (P M Johns, pers.

comm.). They also separately listed a holotype from Akaroa for *Dexamene* (sic) *egregia* Chilton. Chilton's label '*Dexamine*', an amphipod genus name, is possibly a lapsus for *Dynamene*, another sphaeromatid genus similar to *Cymodocella*. Both belong in the Dynameniinae.

Stenetrium fractum Chilton, 1884

= *Tristenium fractum* (Chilton, 1884) Stenetriidae

Lyttleton Harbour, single specimen (Chilton 1884a, Serov & Wilson 1995).

CMNZ. Holotype: specimen 'A' on 2 microslides (body; ant gnath), catalogued as 'type' (2015.149.1833).

Trichoniscus commensalis Chilton, 1910

= *Styloniscus commensalis* (Chilton, 1910) Styloniscidae

New Plymouth and Mount Egmont, in nests of *Amblyopone cephalotes* and *Hubena striata* (W W Smith); Rai Valley, in nests of ants (J MacMahon). Probably widely distributed in the North Island and in the north-western portion of the South Island (Chilton 1910, Green 1971, Vandel 1977).

CMNZ. Syntypes: 1 specimen, dissected on 2 microslides, '*Trichoniscus commensalis* Chilton, Rai Valley Marlborough. J. McMahon 1902' (2015.149.1239); microslide with leg fragments without coverslip (2015.149.1240); 398 specimens in alcohol, '*Trichoniscus commensalis* Chilton, Rai Valley. J. McMahon 1902' (2015.149.1241–1638).

Trichoniscus kermadecensis Chilton, 1911

= *Styloniscus kermadecensis* (Chilton, 1911) Styloniscidae

Four specimens, labelled 'Fresh-water stream, Sunday Island' (Chilton 1911a, Vandel 1977).

CMNZ. Syntype: 1 microslide, 'prp 7, W.R.B. O[liver] 1908' (2015.149.1836).

Trichoniscus phormianus Chilton, 1901

= *Styloniscus phormianus* (Chilton, 1901) Trichoniscidae

Very common all over Canterbury, frequently found on the dead decaying leaves of the New Zealand flax (*Phormium*), and always in damp situations. Also from Dunedin, Kenepuru, Greymouth (Chilton 1901, Vandel 1952).

CMNZ. Syntype: 1 specimen on 2 microslides, Canterbury (2015.149.1867). No syntypes in alcohol located or catalogued.

Tylos neozelanicus Chilton, 1901

Tylidae

Lyall's Bay, Wellington (R.M. Laing), 'Wellington, under tussocks near the beach' (G.M. Thomson) (Chilton 1901).

CMNZ. Syntypes: 2 specimens on 5 microslides, 'Wellington, N.Z. G.M. Thomson' (2015.149.1834–1835); 3 specimens in alcohol 'Wellington (Beach), G.M. Thomson' (2015.149.397–399); 3 specimens in alcohol 'Lyall's Bay, Wellington 'Wanganui', R.M. Laing' (2015.149.400–402).

Tanaidacea

Apseudes chilkensis Chilton, 1924

= *Ctenapseudes chilkensis* (Chilton, 1924) Parapseudidae

India, Chilka Lake. 1–3 miles S.E. by E. ½ E. of Patsahanipur. Three specimens. / 1 mile E. by N. of Patsahanipur. Many specimens. / 2–6 miles E. by S. ½ S of Patsahanipur. Several specimens. / Nalbano Island, Chilka Lake. Several specimens. 'Stomach of *Trygon imbricata*'. / Station 158. 'Chief food of *Trygon imbricata*.' Several specimens. / Off Barkul, Chilka Lake. Three specimens. / Off Samal Island, 8–15 feet. One specimen. (Chilton 1924).

CMNZ. Syntypes: specimen C on 3 microslides (2015.149.1839); specimen F on 2 microslides (1840); male J on 4 microslides (2015.149.1841); male K on 3 microslides (2015.149.1842); male cheliped (2015.149.1843); 6 specimens on 6 microslides (2015.149.1844–1849); 81 specimens in alcohol 'Chilka Lake sta. 61' (2015.149.1639–1719).

Apseudes latus Chilton, 1884

Apseudidae

Lyttelton Harbour. A single specimen found creeping in mud at the root of some seaweed (Chilton 1884a).

CMNZ. Holotype on 1 slide 'Lyttleton'; catalogue entry states '*Apseudes latus* Chilton, Lyttleton, Type' (2015.149.1850). Non-type material from Port Jackson.

Apseudes sapensis Chilton, 1926

= *Ctenapseudes sapensis* (Chilton, 1926) Parapseudidae

Thailand. Talé Sap, Stations 5 (several specimens), 6 (1), 8 (many), 9 (5), 11 (1), 21 (5), 23 (several), 31 (5), 37 (several) (Bamber et al. 1997, Chilton 1926b).

CMNZ. Syntypes: 12 specimens, sta.8 Tale Sap Siam (in alcohol; 2015.149.403–414); specimen P (2015.149.1851); specimen Q (2015.149.1852) specimen R (2015.149.1853); specimen S (2015.149.1854); 5 specimens on 5 microslides from Stations 8, 25 or 31 (2015.149.1855–1859).

Apseudes timaruvia Chilton, 1883

= *Apseudomorpha timaruvia* (Chilton, 1883) Metapseudidae

Timaru, single specimen (Chilton 1883a).

CMNZ. Holotype: 1 microslide gnathopod only card catalogue states 'cheliped of type. This is the only part of the type preserved – the rest being used for dissection and sacrificed'; 2015. 149.1860); One jar of non-type material (Jar 170).

Paratanais ignotus Chilton, 1885

= *Leptochelia ignota* (Chilton, 1885) Paratanaidae

Australia, collected in early January, from seaweed, &c., growing on the rocks exposed at low tide near the point known as Lady Macquarie's Chair, in Sydney Harbour (Chilton 1885c).

CMNZ. Syntypes: entire animals on 1 microslide, Sydney 1.1.[18]84. Catalogue card indicates type. No specimens in alcohol located or catalogued.

AM. Neotype [set aside]: P.85770, Port Jackson, Quarantine Bay, NSW.

Edgar (2012) assumed that Chilton's type material was lost and erected a neotype from a nearby locality in Sydney Harbour. Following ICZN Article 75.8 this neotype designation must be set aside.

Decapoda

Elamena (?) *lacustris* Chilton, 1882

= *Amarinus lacustris* (Chilton, 1882) Hymenosomatidae

Lake Pukuke, Auckland (Chilton 1882b) [February 1882]; later described in detail (Chilton 1882a) [May 1882].

CMNZ. Syntype: 1 specimen in alcohol (2015.149.415).

Johns & Pollard (2002) incorrectly listed this as the holotype of *Hymenosoma lacustris* Chilton, 1882.

Eupagurus norae Chilton, 1911

Replacement name for *Eupagurus edwardsii* Filhol, 1885 (preoccupied) = *Diacanthurus spinulimanus* (Miers, 1876) Paguridae

As a replacement name no types are expected (Chilton 1911b). No material of this species known at CMNZ.

Hymenicus marmoratus Chilton, 1882

= *Halicarcinus varius* (Dana, 1851) Hymenosomatidae

Lyttelton Harbour (Chilton 1882b) [February 1882]; later described in detail (Chilton 1882a, Poore et al. 2016).

CMNZ. Syntypes: male, 3 females (in alcohol; 2015.149.416–419).

Iconaxiopsis kermadecensis Chilton, 1911

= *Dorphinaxius kermadecensis* (Chilton, 1911) Axiidae

Several specimens from Meyer Island and Coral Bay; others from rock pools at Sunday Island, collected by Captain Bollons (Chilton 1911a, Poore & Collins 2009).

CMNZ. 4 Syntypes: '53. Meyer Island. 2 rockpools, 19.5.08 W.R.B. Oliver' (2015.149.420–423).

BMNH. Syntypes: 1912.5.25.44–46 (fragments of 5 chelipeds, 1 body with only abdominal segments identifiable, 1 body with anterior carapace, 1 right uropod; annotated 'Cotypes Pres. Prof. Chilton. The specimens came back from Godstowe very macerated—only fragments left. I. G[ordan] v/46.'). New Zealand, Kermadec Islands, Meyer I. and Coral Bay, rock pools at Sunday I. [= Raoul I.] (29°16'S, 177°55'W), Captain Bollons.

Acknowledgements

We thank the Mason Foundation for travel funds for GCBP. Jim Lowry and Stefano Taiti kindly assisted with nomenclatural details for amphipods and oniscidean isopods respectively. Peter Johns provided advice on likely materials used to make slides. Various people searched for Chilton material in collections they care for including Graham Fenwick (National Institute for Water & Atmosphere, Christchurch), Sadie Mills (National Institute for Water & Atmosphere, Wellington), Jim Lowry (AM), Steve Keable (AM) and Kristen Spring (Queensland Museum).

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Two further species of *Deleatidium* (*Deleatidium*) (Ephemeroptera: Leptophlebiidae) from New Zealand

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Two new species of mayfly, *Deleatidium* (*Deleatidium*) *acerbum* sp. nov. and *D.* (*D.*) *kawatiri* sp. nov., from the western South Island of New Zealand are described. The principal life stages are included and have been associated by rearing. Notes on ecology and distribution in weakly acidic streams are given. Diagnostic characters of the new species are illustrated and compared with similar species.

Keywords: Ephemeroptera, key, mayflies, Leptophlebiidae, *Deleatidium*

Introduction

The New Zealand mayfly fauna described at present comprises 8 families in 22 genera. The largest family, the Leptophlebiidae, which is distributed world-wide, includes the New Zealand endemic genus *Deleatidium* Eaton, 1899. Currently *Deleatidium* has 16 species. The genus was described by Eaton (1899) and was added to by Phillips (1930). It was further increased and revised by Towns and Peters (1979, 1996) who divided the genus into two subgenera, *Deleatidium* (*Deleatidium*) and *D.* (*Penniketellum*). Further species were included by Hitchings (2008, 2009a, 2009b, 2010). This work adds another two species. Information is provided for their identification and to distinguish them from similar species. A distribution map and habitat information are included.

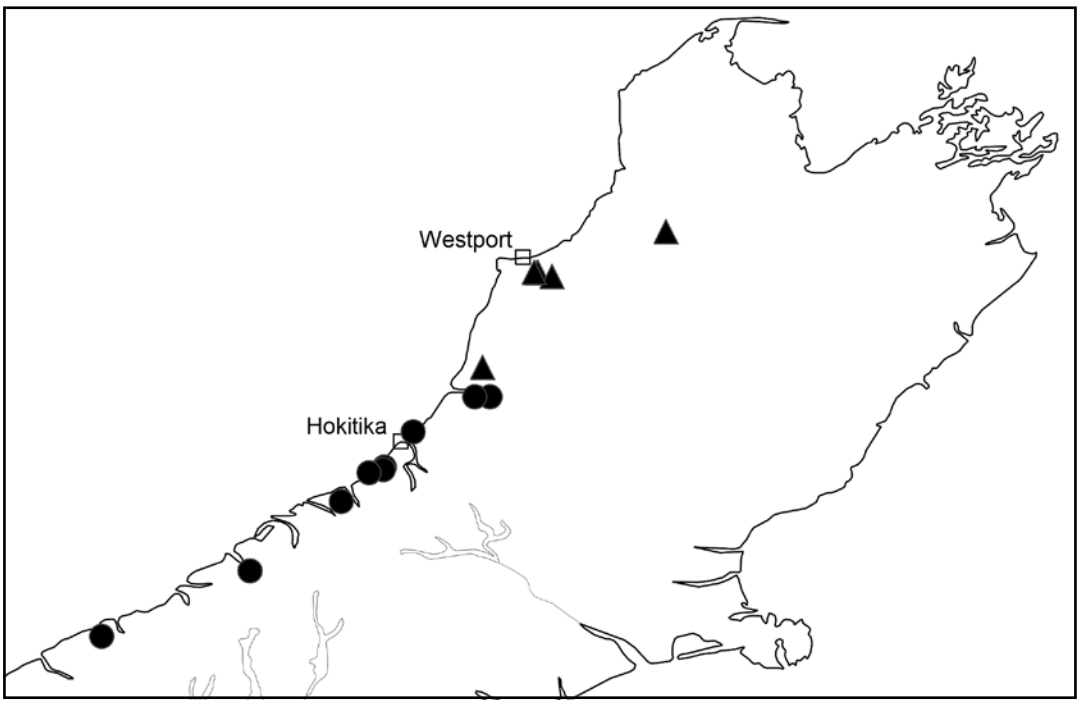
Materials, methods and conventions

Larvae were associated by proximity and rearing in aquaria. All specimens are stored in 80% ethanol. Body, fore and hind wing lengths of imagos and larvae are given, with means in parentheses, length ratios of the foreleg segments (femur: tibia: tarsomeres 1–5) are based on the length of the tibia (absolute measurements in mm, in parentheses). Species variation was not noted as both species were collected from restricted ranges. Species variation is more likely to be observed when collecting has been done over wider areas.

