Chironomids at Forrestdale Lake: A Guide to Larval Monitoring and a Report on the 1991 / 1992 Monitoring Programme

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PREFACE

There are two sections to this report. The first provides a guide to monitoring chironomid larval populations at Forrestdale Lake. The methods described are identical to those which have practiced at the lake since chironomid monitoring began in 1987. The second part of this report details the results of the monitoring which took place in the midge season of 1991 / 1992. This should compliment existing data for Forrestdale Lake which is documented in reports by Davis *et al.* 1988, 1989, 1990 and Pinder *et al.* 1991. Recommendations and predictions for the midge season 1992 / 1993 are provided.

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LARVAL MONITORING AT FORRESTDALE LAKE

Monitoring of midge larval populations at Forrestdale Lake has taken place over five years according to the following procedure. Continuation of this technique will provide information relating to the necessity for and the effectiveness of larvicide treatments, ongoing environmental data and add to an already substantial data base associated with the lake.

Monitoring: frequency and timing

The timing and frequency of sampling will depend on a number of factors including lake depth, spring-summer air temperatures and the availability of personnel. On the basis of previous years monitoring it is recommended that an initial sampling occasion be undertaken in early October. This will allow the placement of max-min thermometers in the lake so that temperature can then be used as a guide to the period in which nuisance problems will begin. Sampling should then occur every two weeks until the median (difference between maximum and minimum) temperature has exceeded 22°C. The month in which this will occur will depend on the depth of the lake. In 1988 this occurred in January (max depth 1.4m), in 1989 it occurred in November (max depth 0.9m). Once the median temperature has exceeded 22°C, sampling should occur every week and a rapid rise in midge larval density and nuisance levels may be expected within 4 to 6 weeks. Temperature can only be used as a guide to the first onset of problems, following this larval midge densities must be used. Sampling should continue on a weekly basis until the end of the midge season which usually occurs in late March or early April.

Monitoring procedure

Equipment required: See Appendix 1

Lake sampling: Twenty cores taken from the open water region of the lake have been shown to consistently provide an accurate estimate of midge density. These cores must be taken randomly and in the past this has been done as follows. The northern half of the lake is divided into four regions consisting of concentric semi-circles with the largest being the edge region and the smallest the central area (Figure 1). In these regions one, four, six and nine cores are taken at random compass coordinates from within the deepest central area to the shallowest region, respectively. The random coordinates can be generated using standardized tables, a computer and simply by

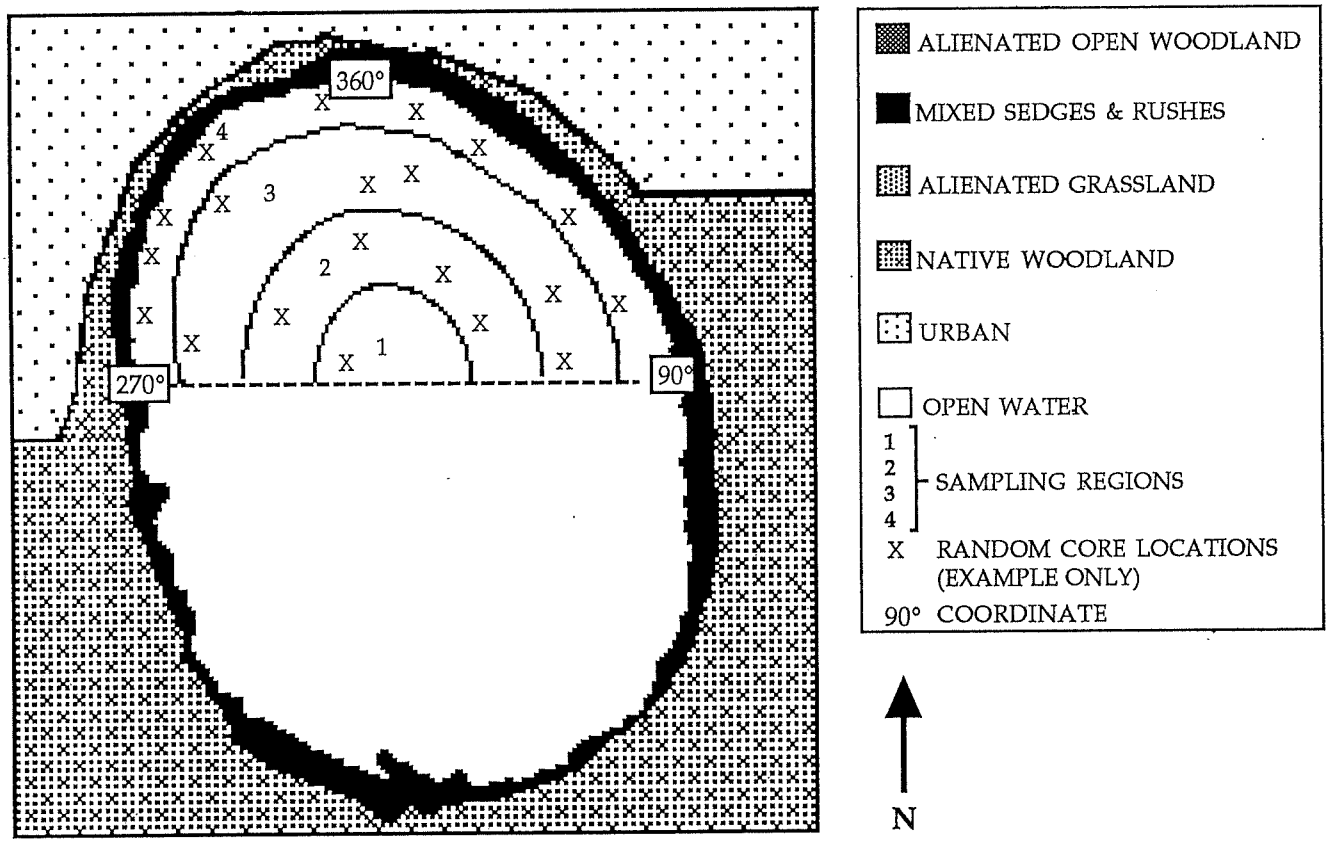

Figure 1: Map of Forrestdale Lake showing the four sampling regions, random location of cores within each region and coordinates

drawing numbers from a hat. These should be between 0 - 90° and 270 - 360°. In the field the location of each coordinate is found by making a compass sighting on a marker located in the middle of the lake (this will need to be put in place). The core sample is placed into a plastic bag with a label indicating the site at which it was taken, date etc. The cores should be preserved in ethanol and stored in a cool place if sorting is not going to occur within 2 days of collection. At each sampling site some physical and biological data can be collected (eg. depth, substrate type, presence of plant material) as this may provide some clue to the midge distribution pattern (Figure 2 shows a typical field data sheet). Cores can be taken from the boat or whilst the person sampling is in the water, in which case they should avoid treading on the area in which the core is to be taken.

***Typha* sampling:** If the water level is sufficiently high, midges will be present in both the *Typha* beds and the open water and thus it may be appropriate to sample in that region. To do this thoroughly as many as 10 cores may be required. Fewer cores could be used to establish presence / absence of midges in this region.

