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LONGITUDINAL VARIATION IN COMMUNITY STRUCTURE OF CHIRONOMIDAE (DIPTERA) IN TWO SOUTH-WESTERN AUSTRALIAN RIVER SYSTEMS.

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ABSTRACT - The chironomid fauna of riffle zones in two Western Australian river systems; the Canning and North Dandalup are described. Thirty sites in upland-forested, lowland-urban and lowland-rural areas were quantitatively sampled on a quarterly basis over 12 months. Data on species richness, abundance and sub-family composition are presented. Forty-two and 56 species or species-complexes were recorded from the North Dandalup and Canning rivers respectively. Communities in lowland-rural sites, in summer and autumn were characterised by high abundance (c. 31,600 larvae m^{-2} river bed), dominated by *Cladotanytarsus ?mancus* and *Tanytarsus* spp complex. The sub-family Chironominae exhibited a proportionately higher species richness in the lowland (64.5%) than the upland (38.6%) sites with the sub-families Aphroteniinae and Podonominae restricted to upland sites.
Classification, based on Czekanowski's Similarity Coefficient separated upland site fauna from lowland, with intermittent sites tending to separate from permanent. The impact on the fauna of an existing impoundment on the Canning River was demonstrated by the classification of a mid-order site with lowland sites.

Key words: Chironomidae, community structure, subfamily composition, Western Australia.

1. INTRODUCTION

Research on the Chironomidae of lotic systems in Australia has been limited, with no specific studies on the family (for review; see Edward, 1986). This is partly due to the lack of suitable keys to both immature and adult stages but also due to the paucity of research on the ecology of the freshwater macroinvertebrate fauna of streams and rivers. An introductory picture of the Chironomidae of lotic environments is presented in recent surveys of aquatic macroinvertebrates of the La Trobe River, Victoria (Marchant *et al.*, 1984; Metzeling *et al.*, 1984), and of streams of the northern jarrah forest, Darling Range, Western Australia (Bunn, *et al.*, 1986).

Both studies demonstrate that the chironomids are the most abundant group of invertebrates collected, comprising an average of 32% of the fauna at each site in the upper catchment and over 20% at each lowland region for the Victorian river, and over 40% of all fauna sampled in upland streams in Western Australia (Edward, 1986).

During the past decade an extensive voucher collection of the chironomid fauna of lotic systems in Western Australia has been established. The funding of a long term water quality monitoring and environmental impact assessment programme has facilitated an intensive study of the chironomid fauna of streams and rivers of Western Australia.

A detailed description of community structure of Chironomidae from upland and lowland sites on two river systems in Western Australia is presented. Longitudinal changes in community structure are reported, along with changes in species richness, total abundance and subfamily composition. Comparisons are made to previous studies of the Chironomidae of lotic systems in Western Australia and the northern hemisphere.

2. STUDY AREA

Situated in the south-west of Western Australia the study area consisted of 30 sites in two catchments, the Canning and North Dandalup Rivers (Fig. 1). Both systems arise in the northern jarrah forest on the Darling Range (300 metres ASL) and have swamps on their headwaters. The streams flow over lateritic soils and granite bedrock before descending to the Swan Coastal Plain with a substratum dominated by sand. The location, geology and flora of the Darling Scarp has previously been described by Bunn *et al*. (1986). The headwaters of the North Dandalup River are relatively undisturbed, subjected to minimal logging, with the lower river flowing through areas of extensive rural land-use. Conversely, the headwaters of the Canning River have been extensively logged, with some headwater and mid-order streams flowing through mixed fruit orchards. The lower sites are located within the Perth Metropolitan Area. Both systems are regulated by impoundments, immediately above sites LC1 and ND5 on the Canning and North Dandalup Rivers respectively, although at site ND5 the small pipehead dam overflows each winter. Within the study period the majority of headwater sites in the Canning were intermittent (SC1, SC2, SC3, CD1A, CD1 - CD4, LC2 & LC3) whilst only site ND7 of the North Dandalup River stopped flowing.

3. METHODS

All samples were collected as part of an extensive biological monitoring programme within the two systems. Each site was sampled four times (spring, summer, autumn and winter) with sampling restricted to riffle zones. On each occasion six replicate Surber samples were taken (mesh aperture 250 μm, area 0.0625 m^2). Large stones were first removed and washed into the net to remove pupae and other attached invertebrates. The substratum was then vigorously disturbed to a depth of 10 cm for 2 minutes to allow the current to sweep the resident fauna into the net. Samples were removed from the Surber net, placed in plastic bags and fixed in 10% formalin.

In the laboratory, samples were washed to remove preservative before separation of inorganic and organic fractions in a $CaCl_2$ solution (specific gravity 1.40). All macroinvertebrates were removed from the organic fractions, under low-power microscope before storage in 70% ethyl alcohol. Chironomid larvae and pupae were identified to the lowest possible taxon using previously collected and curated voucher specimens. The abundance of each taxa was recorded for each replicate.

Species richness (S) and mean density (No. m^{-2} river bed) of chironomid larvae were calculated for each site and season. The relative proportion of the chironomid fauna comprised by each subfamily was determined, utilising the mean abundance of each species at each site over the year. A classification of sites, based on species composition and relative abundance, was made using Czekanowski's Similarity Coefficient and dendrograms were constructed for each river system using the average linkage method.

