Subterranean aquatic fauna downstream of the Fortescue Marsh: preliminary report

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Background

In 1997 Spelaeogriphacea, a new order of crustaceans for Australia, was identified from Millstream aquifer in the Pilbara. This order was originally described (1957) from a sandstone cave 700 m up Table Mountain in South Africa, and this remained the only locality for three decades when another member of the order was found in a cave in the Mato Grosso in western Brazil. The Millstream species, which is the third locality for the order globally, represents a new genus that widely inhabits the Millstream aquifer (Poore and Humphreys, 1998), together with a range of other ancient lineages. Initially, living spelaeogriphaceans were thought to represent a Gondwana freshwater lineage — there is a marine fossil known from the Carboniferous (290 Ma) of Nova Scotia — but within the last year fossil spelaeogriphaceans of modern appearance have been found in freshwater lake deposits in China and Spain of late Jurassic and early Cretaceous age (c. 140 Ma). Hence, it appears that this lineage may have already been in freshwater prior to the dissolution of the supercontinent Pangaea and long before the fragmentation of Gondwana (Poore and Humphreys, 1998).

The associated stygofauna includes other taxa with Gondwana affinities, such as Phreodrilidae (Oligochaeta: generally with a cool climate Gondwana distribution: A. Pinder, personal communication 1997), Phreatoicidea (*Pilbarophreatoicus* Knott and Halse, 1999, Wilson and Johnson, 1999: Isopoda), crangonyctoid amphipods (gen. nov., J.H. Bradbury, personal communication 1999; Gondwana Williams, 1986), and *Tiramideopsis* (Acari: genus previously known only from India: Harvey, 1998). Other stygofauna include a new hydrobiid (Gastropoda: W.F. Ponder, personal communication 1997), Bathynellacea (Syncarida), cyclopoid and harpacticoid Copepoda, Ostracoda (3+ species), and ceinid and melitid amphipods. Several of these also probably have Pangaean affinities, including the Spelaeogriphacea (Poore and Humphreys, 1998), Syncarida (Schminke, 1974; Boutin and Coineau, 1987) and Crangonyctoidea (Barnard and Karaman, 1983).

The context for this stygofauna (Humphreys 1999a, in press) and additional information on that occurring on the 'Western Shield' is contained elsewhere (Bradbury in press; De Laurentiis *et al.* 1999, in press; Eberhard and Humphreys 1999; Harvey 1998; Humphreys 1999a, 2000a, 2000b, 2000c, in press; Poore and Humphreys 1998; Watts and Humphreys 1999a, in press, in prep).

A tethyan fauna, allied to the stygofauna of the Cape Range peninsula and Barrow Island, intrudes towards Millstream from the west and is present in aquifers of the lower reaches of the Robe and Fortescue River. Elements of the fauna reach an altitude of c. 300 m in the Robe River, the approximate level of the Late Eocene sealevel high on the Yilgarn (G.W. Kendrick, personal communication 1999). The Fortescue Marsh is an internal drainage basin (D.P. Commander, personal communication 2000) and even in times of peak flow it does not overflow downstream towards Millstream, where floods that occur result from flows of the Fortescue River South. Hence, the Millstream aquifer is probably isolated from those upstream.

The general lack of stygofauna sampling between the Western Fortescue Plain Aquifer and Ethel Gorge means that the extent of the 'Millstream' stygofauna assemblage is uncertain. This sampling reported here was undertaken to delineate the extent of the 'Millstream' stygofauna and is based on sampling between the Fortescue Marsh and Millstream and opportunistic sampling of the upper part of the Marsh and the palaeodrainages leading towards Lake Disappointment.

Methods

About 32 sites were sampled, comprising pastoral wells and boreholes constructed for water abstraction, groundwater investigation and mineral exploration in a number of fractured rock, alluvial and groundwater calcrete aquifers. The sampling included areas up and down stream of the Fortescue Marsh in the Fortescue Valley, and in Savory

Creek and Ilgarari Creek draining towards Lake Disappointment — these are the first samples obtained from this palaeovalley system (Figure 1).

The stygofauna were taken by plankton nets hauled through the water column of the bores and wells, or sometimes from baited traps.

Physico-chemical parameters in the water were determined either *in situ* using electronic instruments-- pH using a WTW pH 320 meter with a SenTix 97T pH-combined electrode with integrated temperature sensor and redox probe and dissolved oxygen using a WTW Oxi 320 meter and a CellOx 325 oxygen sensor (Wissenschaftlich-Technisch Werkstatten GmbH, Weilheim, Germany). Conductivity was measured with a TPS Model LC 84 conductivity meter (TPI Electronics, Springwood, Queensland, Australia). All were calibrated as specified using the recommended standards.