Measurement of environmental parameters: There are a number of physical and chemical parameters of the lake water which can be measured on a regular basis for little or no cost. These include temperature, pH and salinity. Changes in these parameters can effect midge abundance and species composition. A maximum-minimum thermometer should be anchored on the lake bed in water 40cm deep on the first sampling occasion. This may need to be moved regularly so that it remains in that depth of water. These thermometers allow the maximum and minimum temperature the be recorded in the period between each sampling occasion and the thermometer can be reset on the day of larval sampling. Ideally measurements of pH and conductivity should take place in the field using pH and conductivity (or salinity) meters. However if this is not possible then water samples should be collected and kept cool until this can be done in a laboratory. Water may also be collected for nutrient (phosphorus and nitrogen) and chlorophyll-*a* analyses in order to determine the relationship between these factors and chironomid abundance. However these are costly to analyse.

FORRESTDALE LAKE MONITORING

DATE *13-Mar-92*

OPEN WATER

CORE NO.	REGION	COORDINATE	DEPTH	SUBSTRATE
1	1	286°	52	Sand
2	2	287°	55	Sand
3	2	323°	50	Sandy Clay
4	2	68°	55	Clay
5	2	82°	52	Sandy Clay
6	3	71°	50	Sandy Clay
7	3	56°	56	Sandy Clay
8	3	35°	53	Sandy Clay
9	3	352°	50	Sandy Clay
10	3	304°	48	White Clay
11	3	272°	50	Sandy Clay
12	4	306°	30	Sandy Clay
13	4	321°	39	Sandy Clay
14	4	350°	32	Sandy Clay
15	4	352°	33	Sandy Clay
16	4	356°	30	Sandy Clay
17	4	22°	32	Sand
18	4	30°	35	Sand
19	4	76°	39	Sand
20	4	89°	40	Sand

TYPHA

CORE NO.	COORDINATE	DEPTH	SUBSTRATE
1	270°	40	Organic Matter
2	290°	40	Sand
3	295°	40	Organic Matter
4	32°	42	Sand and Organic Matter
5	40°	42	Organic Matter
6	65°	42	Sand and Organic Matter

Depth (on guage) = *54cm*

Water Temperature

Maximum	Minimum	Current
26°C	*22°C*	*23°C*

Water samples collected from: *Middle*
Edge: 30°
Edge:90°
Edge:270°
Edge: 330°

Figure 2: Typical field data sheet

Sorting

The calcium chloride flotation method is the best procedure for separating midge larvae from the sediment. Samples should be sorted immediately although this is not always possible. Short term storage requires refrigeration of the samples. Long term storage requires refrigeration plus preservation in alcohol. Approximately 200mL of technical grade ethanol is used to preserve each sample.

Equipment required: See Appendix 2

Procedure: Make-up a solution of calcium chloride by adding 2.5kg of calcium chloride flakes to 4L of water and stir this solution until all of the salt is dissolved. As with any salt solution, this solution will be irritable to the skin and therefore rubber gloves should be worn. Leave the solution to stand (approx 10min) and a scum will develop on top of the solution. This can be removed using a folded cloth.

Transfer a core sample to the calcium chloride solution. Ensure all of the sample is removed from the bag. Break up the sample so that no lumps remain (this is important) and allow time for the suspended solids to settle and the midge larvae to float to the surface. The larvae can be picked out using the tweezers, transferred to small vials containing preservative and stored for later counting and identification. The waterproof paper label from the sample should also be transferred to the vial.
Not all the larvae will float to the surface at one time as some may be trapped within the sample. Therefore the sample should be stirred several times to ensure that all larvae in the sample are recovered. When no larvae remain in the sample it can be discarded but the calcium chloride solution should be recovered. This is achieved by straining the slurry material through the 250µm sieve into another bucket. Forrestdale Lake sediments contain a lot of clay and silt and generally the solution can then be re-used five or six times before a new solution is required.

Identification

The identification of midges at Forrestdale Lake will aid in the assessment of the potential for a nuisance problem to occur. Some species (eg. *Procladius villosimanus*) are less likely to swarm than others. Identification can be achieved using a binocular microscope (up to 400x magnification), the guide to species identification (Appendix 3) and a voucher collection of common species occurring in Forrestdale (this has been provided).

LAKE :

DATE :

SAMPLE TYPE :

	NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	MEAN	S.E.	TOTAL	%COMP
	COOR.																								
	DEPTH																								
SPECIES																									
TOTAL																									

SAMPLE TYPE :

	NO.	1	2	3	4	5	6	7	8	9	10											MEAN	S.E.	TOTAL	%COMP
	COOR.																								
	DEPTH																								
SPECIES																									
TOTAL																									

Table 1: Data sheet used for scoring midge abundance for each core sample after sorting, identification.

In the process of identifying larvae, the size of larvae should be noted. Midge larvae progress through a series of instar moults during their life cycle and only emerge as adults after pupation which follows the final moult. Often many of the larvae in the lake will be synchronous in their moult cycle and the stage of the cycle can be useful in determining the potential for nuisance. See Appendix 3 and the voucher collection for a guide to the size of larval instars of *P. nubifer*

Calculation of densities

The number of larvae per core should be scored on a table similar to Table 1 and can be used to determine the density of larvae / m^2 using the following method:

Step 1: Calculate how many times the corer fits into a square meter (**C**)

C = 1/ (3.14 x radius radius). *note: radius is that of the core base in meters

For a 10cm diameter corer C = 127.4

Step 2: Calculate the average number of larvae per core (**X**) and the standard error (**s.e**).

(**X** = total number of larvae in all cores / n)

{**s.e.** = standard deviation / ($\sqrt{n-1}$)}. * note: n is the number of samples

Step 3: Calculate the density of larvae / m^2 (± s.e.)

(**X** x **C**) ± (**s.e.** x **C**)

Densities can be determined for separate species and total larvae. Refer to the data sheet in Appendix 4 for a worked example.

Assessment of the potential for midge nuisance problems

A flow chart has been drawn up in order to assist with the prediction of midge nuisance problems and the timing of larvicide treatment (Figure 3). Densities of 2000 *P. nubifer* larvae / m^2 have been shown to cause nuisance problems but this is dependent on a number of factors including air temperature, humidity, wind strength, larval distribution and instar stage. All of these factors have been taken into account.

The flow chart is primarily based on larval *Polypedilum nubifer* densities as this species has been shown to be the main species which causes nuisance problems at

