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The macroinvertebrate fauna of an Australian dryland river: spatial and temporal patterns and environmental relationships

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Abstract. Waterholes within the dryland Cooper Creek, Lake Eyre Basin, Australia, are connected only during floods and are typically isolated for long periods. Spatial changes in the macroinvertebrate assemblages of 15 of these waterholes belonging to four regions were explored and these changes were related to environmental aspects of the waterholes measured at four spatial scales: floodplain, waterhole, within waterhole and sample habitat. To explore temporal patterns, one region was sampled on four occasions differing in time since connection. Spatial patterns were characterised by ‘differentiation by distance’ whereby samples collected closer to each other in the landscape were more similar in assemblage composition than those collected further apart. Thus, there were significant differences between the assemblages of the four regions. Although there was a correlation between macroinvertebrate spatial patterns and a combination of local habitat, geomorphology and water chemistry attributes, it appears unlikely that these variables were responsible for the faunal differentiation by distance. Temporal variability was larger than spatial variability and temporal assemblage patterns were best explained by the ‘connectivity potential’ of waterholes, reflecting the position of individual waterholes within the broader channel network and long-term connectivity relationships, rather than the actual time since hydrological connection.

Appendix 1. Environmental variables used in the study and the units in which they were expressed

Those in bold type were included in BIOENV analyses following variable redundancy analysis

Variable class	Description	Abbreviation
Floodplain morphology	**Total floodplain width (m)**	**FW**
	Effective floodplain width (m)	**EFW**
	Floodplain setting	**FS**
	Bifurcation ratio	**BR**
	Number of channels	NOC
	Channel distance to the nearest waterhole (m)	**CD**
	Straight line distance to the nearest waterhole (m)	**SLD**
Waterhole morphology	**Surface Area (m^2)**	**A**
	Perimeter (m)	P
	Length (m)	L
	Width (m)	W
	Fetch length (m)	**FL**
	Circularity	C
	Elongation ratio	ER
	Length to width ratio	LW
	Bankfull cross-sectional area (m^2)	**CSA**
	Width to depth ratio	**WD**
	Hydraulic radius	**HR**
	Wetted perimeter (m)	**WP**
	Shape Index	**SI**
	Depth of cross section (m)	**DCS**
	Volume (m^3)	V
Within waterhole morphology	**Mid-channel bars**	**MCB**
	Backwater	**BAW**
	Off-take channels	**OC**
	Bench 0 - 1/3	**B1**
	Bench 1/3 – 2/3	**B2**
	Bench 2/3 – 3/3	**B3**
	Side bars	**SB**
	Miscellaneous bars	**BAR**
	Anabranches	**AN**
	Bed and bank complexity	**BBC**
	Eroding banks	**EB**
	Snag Density	**SD**
	Scour holes	**SH**
	Boulders	**BOU**
	Fringing vegetation	**FV**
	Overhanging vegetation	**OV**
Sample habitat	% deep (not samplable)	%D
	% edge	**%E**
	% silt/clay pool	%S/C
	% sandy pool	**%S**
	% rocky pool	**%R**
	edge algae density (category)	**EAD**
	edge detritus density (category)	**EDD**
	edge macrophyte density (category)	**EMD**
	rocks (presence/absence)	**R**
	mean wetted width (m)	**MWW**