4. RESULTS

The Chironomidae sampled together with an indication of their mean abundance are listed in Tables 1 and 2 for North Dandalup and Canning Rivers respectively. A total of 42 and 56 taxa were recorded from the respective catchments. The majority of species remain to be described and are identified by voucher numbers. Of the total taxa in the North Dandalup system, 31% demonstrated distributions restricted to headwater sites with 30% similarly restricted in the Canning. Taxa restricted to lowland sites comprised 17% and 23% of the fauna in the respective catchments with the majority of taxa cosmopolitan to upland and lowland sites: North Dandalup, 52%; Canning, 47%.

Species richness, calculated for each site in each season demonstrated between-site and season differences in both the North Dandalup and Canning catchments (Fig.2). Seasonal and between-site differences in total abundance were also apparent. In the North Dandalup River larval numbers were higher in summer and autumn than winter and spring, with greater densities in lowland than upland sites (Fig.3). Lowland sites were dominated by approx. five species of which *Cladotanytarsus ?mancus* (Walker) and *Tanytarsus* spp complex were the most abundant (Table 1). Trends in seasonal and between-site changes in larval abundance were not as obvious in the Canning River although lowland sites similarly demonstrated a higher density (Fig.3). *Cladotanytarsus ?mancus* and *Tanytarsus* spp complex were again dominant, with *Cricotopus annuliventris* (Skuse) also abundant (Table 2).

Longitudinal changes in subfamily composition were evident in both systems, with the Chironominae proportionately more dominant in lowland sites. In the North Dandalup this subfamily increased in importance from 51% to 65% of taxa (Fig.4), with the tribe Chironomini demonstrating a greater downstream increase than the Tanytarsini. In the Canning the Chironominae increased in importance from 34% to 65% of taxa (Fig.4), with the Chironomini again demonstrating a greater change than the Tanytarsini. The subfamilies Aphroteniinae and Podonominae were restricted to upland, forested sites, with the latter recorded only from the Canning catchment.

Classification of North Dandalup sites (Fig.5a) identified four groups, separating longitudinally, from headwaters to the coastal plain. A similar trend was evident for classification of Canning catchment sites (Fig.5b). Site LC1 was an exception. This mid-order site classified away from other mid-order sites (LC2 & LC3) and alongside downstream, coastal plain sites (LC7 & LC5). Community structure at site CD1A was distinctive, with this site separating from all other sites at 23% similarity. Classification of upland, headwater sites demonstrated a separation of perennial (CD5 & CD6) from highly intermittent sites (CD1, CD2, CD3 & CD4).

5. DISCUSSION

This study reports advances in our knowledge of the chironomid fauna of lotic systems in Western Australia. Bunn *et al.* (1986) recorded 33 taxa of Chironomidae from northern jarrah forest streams, with eight species of Orthocladiinae (five recognised species and three vouchers; V15, V22 & V35) and one Aphroteniinae. At present a total of 58 taxa have been recorded, with 24 species of Orthocladiinae and two Aphroteniinae. Seven of the 10 recognized subfamilies of Chironomidae are recorded from Australia, five of which occur in Western Australian streams. The subfamily Podonominae, previously recorded from

Table 1. Abundance categories of chironomid taxa, in North Dandalup River system, based on annual mean number of larvae m^{-2} river bed, for 4 sampling occasions, (1=1-3, 2=4-9, 3=10-27, 4=28-81, 5=82-243, 6=244-729, 7=730-2187, 8=2188-6561, 9=6562-19683, 10= >19684).

TAXA	SITE ND1	ND2	ND3	ND4	ND5	ND6	ND7	ND8	ND9	ND10	ND11
TANYPODINAE											
Paramerina levidensis (Skuse)	4	4	5	5	5	4	5	3	-	2	3
Macropelopia sp. V9	-	-	1	1	1	-	-	-	-	-	-
?*Ablabesmyia* sp.A V10	4	5	4	3	-	-	-	-	-	-	-
Tanypodinae sp. V20	3	3	5	2	2	-	-	-	-	-	-
Ablabesmyia sp.B V37	-	-	1	-	-	-	-	-	-	-	-
Procladius paludicola (Skuse)	-	-	-	-	2	4	2	3	4	5	3
ORTHOCLADIINAE											
Cricotopus annuliventris (Skuse)	4	4	3	3	4	5	6	2	2	4	5
Thienemanniella sp. V19	1	1	2	3	3	4	7	1	5	5	5
Stictocladius uniserialis Freeman	3	4	4	4	4	1	-	-	-	3	1
Orthocladiinae sp. V11	6	4	3	4	3	2	1	-	-	-	-
Orthocladiinae sp. V15	3	-	1	1	-	-	-	-	-	-	-
Limnophyes sp. V31	2	4	-	1	-	-	1	-	1	2	-
Orthocladiinae sp. VCD2	-	1	-	-	-	-	-	-	-	-	-
Cricotopus albitibia (Walker)	-	-	-	-	-	-	-	-	3	2	1
Orthocladiinae sp. VSC9	-	-	-	1	-	-	-	-	-	-	-
Limnophyes pullulus (Skuse)	-	-	-	-	-	-	1	-	-	-	-
Orthocladiinae sp. VCD6	-	-	-	-	-	1	-	-	-	-	-
Orthocladiinae sp. V44	-	-	-	-	1	-	-	-	-	-	-
Nanocladius sp. VCD7	-	-	-	-	-	1	-	-	-	-	-
CHIRONOMINAE											
Chironomini											
Riethia sp. V5	5	5	3	4	3	1	-	-	-	-	-
Riethia sp. V4	5	5	6	5	5	3	-	1	-	-	-
Polypedilum sp.A V3	5	1	4	4	4	3	1	2	3	5	3
Stenochironomus sp. V27	1	-	4	3	1	1	-	-	-	1	-
?*Paratendipes* sp. V12	2	1	5	-	-	-	-	-	-	-	-
Demicryptochironomus sp. V14	-	1	-	-	-	-	-	-	-	-	-
Chironomus aff. *alternans* Walker	1	-	3	1	-	3	4	5	5	2	1
Cryptochironomus griseidorsum Kieffer	-	-	-	-	3	5	5	6	6	6	6
Polypedilum sp. B V33	3	2	3	-	3	1	-	1	-	1	1
Dicrotendipes sp. V47	-	-	-	-	-	4	1	1	-	-	-
Chironomini sp. V40	-	-	-	1	-	2	-	1	-	-	-
Chironomini sp. V69	-	-	1	-	-	-	-	-	-	-	-
Polypedilum nubifer (Skuse)	-	-	-	-	-	1	1	5	6	4	5
Cladopelma curtivalva Kieffer	-	-	-	-	-	5	-	3	4	5	1
Harnischia sp. VCD10	-	-	-	1	2	3	5	6	6	6	6
Tanytarsini											
Tanytarsus spp. V6, V32, V34, V36	5	5	4	5	7	7	7	7	8	9	8
Stempellina ?*australiensis* Freeman	2	3	3	4	5	2	-	-	-	-	-
Tanytarsini sp. V13	-	-	2	1	-	1	-	-	-	-	-
Rheotanytarsus sp. V18	1	2	2	2	3	1	1	-	-	1	-
Cladotanytarsus ?*mancus* (Walker)	-	-	-	-	1	7	8	9	7	10	9
Tanytarsus sp. V58	-	-	3	1	1	1	-	-	-	-	-
APHROTENIINAE											
Aphroteniella filicornis Brundin	3	3	1	1	-	-	-	-	-	-	-
Aphroteniella sp. V30	-	-	1	1	-	-	-	-	-	-	-