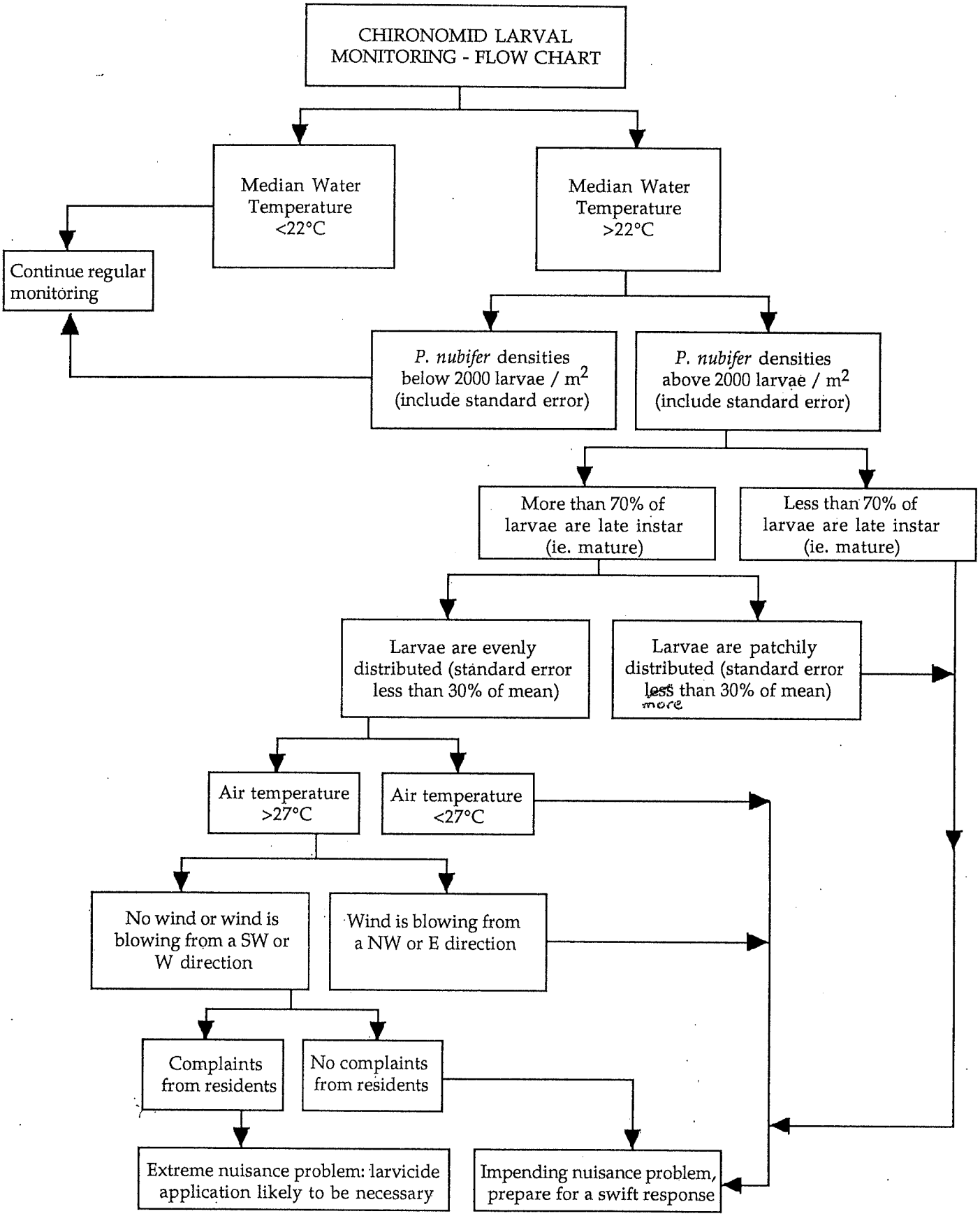

Figure 3: A flowchart to assist with decisions on larvicide application. Boxes refer to weekly monitoring and environmental parameters.

Forrestdale. However there other species which can cause problems (eg. *Chironomus alternans, C. occidentalis, Tanytarsus fuscithorax*). The presence of these species will essentially depend on environmental conditions within the lake. *C. alternans* and *C. occidentalis* tend to prefer cooler deeper water than *P. nubifer*. The midge,*T. fuscithorax*, can tolerate greater salinity than other species and may be found in larger numbers prior to the lake drying.

Spraying

Traditionally the larvicide Abate® has been used to control midge populations at Forrestdale Lake and this has been applied either by helicopter or fixed wing aircraft. Legal rates of application range from 1.5 - 2 kg / ha at 50cm depth. The highest rate is generally reserved for lakes with high organic content. A rate of 1.8kg/ha has been shown to be effective against *P. nubifer* at this lake and this rate should be adjusted for depth (average). Higher rates may be required to control *C. occidentalis*. Care should be taken to ensure that applications are evenly distributed and that areas known to have high numbers of larvae are sprayed.

Post Spray

Midge densities should decline within 24 hours after application and, in order to assess this, sampling should occur within 2 to 5 days afterwards. The decline in density should not exceed 90% as the aim of the application is to reduce nuisance levels, not to eliminate midges completely, as they are an important component of the wetland food chain. Residents may find that there is an initial increase in nuisance levels following the spray and this is thought to be a response of the insects to a change in their environment. This should be short lived. Some species are highly tolerant to Abate® applications and may increase post spray (eg. *P. villosimanus*) This species preys upon other chironomids and rarely swarms or causes a nuisance.

CHIRONOMID MONITORING PROGRAMME 1991 / 1992

Introduction

In the years between 1987 and 1990 chironomid monitoring at Forrestdale Lake had been performed by research staff at Murdoch University and all pesticide applications were undertaken either by Armadale City Council or C.A.L.M. In the summer of 1991/1992 C.A.L.M in consultation with Murdoch University undertook chironomid monitoring at the lake. The data collected by the larval monitoring programme was used in making decisions about the timing of larvicidal treatments, to assess the effectiveness of treatment and to add to an ongoing database for the lake that might eventually enable the accurate prediction of the onset of midge nuisance swarms.

Methods

Sampling took place every week from the 9th of December 1991 until the 13th of April 1992. Only the northern half of the lake was sampled because of its size. Equipment problems were encountered on the first sampling occasion but following this twenty cores were taken from the open water at locations determined by random numbers. An additional six cores were taken from the *Typha* beds around the lake perimeter until the 28th of January. Water samples were taken weekly for determination of pH and conductivity. Maximum and minimum water temperature was measured each week during the sampling programme.

All core samples were sorted using the calcium chloride differential flotation method. Larvae were counted and identified according to descriptions in Appendix 3.

To determine the density of larval midges which would cause nuisance problems to residents in the suburb surrounding the lake, a weekly survey was conducted from 13th of January until 6th April 1992 (see Appendix 5). Residents were asked to score the level of nuisance and collect samples of nuisance midges for identification.

Results and Discussion

Species composition: The chironomid *Polypedilum nubifer* dominated the larval community in the open water during the whole season but was only present in low numbers in the *Typha* (Figure 4). Another species, *Chironomus alternans*, prefers cool water and only occurred in the open water early in the season but dominated the larval composition within the *Typha* (Figure 4) where the water was cooler. The