In the case of one of the species (*D.* (*D.*) *acerbum* sp. nov.), it seemed relevant to measure the acidity of the habitat. These streams were monitored using a Digital 222 PE12 pH meter calibrated with pH 4.0 and 7.0 buffers. After the conclusion of the investigation the buffers were found to measure pH 3.95 and 6.95 respectively. Where possible, stream pH was determined at the mountain forest/plain boundary and again in the same stream at a lower point on the plain.

Stream locations were measured from the topographical map series NZ GD 2000/WGS 84 and gradients expressed as a ratio of altitude difference to the map distance between two locations.

Collecting sites are grouped into regions of New Zealand using the system of Crosby et al. (1976) in which each is allocated a two letter code. Regions referred to in this paper are: BR



Collecting sites of *Deleatidium acerbum* ● and *D. kawatiri* ▲ in the western South Island.

- Buller, NC - North Canterbury, NN - Nelson and WD - Westland. Reference is also made to the Westland Forest Ecological Region proposed by Harding and Winterbourn (1997).

Map references are given as latitude and longitude in degrees and decimals of a degree. Heights above sea level are given in metres.

Collections: all material is held at Canterbury Museum, Christchurch (CMNZ), the New Zealand Arthropod Collection, Landcare Research, Auckland (NZAC) and the Swedish Museum of Natural History (SMNH).

Systematics

Order	Ephemeroptera Hyatt & Arms, 1891
Family	Leptophlebiidae Banks, 1900
Genus	*Deleatidium* Eaton, 1899 As diagnosed by Towns and Peters 1996: 27–28.
Subgenus	*Deleatidium* (*Deleatidium*) Towns & Peters, 1996 As diagnosed by Towns and Peters 1996: 30.

Deleatidium (*Deleatidium*) *acerbum* sp. nov. Figs 1–8

Description: Dimensions (mm). Imago, male: length of body 7.3–8.8 (8.0), forewing 10.1–10.5 (10.3). Imago, female: length of body 8.0–8.8 (8.4), forewing 10.7–11.1 (10.9). Mature larva: length of body 6.5–8.5 (7.3).

Male imago: Head dark brown between the eyes; antennal scapes, pedicel and antennae brownish; eyes, dorsal half yellowish brown and ventral half blackish brown, eyes almost in contact on meson of head. Thorax. Pronotum brownish, darker at margins and with a median longitudinal mark. Mesonotum and metanotum dark brown with paler paired longitudinal marks which continue on to the scutellum. Thoracic sterna pale brown, darker at the margins. Legs brownish yellow, blackish at the articulations of the femora and tibiae, paler apically. Length ratios of the foreleg segments 0.70–0.79: 1.00 (2.40–3.25 mm): 0.04–0.08: 0.21–0.34: 0.08–0.13. Tarsal claws of a pair dissimilar, one with a pad only and the other with a pad and hook. By contrast, *D. lillii* Eaton, 1899, has a hook and

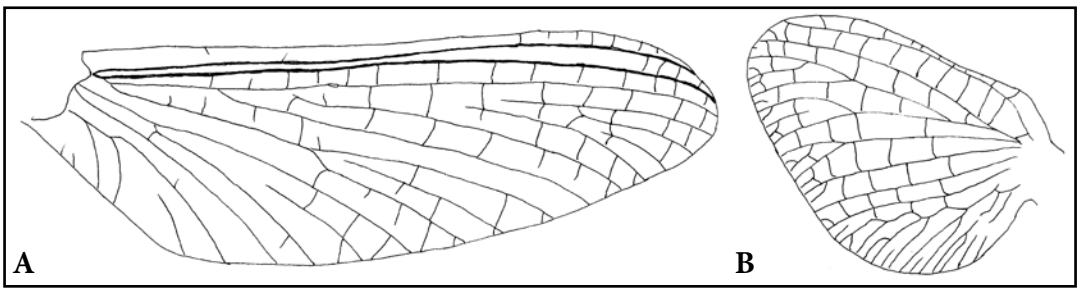


Figure 1. Wings of male imago of *D. acerbum*. **A,** Forewing. **B,** Hindwing (not in proportion).

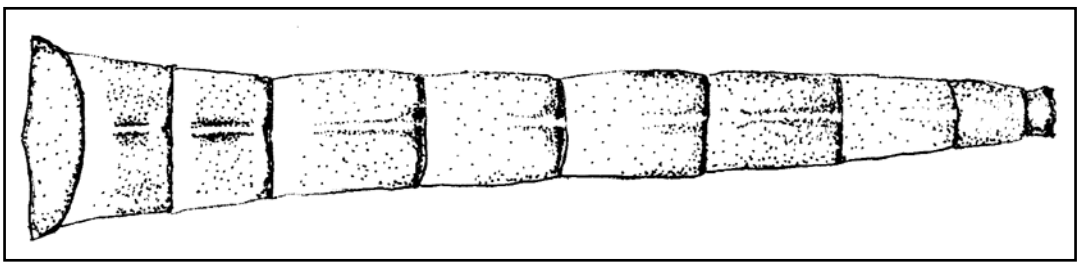


Figure 2. Dorsal abdomen of male imago of *D. acerbum*.

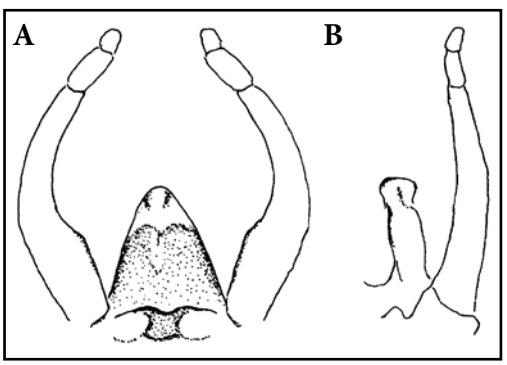


Figure 3. Genitalia of male imago *D. acerbum*. **A,** ventral view. **B,** lateral views.

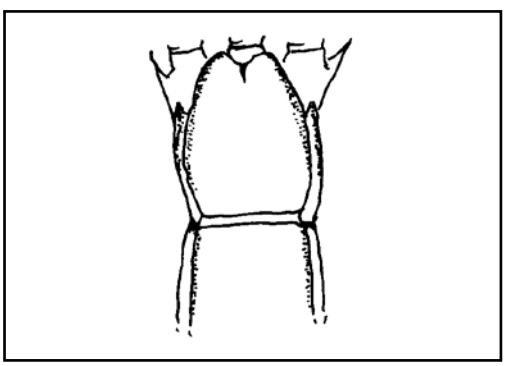


Figure 4. Sternum 9 of female imago of *D. acerbum*.

Figure 5. Dorsal abdomen of mature larva (antennae and caudal filaments truncated) of *D. acerbum*.

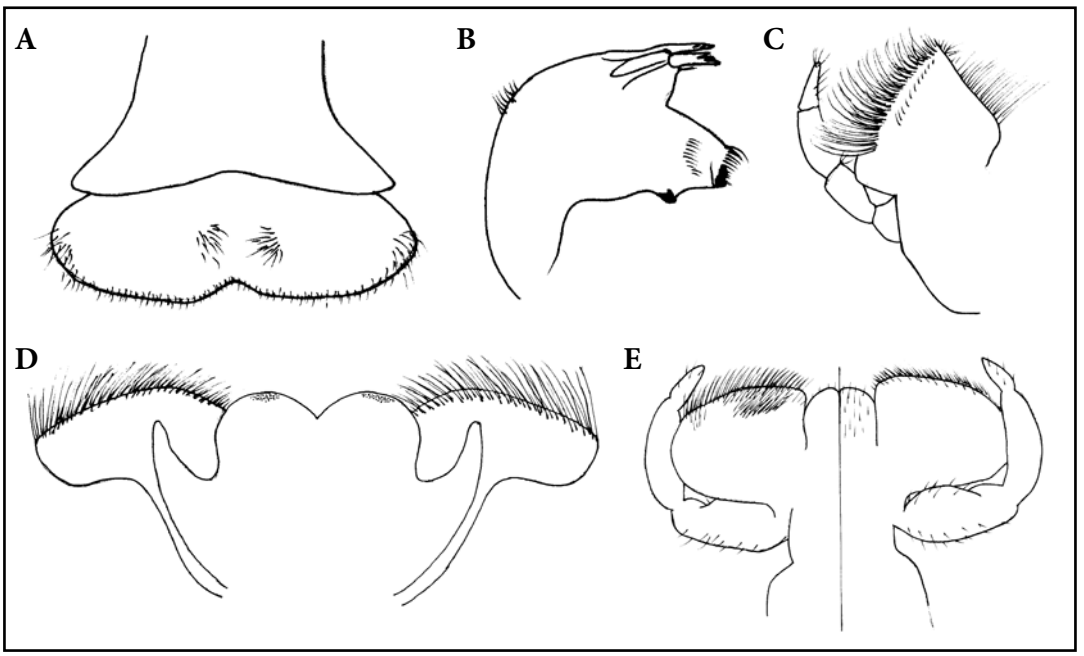


Figure 6. Mouth parts of larvae of *D. acerbum*. **A,** clypeus and labrum. **B,** mandible. **C,** maxilla. **D,** labium. **E,** hypopharynx.

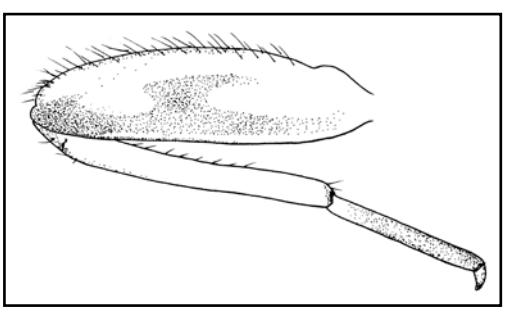


Figure 7. Foreleg of larva of *D. acerbum*.

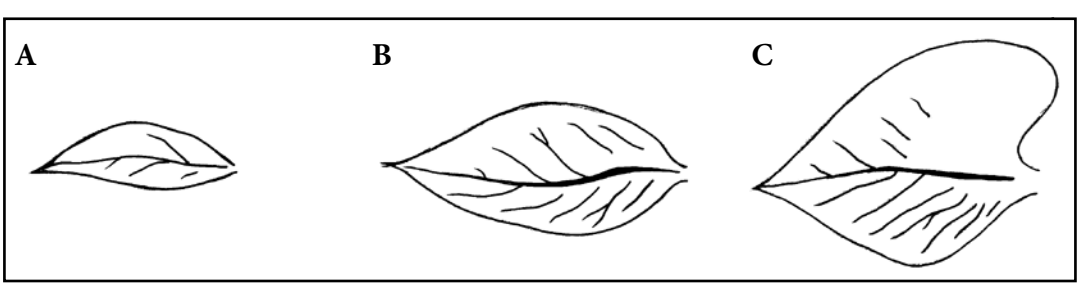


Figure 8. Abdominal gills of larva of *D. acerbum*. **A,** gill 1. **B,** gill 4. **C,** gill 7

also a small opposing hook on the pretarsal pad. Wings (Figs 1a, b). Forewing maximum width 0.31 x length; longitudinal veins: costa and subcosta yellowish brown, the remainder, including cross veins, dark brown. Crossveins between costa and subcosta in the basal portion faint or missing. Membranes hyaline. Hindwing width 0.55 x length and length 0.23 x that of forewing; vein Sc 0.93 x wing length. Cross veins few and faint in the dorsal half of the hindwing. Membranes hyaline. Abdomen (Fig. 2). Terga: yellowish brown, darker at the posterolateral margins; darker diffuse submedian marks separated dorsally by a whitish longitudinal line from terga 1 to 7. Sterna: pale brownish, lighter at posterior margins; ganglia hyaline. Genitalia (Figs 3a, b). Forceps and penes greyish yellow, darker basally. Penes fused to apices, rounded and slightly expanded at mid-length. In ventral view the apical portion with a paler V-shaped mark extending to mid-length. In lateral view penes with a shallow ventral indentation with a darker basal margin. Styliger plate brownish, emarginated. Caudal filaments greyish yellow, darker at the annulations.