Results

Thirty-two groundwater sites were sampled (Table 1: Figure 1) of which 20 (67%) yielded aquatic fauna of which 12 sites (60%) definitely contained stygofauna and the remainder are yet to be determined.

About 700 specimens were collected divided amongst 71 lots.

The stygofauna comprised Copepoda, Ostracoda, Bathynellacea, Amphipoda and Spelaeogriphacea, which have yet to be worked up (Table 1).

Of the physical parameters measured (Table 2) only oxygen content was significantly associated with the number of orders sampled. The oxygen saturation was inversely associated with the number of stygal orders present ($F_{1, 14} = 6.987$, $P = 0.019$).

Limitations

Sampling was considerably delayed owing to record floods in the Fortescue Valley in 1999 and 2000. At the time of sampling many areas were still inaccessible and extensive detours were necessary to access some sample sites. Hence, some sites that need to be examined remain on Mulga Downs and Mt Florance Stations. Numerous sites had sealed bores and could not be sampled.

Access to the groundwater was predominantly through pastoral wells rather than bores and these often yield quite different data from narrow tube bores (Watts and Humphreys in press). New bores are being drilled for Iron Ore exploration by Robe River Exploration on Mulga Downs and these may permit better access to the groundwater if cooperation can be arranged. However, access to a large series of mineral exploration bores was lost owing to the floods in 1999/2000.

Traditional wide aperture pastoral wells and narrow bores may provide a different picture of the groundwater fauna. In one study pastoral wells did not yield stygofauna whereas adjacent narrow bore wells did (Watts and Humphreys in press). However, dealing with a similar fauna a study in another area found stygofauna in both types of locations (Watts and Humphreys in prep).

Discussion

Although the collection has yet to be worked-up the stygofauna between the Fortescue Marsh and Millstream lacks many higher taxa characteristic of the Millstream area, such as phreodrillids worms, phreatoicdean isopods, spelaeogriphaceans and hydrobiid molluscs. The Marsh itself has not been sampled (flooded and high salinity at depth :

60,000 mg L^{-1}). Immediately east of the Marsh spelaeogriphaceans occur but the other elements were not found, albeit in sparse sampling, but neither spelaeogriphaceans nor the other characteristic Millstream higher taxa are known from the more adequately sampled Ethel Gorge area further upstream.

Paramelitid amphipods of the genus *Molina* Bradbury in press (Paramelitidae) occur at Millstream but at Mulga Downs they are represented by the genus *Chydaekata* Bradbury in press (Paramelitidae). The species of *Chydaekata* known from Mulga Downs is different from the many species occurring at Ethel Gorge (Bradbury in press) which has the most species rich assemblage of stygal amphipods in the world.

The Millstream stygal assemblage appears to be unique, notwithstanding the presence of Spelaeogriphaceans (of as yet unknown specific status) on Roy Hill Station, east of the Fortescue Marsh.