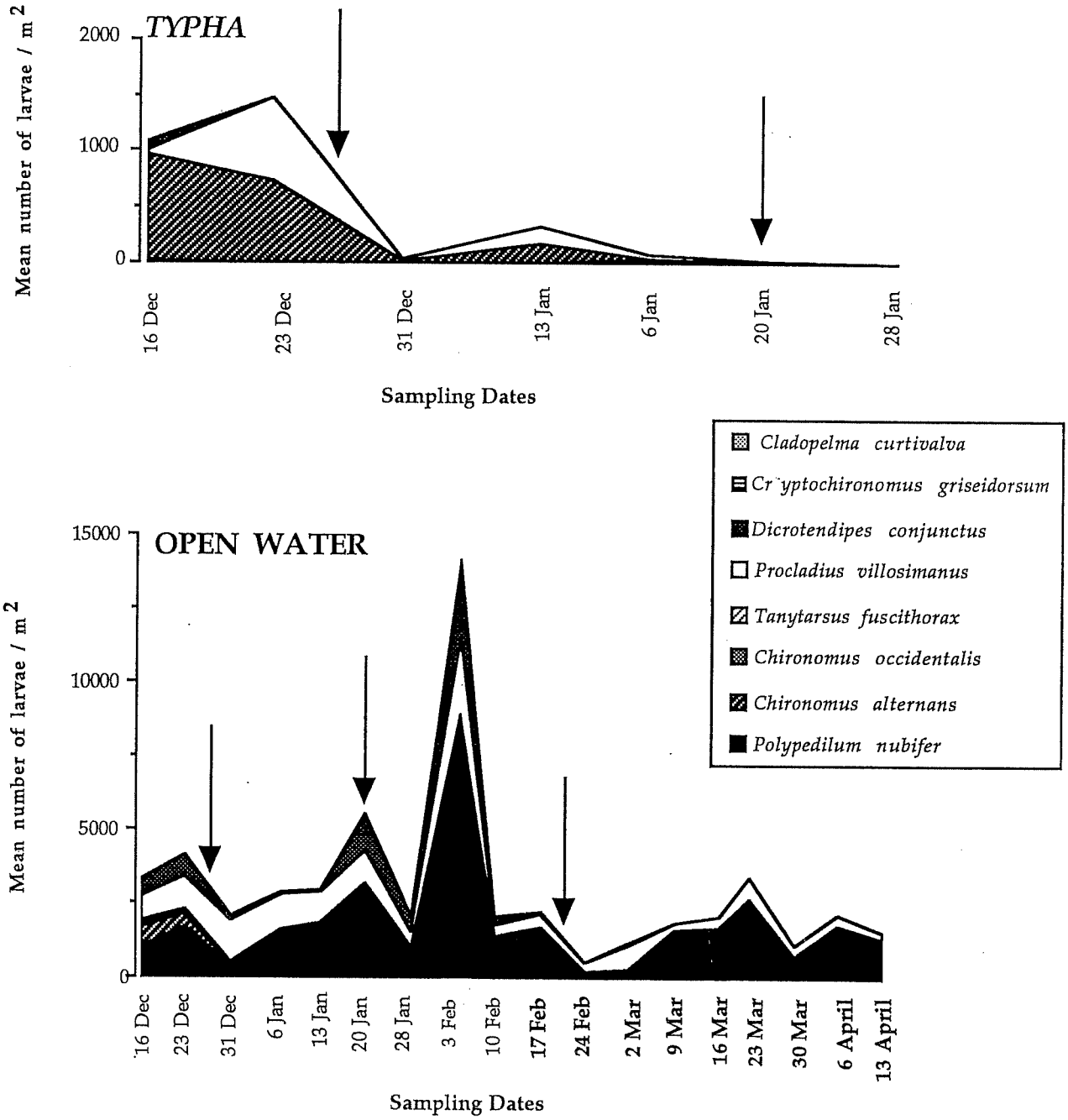

Figure 4. Densitiy of chironomid larvae in the open water and *Typha*. Arrows indicate the time of Abate application.

tanypod midge, *Procladius villosimanus* was common in both the open water and *Typha* (Figure 4).

Chironomid abundance in the 1991 / 1992 season was the worst on record. In the open water region total larval densities were frequently above 2000 larvae / m^2 and a maximum density of 11702 larvae / m^2 recorded in February exceeded that of any year since 1987 (Pinder *et al.* 1991).

Chironomid nuisance and pesticide applications: The chironomid *P. nubifer* is the major nuisance species at Forrestdale Lake. In the past *P. nubifer* densities of 2000 and 500 larvae / m^2 have been used as 'threshold' levels or guides as to when pesticide applications should occur (Davis *et al.* 1988,1989). Resident surveys taken in 1992 indicated that densities above 2000 *P.nubifer* larvae / m^2 tended to result in nuisance problems. Therefore maintaining *P. nubifer* densities below this threshold level was the main criterion for Abate® applications, although this was moderated by other factors including larval distribution, larval development and various environmental conditions.

The first pesticide application took place on the 27th of December at which time *P. nubifer* larval density was 1726 ± 530 larvae / m^2. The rate of application was 1.5kg Abate® / ha and this resulted in an 80% decline in *P. nubifer* larvae (Figure 5). The application did not reduce the abundance of the non nuisance species *P. villosimanus*. This species belongs to the subfamily Tanypodinae which are commonly reported to be less sensitive to Abate® than the subfamily Chironominae to which *P. nubifer* belongs.

The second application of Abate® occurred on the 20th of January 1992 when densities of *P. nubifer* were 3109 ± 821 larvae /m^2. This application was again at the rate of 1.5kg / ha but only reduced *P. nubifer* abundance by 66% (Figure 5). However it was noted that in the shallow edge region of the lake chironomid densities were reduced by approximately 83% and it was thought that that region may have received more pesticide than the central region. Therefore it was decided that the rate of any further pesticide applications be 1.8kg / ha. A third and final application of pesticide took place on the 20th of February 1992 after *P. nubifer* densities were recorded as 1701 ± 506 larvae / m^2. This application resulted in a 90% reduction in *P. nubifer* density and

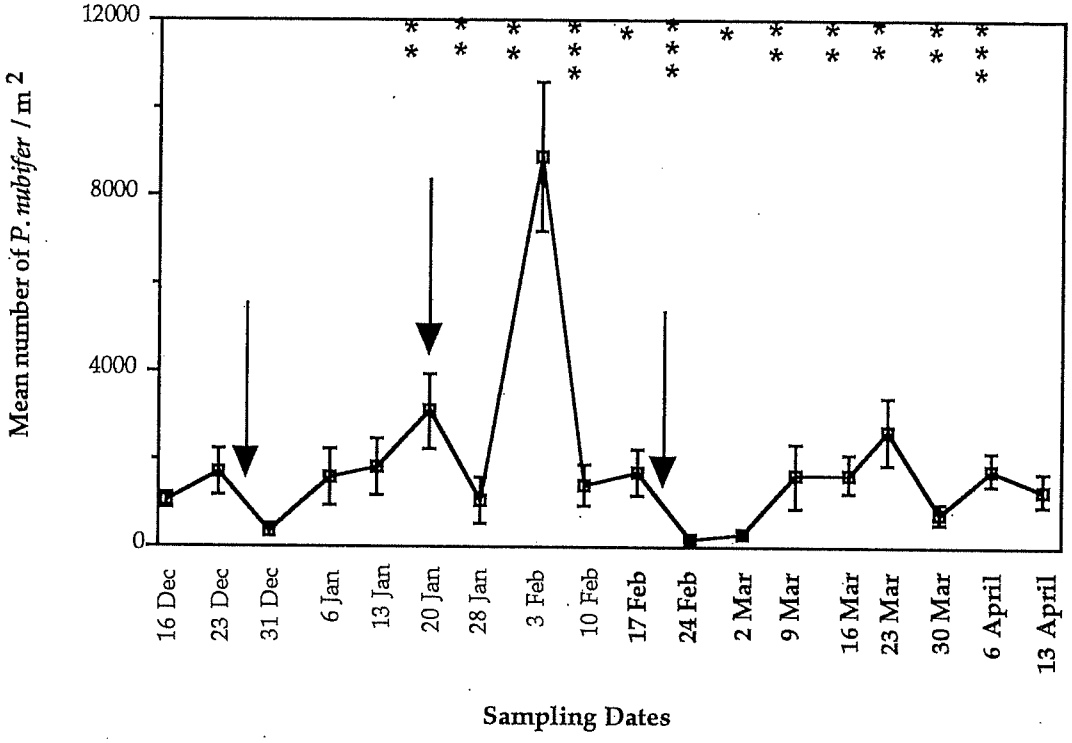

Figure 5. Densitiy of *Polypedilum nubifer* larvae on each sampling occassion. Arrows indicate the time of Abate application. Asterisks indicate level of nuisance where * is low, ** is moderate and *** is high

again the abundance of *P. villosimanus* was not reduced by the application (Figure 5).