Female imago: As in the male imago except as follows: Eyes uniformly blackish grey, head yellowish white, darker at the margins, pedicel brown, ocelli whitish. Eyes separated by about three times an eye width. Pronotum dark brown, meso- and metanotum paler. Forewing width 0.32–0.33 (0.33) x that of the length; length of hind wing 0.20–0.23 (0.22) x that of forewing. Egg guide reduced to a small thickening on the posterior margin of sternum 7. Sternum 9 with a V-shaped cleft extended by a basal cleavage mark (Fig. 4).

Subimago: The male and female as in the imago except as follows: head yellowish brown between the eyes; eyes above yellowish orange and blackish below. Pronotum brownish, divided by a narrow mesial, longitudinal orange line. Mesonotum orangeish with submedian brown marks and lateral black marks. Metanotum orangeish, black laterally. Pleura orangeish, darker at the margins. Ventral thorax pale brown, darker at the margins except for the dark brown lateral sterna. Legs yellowish orange, darker brown at the prolateral and retrolateral margins and the articulations. Wings uniformly greyish with veins C, Sc and R1 pale yellowish. Remaining longitudinal and cross veins greyish. Dorsal abdomen greyish brown with dark brown posterolateral bands. Terga I–7 with paired submedian dark brown marks. Terga 7 and 8 with submedian broad brownish marks. Ventral abdomen pale brown. In the male, genitalia yellowish grey, forceps darker at margins.

Late Instar Larva: Length 6.5–8.5 mm. Head yellowish washed with brownish black especially at margins of clypeus. Eyes of female black; male upper portion yellowish black, lower portion black. Antennae 1.5–1.7 x length of head. Mouth parts (Figs 6a–e) Clypeus and labrum (Fig. 6a). Labrum: length 0.71–0.78 (0.75) x that of clypeus, width 1.09–1.26 (1.17) x that of clypeus. Anterior margin smoothly curved with deep broad anteromedian cleft, no denticles. Mandibles (Fig. 6b). Maxillae (Fig. 6c). Galea-lacinia with subapical row of 20–22 spines. Palp segment 2, 0.94–1.07 (0.99) x length of segment 1; segment 3, 0.67–0.96 (0.78) x length of segment 2. Labium (Fig. 6d). Palp segment 2, 0.86–0.95 (0.88) x length of segment 1; segment 3, 0.42–0.54 (0.48) x length of segment 2. Hypopharynx (Fig. 6e). Thorax brownish yellow. Pronotum with irregular darkish markings towards lateral margin. Pleura pale yellow washed irregularly with brown-black. Foreleg (Fig. 7). Legs yellowish washed with darker black, each femur with a distinct long oval whitish macula proximally and a less distinct oval whitish macula distally. Abdomen. Posterolateral projections generally small on segments 2–9 but increasing in size posteriorly. Terga pale yellow brown to dark brown and with a well-defined posterior transverse band on segments 1–8. Prominent dark lateral maculae on terga 2–6, can be obscured by gills. Pale dorsal median line interrupted by the terminal transverse bands. Sterna pale yellow with ganglia hyaline or faintly pigmented on segment 7. Abdominal gills shown in Figs 8a–c. Gills broad near base, tapering acutely to point at apex. Gill 1 pointed and with small ventral lobe, maximum width 0.5–0.6 x length (Fig. 8a). Gill lamellae translucent with numerous blackish tracheal elements varying between equally developed in

dorsal and ventral lobes to less marked in the ventral lobes. Caudal filaments up to 1.9 x body length, yellowish with whorl of small brown denticles.

Holotype: Male imago, WD, Camp Creek, 42.8518°S, 170.8797°E, 20 m, 25 October 2015, Terry & Tim Hitchings (CMNZ 2016.66.1).

Allotype: Female imago, WD, Camp Creek, 42.8505°S, 170.8780°E, 40 m, 25 October 2015, Terry & Tim Hitchings (CMNZ 2016.66.2).

Paratypes: Male imago, WD, Camp Creek, 42.850°S, 170.878°E, 20 m, 24 January 2016, Terry & Tim Hitchings (CMNZ 2016.66.3); male imago, WD, Camp Creek, 42.850°S, 170.878°E, 20 m, 24 January 2016, Terry & Tim Hitchings (CMNZ 2016.66.4); male subimago, WD, Camp Creek, 42.8518°S, 170.8797°E, 20 m, 25 October 2015, Terry & Tim Hitchings (CMNZ 2016.66.5); 14 female subimagos, WD, Frosty Creek, 42.802°S, 170.942°E, 15 m, 20 January 2001, J B & G M Ward (CMNZ 2014.2.34536–34549); 7 larvae, WD, Stenhouse Creek, 42.8583°S, 170.8717°E, 30 m, 10 July 2014, EOS Ecology Laboratory (CMNZ 2014.2.34550–34556); 3 larvae, WD, Stafford Loop Creek, 42.667°S, 171.031°E, 30 m, 25 October 2015, Terry & Tim Hitchings (CMNZ 2016.66.6–8); male imago, WD, Camp Creek, 42.850°S, 170.875°E, 30 m, 25 January 2016, Terry & Tim Hitchings (NZAC); male subimago, WD, Frosty Creek, 42.8059°S, 170.9421°E, 15 m, 24 October 2015, Terry & Tim Hitchings (NZAC); female imago, WD, Camp Creek, 42.8518°S, 170.8797°E, 20 m, 25 October 2015,Terry & Tim Hitchings (NZAC); female subimago, WD, Frosty Creek, 42.802°S, 170.942°E, 15 m, 28 January 2001, J B & G M Ward (NZAC); 4 larvae, WD, Woolhouse Creek, 42.881°S, 170.800°E, 110 m, 26 January 2016, Terry & Tim Hitchings (NZAC).

Other material examined: 9 larvae, BR, Glenn Creek, Aratika Forest, 42.5687°S, 171.41777°E, 160 m, 14 November 1998, T R Hitchings (CMNZ 2014.2.15527–15535); larva, BR, Kokiri Stream, Arnold, 42.4989°S, 171.3843°E, 60 m, 16 March 1993, T R Hitchings (CMNZ 2014.2.15544); 6 larvae, WD, Camp Creek, 42.850°S, 170.878°E, 40 m, 24 October 2015, Tim Hitchings (CMNZ 2016.66.10–15); female imago, WD, Camp Creek, 42.850°S, 170.878°E, 20 m, 24 January 2016, Tim & Terry Hitchings (CMNZ 2016.66.22); 6 larvae, WD, Camp Creek, 42.8505°S, 170.8780°E, 40 m, 24 October 2015, Tim & Terry Hitchings (CMNZ 2016.66.16–21); female subimago, WD, Canavans Creek, 43.394°S, 170.178°E, 150 m, 20 January 1996, J B Ward (CMNZ 2014.2.34557); 6 female subimagos, WD, Duffers Creek, 43.031°S, 170.655°E, 70 m, 2 February 2002, J B & G M Ward (CMNZ 2014.2.34558–34563); larva, WD, Fox River, 42.041°S,171.394°E, 20 m, 17 May 2014, P E Penney (CMNZ 2014.2.34564); male subimago, WD, Kiwi Creek, near Lake Paringa, 14 February 2002 43.736°S, 169.402°E, 30 m, J B & G M Ward (CMNZ 2014.2.34565); larva, WD, Stenhouse Creek, 42.855°S, 170.860°E, 20 m, 10 July 2014, EOS Ecology Laboratory (CMNZ 2014.2.34566); larva, WD, Woolhouse Creek, 42.881°S, 170.900°E, 110 m, 23 January 2016, Terry & Tim Hitchings (CMNZ 2016.66.9).

Distribution and habitat: Deleatidium acerbum seems to be restricted in distribution to small streams of the coastal plain of Westland between the Buller River in the north and streams flowing into Lake Paringa in the south. This is part of the Westland Forest (WD) ecoregion of Harding and Winterbourn (1997). Much of the region is 5–10 km wide and sloping (gradient 1/50) from east to west into the Tasman Sea. The underlying geology is greywacke and glacial schist gravels derived from the Southern Alps, which form the eastern boundary of the plain (Harding & Winterbourn 1997). Major rivers and many streams originate from rain and snowmelt on tussock and mixed podocarp forest on mountain slopes. In addition, small streams and drains arise on the plain itself and have cut channels sometimes up to 10 metres deep into the alluvium. Many are lightly stained brown with humic acids, a complex mixture of compounds that function as weak dibasic or tribasic acids. These streams are lightly coloured due to microbial degradation of dead plant matter such as lignin. Brown stained streams are typically small (widths up to 3 metres) and acidic, having pH sometimes as low as 4.7 (Harding & Winterbourn 1997, Leathwick et al.

2003). Much of this plain in the area collected is now improved grassland used for pastoral farming.

The impact of acid waters on mayfly populations has been widely studied. Mayflies generally have been found to be relatively sensitive to low pH (Rowe et al. 1989). In several Northern Hemisphere studies, species of Leptophlebiidae have been found to be the most acid tolerant mayflies (Winterbourn & McDiffett 1996). In New Zealand, species of the leptophlebiid genus *Deleatidium* are the most abundant mayflies in acidic brown-water streams (Winterbourn & Collier 1987). Winterbourn and McDiffett (1996) found *Deleatidium* at 32 of 37 sites in northern Westland, in coastal plain streams (pH 5.5–6.7).

In their study of the population dynamics of some acid and alkaline streams, Collier and Winterbourn (1990) were of the opinion that at some of the acidic stream sites they described, only one species of *Deleatidium* (of the informally called "lillii group") was present, whereas in the alkaline studied streams two or three species of both the "lillii" and "myzobranchia" groups were present (Winterbourn et al. 2006). It is possible that *Deleatidium acerbum*, described here, is also the prevalent species in the browner, more acidic waters of relatively unmodified forest streams.

Mayflies were collected from six streams of the coastal plain between Hokitika and Ross and the acidity of the water measured.

Discussion: In general, streams sourced above this part of the Westland coastal plain and draining the steeper slopes tend to be slightly alkaline. As they flow across the plain, now much modified from the original lowland forest, they become weakly acidic. The extent to which this relatively minor lowering of the pH results from the removal of forest cover and modern farming practices can only be conjectured. It has been pointed out that waters containing the salts of weak acids such as the humic acids can act as buffer solutions, which resist a decrease in pH (Kullberg et al. 1993). The addition of weak organic acids to stream water does not necessarily result in much lowering of the pH. Humic substances may significantly increase the survival of mayflies (Holland et al. 2014). The removal of cations such as Fe+++ or Al+++ by the buffering effect may have physiological consequences for aquatic invertebrates. However, it has been found that the richness of ephemeropteran taxa in streams such as these is not correlated with pH down to about 4.5 (Winterbourn & Collier 1987). Mayfly mortality may be linked to additional physical and chemical factors including the presence and concentration of ions other than H+ (Collier et al. 1990). It is also possible that the present distribution of *Deleatidium acerbum* is also, in part, a consequence of the past biogeography of coastal Westland.

Deleatidium acerbum sp. nov. appears to most closely resemble *Deleatidium lillii*. In the imaginal forewing the crossveins between the costa and R1 are mainly indistinct or missing as in *D. lillii* (Towns & Peters 1996: 80). Characters useful for distinguishing *D. acerbum* include: in the male imago; (1) tarsal claw pad without a hook, (2) penes in lateral view with a prominent ventral indentation, the basal surface of which bears a darkened mark. In the female, sternum 9 with a V-shaped cleft, which extends with a cleavage mark. In the larva; (1) fore-femur with a basal whitish oval macula at least 1/3 length

Table 1. Physical characteristics of streams where *Deleatidium acerbum* were collected.

Stream	Region	Altitude (m)	Colouration	Temperature (°C)	pH
Halton Creek	WD	180	Clear	16.2	7.9
Fox Creek	WD	180	Clear	16.4	7.5
Unnamed creek	WD	100	Brown	15.6	6.6
Harvey Creek	WD	50	Brown	15.9	7.0
Woolhouse Creek	WD	20	Brown	17.0	6.3
Camp Creek	WD	20	Brown	21.0	7.0

of femur, (2) gill lamellae with blackish tracheal elements equally developed in dorsal and lateral elements, (3) the presence of prominent dark maculae laterally on terga 2–6.

Deleatidium acerbum also resembles *Deleatidium fumosum* Phillips, 1930, but can be distinguished in the male imago by penes lacking in mid apical ventral appendages and in both sexes by lack of well-defined blackish maculae on any sterna. In the larva, gills broad near the base and tapering to extended filamentous apices on all laminae.

Furthermore larvae of this species, particularly from the Arnold River catchment (BR), closely resemble those of *Deleatidium cerinum* Phillips, 1930. They can be distinguished from the latter by the abdominal body pattern with a pale mid-dorsal line and paired lateral dark dorsal maculae on terga 2–6.

Etymology: The species name is derived from "acerbum" (Latin), "acidic", with reference to the preference of the species for acidic waters.

