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Charles Chilton: the Phreatoicoidea and other interests of a phreatic pioneer from down under

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Abstract

Besides his widespread activities in zoology and university development, Charles Chilton (1860–1929) was a pioneer in phreatic research who opened up the possibilities of the new science in the Southern Hemisphere. He described phreatic and subterranean species of Isopoda and Amphipoda from New Zealand, Australia and elsewhere and discussed the significance of their morphology and habitat. His finds included the first species of the widespread endemic Southern Hemisphere group, the Phreatoicoidea, and he pointed to Gondwanaland connections in this and other groups which he accepted and interpreted in the context of his time.

Résumé

En plus de ses activités dans le domaine de la zoologie et pour le développement des universités, Charles Chilton (1860–1929) était un pionnier de la recherche phréatologique. En effet, il révéla les possibilités de la science nouvelle dans l'Hémisphère Sud. Chilton décrivit des espèces phréatiques et autres espèces souterraines d'Isopodes et d'Amphipodes de Nouvelle-Zélande, d'Australie et d'ailleurs, et discuta la signification de leur morphologie et de leur habitat. Ses découvertes inclurent la première espèce d'un groupe largement répandu et endémique de l'Hémisphère Sud, les Phreatoicoidea; il indiqua les rapports entre ce groupe (et d'autres groupes qu'il accepta et expliqua dans le contexte de son époque) et le Gondwanaland.

Introduction

The origins, environment and adaptations of the newly recognised phreatic fauna were succinctly described by Charles Chilton in two early works on the subterranean fauna of New Zealand:

"I believe that the Crustacea live in the water which percolates through the interstices between the stones in the bed of gravel" (Chilton, 1883: 87).

"No doubt the subterranean Crustacea, as well as the freshwater forms, have originally sprung from forms inhabiting the sea, but from the fuller array of facts now before us, there can be no doubt that they have not been derived directly from these, but from a freshwater fauna ... Although it is thus probably true that some species of the subterranean fauna are ancient forms that have long since taken up their abode in the underground waters, we should naturally expect to find others, especially in the fauna of caves, that have much more lately adopted a cave life and are the direct descendants of surface-species still inhabiting the neighbourhood. Such specimens we undoubtedly do find, and they appear also to show several stages or transitions from surface-forms accidentally carried into the caves up to true cave-inhabiting forms" (Chilton, 1894: 255, 257).

"They are found ... in the dark recesses of caverns and of the waters under the earth, where no storm ruffles the everlasting stillness, no light illumines the thick darkness, and no sound breaks the eternal silence" (Chilton, 1894: 273).

Charles Chilton was a man of several careers. He began as a secondary schoolteacher rising quickly to become Vice-Principal of the local Teachers' Training College and Headmaster of a District High School in his twenties. He then began a medical career, which he gave up to become professor of Zoology at Canterbury University College and, while his zoology never became less important, he created parallel careers in University administration and in civic affairs.

Chilton was born in Leominster, England, in

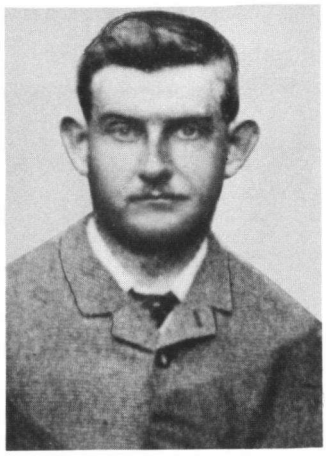

Fig. 1. Charles Chilton, aged 27. Photo: Alexander Turnbull Library, Wellington.

1860*. He came to New Zealand as a boy when his parents took up farming at East Eyreton, about 25 km outside the present Christchurch city limits. It was on this farm that he first collected phreatic Crustacea from a well 8 metres deep, and noted that the animals were brought up most abundantly when the water level in the well was sinking.

"About the year 1880 ... these well shrimps were found rather abundantly in a well at the writer's home at Eyreton, and he was then commencing the study of zoology, first under Dr. Llewellyn Powell and later under Captain F.W. Hutton ... some enquiries were made into the nature and significance of the animals. They proved to be small crustacea ... On examination, these well shrimps proved to be blind or to have only imperfect eyes, and they were colourless or semi-translucent. It was thus clear that they were not surface forms that had accidentally fallen into the wells, but that they were permanent inhabitants of the underground waters and were adapted for life in those dark and restricted localities." (Chilton, 1924: 6.)