Chironomid densities and environmental factors: When the sampling programme began median water temperature was well above 22°C (Figure 6) and hence it was not possible to use temperature to estimate the first onset of midge nuisance problems. High air temperatures and rapidly declining water levels resulted in median water temperatures above 24°C for much of the season. Neither the range of pH or conductivity were outside that recorded for previous years (Pinder *et al.* 1991). The pH of the lake ranged from 8.0 to 9.9 and the water was brackish for most of the season but tended to become more saline as the lake level declined (Figure 6).

On the 8th of February 1992 an intense rain event caused to lake level to increase from 56 to 72cm within a 24hr period and this resulted in reduced water temperature, pH, conductivity and midge abundance (Figure 6). Midge densities prior to the rain were 11702 ± 2352 larvae $/m^2$ comprising mostly immature larvae and this fell to 1803 ± 502 larvae $/m^2$ with only the mature larvae remaining. One explanation for the rapid decline in midge density over such a short period is that the the incoming freshwater formed a separate layer above the more dense brackish water of the lake, thus preventing oxygen from mixing in the water column and resulting in the deeper water becoming anoxic. Mature chironomid larvae possess a the haemoglobin pigment, erythrocruorin, which aids respiration in water with low levels of dissolved oxygen (Williams 1980). However this pigment is absent or only present in very low amounts in immature larvae (Tichy 1980). Hence the mature larvae were able to survive the stress of oxygen depletion but immature larvae could not. An alternative explanation is that the osmotic balance of the larvae was disrupted by the large influx of freshwater.

Although the freak rain event appeared to be responsible for the large decline in larval densities it also served to increase the length and intensity of the midge nuisance at the lake. The influx of so much water would have been accompanied by high levels of nutrients which, in turn, may have been responsible for a subsequent algal bloom. That algal bloom is likely to have provided an increased food source to the midge larvae. In addition, the increased depth of the lake meant that it did not dry out during the season.

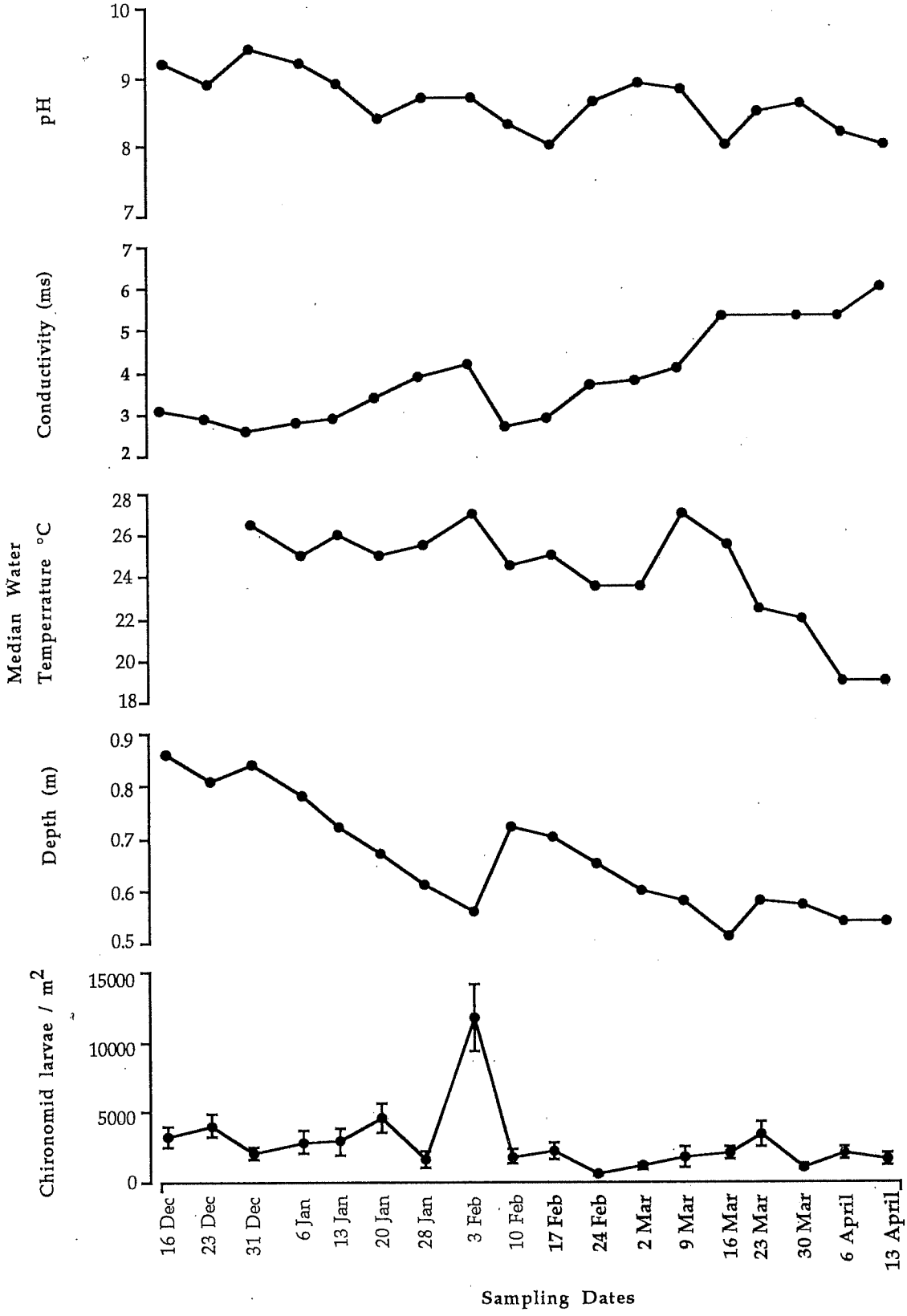

Figure 6. Relationship between measured physical parameters and chironomid larval density.

Recommendations and Predictions for 1992 / 1993 midge season

The 1991 / 1992 midge season was the worst on record and this may, in part, be due to the declining water quality of the lake. The proposed nutrient balance study for Forrestdale Lake will address this problem and should identify the source of nutrients to the lake.

Midge monitoring should begin in October 1992 on a two weekly basis until median water temperature rises above 22°C and then should continue weekly until the end of the season.

As a result of the high rainfall in February and the wet winter of 1992 it is predicted that the lake level in late spring will be high (>1.4m). This may result in the late onset of nuisance problems associated with *P. nubifer* which may not occur until February 1993. However, other chironomid species such as *Chironomus alternans* and *C. occidentalis* may cause nuisance problems earlier in the season. These species prefer cooler, deeper water and are generally less of a nuisance than *P. nubifer.*

It is difficult to predict the intensity and duration of midge nuisance problems in 1992 / 1993 as this will depend on a range of environmental factors which include air and water temperature and water quality. These factors will influence the rate at which the lake level declines, the amount of biological activity, the amount of food available to the larval midges and their growth rate.