Deleatidium (*Deleatidium*) *kawatiri* sp. nov. Figs 9–16

Description: Dimensions (mm). Imago, male: length of body 7.8–10.1 (9.0), forewing 8.5–9.8 (9.2). Imago, female: length of body 8.8–9.0 (8.9), forewing 9.5–11.1 (10.3). Mature larva: length of body 6.5–9.1 (8.4).

Male Imago: Head blackish between the eyes and antennal scapes; antennal scapes, pedicel and antennae yellowish brown; eyes, dorsal half yellowish, ventral half black, eyes almost in contact on the meson of the head. Thorax. Pronotum, meso- and metanotum brownish with darker median longitudinal mark and dark margins. Posterior portion of the scutellum dark brown. Thoracic sterna yellowish brown, darker at the margins. Legs yellowish white, articulations of the femora and tibiae darker. Length ratios of the foreleg segments 0.8: 1.0 (2.5 mm): 0.06: 0.30: 0.30: 0.10 (1 specimen only). Tarsal claws of a pair, one with a pad hooked and with an opposing hook, the other with a small unopposed hook. Wings. (Figs 9 a, b). Forewing maximum width 0.35–0.42 x length; longitudinal veins yellowish, darker at costal brace; cross-veins and membrane hyaline. Hind wing maximum width 0.56 x length and length 0.24 x that of forewing; vein Sc 0.96 x wing length; cross-veins few and faint in the dorsal half of the wing, veins greyish, membranes hyaline. Abdomen (Fig. 10). Terga: brownish yellow, anterior and posterior of each tergum darker; a pale mid-dorsal line from terga 1–7; paired, dark brown lateral submedian marks and a transverse posterior band on each segment. Sterna: pale brownish, ganglia usually hyaline but may have faint signs of greyish ganglia markings. Genitalia (Figs 11a, b). Forceps and penes greyish, darker greyish yellow basally; penes tapering uniformly to a narrowing at 2/3 length to apex. Penes fused to a dome-shaped apex and with a prominent ventral mid-apical black inverted U-shaped mark. Styliger plate yellowish brown, slightly emarginated. Caudal filaments greyish yellow with dark brown annulations at articulations.

Female imago: As in imago, except as follows: Eyes uniformly blackish, head greyish, ocelli white, black basally and between them. Eyes separated by about twice an eye width. Thorax greyish brown with similar dark brown submedian maculae on terga 2–6. Sterna brownish grey, darker anteriorly and posteriorly; ganglia faintly greyish. Sternum 9 (Fig. 12) with a deep V-shaped apical cleft.

Subimago: As in the imago except as follows: pronotum and mesonotum brownish, dark brown at the lateral margins, with paler paired median longitudinal marks. Posterior scutal protuberances grey, scutellum darker. Pleura greyish brown, darker at the margins. Legs pale greyish yellow, darker at the femorotibial articulations. Wings uniformly greyish with veins C, Sc and R1 pale greyish yellow. Dorsal abdomen brownish, darker at posterior margins. Ventral thorax and abdomen pale yellowish brown, darker at the posterior margins of the forked sternum and sterna 6–8. Male abdominal body pattern more strongly marked than that of the female. Male genitalia greyish yellow, penes pale grey apically.

Larva: Head yellowish grey, darker at the margins; labrum greyish laterally, clypeus

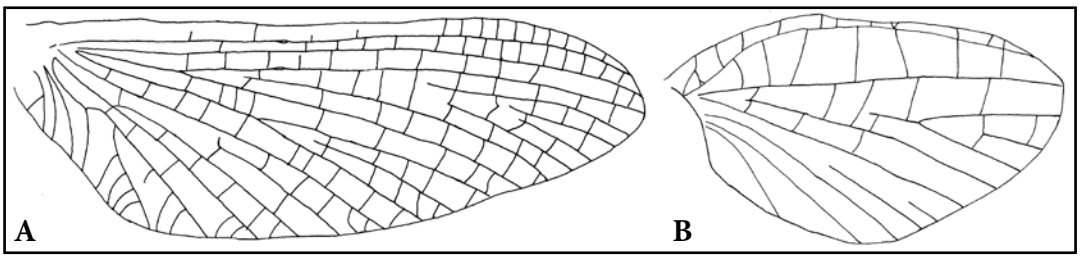


Figure 9. Wings of male imago of *D. kawatiri.* **A,** Forewing. **B,** Hindwing (not in proportion).

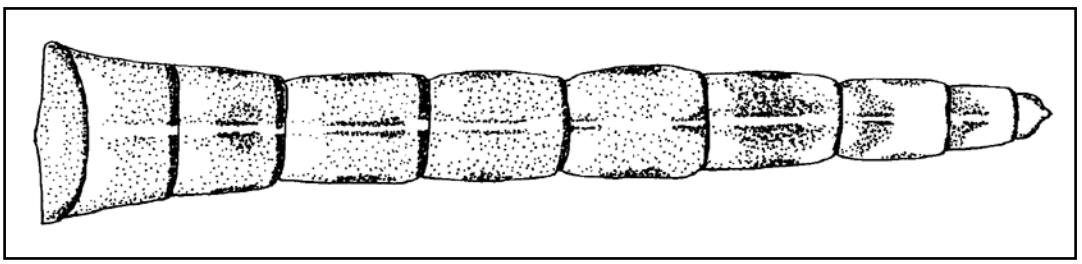


Figure 10. Dorsal abdomen of male imago of *D. kawatiri.*

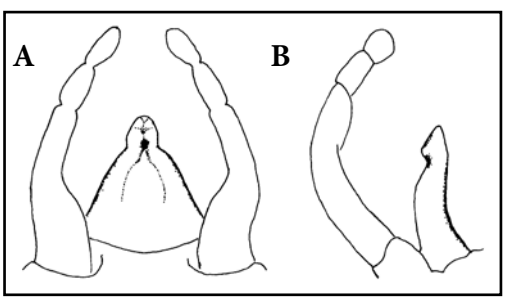


Figure 11. Genitalia of male imago of *D. kawatiri.* **A,** ventral view. **B,** lateral views.

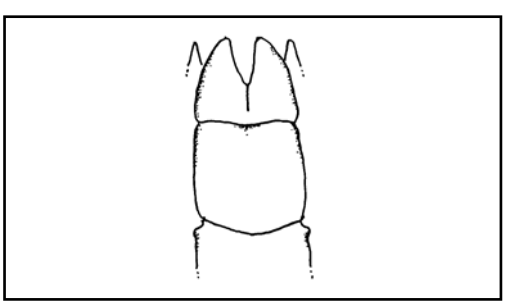


Figure 12. Sternum IX of female imago of *D. kawatiri.*

Figure 13. Dorsal abdomen of mature larva (antennae and caudal filaments truncated) of *D. kawatiri.*

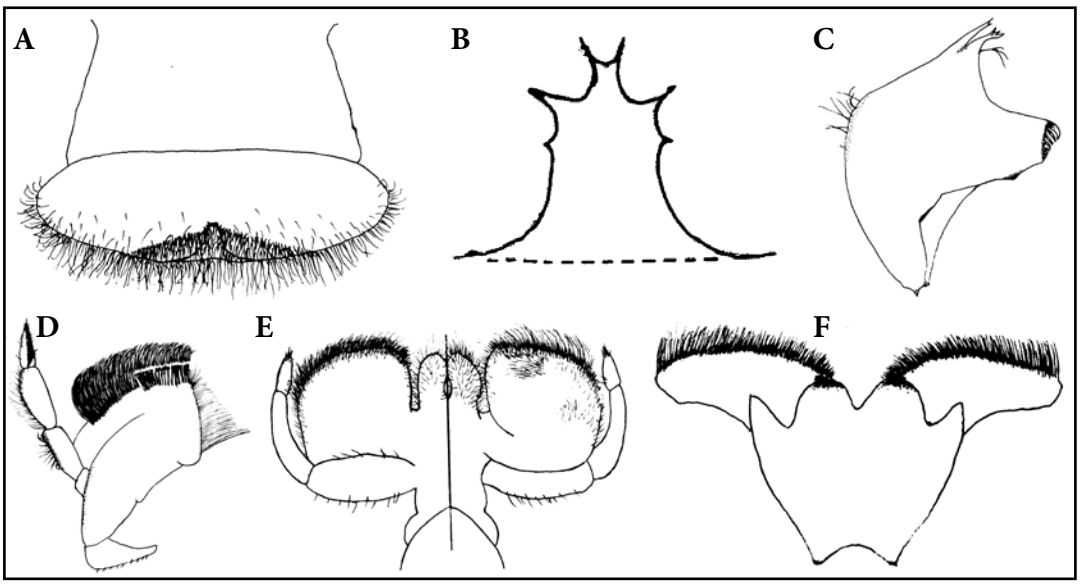


Figure 14. Mouth parts of larvae of *D. kawatiri.* **A,** clypeus and labrum, **B,** enlarged anteromedian emargination of the clypeus. **C,** mandible. **D,** maxilla. **E,** labium. **F,** hypopharynx.

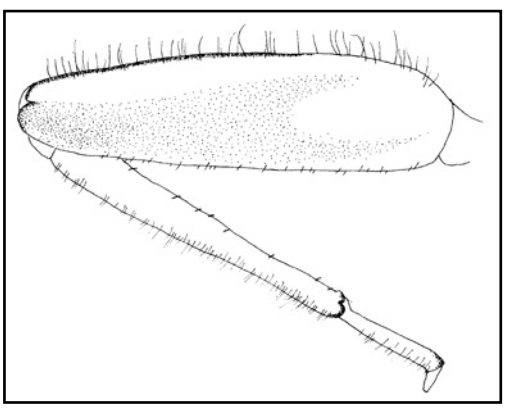


Figure 15. Foreleg of larva of *D. kawatiri.*

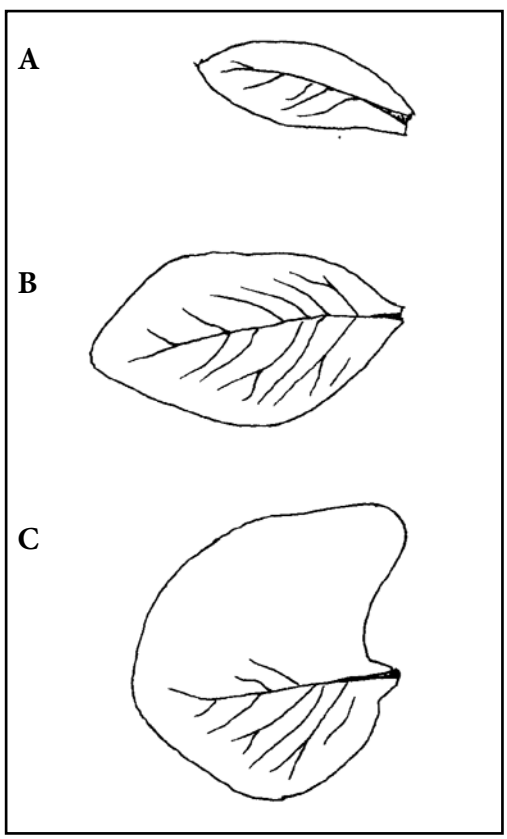


Figure 16. Abdominal gills of larva of *D. kawatiri.* **A,** gill 1. **B,** gill 4. **C,** gill 7.

flecked blackish submesially as is the region of the frons. Eyes of female black and those of the male grey above and black below. Antennae 1.64–1.90 x as long as head. Mouth parts (Figs 14a–f).Clypeus and labrum (Fig. 14a): labrum length 0.59–0.76 x that of clypeus, width 1.14–1.24 x that of clypeus; anterior margin with deep median cleft with 5 small rounded denticles. The anterior dorsal surface well supplied with hairs. Mandibles (Fig. 14b): 5–9 hairs at the centre of the outer margin, outer incisors with 4 serrations on the mesial surface, inner incisors with 3 serrations. Maxillae (Fig. 14c): galea-lacinia with a subapical row of 17–19 spines; palp segment 2, 0.75–1.00 x as long as segment 1, segment 3, 0.75–0.91 x as long as segment 2. Labium (Fig. 14d): submentum shoulder without spines. Palp segment 2, 0.76–0.88 x as long as segment 1, palp segment 3, 0.36–0.38 x as long as segment 2. Segment 2 without long spines. Hypopharnyx (Fig. 14e): lobes of the lingua separated by a deep, narrow V-shaped emargination. A sclerotised bunch of short hairs borne apically on each lobe. Thoracic terga yellowish brown, darker at the margins particularly at the anterolateral margins of the mesonotum. Sternum paler with thoracic ganglia sometimes visible. Legs yellowish white, darker at the femoro-tibial articulations. Ventral thorax and sterna whitish. Foreleg (Fig. 15). Each leg with a prominent yellowish-white macula on the proximal anterior surface of each femur. Abdomen: terga 2–4 and 7–8 each with a posterior blackish band divided mesially by a whitish longitudinal mark. Terga 2–7 or 8 with paired black submedian maculae. Posterolateral projections small on all abdominal segments, that on tergum 9 the largest. Sternal ganglia hyaline. A small tuft of about 12 hairs on the ventral surface of segment 9. Abdominal gills shown in Figs 16a–c. Gills single, plate-like and rounded apically, except gills 3–7, which sometimes have small apical points. Gill 1 wider than long (1.2–1.6: 1.0) (Fig. 16a); gill 7 not folded ventrally (Fig. 16c). Gills overlapping but not forming a deflection disc. Lamellae translucent with numerous tracheae. Caudal filaments yellowish, 1.4–1.6 x as long as the body.