Table 2. Abundance categories of chironomid taxa in the Canning River System, based on annual mean number of larvae m^{-2} river bed for 4 sampling occasions, (1=1-3, 2=4-9, 3=10-27, 4=28-81, 5=82-243, 6=244-729, 7=730-2187, 8=>2188).

TAXA	SITE																		
	SC1	SC2	SC3	CD1A	CD1	CD2	CD3	CD4	CD5	CD6	LC1	LC2	LC3	LC4	LC5	LC6	LC6A	LC7	LC7A
TANYPODINAE																			
Paramerina levidensis (Skuse)	3	5	4	4	1	4	3	2	4	4	4	5	5	1	1	1	4	2	2
Macropelopia sp. V9	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
?*Ablabesmyia* sp.A	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
Tanypodinae sp. V20	4	2	5	2	2	1	-	2	3	2	-	1	1	-	-	-	-	-	-
Ablabesmyia sp.B	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Procladius paludicola (Skuse)	-	1	1	-	-	-	-	-	1	-	7	3	1	-	-	-	1	1	2
ORTHOCLADIINAE																			
Cricotopus annuliventris (Skuse)	5	5	3	5	2	3	4	3	3	6	-	5	8	6	5	4	6	2	2
Thienemanniella sp. V19	4	5	4	7	5	2	3	1	4	4	-	5	6	5	3	3	4	4	-
Stictocladius uniserialis Freeman	-	2	-	2	4	1	4	5	-	4	-	-	1	-	-	-	-	-	-
Orthocladiinae sp. V11	1	1	1	3	2	1	1	-	2	5	-	4	5	6	5	5	5	1	-
Orthocladiinae sp. V15	-	1	1	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-	-
Orthocladiinae sp. V22	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Limnophyes sp. V31	-	-	-	2	-	-	-	2	1	1	-	1	-	-	-	-	-	-	-
Orthocladiinae sp. V35	-	4	3	-	-	-	2	-	-	-	-	2	-	1	-	-	-	-	-
Orthocladiinae sp. VSC1	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthocladiinae sp. VSC2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthocladiinae sp. VCD2	1	-	-	-	-	1	-	-	5	-	6	3	-	4	5	5	4	-	2
Corynoneura sp. V49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Cricotopus albitibia (Walker)	-	-	-	-	-	-	-	-	-	-	-	-		3	2	-	1	1	-
Orthocladiinae sp. VSC8	2	-	1	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Orthocladiinae sp. VSC9	5	-	3	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Orthocladiinae sp. VSC11	-	1	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-
Limnophyes pullulus (Skuse)	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthocladiinae sp. VCD6	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Orthocladiinae sp. V43	-	-	-	4	-	3	3	3	-	-	-	1	-	-	-	-	-	-	-
Orthocladiinae sp. V44	-	-	-	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Orthocladiinae sp. V45	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nanocladius sp. VCD7	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	2	-
Orthocladiinae sp. VCD8	-	-	-	1	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthocladiinae sp. VS2	-	-	-	-	-	-	-	-	-	-		1	-	-	-	-	-	-	-
CHIRONOMINAE																			
Chironomini																			
Rietnia sp. V5	-	1	-	-	1	-	-	1	-	1	-	2	-	-	-	-	-	-	-
Rietnia sp. V4	-	-	1	-	-	-	-	-	-	4	6	3	2	-	-	-	-	-	-
Polypedilum sp.A V3	2	3	2	-	-	-	1	-	3	2	2	2	1	-	5	3	3	4	3
Stenochironomus sp. V27	-	1	-	-	-	-	-	-	1	2	2	2	1	3	3	2	1	-	-
?*Paratendipes* sp. V12	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-
Demicryptochironomus sp. V14	-	2	-	-	-	-	1	1	1	1	2	1	-	-	-	-	1	-	-
Chironomus aff. *alternans* Walker	-	-	2	-	-	-	-	-	1	-	3	-	-	2	4	1	5	2	7
Cryptochironomus griseidorsum Kieffer	-	-	-	-	-	-	-	-	3	-	4	2	3	1	5	3	4	3	4
Polypedilum sp.B V33	-	1	-	2	-	-	2	4	2	-	5	-	2	1	6	3	2	2	1
Dicrotendipes sp.V47	-	-	1	-	-	-	-	-	-	-	4	3	2	-	3	3	3	2	1
Kiefferulus intertinctus (Skuse)	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	1	2	-	4
Cladopelma sp. VCD3	-	-	-	-	-	-	-	-	-	-	6	-	-	-	4	3	1	-	-
Chironomini sp. VCD4	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Xenochironomus sp. VCD5	-	-	-	-	-	-	-	-	-	-	-	3	-	-	1	-	-	-	-
Chironomini sp. V40	-	1	1	-	-	-	-	-	-	-	3	-	-	1	1	2	2	-	-
Chironomini sp. V69	-	-	-	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-
Polypedilum nubifer (Skuse)	-	-	-	-	-	-	-	-	-	-	-	-	5	1	-	-	1	-	5
Cladopelma curtivalva Kieffer	-	-	-	-	-	-	-	-	-	-	5	-	3	-	3	1	-	-	6
Harnischia sp. VCD10	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	3	3	2
Tanytarsini																			
Tanytarsus spp. V6,V32,V34,V36	3	6	5	4	1	3	3	5	6	6	8	7	7	6	8	6	6	8	6
Stempellina ?*australiensis* Freeman	-	-	1	1	-	-	-	-	4	3	4	1	-	-	1	-	-	-	-
Tanytarsini sp. V13	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
Rheotanytarsus sp. V18	4	6	5	5	2	-	1	1	-	5	-	6	6	6	3	4	3	2	-
Cladotanytarsus ?*mancus* (Walker)	-	-	2	-	-	-	-	-	2	-	-	2	5	2	6	7	4	6	6
APHROTENIINAE																			
Aphroteniella filicornis Brundin	-	-	-	-	-	-		1	1	-	-	-	-	-	-	-	-	-	-
PODONOMINAE																			
Podonomopsis ?*evansi* Brundin	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