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Tichy, H. (1980). The haemoglobin synthesising tissue of *Chironomus*. In: "Chironomid Ecology Systematics, Cytology and Physiology." Proceedings of the 7th International Symposium on Chironomidae, Dublin 1979 (ed. D.A. Murray). Pergamon Press: Oxford.

ACKNOWLEDGEMENTS

All monitoring at Forrestdale Lake in the 1991 / 1992 midge season took place with the assistance of C.A.L.M. personnel. Special thanks go to Lyndon Mutter and Gary Hartnett.

APPENDIX 1

MONITORING - EQUIPMENT REQUIRED

Equipment	Supplier
• Stainless steel corer (10cm diameter: see Figure 7)	Custom made
• Waders (Hornes-Tuffware)	The Complete Fisherman 98A Stirling Hwy Nedlands
• Waterproof paper (A4 white, matt finish, phase 3, 85g)	Daltons Fine Paper 11 Cressall Rd. Balcatta or diving equipment supplier
• Thermometer (maximum/minimum)	FSE Pty Ltd. 126 Kewdale Rd. Kewdale
• Motor boat or canoe	
• Marker (2m wooden stake and bouys)	
• Elastic bands	
• Plastic bags	
• Compass	
• Preservative (eg. 70% ethanol) **optional**	
• pH meter optional **optional**	
• Conductivity meter or salinometer **optional**	

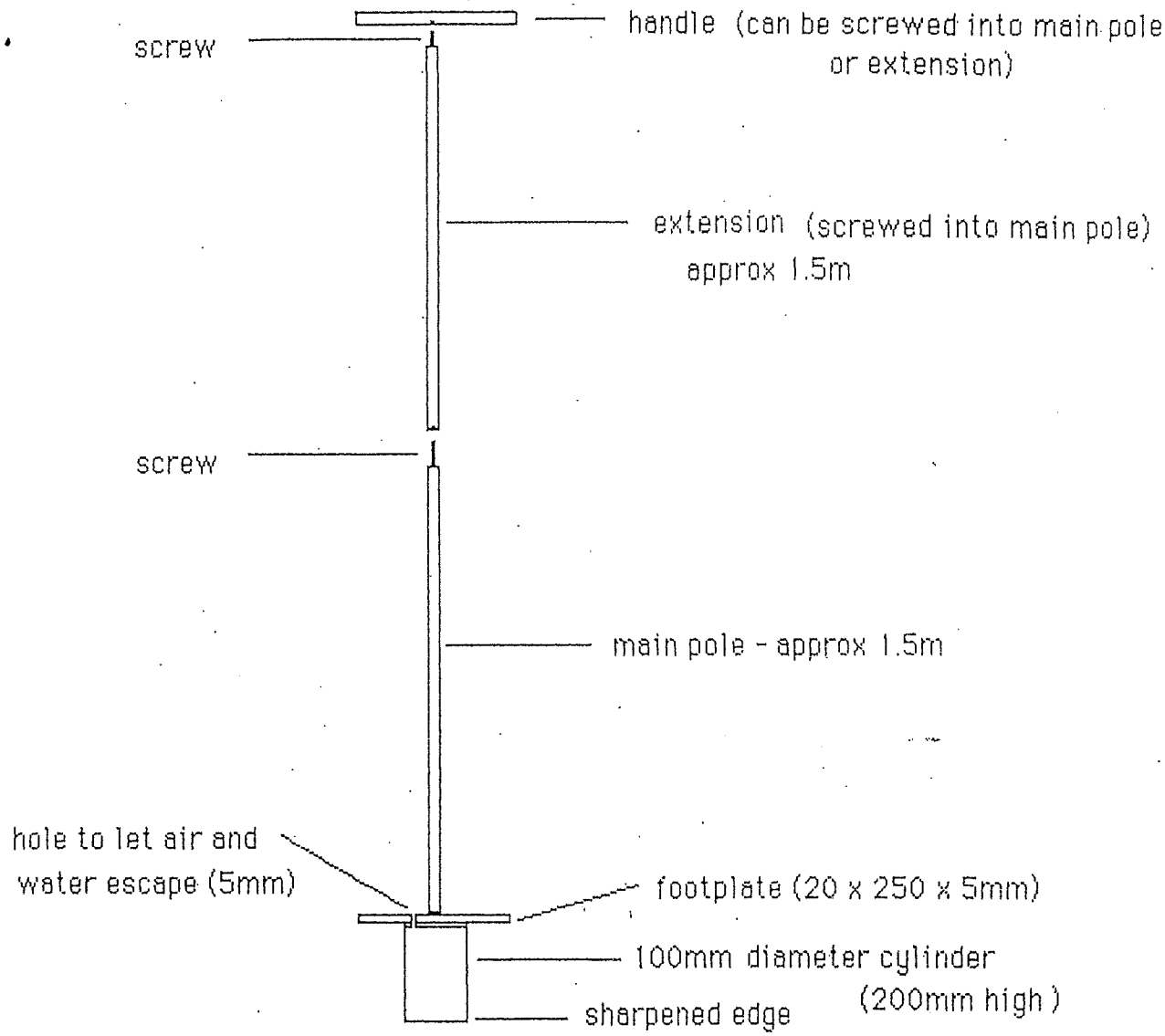


Figure 7: Corer for sampling Lake sediments. This should be constructed from stainless steel so that the base can be sharpened.

APPENDIX 2

SORTING - EQUIPMENT REQUIRED

Equipment	Supplier
• Calcium chloride (Technical grade, 25kg bags)	Ramprie Laboratories 71 Division Rd. Welshpool
• Tweezers (Jewellers forceps)	Australian Entomological Supplies catalogue available from: PO Box 314 Miranda, NSW 2228
• Sieve (Stainless steel 250µm)	Laboratory Supply 45 Roberts Rd. Osborne Park
• Light source	
• Preservative (eg. ethanol)	
• Three plastic buckets	
• Rubber gloves	
• Chux cloths	
• Plastic vials / specimen jars	

APPENDIX 3

A GUIDE TO THE COMMON MIDGE (CHIRONOMIDAE) OF THE PERTH METROPOLITAN AREA

Produced by the Midge Research Team Murdoch University (July 1988)

This key was compiled from information and drawing included in:

Edward, D.H.D. (1964). The biology and taxonomy of the chironomids of south-western Australia: Unpublished PhD thesis, University of Western Australia

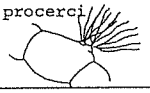
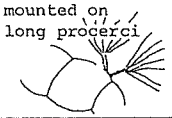
Merrit, R.W. and Cummins, K.W. (1984). An Introduction to the Aquatic Insects of North America. Kendall Hunt, Iowa. 2nd edition, 722pp.

Original drawings by Shirley A. Balla and Adrian M. Pinder are also included.