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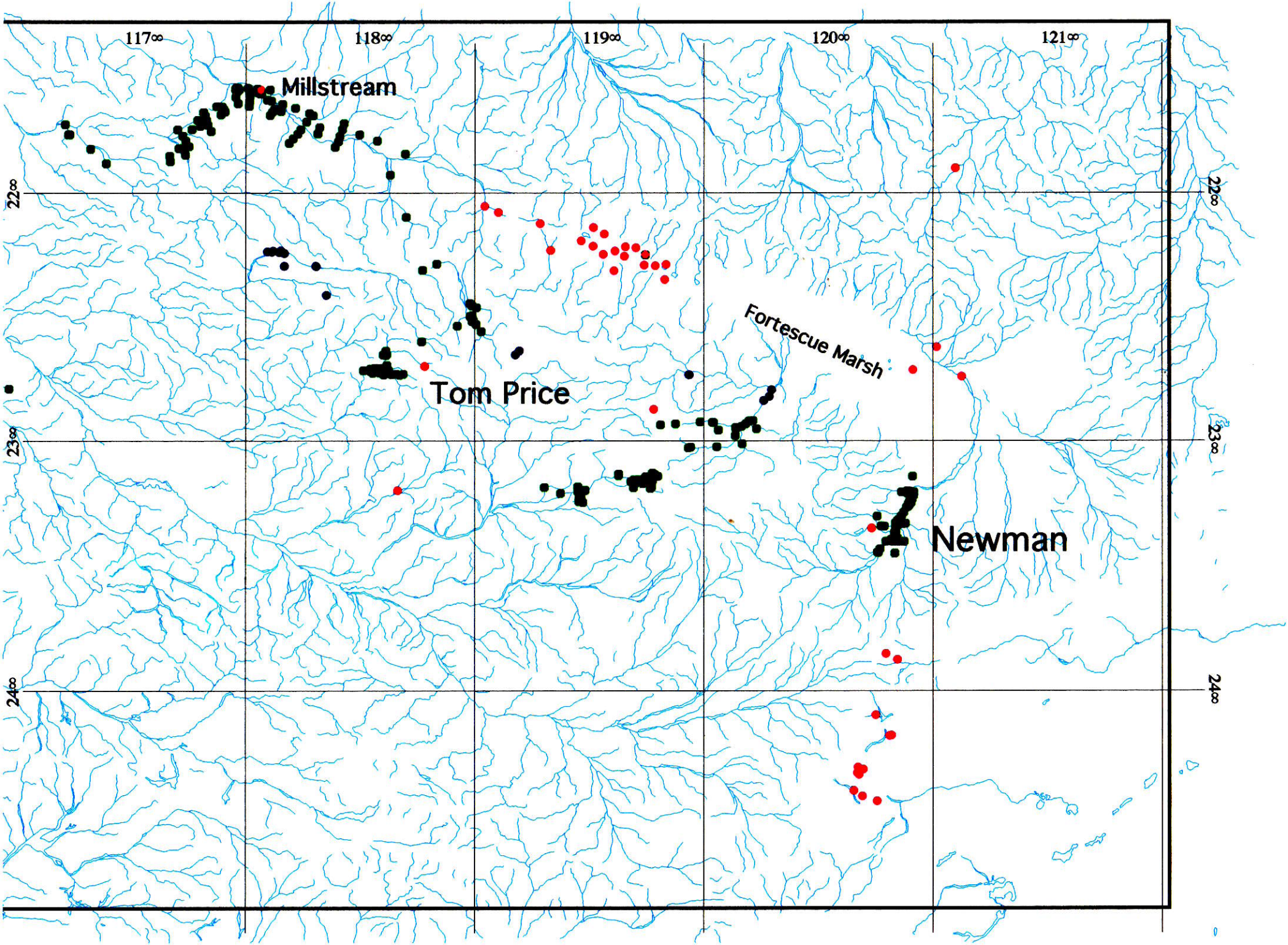
Table 1: Sites sampled from 2-8 September 2000

Site	Location	Northing	Easting	Fauna
1	Marnanoonah Well	-22.12444	118.28779	Copepoda, Ostracoda
2	Murrays Well	-22.14055	118.51925	
3	Robinson Well	-22.16602	118.56752	
4	Munjong Well	-22.22236	118.70542	Ostracoda, Copepoda
5	Ebathacalby Well	-22.24978	118.74775	Ostracoda, Copepoda, Amphipoda
6	Maddina Well	-22.21762	118.65956	Hydracarina, Ostracoda, Copepoda
7	Pipally Well	-22.23527	118.61445	Amphipoda, Copepoda, Ostracoda
8	Yampire Well	-22.24849	118.56225	Amphipoda, Ostracoda, Copepoda
9	Browns Well	-22.21506	118.51808	Amphipoda, Ostracoda, Copepoda
10	Calamina (Katamina) Well	-22.19418	118.46732	Amphipoda, Ostracoda, Copepoda
11	Silver Grass Well	-22.25671	118.65630	Copepoda
12	V15 Well [probably]	-22.07922	118.10514	Copepoda
13	Outcamp Well	-22.05387	118.04531	Amphipoda, Ostracoda
14	Chaddelinna Bore	-22.29268	118.74102	
15	Bernies Bore	-22.29005	118.83788	
16	Salt Well	-22.29492	118.78946	Amphipoda, Ostracoda, Copepoda
17	Bore KDD223	-22.35055	118.83115	
18	Unnamed 'Bloodwood Bore"	-22.46009	118.70455	Amphipoda
19	Bore with Mill	-22.87297	118.78304	Vermes
20	700 Mile Bore	-23.85297	119.79638	
21	Peter Bore	-23.8757	119.84655	
22	Scottys Well	-24.09639	119.75194	Amphipoda, Ostracoda
23	Bore near No 38 Govt Well	-24.17872	119.81200	
24	No 38 Govt Well	-24.17758	119.82167	
25	No 37 Govt Well	-24.31355	119.69760	Copepoda, Ostracoda, Hyrdacarina
26	Well abandoned	-24.3277	Copepoda	Copepoda
27	Old Ilgarari Well	-24.33421	119.67996	
28	Yanneri Bore	-24.39791	119.65635	
29	Yanneri Well	-24.43967	119.75749	Amphipoda, Copepoda, Ostracoda, Bathynellacea
30	Battle Hill Well	-22.74116	120.12706	Amphipoda, Copepoda, Ostracoda, Speleogriphacea
31	4 mile Well	-22.62229	120.01784	
32	Aerodrome Bore	-22.71479	119.91460	Amphipoda, Ostracoda, Speleogriphacea