temporary streams on granite outcrops (*Archaeochlus brundini;* Cranston *et al.*, 1987) is now represented by a second species, *Podonomopsis ?evansi* Brundin in upland forested streams. Although the present study incorporates lowland sites, the majority of taxa were either restricted to upland, headwater streams or were cosmopolitan in distribution. Continued sampling of Western Australian streams will undoubtedly reveal additional taxa.

Of interest is the increase in the number of orthoclad species. Of the 24 recorded species, 15 demonstrate characteristics associated with Holarctic genera, two species are interstitial and probably hyporheic and seven are specialist borers, inhabiting bark, wood and possibly macrophyte. The borers have not been recorded from other parts of Australia and appear to be endemic to Western Australia. All the Orthocladiinae are adapted to warm waters, with the minimum winter water temperature in upland streams rarely falling below 10° C (Bunn *et al.*, 1986).

The gradual change in subfamily composition from upland mountain streams to lowland rivers, as reported by Thienemann (1954) was observed in Western Australian river systems. Thienemann refers to cold, fast flowing mountain streams in which the Orthocladiinae dominate, comprising c.80% of the chironomid fauna, with the Chironominae making up only c. 10%. In Western Australia, because of the geological age of the landmass, high montaine areas are absent with the Darling Range representing high ground. Even so, the Orthocladiinae are more abundant, in terms of species richness in the headwater streams (c . 42%) than lower river sites (c . 25%). The cold adapted montaine orthoclad species may therefore have been lost from the fauna of Western Australia. Also possible is the gradual adaptation of this fauna to warmer waters, at a lower altitude, giving rise to the high number of specialist Orthocladiinae.

The value of Chironomidae in biological monitoring, using larvae (Armitage and Blackburn, 1985; Saether, 1979) and pupal exuviae (Wilson and Bright, 1973; Wilson and McGill, 1977, 1979) is recognised. Classification of sites in this study demonstrated the value of this approach in streams of Western Australia. The classification of site LC1, an impounded mid-order site, alongside lower river sites was the result of a change in community structure to that dominated by the Chironominae. Decreased stream discharge with high water temperatures and sediment loads are a feature of this site. A second site, ND5, although impounded was not as regulated, subject to winter spates. Community structure at this site appeared not to be altered.

Classification also demonstrated a separation of intermittent and perennial sites on the basis of chironomid community structure. The difference in total macroinvertebrate fauna between these stream types was previously reported by Bunn *et al.* (1986). In the northern hemisphere, Wright (1984) similarly noted that the use of Chironomidae alone would differentiate between intermittent and perennial sites on a southern England chalk stream in the same way as total fauna. The possible impact of nutrient enrichment on the chironomid fauna of lowland sites on the North Dandalup River was demonstrated. These sites lie in areas of rural land-use and exhibited reduced species richness with increased overall abundance, particularly in summer and autumn months, when water temperatures exceed 25° C.