* Further biographical details can be found in the *Christchurch Press* of October 26 and 28, 1929; the *Christchurch Times* of October 26, 1929; volume 60 of the *Transactions of the Royal Society of New Zealand; Proceedings of the Linnean Society* for 1929–1930; *Nature* 1929; a memoir by Stella M. Allan in the *Christchurch Star-Sun* of August 26, 1958; volume 3, part 43 of *New Zealand's Nature Heritage* (1974); and histories of Canterbury College, Canterbury University, and Christchurch Boys' High School by Hight and Candy (1927), Gardner et al. (1973), and Campbell et al. (1981), respectively.

In his youth, Chilton lost a leg which almost certainly curtailed his later collecting activities (the marks of his peg-leg were still visible on the floor in front of a hand-basin in his study at the University in 1950) but he made good use of other people to collect material. For instance, he had a leaflet printed for lighthouse collectors on how to collect and preserve material in which he was interested.

Phreatic research

Chilton was a pioneer in phreatic research. His first important paper (Chilton, 1882a) recorded three species of amphipods and one of isopods from groundwater in the Canterbury Plains. He added further descriptive material and described two additional species of isopods including the first phreatoicoid isopod – five genera in all – in a major contribution which also reviewed the world literature (Chilton, 1894). In this monograph he acknowledges his debt to Humbert's 1876 review, Packard's paper on the cave fauna of North America (Packard, 1886), Stebbing's annotated Challenger bibliography of amphipods (Stebbing, 1888) and Wrzesniowski's paper on subterranean amphipods (1888)). Thus, despite his remoteness from international libraries and other research workers on the subterranean fauna, he was well aware of the work of his pioneering contemporaries.

In his 1894 monograph, Chilton surmised that phreatic forms like *Phreatoicus typicus* had been derived from surface forms which might yet be found by further research. With some satisfaction, he was later able to report that "this prophecy was fulfilled by the discovery of *P. kirkii* in 1906" (Chilton, 1918).

Although Chilton's scientific writings on the phreatic fauna never again achieved these heights, his interest in phreatic fauna continued throughout his life and he involved himself in the politics of the Christchurch artesian water supply. His 1924 paperback, "The Christchurch artesians and the city water supply" begins by stating that "The waters that feed the reservoirs under the city, tapped by the artesians, come from much farther afield. To understand the problems connected with the artesian system, it is therefore necessary to

know something about the Canterbury Plains, their extent, origin and structure, and particularly of the underground waters of the plains and the subterranean animals or 'well shrimps' that are found in some of them."

This was something of an introductory teaser. Nevertheless, although most of the book is devoted to the mechanics of the water supply, he gives some information on his phreatic crustaceans:

"... The well at Eyreton ... was about twenty feet deep, and the level at which the water stood in the well depended chiefly on the conditions of the river Eyre, the bed of which is about a mile away. This river ... is frequently quite dry, but is subject to floods following heavy rain on the Oxford Hills, some twenty or twenty-five miles away. Its bed, formed from the shingle and sand brought down by the floods, is slightly higher than the surrounding country, hence when the river is in flood the water soon percolates through the loose shingle, and the level of the ground water rises to within a few feet from the surface ... The five different kinds of well shrimps ... are all blind and colourless; most of them are long and slender and can thus make their way without difficulty through the narrow interstices between the stones and sand of the soil in which they live ..." (Chilton, 1924.)

The five species found in this well were the isopods *Phreatoicus typicus* Chilton, 1883 and *Cruregens fontanus* Chilton, 1882 and the amphipods "*Crangonyx*" (now *Paracrangonyx*) *compactus* Chilton, 1882, *Gammarus* (now *Phreatogammarus*) *fragilis* Chilton, 1882, and "*Calliopius*" (now *Paraleptamphopus*) *subterraneus* Chilton, 1882. The last four names, without taxonomic details, were also used in a brief note (Chilton, 1882b) recording the meeting at which he first presented his work. One of these, *Phreatogammarus fragilis*, has since been found living "above ground" in the shingle of the Selwyn River ... "the shingle is rounded and covered with a fine coating of algae; these specimens were found buried in this shingle down to a depth of six inches" (Hurley, 1954).