Water quality	**conductivity (uS/cm @ 25°C)**	**Cond**
	pH (@ 23°C)	pH
	turbidity (NTU)	**Tur**
	depth 1% light (cm)	DL
	total hardness (mg/L $CaCo_3$)	Thar
	alkalinity (mg/L $CaCo_3$)	Alk
	true colour (Hazen)	Tcol
	total dissolved ions (mg/L)	TDI
	total suspended solids (mg/L)	TSS
	total N (mg/L)	**TN**
	total P (mg/L)	TP
	ratio total N: total P	**N:P**
	DO 24 hr maximum (mg/L)	DOmax
	DO 24 hr minimum (mg/L)	**DOmin**
	water temperature 24 hr maximum (°C)	**Mtemp**
	water temperature 24 hr minimum (°C)	Mintemp
	Silicate (mg/L)	**Sil**
	Sodium (mg/L)	Na
	Potassium (mg/L)	K
	Calcium (mg/L)	Ca
	Magnesium (mg/L)	Mg
	Bicarbonate (mg/L)	Bcarb
	Carbonate (mg/L)	Carb
	Chloride (mg/L)	Cl
	Flouride (mg/L)	Fl
	Nitrate (mg/L)	Nit
	Sulphate (mg/L)	**Sul**
Hydrology	**Time since discharge > 1500 ML/day (days)**	**D>1500**
	Time since discharge > 1000 ML/day (days)	**D>1000**
	Time since discharge > 500 ML/day (days)	D>500
	Time since discharge > 50 ML/day (days)	**D>50**
	Total antecedent discharge in past 90 days (ML)	**TAD90**
	Total antecedent discharge in past 60 days (ML)	**TAD60**
	Total antecedent discharge in past 30 days (ML)	**TAD30**
	Duration of most recent high flow event > 500 ML/day (days)	**AHF**

Appendix 2. Taxa identified from samples collected from waterholes in the Cooper Creek catchment between April 2001 and May 2003

	Species
NEMATODA	Indeterminate spp.
TEMNOCEPHALIDEA	*Temnocephala* sp.
MOLLUSCA	
BIVALVIA	
Sphaeriidae	*Sphaerium* sp.
Corbiculidae	*Corbiculina australis*
Hyriidae	*Velesunio wilsonii*
GASTROPODA	
Ancylidae	*Ferrissia* spp.
Bithyniidae	*Gabbia* sp. (?)
Thiaridae	*Thiara balonnensis*
Viviparidae	*Notopala sublineata*
OLIGOCHAETA	Indeterminate spp.
ARACHNIDA	Acarina spp.
CRUSTACEA	
ISOPODA	
Oniscidae	*Haloniscus* sp.
DECAPODA	
Palaemonidae	*Macrobrachium australiense*
Parastacidae	*Cherax destructor*
Sundathelphusidae	*Holthuisana* sp.
INSECTA	
EPHEMEROPTERA	
Caenidae	*Tasmanocoenis arcuata*
	Wundacaenis dostini
ODONATA	
Coenagrionidae	*Xanthagrion* sp.
	Ischnura aurora
Telephlebiidae	*Austroaeschna pulchra*
Gomphidae	*Austrogomphus australis*
	Austrogomphus cornutus
	Antipodogomphus acolythus
Hemicorduliidae	*Hemicordulia continentalis*
Libellulidae	*Orthetrum caledonicum*
HEMIPTERA	
Veliidae	*Mesovelia* sp.
Pleidae	*Paraplea* sp.
Corixidae	
	Micronecta spp.
Notonectidae	*Anisops* spp.
COLEOPTERA	
Dytiscidae	*Antiporus* spp.
	Megaporus sp.
	Allodessus sp
	Liodessus sp.
	Sternopriscus sp.
	Laccophilus sp.
	Hydroglyphus sp.
	Eretes australis
	Onychoydrus scutellaris
	Hyphydrus sp.

Hydrophilidae	*Enochrus* sp.
	Coelosoma sp.
	Paranacaena sp.
	Laccobius sp.
	Paracymus sp.
Hydraenidae	Indeterminate sp. (larvae)
DIPTERA	
Tipulidae	Indeterminate sp.
Psychodidae	Indeterminate sp.
Chironomidae	Tanypodinae
	Chironominae
	Orthocladinae
Ceratopogonidae	*Bezzia* sp.
	Forcipimia sp.
	Atrichopogon sp.
Tabanidae	Indeterminate sp.
Sciomyzidae	Indeterminate sp.
Muscidae	Indeterminate sp.
Ephydridae	Indeterminate sp.
LEPIDOPTERA	
Pyralidae	Indeterminate sp.
TRICHOPTERA	
Ecnomidae	*Ecnomus* sp.
Leptoceridae	*Triplectides australis*
	Oecetis sp.