Edward (1986) in his review of the Chironomidae of Australia discussed three major elements in the composition of the chironomid fauna of Australia: common cosmopolitan fauna, endemic genera and genera with a distribution on southern land masses. The present study reiterates those elements, although it would now seem appropriate to subdivide the endemic genera into a) endemic to Australia and b) endemic to Western Australia. Endemicity in the lotic macroinvertebrate fauna of Western Australia has been reported for the Gastropoda (Bunn and Stoddart, 1983), Plecoptera (Hynes and Bunn, 1984), Odonata (Watson, 1981), and Trichoptera (Neboiss, 1981). Within the Chironomidae there appears to be a number of endemic species, including the specialist orthoclad species not recorded from other parts of Australia. The endemicity in the fauna so far studied indicates *in situ* speciation. The isolation and subsequent speciation in the fauna may have been a response to hydrological oscillations that have occurred in past geological periods. As Edward (1986) states "The pattern of speciation of the fauna in south-western Australia would now seem to involve ancestral species that were widely spread across Australia during sustained humid climates of an earlier geological period and became isolated in Western Australia during a later arid phase. Subsequently, the fauna has remained isolated and has speciated in response to hydrological oscillations through invasions, contractions and isolations in the inland areas".

Seasonal changes in abundance and species richness at each site suggest changes in species dominance and community composition. Seasonality in the total macroinvertebrate fauna of northern jarrah forest streams has previously been reported by Bunn, *et al.* (1986). However, such apparent seasonality can not be fully defined until basic information on life history strategies of dominant species of macroinvertebrates, including Chironomidae are described.

6. ACKNOWLEDGEMENTS

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7. SUMMARY

Continued research in Western Australian streams has increased the total number of chironomid taxa known from this region. The fauna includes a number of species endemic to Western Australia, in particular specialist borers belonging to the subfamily Orthocladiinae. Longitudinal changes in subfamily composition were noted with downstream increases in the proportion of species belonging to the Chironominae. The use of the Chironomidae in biological monitoring was demonstrated with intermittent, impounded and organically enriched sites identified on the basis of community structure. The need for basic life history studies on the Chironomidae of streams of Western Australia is highlighted.

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LEGENDS TO FIGURES

Figure 1. The location of study sites on the Canning and North Dandalup Rivers.

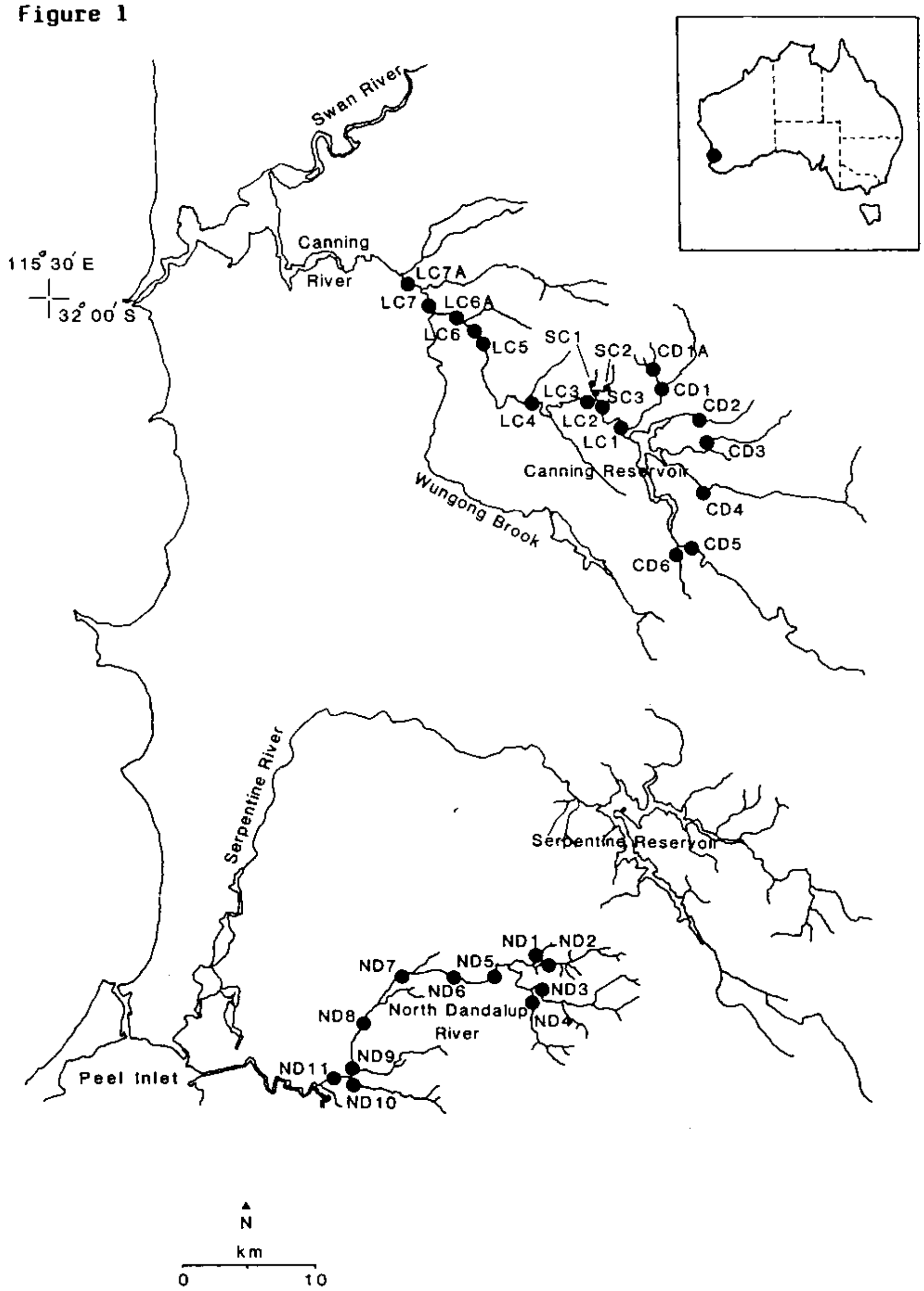
Figure 2. Species richness (S) at each site on each sampling occasion.