Holotype: Male imago, BR, Little Ten Mile Creek, 41.836°S, 171.684°E, 30 m, 7 December 2001, T R Hitchings (CMNZ 2014.2.34501).

Allotype: Female imago, BR, Little Ten Mile Creek, 41.836°S, 171.684°E, 30 m, 7 December 2001, T R Hitchings (CMNZ 2014.2.34502).

Paratypes: 2 male subimagos, BR, Ten Mile Creek, 41.836°S, 171.677°E, 20 m, 4 April 1964, VM Stout (CMNZ 2014.2.34503–34504); female subimago, BR, Little Ten Mile Creek, 41.836°S, 171.684°E, 30 m, 9 December 2001, T R Hitchings (CMNZ 2014.2.34505); 3 male subimagos, BR, Nine Mile Creek, 41.835°S,171.663°E, 20 m, 24 November 2004, J B & G M Ward (CMNZ 2014.2.34506–34508); female subimago, BR, Little Ten Mile Creek, 41.837°S, 171.684°E, 20 m, 9 December 2001, Terry Hitchings (CMNZ 2014.2.34509); 6 larvae, BR, Batty Creek, 41.856°S, 171.757°E, 50 m, 28 January 2011, Terry & Tim Hitchings (CMNZ 2014.2.34510–34515); larva, BR, Ten Mile Creek, 41.836°S,171.677°E, 20 m, 4 April 1964, VM Stout (CMNZ 2014.2.34516); male subimago, BR, Nine Mile Creek, 41.835°S, 171.663°E, 20 m, 24 November 2004, J B & G M Ward (CMNZ 2014.2.34517); female subimago, BR, Ten Mile Creek, 41.836°S, 171.677°E, 20 m, 24 November 2004, J B & G M Ward (CMNZ 2014.2.34524); male subimago, BR, Little Ten Mile Creek, 41.834°S, 171.684° E, 9 December 2001, T R Hitchings (CMNZ 2014.2.34525); larva, BR, Batty Creek, 41.856°S, 171.757°E, 40 m, 23 January 2011, Terry & Tim Hitchings (CMNZ 2014.2.34526); male imago, BR, Fuchsia Creek, 41.836°S, 171.684°E, 20 m, 4 January 2005, KA Johansen (NZAC); male subimago, BR, Fuchsia Creek, 41.836°S, 171.664°E, 20 m, J B & G M Ward (NZAC); female imago, BR, Ten Mile Creek, 41.836°, 171.677°E , 20 m, 24 November 2004, J B & G M Ward (NZAC); female subimago, BR, Nine Mile Creek, 41.834°S, 171.664°E, 10 m, 24 November 2004, J B & G M Ward (NZAC); 3 larvae, BR, Little Ten Mile Creek, 41.837°S, 171.684°E, 20 m, 6 December 2002, T R Hitchings (NZAC); female subimago, BR, Fuchsia Creek, 41.837°S, 171.684°E, 40 m, 4 January 2005, K A Johansen (SMNH); male subimago, BR, Nine Mile Creek, 41.834°S, 171.664°E, 10 m, 24 November 2004, J B & G M Ward (SNMH); 4 larvae, BR, Little Ten Mile Creek, 41.837°S, 171.684°E, 20 m, 9 December

2001, T R Hitchings (SNMH).

Other material examined: 3 larvae, NN, Matiri River above lake, 41.6212°S, 172.3532°E, 398 m, 26 October 2015, L Hartley (CMNZ 2016.67.1–3); 4 larvae, BR, Nine Mile Creek, 41.834°S, 171.663°E, 30 m, 23 January 2011, Terry & Tim Hitchings (CMNZ 2014.2.34518–34521); larva, BR, Smoke-ho Creek, 42.331°S, 171.394°E, 270 m, 15 May 2014, P E Penney (CMNZ 2014.2.34522); female subimago, BR, Fuchsia Creek, 41.847°S, 171.682°E, 20 m, 24 December 2000, J B & G M Ward (CMNZ 2014.2.34523); 9 subimagos, BR, Ten Mile Creek, 41.836°S, 171.678°E, 20 m, 24 December 2000, J B & G M Ward (CMNZ 2014.2.34527–34535).

Distribution and habitat: D. kawatiri has been found in forested tributaries of the Buller River and one site in the catchment of the Grey River. These first and second order streams descend steeply through podocarp or beech forest to almost sea level. This species does not have the dark dorsal colouration of some other New Zealand alpine Leptophlebiidae (Hitchings, 2009a). Its distribution may be restricted to well shaded forest. However, larvae have a small tuft of hairs on sternum 9, as found in other *Deleatidium* species adapted to fast water alpine habitats.

Discussion: A change in morphological shape of the larval gills with maturation is particularly noticeable with *D. kawatiri*. As successive instars develop, corresponding gills widen in proportion to their length and the apices of gills 2–7, initially pointed, become more rounded. Stream gradients can exceed 0.5 in places where *D. kawatiri*, and *D. myzobranchia* Phillips, 1930 are found. The late instars of both species have large ovate gills, which probably help them maintain their position in fast water through current deflection. Thus down-force increases when the gills are tilted into the current (Hitchings 2016). It is possible that with growth and development, larvae are enabled to migrate out of boundary layer close to the substrate and from crevices into flows.

Deleatidium kawatiri most closely resembles *D. autumnale* Phillips, 1930 and *D. angustum* Towns & Peters, 1996. In the imago, it may be distinguished from both of these by the presence of a ventral mid apical U-shaped black mark on the penes of the male and in the female by the deep V-shaped emargination on sternum 9. In the subimago, the genitalia are sufficiently developed to afford the same characters for identification. The subimaginal wings of *D. autumnale* are marbled but those of *D. kawatiri* are uniformly grey.

In the larva, *D. kawatiri* can be distinguished from *D. angustum* by a cluster of hairs on sternum 9 in the former but only a few scattered hairs in the latter, and from *D. autumnale* by the absence of blackish sternal ganglia.

One specimen from Little Ten Mile Creek, a subimago, showed gynandromorphic characters, with a partially developed right forceps (male) and on the left an emarginated ninth sternite (female).

Etymology: The species name is derived from "Kawatiri", which is a Māori name for the Buller River and is believed to mean "deep and swift".

Acknowledgements

We thank Cor Vink and Matthew Shaw for professional support at Canterbury Museum; Shelley McMurtrie and the staff of EOS Ecology who provided work-space, specimens and resources when Canterbury Museum was undergoing earthquake repairs; Bill Crawford, Taupo, who made many helpful suggestions on the manuscript and two referees for valued comments.

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The life and legacy of Sir Julius von Haast: exploring archival documentary heritage collections

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Sir Julius von Haast (1822–1887) was one of the most influential German-born New Zealand scientists of the nineteenth century. He contributed to the establishment and development of scientific institutions, palaeontological research, geographical exploration and geological surveys, and established a network of correspondents around the globe to facilitate the exchange of information, knowledge, specimens and publications. The results of his efforts are evident from the maps and reports of geological surveys undertaken in the provinces of Nelson, Canterbury and Westland, and the establishment and development of Canterbury Museum. Details of his activities and approach to scientific endeavour and collegial cooperation become more fully evident through examining the archives representing his life and work found in the manuscripts, letters, photographs and sketches held in the collections of the Alexander Turnbull Library and elsewhere.

Keywords: Julius Haast; Canterbury Museum; New Zealand; German scientists; exploration and discovery; history of science; heritage collections; archives and manuscripts; correspondence and papers; geology and palaeontology

Introduction

Haast was one of the leading New Zealand scientists of the second half of the nineteenth century, a self-made man of humble origins, who founded a new life for himself in Canterbury, embraced every opportunity to further the scientific and cultural endeavours of the pioneering settler community, and promoted the establishment and growth of Canterbury Museum with all his energy and networking abilities. He was a remarkable individual noted for his stamina and perseverance in the face of obstacles, ranging from the mountain wilderness to the tangles of provincial bureaucracy (Fig. 1).

This paper aims to compile and establish some of the facts around identity and dates relating to the biography of Sir Julius von Haast and members of his family, especially for the early period of his life prior to his arrival in New Zealand, an area of research to which the most significant contribution to date has been the work of Langer (1992, 2004). Earlier publications have tended to be either prepared with too great a sense of loyal friendship, as for instance Bickerton (1884), filial piety, as in the case of the monumental biography by his son Heinrich Ferdinand von Haast (1948), or a lack of access to primary sources, exemplified by Burdon (1950), who was working on the subject without access to Haast's papers in the 1940s. Much of the later literature, including Maling (1990) and the chapter on Canterbury Museum in MacKenzie (2009), has largely repeated earlier sources, while academic research by Caudel (2007) has greatly increased our understanding of the role of freemasonry, and Cooper (2011) has presented an excellent series of critical case studies looking at Haast's relationship with indigenous New Zealanders and their culture. However, in terms of Haast's early biography, the secondary literature, with the exception of

Figure 1. Earliest known portrait of Julius Haast, inscribed with dedication to Arthur Guyon Purchas, dated Auckland, 26 July 1859 (Sir George Grey Special Collections, Auckland Libraries, 881-1).

Langer, has primarily added to the confusion by mixing facts with conjecture, often compounded perhaps by the difficulties of English speaking scholars attempting to work with a subject that inherently includes a major German language element.

In this study, questions around Haast's name and identity are posed, and an attempt is made to resolve some of these. The published legacy of Haast is briefly sampled, and in response to what H F Haast (1948) records as the lamentable loss of numerous examples of Haast's intellectual output in the form of manuscripts that never made it to print and where no copy appears to have been preserved, the discovery of a manuscript copy of an important paper from the early period of Haast's exploration in the Southern Alps, held in a European collection, is documented. The letters of Haast as evidence of his networking and the range of his contacts are mentioned and an overview is given of other archival material in a diverse range of formats in the Haast collection of the Alexander Turnbull Library, complimented by examples of documentary heritage material from the estate of Ferdinand von Hochstetter (1829–1884) held in European collections.

Biography: dates and identity

For the biographer, Haast is a difficult subject, as relatively little is known about him for the period prior to his arrival in Auckland on 21 December 1858, and this is in no small part due to the subject's own contribution to myths and misinformation, resulting in a state of confusion and relative lack of verified early biographical information.

Setting out to separate the facts from the fiction, it may be accepted that Johann Franz Haast, as he was named in all early sources, was born at 320 Bonngasse, Bonn (Prussian Germany) on 1 May 1822 (Fig. 2), the son of Mat[t]hias Haast and his wife Anna Eva Theodora Rüth (1788–1853). Haast's father, who was born in Bonn on 16 October 1784 and died on 25 July 1852, was variously described as a tailor and merchant in the birth notices of his children, and as Langer (1992) concludes, contrary to some sources, including Maling (1990), did not serve as mayor of Bonn.

Haast received his schooling in Bonn and later in Köln (Cologne) with only average results and did not remain to complete the

Civilſtand der Kreisſtadt Bonn.

Geburten.

Den 29. April, Friedrich Carl Emil, Sohn von Hrn. Carl Johann Koch, Ober-Zoll- und Steuer-Inſpektor, und Conradina Friederika Suſanna Tetlinden.

Den 1. Mai, Johann Franz, Sohn von Matthias Haaſt, Handelsmann, und Anna Eva Theodora Rüth.

Den 1ſten, Eliſabetha, Tochter von Wilhelm Balg, ohne Gewerb, und Anna Maria Göbel.