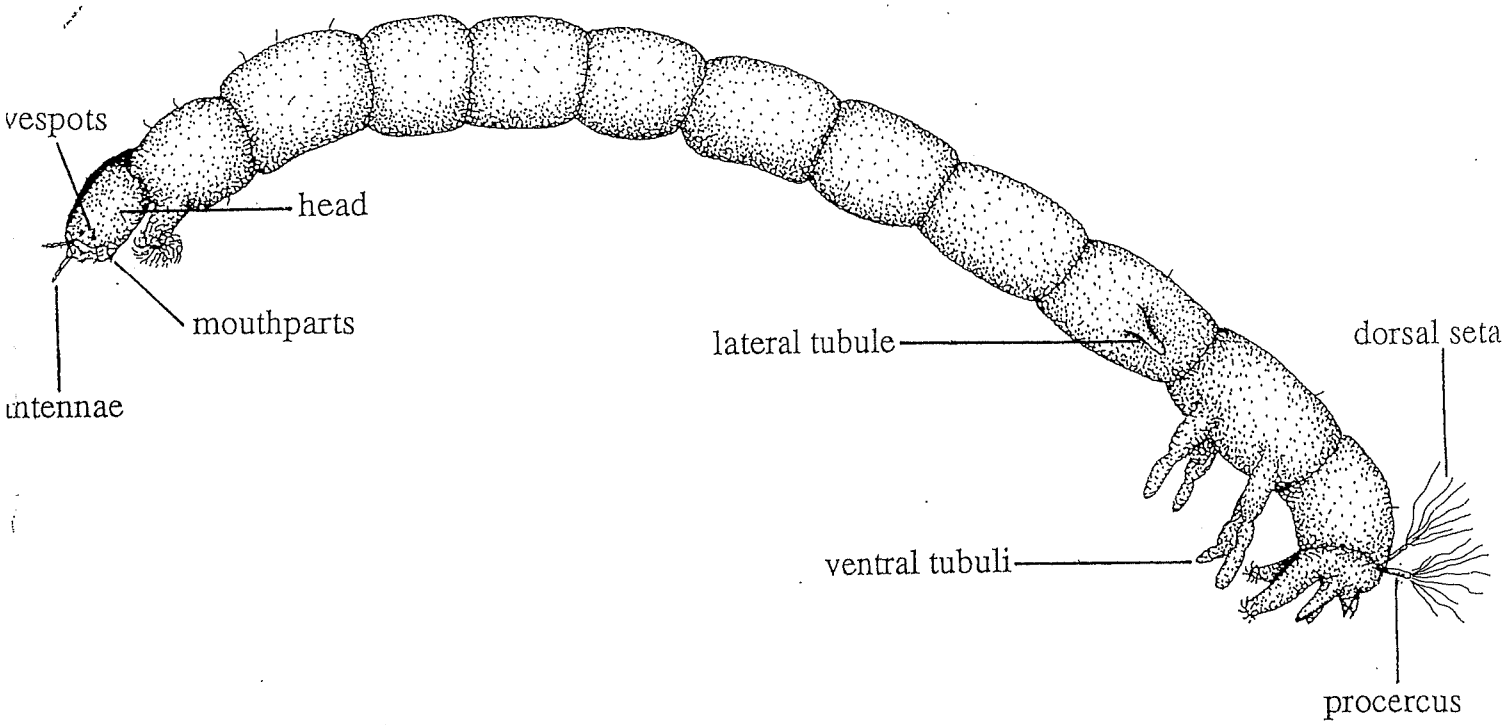
Larval Midges

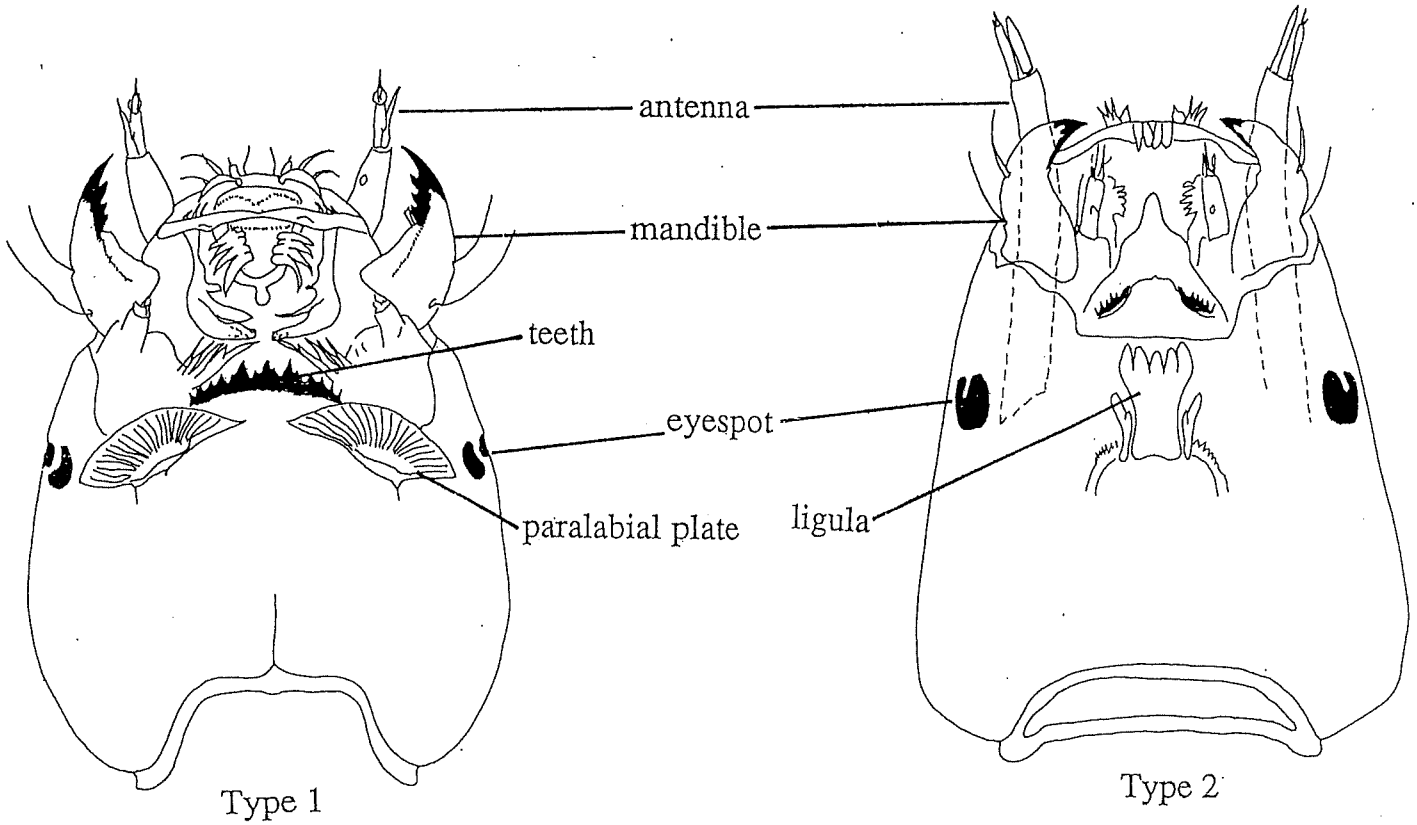
IDENTIFICATION CHART for 11 species occurring in Perth wetlands

(refer to drawing of generalized midge larva for illustration of terms and to the drawings of individual species. For verification of identifications made using this chart, head squashes should be made)