Because of his 1894 monograph, Chilton was invited to write on subterranean forms collected elsewhere. He reviewed the subterranean Amphipoda of the British Isles (Chilton, 1900); recorded *Phreatoicus shephardi* from peat moss at an altitude of 4,600 ft in New South Wales (Chilton, 1916); described a new species of "*Niphargus*"

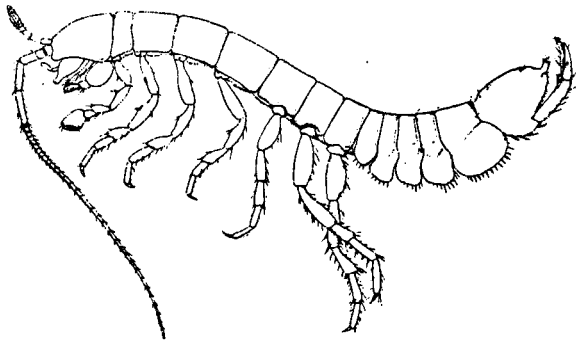

Fig. 2. Phreatoicus typicus Chilton, adult female (from Chilton, 1894).

from a well in the Philippines (Chilton, 1920a); a blind "*Niphargus*" from a coal mine 300 ft deep in Bengal (Chilton, 1923) and isopods from the Batu Caves in Selangor (Chilton, 1929) as well as other new species of freshwater crustaceans, including more phreatoicoids, from Australia (Chilton, 1916, 1920a, 1922, 1925). In 1920, he described the remarkable isopod *Haloniscus searlei* found in inland Australian salt lakes in salinities from 8 ppt to 159 ppt (Ellis & Williams, 1970), and canvassed the possibility that it had evolved directly from a marine ancestor but concluded that it was descended from "a form that was terrestrial in habits and that, owing to the special circumstances arising from its habitat, ... has become re-adapted to aquatic life" (Chilton, 1920a), a view that Bayly and Williams (1966) still found "entirely reasonable" fifty years later.

Chilton's work on the phreatoicoids was capped by the discovery in Australia of a fossil species from Triassic beds in New South Wales (Chilton, 1918) and a species from a hot artesian bore in Central Australia three miles from the nearest natural springs (Chilton, 1922) where *Phreatoicus latipes* Chilton, 1922 was reported by Professor Wood Jones (in Chilton, 1922) as being present "in their thousands swimming in the hot water near the bore head ... It is very hot; steam arising from it". (The animals are found in nearby springs over an area of some 30 miles.) In describing the fossil *Phreatoicus wianamattensis*, Chilton drew attention to the similarity of its known distribution in Tasmania with "the peculiar fresh-water shrimps, *Anaspides tas-*

maniae and *Paranaspides lacustris*" and *Koonunga* (Chilton, 1918).

The family Phreatoicidae, now raised to the rank of infra-order, is widely distributed throughout South Africa, Australia and New Zealand and is also found in India (Chopra, 1947; Chopra & Tiwari, 1950), in situations which range from near-littoral through standing water, running water, peat bogs, and swamps to the original phreatic and well environments. Its distribution is thus typically Gondwanian, a point noted by Chilton (1918) who quotes, with apparent approval, Keppel Barnard's comment on the discovery of *Phreatoicus capensis* in South Africa as "one more fact in support of the existence of an ancient land-mass connecting the southern continents (Gondwana land)" (Barnard, 1914).

The later discovery of phreatoicoid fossil remains in the Northern Hemisphere (Birstein, 1962; Schram, 1970) and the absence of the group from South America complicate this situation. Williams (1981), however, notes that the northern fossils are all of Palaeozoic marine forms whereas Chilton's Australian Mesozoic fossil is the only known freshwater fossil phreatoicoid.

Chilton's other research

Chilton's other "careers" should be mentioned. His family intended him to become an "agriculturist" but the loss of his leg, it is said, forced him into "pupil teaching", at that time "a not uncommon stepping stone to Canterbury University". This and his academic promise led him to become one of the first students at Canterbury which he entered without matriculation and "probably without any secondary schooling". Here, he won several important scholarships during a distinguished scholastic career, culminating in a Master of Arts degree with first class honours in zoology.

In 1887 he gained New Zealand's first Bachelor of Science degree at the University of Otago and took up teaching. In 1888 he was appointed Rector of Port Chalmers District High School but he resigned in 1895 after failing on a split vote to obtain a prestigious headmastership in Dunedin and set off for Edinburgh seeking a medical degree.

By 1899 he was house surgeon in the ophthalmic ward at the Royal Infirmary at Edinburgh. He spent a season in Europe at Heidelberg, Vienna and Berlin before returning to Christchurch in 1901 to practise as an ophthalmic surgeon.