Figure 2. Birth notice of Johann Franz Haast, born on 1 May 1822, published in *Bonner Wochenblatt* newspaper, 23 May 1822.

senior year, but as Langer (1992) states, even graduating as a senior from the school he attended would not have resulted in the gaining of a university entrance qualification. It must therefore be concluded that Haast did not in fact study at university. As Haast later stated in a letter to Rudolf Veling (1812–1901), given the opportunity he would have studied mining, but

Figure 3. Masonic certificate with Haast's signature in right margin, 30 x 40 cm (Alexander Turnbull Library, MS-0037-21-18). **A,** Detail showing altered name on Masonic certificate (Alexander Turnbull Library, MS-Papers-0037-21-18).

instead his father wanted him to leave Bonn and he was sent to live in Verviers, Belgium (Letter, Haast to Veling, 4 May 1881, ATL MS-Papers-0037-25B-5). Here, at the age of 21, he was initiated in the Masonic ´Lodge Philadelphes´ on 16 October 1842, and less than a year later attained the level of a Masonic master´s degree on 11 May 1843 (Fig. 3).

In 1844, he moved to Frankfurt am Main and, as recorded on his Masonic certificate, visited several Lodges there that year, and eventually relinquished his Prussian citizenship to become a citizen of the city in response to his application dated 1 September 1846. Shortly afterwards, on 26 October 1846, Haast married the pianist Antonie Johanna Caroline Schmitt, who was born in Berlin on 4 December 1825, baptised there on 4 April 1826, and died in Frankfurt am Main on 14 October 1859. She came from a prominent musical family, being the daughter of the pianist and composer Aloys Schmitt, who was born in Erlenbach am Main on 26 August 1788 and died in Frankfurt am Main on 25 July 1866, and his wife Auguste Caroline Wohl, who was born in Frankfurt am Main on 14 August 1802, and died 5 February 1872.

Haast and his first wife had a son named Mathias Robert Haast, who was born in Frankfurt am Main on 10 January 1848, and died 27 May 1895. Robert, as he was known, was raised by his mother's family after her death, went on to serve in the Prussian military, and did not meet his father again until 1886 when Haast and his second wife visited Europe. Another relative Haast visited during his European visit in 1886 was his older sister Veronica Rossum, née Haast, who was born in Bonn on 15 June 1810 and died there on 27 September 1887, the widow of Johann Heinrich Rossum, whom she had married on 17 July 1838 (Figs 4, 5).

Figure 4. Haast's older sister, Veronica Rossum, née Haast. Carte de visite, 10 x 6.5 cm (Alexander Turnbull Library, PA2-2126).

Figure 5. Haast's brother-in-law, Johann Heinrich Rossum. Carte de visite, 9.8 x 6.3 cm (Alexander Turnbull Library, PA2-2125).

While biographical accounts make reference to Haast's early travels in Europe, including Italy, Holland, Russia, France and England, it is the time he spent residing in Belgium that is most definitively verifiable through his Masonic certificate (Fig. 3). In fact this Masonic certificate of 1842 from Belgium is the earliest surviving document in the Haast family papers collection held in the Alexander Turnbull Library. The lithographed certificate printed by Hubert Joseph Hahn in Verviers, with the imprint 'Lith. de H. J. Hahn, Crapeaurue, 114, Verviers', includes the following in the wording '[…] certifions que le très cher Frère Haast, Jules François né à Bonn dont la signature ici en marge (ne varietur) […]', which may be freely translated as '… certifies that the dear Brother Haast, Jules François, born in Bonn whose signature appears here in the margin …', and in the margin there is the corresponding requisite signature rendered as 'J. F. Haast' (Fig. 3). However, the name 'Jules' on the certificate looks out of place as the ink is noticeably darker and the lettering less regular compared with the remaining text. On closer inspection it would appear as if the original has been overwritten in another hand – the original French 'Jean', for the German name Johann, has been altered to 'Jules', the French form of the name Julius (Fig. 3A). The flourished capital letter 'J' in the certificate was rather too risky to attempt to change, so Haast had no option but to choose a new name of similar length to Jean also beginning with the letter 'J', thus arriving at his new name of Julius. Therefore it is evident that Haast would appear to have adjusted the only identity document he is known to have brought to New Zealand from his earlier life in Europe.

When, on behalf of Haast's son and biographer Heinrich Ferdinand von Haast (1864–1953), Henry Alexander Lamb (1885-1953), the Grand Secretary of the Grand Lodge of New Zealand, made enquiries into Haast's membership and sent the certificate to Belgium for a sort of verification process in 1939, the response was that records would appear to have confirmed that 'Brother Jean Francois Haast' had joined the lodge at Verviers – and it is apparent from the typescript letter dated 1 June 1939 (ATL MS-Papers-0037-021-18) that the original name was indeed 'Jean' and not 'Jules'.

By 1858, Haast was in London, contracted to act as an agent for the shipping firm Willis, Gann and Company to look into the suitability of New Zealand as a destination for German emigrants (Nolden 2002). Haast travelled to New Zealand, departing from Gravesend, England, on 11 September 1858 on the ship *Evening Star*, under the command of Captain Frederick Stanley Ewen (1825–1873), and after a voyage of 101 days arrived in Auckland Harbour on 21 December 1858. The passengers addressed a letter of thanks to the captain, dated two days before their arrival in Auckland; included amongst the names of signatories is 'J. F. Haast' (Anonymous 1858a). The passenger list with the name 'Johann Haast' was also published (Anonymous 1858b).

Thus it may be concluded that Johann Franz Haast was the full name of Haast from the time of his birth until most likely the time of his arrival in New Zealand in 1858. The name Julius, by which he chose to be known in the latter part of his life, certainly does not appear to have come into use prior to the time when he arrived in New Zealand; and after briefly publishing articles on New Zealand in a Viennese newspaper under the pseudonym 'Julius Hanf' in 1859 (Nolden 2007), he became firmly known as Julius Haast.

The period in New Zealand has been well documented (Haast 1948), starting with the fortuitous encounter with Hochstetter, who arrived in Auckland just one day after Haast, on the Austrian *Novara* expedition 1857–1859, and their joint adventures and survey work in the provinces of Auckland and Nelson in 1859. Haast then completed an extension of Hochstetter's survey and wrote his first published report (Haast 1861), before taking up the position of Canterbury Provincial Government Geologist later that year (Johnston & Nolden 2011). He became a naturalised British subject in New Zealand on 18 February 1861, and settled in Christchurch, where, although born a Catholic, he converted to the Anglican faith and married Mary Ann Dobson on 25 June 1863 (Figs 6, 7).

Figure 6. Portrait of Julius and Mary Haast, circa 1863. Carte de visite, 10.5 x 6.5 cm (Alexander Turnbull Library, PA2-2164).

Mary was born in London on 21 January 1844 and died in Rome on 27 July 1913, the daughter of Edward Dobson (1816–1908) and his wife Mary Ann Lough (1821–1913).

Julius and Mary Haast had four sons and one daughter:

Heinrich Ferdinand von Haast (11 May 1864 – 5 January 1953)
George Augustus von Haast (7 February 1867 – 22 February 1954)
James Leopold von Haast (9 June 1868 – 27 April 1956)
Eva Veronica von Haast (25 February 1871 – 30 March 1909)
Julius Hermann von Haast (16 December 1873 – 14 August 1941)

In 1883, the painter and sculptor Alfred Beere (1857–1886) from London spent time residing in Christchurch where he was noted for his paintings and sculptural works in terracotta, some of which he exhibited at the annual exhibition of the Canterbury Society of Arts in 1883 (Vangioni 2002). One of the outstanding pieces was a life-sized bust of Haast, of which

Figure 7. Julius and Mary Haast at their residence 'Glückauf' in Christchurch, 1865. Photograph, 9 x 15.5 cm (Nolden & Nolden 2011, cat. no. 2.19.10; Hochstetter Collection Basel).

Haast proudly sent a photograph to his friend Hochstetter in Vienna with an inscription dated January 1883 (Fig. 8). Posthumously, a marble bust of Haast (Fig. 9) was made in Bonn by the German sculptor Albert Küppers (1842–1929), which was unveiled at Canterbury College on 26 July 1890 and subsequently displayed in Canterbury Museum to commemorate the founding director (Anonymous 1890).

Sir Johann Franz Julius Ritter von Haast (Fig. 10) died in Christchurch on 16 August 1887 and was buried in the graveyard of Holy Trinity Avonside, an Anglican church in Linwood, Christchurch. The church was demolished in September 2011 following earthquake damage but the graveyard still exists. The inscription on the gravestone states:

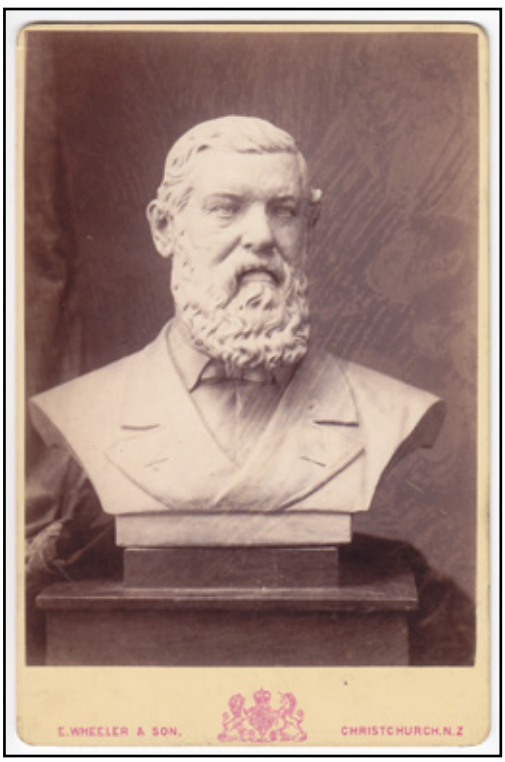

Figure 8. Bust of Julius von Haast by Alfred Beere, with inscription by Haast to Hochstetter, 'Büste in Lebensgröße modellirt von Alfred Beere von London Januar 1883'. Photograph by E. Wheeler & Son, Christchurch. Cabinet card, 16.7 x 10.9 cm (Hochstetter Collection Basel).

JULIUS von HAAST | Born 1st May 1822 | Died 16th August 1887 | VITAM IMPENDERE VERO | - His wife MARY - | Born 29th January 1844 | Died at Rome, 27th July 1913. | - His daughter - | EVA VERONICA von HAAST | Born 25th February 1871 | Died 30th March 1909.

Thus he was memorialised only with the first

Figure 9. Marble bust of Sir Julius von Haast by Albert Küppers, displayed at Canterbury Museum.

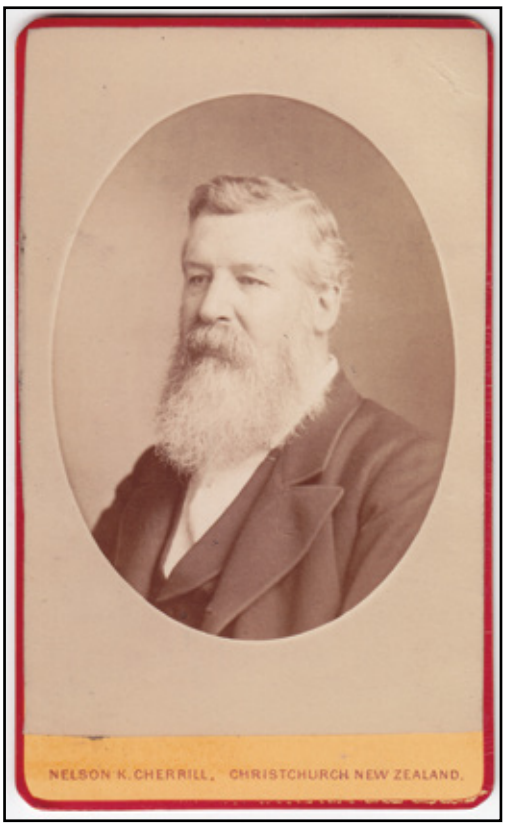

Figure 10. 'Dr Julius Ritter von Haast, 1880'. Photograph by Nelson King Cherrill, Christchurch. Carte de visite, 10.3 x 6.2 cm (Hochstetter Collection Basel).

name he chose himself 'Julius'; the title 'von' he earned himself as a German-born naturalised British subject from the Austrian Emperor in 1875; and the family name 'Haast', the only name that remained as a constant throughout his life. His Latin motto VITAM IMPENDERE VERO, which may be translated as 'life devoted to the search for truth', doubtless aided his relentless striving to establish and grow his professional status and solid reputation as a scientist.