Figure 3. Mean larval abundance (No. m^{-2} river bed) at each site on each sampling occasion (+ 1 S.E.).

Figure 4. Changes in the composition of the Chironomidae at each site.

Figure 5. Classification of sites on the basis of the Chironomid fauna using Czekanowski's Similarity Coefficient; North Dandalup River, b) Canning River.

Figure 1



Swan River
Canning
River
115°30′ E
32°00′ S
LC7A
LC7
LC6A
LC6
LC5
SC1
SC2
CD1A
CD1
LC3
SC3
LC2
LC4
LC1
CD2
CD3
Canning Reservoir
Wungong Brook
CD4
CD5
CD6
Serpentine River
Serpentine Reservoir
ND1
ND2
ND7
ND5
ND6
ND3
ND8
North Dandalup
River
ND4
ND9
Peel Inlet
ND11
ND10
N
km
0
10

Figure 2

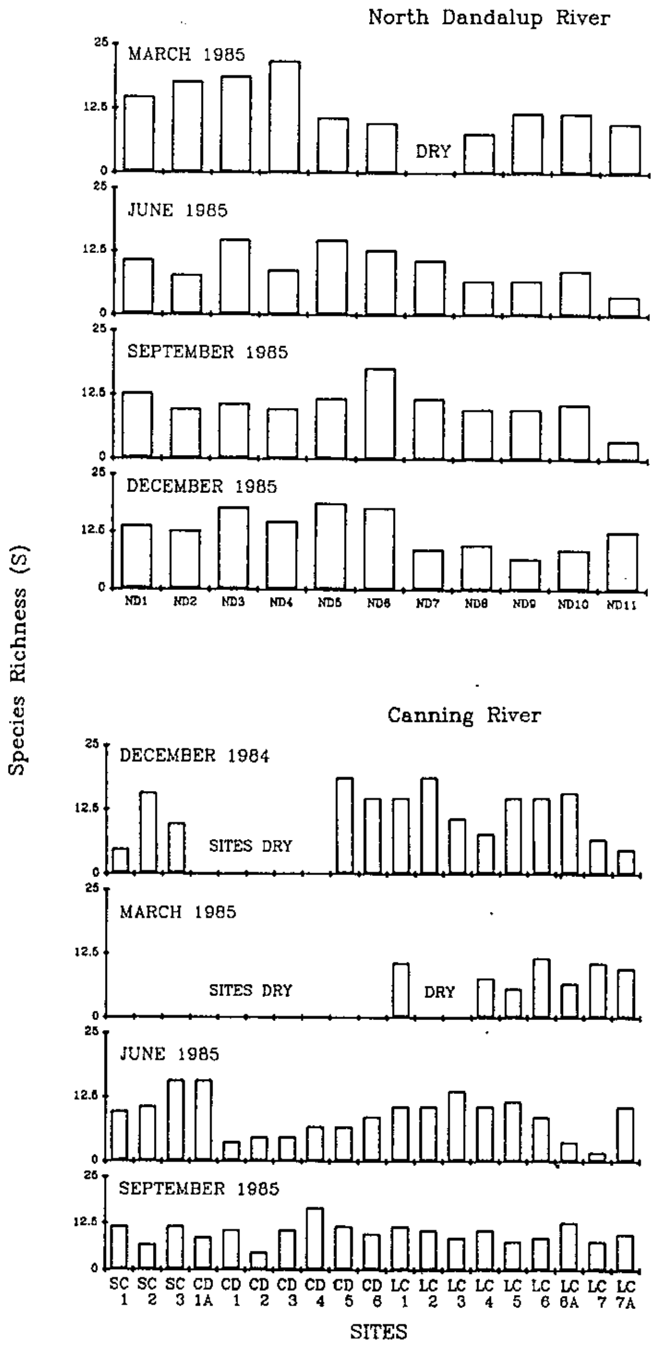

North Dandalup River
MARCH 1985
DRY
JUNE 1985
SEPTEMBER 1985
DECEMBER 1985
25
12.5
0
ND1 ND2 ND3 ND4 ND5 ND6 ND7 ND8 ND9 ND10 ND11
Species Richness (S)
Canning River
DECEMBER 1984
SITES DRY
MARCH 1985
SITES DRY
DRY
JUNE 1985
SEPTEMBER 1985
SC 1 SC 2 SC 3 CD 1A CD 1 CD 2 CD 3 CD 4 CD 5 CD 6 LC 1 LC 2 LC 3 LC 4 LC 5 LC 6 LC 6A LC 7 LC 7A
SITES