Table 2: Water quality of some bores sampled.

Location	Conductivity MS cm^{-1}	Salinity $g\ L^{-1}$	Temp. °C	O_2 mg L^{-1}	O_2 %	pH	Depth to/ of water (m)	Note	Taxa
Bore next to dam	1.35	0.84	24	2.56	35.5	6.6	22.5/10		-
Marnanoonah Well	4.04	2.42	23.3	5.34	60.5	7.82			Copepoda, Ostracoda
Murrays Well	9.14	5.4	23.2						-
Munjong Well	5.72	3.45	20.4						Copepoda, Ostracoda
Ebathacalby Well	4.19	2.47	23.1	5.1	63	8.20			Copepoda, Ostracoda, Amphipoda
Maddina Well	0.48	0.29	22	1.84	21.6	8.39	3/4		Copepoda, Ostracoda, Hydracarina
Pipally Well	3.43	2.02	25.2	5.66	71.5	7.77	2.5/2.5		Copepoda, Ostracoda, Amphipoda
Yampire Well	1.97	1.18	26.6	3.4	43	7.38			Copepoda, Ostracoda, Amphipoda
Browns Well	4.05	2.42	24.4	6.3	77.6	7.4	2/3		Copepoda, Ostracoda, Amphipoda
Calamina (Katamina) Well	6.4	3.78	22.8	5.5	68	7.7	2/4		Copepoda, Ostracoda, Amphipoda
Silver Grass Well	6.07	3.57	26.9	5.9	77.7	7.4			Copepoda
V15 Well [probably]	4.46	2.65	23.6				2.5/4		Copepoda
Outcamp Well	7.35	4.37	23.2	5.82	70	7.78	3.2/8.4	salinity stratified	Ostracoda, Amphipoda
Chaddelinna Bore	4.33	2.55	30.5						-
Bernies Bore							2/1		-
Salt Well	11.6	7.2	25.3	2.2	30.6	7.35			Copepoda, Ostracoda, Amphipoda
Bore KDD223	2.26	1.35	24	1.24	16	7.28			-
Unnamed bore "Bloodwood Bore"							3/11		Amphipoda
Bore with Mill (Auski-Newman)	1.14	0.67	25.5	6.03	81.6	7.4	51/2		Vermes
700 Mile Bore	1.5	.63	25.6	7.16	93	7.6	7/23		-
Peter Bore	1.96	1.15	24.6	7	90	7.52	11/34		-
Scottys Well	7.69	4.54	24.9	4.37	57.6	7.69	3/4		Ostracoda, Amphipoda
No 38 Govt Well							15/2		-
No 37 Govt Well	1.18	0.7	22.5	4.8	58.2	7.6	3/3		Copepoda, Ostracoda, Hydracarina
Well abandoned	1.2	0.73	16.4				0/.3		Copepoda
Old Ilgarari Well	2.87	1.68	23.8	6.5	83	7.65	3/3		-
Yanneri Bore	3.8	2.24	24.4	6.69	85.5	7.56	2/1		-
Yanneri Well	2.24	1.32	21.8	3.98	48	7.72			Copepoda, Ostracoda, Amphipoda, Bathynellacea
Battle Hill Well	6.65	3.94	25.5	1.5	18.6	7.13	3.6/4		Copepoda, Ostracoda, Amphipoda, Spelaeogriphacea
4 mile Well	0.91	0.54	24	4.29	57.5	7.87	9/24		-
Aerodrome Bore	5.67	3.36	29.2	0.71	9.2	7.2	9/2		Ostracoda, Amphipoda, Spelaeogriphacea

Figure 1: Sample sites in the Pilbara Region, Western Australia. Red: Towns or Stations; Pink: sites sampled in this study. Green, sites sampled previously by W.A. Museum; blue, sites sampled by Hamersley Iron.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Millstream
Tom Price
Fortescue Marsh
Newman