Publications: printed legacy

During the time Haast was based in Frankfurt am Main, Müllerott (1966) states that he worked for the Jügelsche Buchhandlung, a publishing house and bookselling institution originally founded in 1823 by Carl Christian Jügel (1783–1869). It is likely that Haast, thus connected with the book trade in Frankfurt am Main, was commissioned to prepare a German translation of Charles Hursthouse, *New Zealand, or Zealandia, the Britain of the South*, published in London in 1857. The German edition was published as *Handbuch für Auswanderer nach Neuseeland, dem Grossbritannien der südlichen Halbkugel: Ein kurzer Abriss der Geschichte und Beschreibung des Klimas, der Boden-Beschaffenheit, der Vorzüge und der Verfassung dieses schönen Landes*, Frankfurt am Main, August Osterrieth, 1859. However, this volume of a mere 143 pages, compared to the 664 pages of the English edition, does not name the translator. If Haast was indeed the translator, then this would likely be what resulted in his being invited to investigate New Zealand as a destination for German emigrants for the London shipping firm, Willis, Gann and Company. Hocken describes the German edition as 'A complete emigrants´ handbook, issued by the shipping firm of Willis, Gann, and Co., for Germans' (Hocken 1909). Heinrich von Haast, in the biography on his father, states that Haast had met Charles Hursthouse at the offices of the firm in London, and was presented with a copy by the author (Haast 1948).

Haast certainly did not identify himself with any publications pre-dating his arrival in New Zealand, which is not surprising given that if he had published anything, it would not have appeared under the name Julius, the name he had very likely only assumed on arrival in New Zealand and by which he became generally known. Soon after his arrival – and having befriended Hochstetter – he was invited to write a continuation of a series of travelogue articles, which Hochstetter had been writing for the *Wiener Zeitung* on a regular basis in serialised form since the departure of the *Novara* expedition from Trieste on 30 April 1857. Haast did not imitate Hochstetter's literary style, but did write a series of articles that were published in eight issues of the *Wiener Zeitung* newspaper between 13 April and 21 April 1859 under the pseudonym Julius Hanf (Nolden 2007).

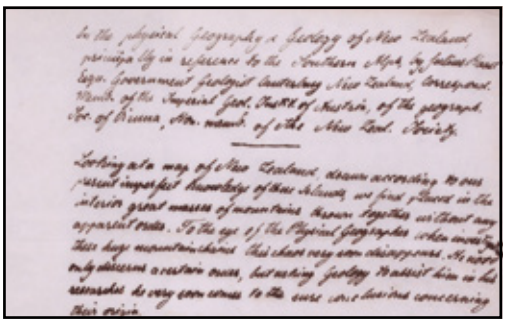

Figure 11. Manuscript copy by Haast of paper read at meeting of the Royal Society of Victoria in 1861 (Hochstetter Collection Basel).

After continuing the survey work in Nelson Province begun by Hochstetter, he wrote his first formal report (Haast 1861), which was then published, albeit without any maps or illustrations. The report was put to good use when, with the assistance and cover letter by Hochstetter, dated 24 September 1862, it was submitted to the University of Tübingen together with a carefully worded curriculum vitae, dated 23 January 1862, leading to Haast being granted a doctorate on 11 October 1862 (Universitätsarchiv Tübingen, UAT 131-12B, 9).

The publications and writings of Haast are listed by H F Haast (1948), however, as an annotated bibliography with 172 entries, this is rather unsatisfactory, especially due to the lack of precise bibliographic details for some items and the confusion between those items published, those that might have been published if only circumstances had not got in the way, and those manuscripts that were 'prepared but not preserved'.

Fortunately, in one instance a manuscript with the title 'On the Physical Geography & Geology of New Zealand, principally in reference to the Southern Alps', that was presumed lost, even though it had been read by the secretary at a meeting of the Royal Society of Victoria in 1861 (Haast 1948), was found in the form of a copy written in ink and pencil, which Haast had sent to Hochstetter, and is preserved amongst the Hochstetter Collection Basel papers (Fig. 11). Hochstetter based most of his chapter on the Southern Alps in his work *New Zealand* (Hochstetter 1867) on information supplied by

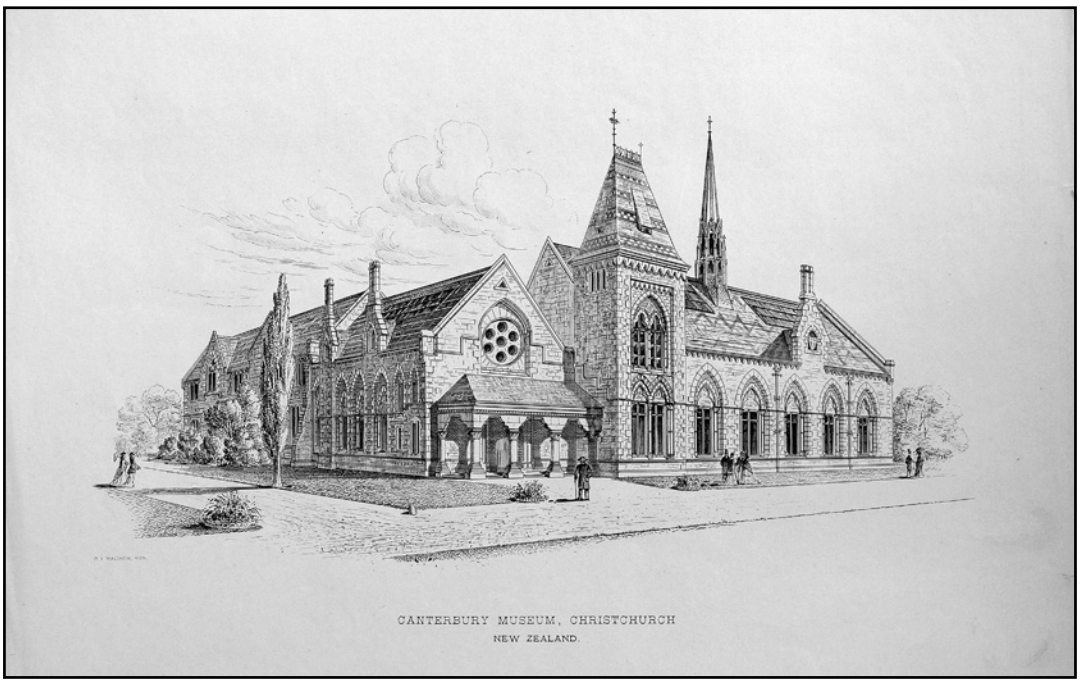

Figure 12. Canterbury Museum, Christchurch, New Zealand. Zincography printed in Vienna by Rudolf von Waldheim as frontispiece for Haast (1879).

Haast, and this manuscript may have been one of his sources.

The only book Haast published was also a project that benefited greatly from his relationship with Hochstetter. Published with the title *Geology of the Provinces of Canterbury and Westland, New Zealand: a report comprising the results of official explorations* (Haast 1879), the printing of the letterpress was completed in Christchurch at the offices of the Lyttelton Times, however, many of the maps and illustrations were printed in Vienna under the capable supervision of Hochstetter (Nolden 2014). The frontispiece depicts Haast's pride and joy – the Canterbury Museum in Christchurch (Fig. 12).

Letters: global networking

Letters provide evidence of Haast's global network of correspondents – the growth and expansion of a world wide web of contacts aimed at the facilitation of an exchange of knowledge, information, specimens and publications (Nolden 2016). Some of the letters have been the subject of extensive research, resulting in a number of annotated editions of English language letters (Nolden et al. 2012; Nolden et al. 2013), and English translations of German letters (Nolden 2013).

The correspondence forms part of the Haast family papers, held in the manuscript collections of the Alexander Turnbull Library MS-Papers-0037, consisting of some 380 folders of papers divided into twelve series, with series 1–8 encompassing the letters and papers of Julius von Haast, and series 9–12 the papers of his son and biographer, H F von Haast. Heinrich was responsible for depositing the collection with the Library between 1948, when he published the biography on his father, and the end of his life, in 1953, although some posthumous deposits were made by his widow Mary.

The Haast family papers are arranged as follows:

Series 1 Sir Julius von Haast – Official papers and correspondence (19 folders)
2 Sir Julius von Haast – Personal papers (7 folders)
3 Sir Julius von Haast – Personal correspondence (127 folders)
4 Sir Julius von Haast – French letters (10 folders)
5 Sir Julius von Haast – German letters (75 folders)
6 Sir Julius von Haast – Italian and other letters (4 folders)
7 Sir Julius von Haast – Manuscripts (32 folders)
8 Sir Julius von Haast – Printed material (19 folders)
9 Heinrich von Haast – Correspondence (17 folders)
10 Heinrich von Haast – Manuscripts (16 folders)
11 Heinrich von Haast – Printed material (16 folders)
12 Heinrich von Haast – Personal papers (38 folders)

However, there is also other Haast manuscript material, which has become separated from this main body of papers, found at MS-Papers-0171, including a folder of larger format material containing certificates and diplomas at MSO-Papers-0171-5.

The Haast collections also encompass material in various other formats. The Photographic Archive collection includes photographs from Haast family albums, where the individual photographic prints in carte de visite and cabinet card formats have been removed from the albums by the Library and the original albums have not been retained. Most of the photographs from the estate of Haast are found under the reference number PA-Group-00377, which consists of more than 400 photographic prints.

In the area of Drawings, Paintings and Prints, Haast's sketches and watercolours are found at A-108-023 to A-108-040, A-149-001 to A-149-013, and larger format material in a collection of 165 drawings with the title 'Topographical drawings from South Island surveys, 1860-1868' at reference C-097-001/181, where it should be noted that individual works consisting of

Figure 13. Pair of lockets with miniature hand-coloured photographic portraits of Julius and Mary Haast with their eldest child Heinrich Ferdinand Haast, circa 1865. Gold lockets, 25 x 19 mm **A,** Left locket exterior, front. **B,** Left locket exterior, back (Alexander Turnbull Library, Curios-005-003 and Curios-005-004).

Figure 14. Julius Haast's miniature medals, with a full-size example for comparison (Alexander Turnbull Library, Curios-005-011 and Curios-005-013/019).

more than one sheet may have more than one identifier, while an example of an even larger work, with the title 'View from Mt Arthur of Karamea R[iver]', is at reference D-007-004. A selection of watercolours was reproduced in Murray-Oliver (1966), Paul (1977/1978), and topographical sketches and maps in Burrows (2005). The collection also features a range of 'curios' including medals and jewellery (Figs 13, 14) at Curios-005-003/026, pieces of china collected by Haast at Curios-038-001/009, and pieces of wooden furniture at Curios-030-029, -040, -044, and -070.

Examples of archival Haast material that compliments the holdings of the Alexander Turnbull Library are found in European collections of papers from the estate of Haast's friend and correspondent Ferdinand von Hochstetter.

The Dr Albert Schedl Collection at the Geological Survey of Austria includes 22 of Haast's sketch maps and watercolours depicting scenes in the Southern Alps from the period of Haast's field survey work (Figs 15–17), which were exhibited in Auckland in 2008 (Nolden 2008), while the Hochstetter Collection Basel includes two large panoramic watercolours of the Southern Alps (Figs 18, 19).

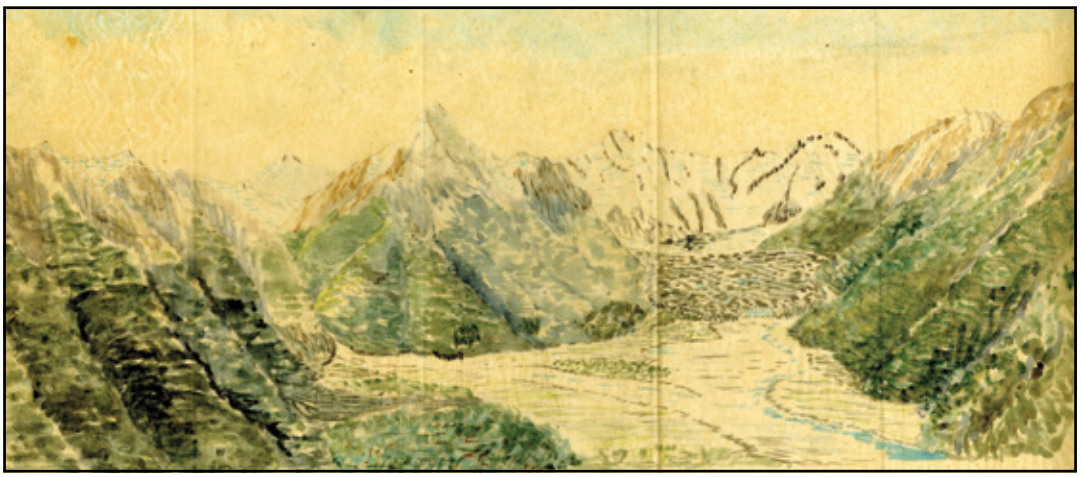

Figure 15. Julius Haast, 'The Great Tasman Glacier Middle Island of New Zealand. 18 miles below junction of the River Hooker with the Tasman River – Mt Cook in the centre'. Watercolour and pencil on tracing paper, 18 x 50 cm (Nolden 2008, exhibit no. 139; Dr Albert Schedl Collection, Vienna).