Figure 3

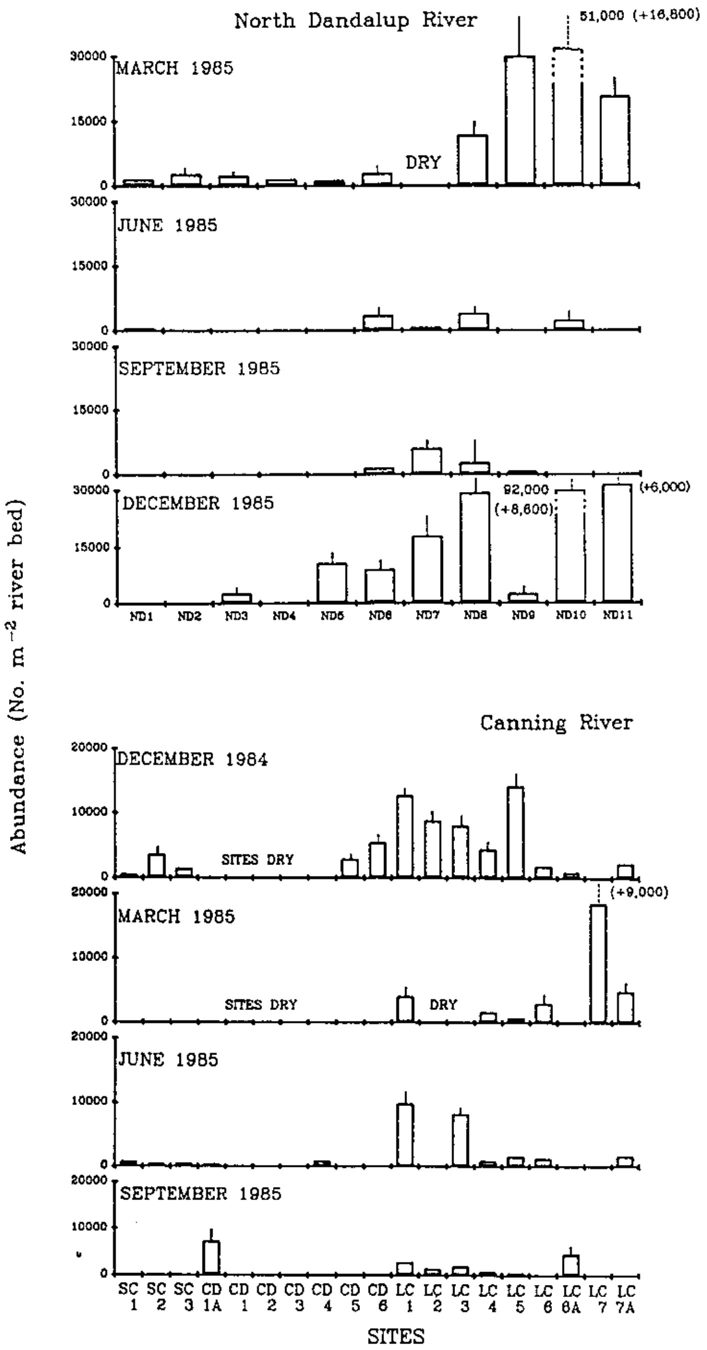

North Dandalup River
MARCH 1985
JUNE 1985
SEPTEMBER 1985
DECEMBER 1985
DRY
51,000 (+16,800)
92,000
(+8,600)
(+6,000)
ND1 ND2 ND3 ND4 ND5 ND6 ND7 ND8 ND9 ND10 ND11
Abundance (No. m^{-2} river bed)
Canning River
DECEMBER 1984
MARCH 1985
JUNE 1985
SEPTEMBER 1985
SITES DRY
DRY
(+9,000)
SC 1 SC 2 SC 3 CD 1A CD 1 CD 2 CD 3 CD 4 CD 5 CD 6 LC 1 LC 2 LC 3 LC 4 LC 5 LC 6 LC 6A LC 7 LC 7A
SITES