In 1902 he was appointed acting Professor of Biology while Professor Arthur Dendy was on leave overseas, but, when Dendy suddenly resigned, Chilton was made Professor of Biology and Palaeontology. As professor, he helped establish and develop the Canterbury high country biological station at Cass. In 1921 he became Rector of Canterbury College.

He held both positions until he retired in 1928 when he was made an Emeritus Professor. In his retirement, his plans to produce the definitive work on New Zealand Crustacea which his friend, G.M. Thomson, had not found time to do, were prevented by Chilton's sudden death in 1929 from double pneumonia.*

Chilton's longer papers included reports on the Crustacea from the New Zealand Trawling Expedition (1911), the Scottish National Antarctic Expedition (1912) and the Australian "Endeavour" Expedition (1921). He produced many short papers of varying quality and several important works, particularly his monograph on subterranean Crustacea (Chilton, 1894), his work on New Zealand terrestrial Isopoda (Chilton, 1901) and his editing of the two-volume work "The Subantarctic Islands of New Zealand" based on the results of the Canterbury Philosophical Society's 1907 Expedition to the Auckland and Campbell Islands in which he participated himself. As well as editing, he contributed articles on the Crustacea, previous scientific investigations in the Subantarctic and a concluding essay on the biological relations of the New Zealand Subantarctic Islands (Chilton, 1909a–c).

* He was survived by his wife, Elizabeth Jack, whom he met at Dunedin Teachers' Training College and married in 1888 and who was keenly involved in his scientific and community work. Their only son, Frank, was a second year medical student at Edinburgh University who joined the Army when war broke out and was killed on Gallipoli in 1915 serving as a lieutenant in the Argyll Highlanders.

Along with G.M. Thomson, he was an active promoter (and secretary) of the Australian and New Zealand Association for the Advancement of Science's "Committee for Biological and Hydrographical Study of the New Zealand Coast" which sponsored and financed pioneer marine research in New Zealand between 1904 and 1928. In this role, he accompanied Dr Th. Mortensen of the Copenhagen Museum on the New Zealand Government Steamer "Hinemoa" on its annual visit around New Zealand servicing lighthouses in December, 1914, and January, 1915. This provided Mortensen with the opportunity to dredge at a number of stations en route and yielded considerable material for the series "Papers from Dr Th. Mortensen's Pacific Expedition 1914–1916" published by the Copenhagen Museum.

In the Subantarctic Islands volumes, Chilton summarises the similarities in freshwater and terrestrial invertebrates in Australia, New Zealand and South America and recognises the reality of a Gondwanaland connection, concluding that the relationships between the crustacean faunas of the islands and those of Australia, Tasmania and New Zealand are "perhaps a little closer than was previously recognised" (Chilton, 1909a: 801). He notes plant and animal similarities with South America and of the two theories then current – *the relict theory* that they were the southernmost outliers of animals developed "on the great land-masses further north" and *the Antarctic Continent theory* that subantarctic lands were formerly more or less connected with the Antarctic Continent – he prefers the latter:

"Scotia soundings ... seem to show how connections could be made between the Antarctic Continent and South America and the subantarctic islands to the south of the Indian Ocean by local elevations of the land of comparatively small extent and without assuming any great change in the relative positions of the great continents and oceans. These would supply the connections required by [its protagonist] without assuming such a huge subantarctic continent as [previously] appeared to be necessary". (Chilton, 1909c: 805.)

He notes, furthermore, that crayfish of the freshwater family Parastacidae are confined to the Southern Hemisphere and represented by different genera in South America, Madagascar, Australia and New Zealand.

Finally, he notes the discovery on Seymour Island of temperate and subtropical species of Tertiary fossil plants related to Chile and Brasil and considers these indicate a closer connection to Australia and New Zealand than their discoverer gave credit for:

"In the subantarctic islands of New Zealand we have some forms of life showing close connection with New Zealand, and evidently derived from that land, many of them doubtless having come originally from the north; and that with these there is mixed a pretty large antarctic element showing affinities particularly with South America, and other more remote affinities with the Kerguelen-Crozet groups and with South Africa. The evidence pointing to former extensions of land from the Antarctic Continent northwards, and to the warmer climate that was enjoyed by this continent in early Tertiary times, seems to offer a fairly satisfactory explanation of the facts before us ..." (Chilton, 1909c: 806.)

These two volumes have been a major reference source in antipodean zoogeography and exploration ever since and have stimulated the long love affair between New Zealand biologists and their Subantarctic Islands.

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