Figure 16. Julius Haast, 'From Spur about 6500 above sea level, leading to Mt Cook, over the Great Tasman Glacier & the Murchison Glacier'. Watercolour and pencil on paper, 11 x 17.5 cm (Nolden 2008, exhibit no. 93; Dr Albert Schedl Collection, Vienna).

Conclusion

It may be concluded that much of what has been written and repeated about the life of Haast prior to his arrival in New Zealand has been largely based on conjecture, with the exception of Langer (1992, 2004) who was the first scholar to contribute substantiated facts to the scant body of biographical knowledge for this early period. Haast's efforts to forge a new identity for himself

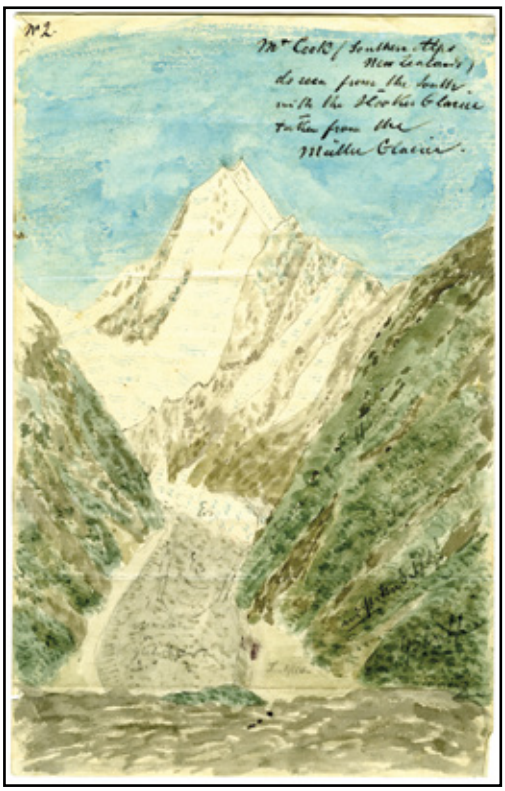

Figure 17. Julius Haast, 'Mt Cook (Southern Alps New Zealand) as seen from the South with the Hooker Glacier taken from the Mueller Glacier'. Watercolour and pencil on paper, 17.5 x 11 cm (Nolden 2008, exhibit no. 89; Dr Albert Schedl Collection, Vienna).

and escape his past have become more fully apparent with the present research, resulting in the realisation that Haast was prepared to change both his identity and allegiances whenever it seemed to serve his purposes – to leave behind his past and build a better future for himself.

Thus the merchant's son had to first leave his native city of Bonn in order to continue his education in Köln (Cologne), but neither completed his schooling nor gained a university entrance qualification (Langer 1992). He was then strongly encouraged by his father to leave Germany and go to Belgium, where by the age of 21 in 1842 he was initiated in the Masonic Lodge at Verviers. In 1844 he returned to Germany, and this time moved to Frankfurt am Main, where he made a number of documented visits to Masonic Lodges, before relinquishing his Prussian citizenship in order to be able to gain citizen's rights in the City of Frankfurt am Main in 1846, and marry into a prominent local musical family.

This was followed by a period of only vaguely documented business ventures and travels, leading up to an eventual arrival in London, where he found employment with a shipping firm. Leaving almost everything, including a wife and son, behind, except the all-important certificate of his membership of the Masonic

Figure 18. Julius Haast, 'The Southern Alps from the Western Shores of Lake Poerua, June 1st 1865'. Watercolour on paper, 16 x 72.5 cm (Nolden & Nolden 2011, cat. no. 1.3.1; Hochstetter Collection Basel).

Figure 19. Julius Haast, 'Panoramic View of the Southern Alps New Zealand from the Mouth of the Waiau, June 17th 1865'. Watercolour on paper, 21.4 x 121.5 cm (Nolden & Nolden 2011, cat. no. 1.3.2; Hochstetter Collection Basel).

Figure 20. Photograph of Mary Lady von Haast, with inscribed dedication to Georgiana von Hochstetter, "With the warmest love and gratitude of the original, Wien October 21, 1896." Photograph by Giovanni Horvath, Vienna. Cabinet card, 16.7 x 10.6 cm (Hochstetter Collection Basel).

Order, which with careful falsification would form the basis of his new identity, Haast was ready to begin a new life. But to fit into his new environs, a change of name, including the interim use of a pseudonym, was not quite enough – again a citizenship was relinquished in favour of a more advantageous one – and as a newly naturalised British subject he was ready to take up a Government position as Provincial Geologist, and although a Catholic since birth, chose to convert to the Anglican faith in order to marry his second wife (Fig. 20), a member of a prominent Cantabrian Anglican family.

The changes continued as both the person and name became increasingly embellished with titles and post-nominal letters. The enormous buying power of moa bones (Barton 2000) and carefully placed geographic names became apparent, as Haast grew his empire of contacts and reaped the rewards of being at a seemingly insurmountable geographic distance from his past and yet having the advantage of being able to offer to those at a distance some of the most desirable currency of museum barter of the day. Finally, the full extent of Haast's contribution and the finer details of his life and work may yet be gleaned from his papers and archives held in the collections of the Alexander Turnbull Library and elsewhere, as these documentary heritage collections represent significant resources of biographical and historical informational value.

Acknowledgements

The above is partially based on a paper read at the 'Finding New Zealand's Scientific Heritage' conference at Victoria University of Wellington, on 23 November 2015, under the title 'Sir Julius von Haast's contribution to New Zealand science: expanding horizons, networking, ambition and controversy'. The author acknowledges and thanks Anthony Wright, Paul Scofield, Inge von Hochstetter, Albert Schedl, Sandy B Nolden, Mike Johnston, Oliver Stead, Simon Nathan, Nicola Frean, Keith Giles, Sir George Grey Special Collections - Auckland Libraries, Stefan Fink, Tübingen University Archive, and the Alexander Turnbull Library.

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The Northern Pinnacle, Poor Knights Islands: natural history notes on a brief landing in 1983

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Fourteen species of vascular plant are recorded for this small, precipitous, rarely visited islet. Brief observations on the vegetation, geology and fauna are recorded.

Keywords: Northern Pinnacle, vascular plant flora, Poor Knights Islands, New Zealand

Introduction

The 1983 Offshore Islands Research Group expedition to the Three Kings Islands left Auckland on the MV Pegasus II on 24 November 1983, heading north. The party on board included marine scientists/divers, and the opportunity was taken en route to dive at The Pinnacles that same day. The seas around The Pinnacles and Sugar Loaf (outliers of the Poor Knights Islands situated some 6 km south of the southern tip of Aorangi Island) form part of the Poor Knights Islands Marine Reserve. The Poor Knights Islands are rodent-free.

The Pinnacles (Figs 1, 2) are also known as the High Peak Rocks, and the two main islets are mapped and named High Peak Rocks (Land Information New Zealand 2009) where the larger northern rock measures approximately 300 x 150 m and has a spot height of 87 m (35.547°S, 174.724°E, Map Reference AW32 563649) and an area of 1.15 ha (Taylor 1989).

From the boat a very large-leaved small tree could be seen near the summit. Geoff Baylis, Ewen Cameron and Bruce Hayward were convinced it was puka (*Meryta sinclairii* (Hook.f.) Seem.), known only from the Three Kings and Hen and Chickens Islands – but not from the Poor Knights in between. Their conviction may have been based, at least partly, on convincing me to land and attempt the climb.

Put ashore for half an hour on the eastern point of the islet I climbed to the summit, recording three pages of field notes on which this article is based.

Geology

Very hard, silicified ignimbritic rock, much cut by quartz veins, particularly towards the summit. One small included patch of a coarser, granular ignimbrite was noted.

Fauna

A colony of Australasian gannet (*Morus serrator* Gray, 1843) numbering some 80–100 adults inhabited the summit area. Most adults were associated with large, downy chicks approximately three-quarters of adult body size. Also present were a few smaller chicks, down to two new-born, black-skinned pulli with several birds still sitting on eggs.

A large population of geckos was observed basking in the sun amongst the gannets in very high density – perhaps 3–4 per m^2. At 16–17 cm long, rather stumpy looking with short tails, and a dark grey-black in colour with black markings, they are possibly the undescribed Poor Knights gecko (*Dactylocnemis* sp.).

Figure 1. Aerial view of the Pinnacles (High Peak Rocks) from the north-north-west, 25 October 2012. The Northern Pinnacle, Poor Knights Islands (centre), Eastern Pinnacle at left and Southern Pinnacle to right. Photo: Richard Robinson www.depth.co.nz

Vegetation

Higher plant vegetation was generally confined to rock crevices on the exposed eastern side of the islet, and slightly more developed amongst the rocks on the summit. Mercury Bay weed (*Dichondra repens* J.R.Forst. & G.Forst.), ice plant (*Disphyma australe* (W.T.Aiton) N.E.Br.) and the two species of pigweed (*Chenopodium* spp.) formed mats amongst the gannet colony.

The large-leaved plant ('enormously' large-leaved according to my notebook) was ngaio (*Myoporum laetum* var. *decumbens* G.Simpson) and no puka was seen. Of the three ngaio leaves collected (AK 173030), the largest is 190 x 90 mm with margins entire in the lower fifth and serrate from there to the tip. The second leaf is 170 x 60 mm with almost entire margins (some minute serrations in the upper half), while the third is 153 x 74 mm with margins entire in the lower third and finely serrate above that. This large-leaved form of ngaio was described as a variety by Simpson (1952) from a cultivated plant derived from the Poor Knights Islands. The variety was based mainly on its prostrate form, but also the large size of its leaves; while the Northern Pinnacle plant was reasonably erect it did have particularly large leaves which caused me to record it under the Simpson varietal name. The variability of the species on northern offshore islands is so great that it is generally now grouped under the polymorphic species name, e.g. Chinnock (2007). The pōhuehue (*Muehlenbeckia complexa* (A.Cunn.) Meisn.) vines were also very lush.

Further vascular plant vegetation was sighted on a terrace about half way up the island on the south-east side, but I did not climb down to explore it. The canopy appeared to be more-or-less continuous circa 0.5–1 m high, dominated by taupata (*Coprosma repens* A.Rich.) with much renga lily (*Arthropodium bifurcatum* Heenan,

Figure 2. (Left to right) Northern Pinnacle partly obscured, Southern Pinnacle in front, Eastern Pinnacle; from the south-west, 10 March 2008. Photo: Ewen Cameron.

A.D.Mitch. & de Lange) amongst it.

Vascular plant species list

Arthropodium bifurcatum Heenan, A.D.Mitch. & de Lange	renga lily
Asplenium haurakiense (Brownsey) Ogle	Hauraki Gulf spleenwort
Chenopodium triandrum G.Forst.	pigweed
Chenopodium trigonon Schult. subsp. *trigonon*	pigweed
Coprosma repens A.Rich.	taupata
Dichondra repens J.R.Forst. & G.Forst.	Mercury Bay weed
Disphyma australe (W.T.Aiton) N.E.Br.	ice plant
Metrosideros excelsa Sol. ex Gaertn.*	pōhutukawa
Muehlenbeckia complexa (A.Cunn.) Meisn.	pōhuehue
Myoporum laetum var. *decumbens* G.Simpson	ngaio
Samolus repens (J.R.Forst. & G.Forst.) Pers.*	sea primrose
Sarcocornia quinqueflora (Bunge ex Ung.-Sternb.) A.J.Scott	glasswort
Spergularia tasmanica (Kindb.) L.G.Adams	New Zealand sea spurrey
Tetragonia implexicoma (Miq.) Hook.f.	native spinach

* reported as seen from the boat by Ewen Cameron and Geoff Baylis on the western side of the island – small trees of pohutukawa and the sea primrose flowering.

I specifically noted that no adventive species were seen. More time and better coverage of the islet is certain to result in additional plant records. I would expect grasses such as coastal wind grass (*Lachnagrostis littoralis* (Hack.) Edgar) and sand wind grass (*L. billardierei* (R.Br.) Trin.); sedges such as knobby sedge (*Ficinia nodosa* (Rottb.) Goetgh., Muasya & D.A.Simpson) and dicotyledons such as shore groundsel (*Senecio lautus* G.Forst. ex Willd.) to occur on an island of this size.

Acknowledgments

Skipper Eric Gosse, MV Pegasus II, for nosing in to put me ashore; Ewen Cameron and the late Geoff Baylis for observations; Peter Bellingham, Ewen Cameron and Paul Scofield for improvements to the manuscript; Richard Robinson for Fig. 1 and Ewen Cameron for Fig. 2.

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