Figure 4

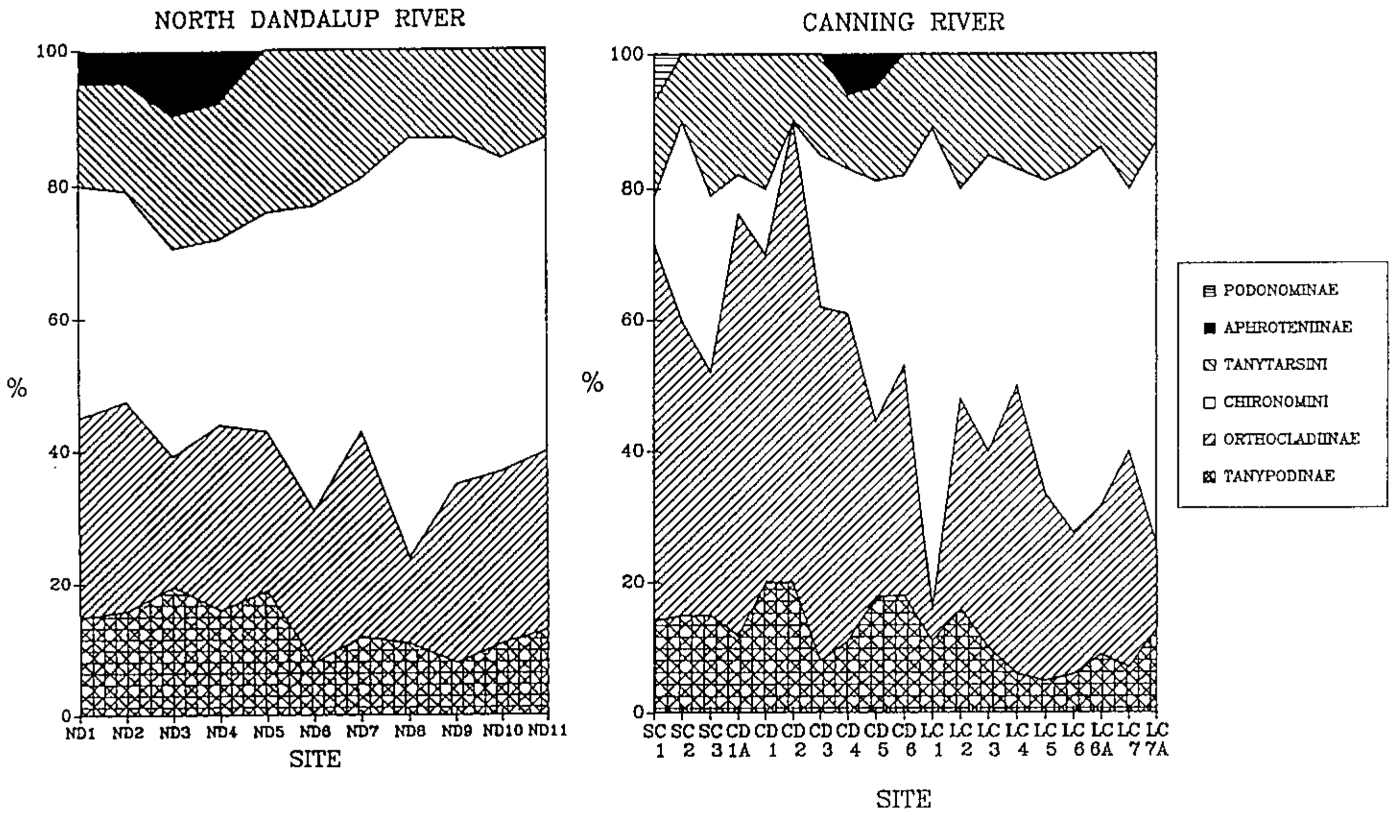
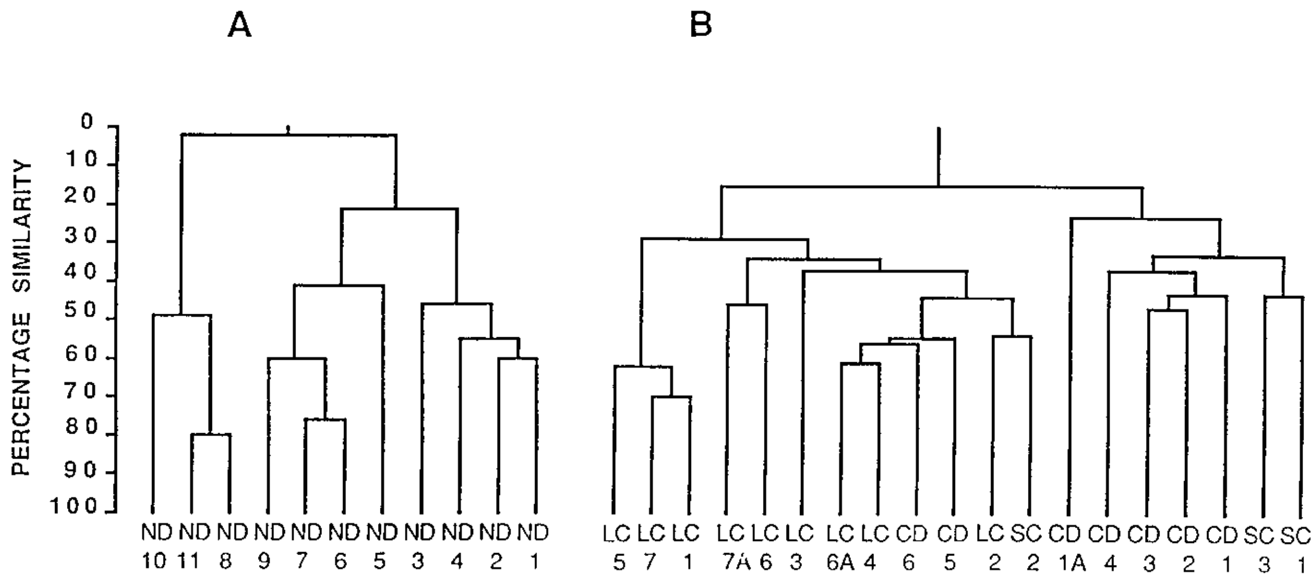

NORTH DANDALUP RIVER
CANNING RIVER
%
100
80
60
40
20
0
ND1 ND2 ND3 ND4 ND5 ND6 ND7 ND8 ND9 ND10 ND11
SC 1
SC 2
SC 3
CD 1A
CD 1
CD 2
CD 3
CD 4
CD 5
CD 6
LC 1
LC 2
LC 3
LC 4
LC 5
LC 6
LC 6A
LC 7
LC 7A
SITE
PODONOMINAE
APHROTENIINAE
TANYTARSINI
CHIRONOMINI
ORTHOCLADIINAE
TANYPODINAE

Figure 5


A
B
PERCENTAGE SIMILARITY
0
10
20
30
40
50
60
70
80
90
100
ND 10
ND 11
ND 8
ND 9
ND 7
ND 6
ND 5
ND 3
ND 4
ND 2
ND 1
LC 5
LC 7
LC 1
LC 7A
LC 6
LC 3
LC 6A
LC 4
CD 6
CD 5
LC 2
SC 2
CD 1A
CD 4
CD 3
CD 2
CD 1
SC 3
SC 1