Species	Ventral Tubuli	Eyespots	Antennae	Head	Dorsal Setae	Max. Length & Colour of 4th instars
Chironomus occidentalis	two pairs; both long and straight with constrictions half-way along their lengths	2 pairs	antennae shorter than head	mature larvae often with dark triangle on back of head  Type 1	mounted on small rounded procerci 	large, 22mm red when alive
Chironomus alternans	two pairs; one pair long and bent, one pair coiled. Also one pair of lateral tubuli	2 pairs	antennae shorter than head	Type 1	mounted on small rounded procerci	medium, 16mm red when alive
Kiefferulus intertinctus	one pair; long and coiled	2 pairs	antennae shorter than head	Type 1	mounted on small rounded procerci	medium, 12mm red-brown when alive
Cryptochironomus griseidorsum	no tubuli	2 pairs	antennae shorter than head	small, often held back Type 1	short, mounted on small rounded procerci	medium, 11mm red when alive
Cladopelma curtivalva	no tubuli	2 pairs both eyes more-or-less round	antennae shorter than head	roundish pale head, may be darker underneath Type 1	mounted on small rounded procerci	medium, 9mm red when alive
Dicrotendipes conjunctus	no tubuli	3 pairs	antennae shorter than head	light to dark brown except for pale area around eyespots Type 1	long, mounted on small rounded procerci	small, 8mm pale red with green patches when alive
Polypedilum nubifer	no tubuli	2 pairs bottom eye kidney shaped	antennae shorter than head	small head, later instars are dark on underside of head Type 1	mounted on small rounded procerci	medium, 12mm red when alive
Tanytarsus fuscithorax	no tubuli	2 pairs	antennae almost as long as head	pale Type 1	mounted on small rounded procerci	small, 7mm
Paralimnophyes pullulus	no tubuli	1 pair	antennae shorter than head	mouthparts form distinctive dark area on underside of head Type 1	mounted on small rounded procerci	small, 4mm
Procladius villosimanus	no tubuli	1 pair curved 	may be withdrawn into head and not visible	large and pale Type 2	mounted on long procerci 	medium, 10mm light brown when alive
Coelopynia pruinosa	no tubuli	1 pair rough-edged oval 	may be withdrawn into head and not visible	long and flat Type 2	mounted on long procerci	medium, 10mm

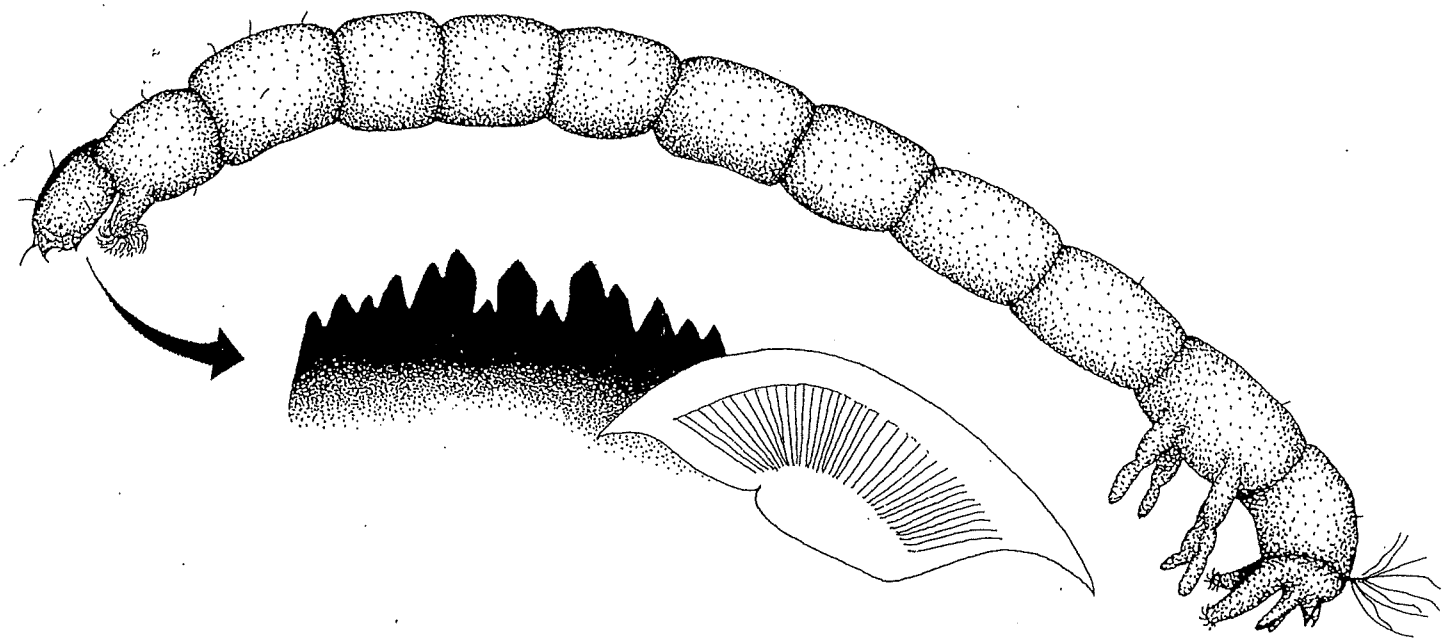
GENERALIZED MIDGE LARVA





HEADS OF MIDGE LARVE (FROM BELOW)

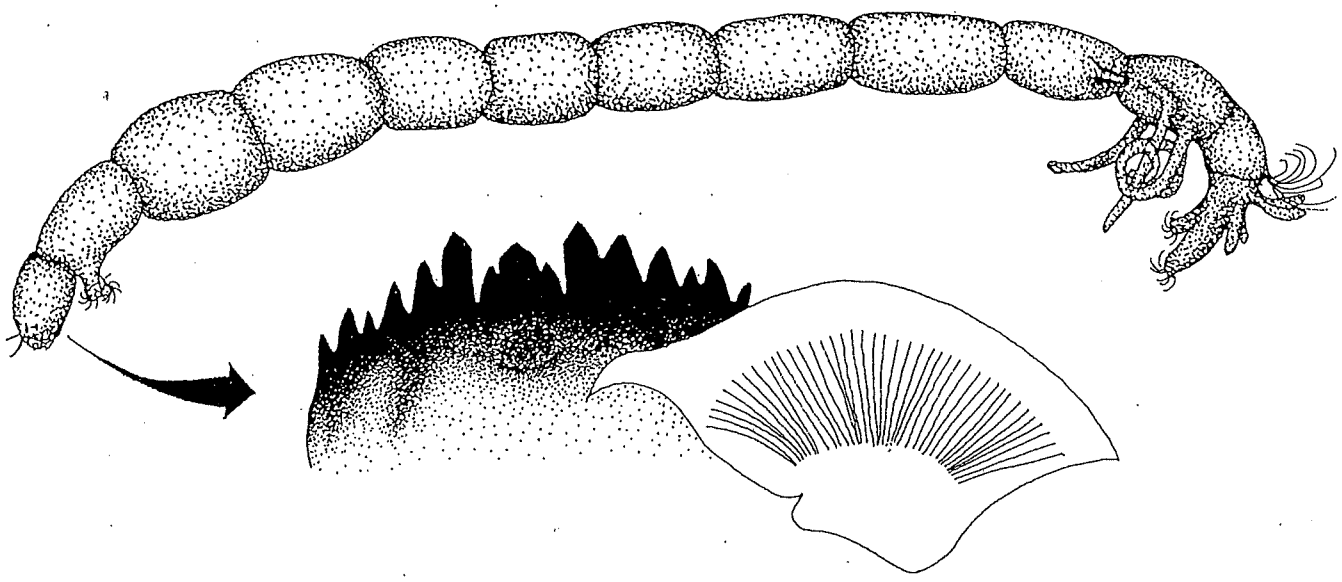
Chironomus occidentalis larva



- Red when alive
- 2 pairs of straight ventral tubules

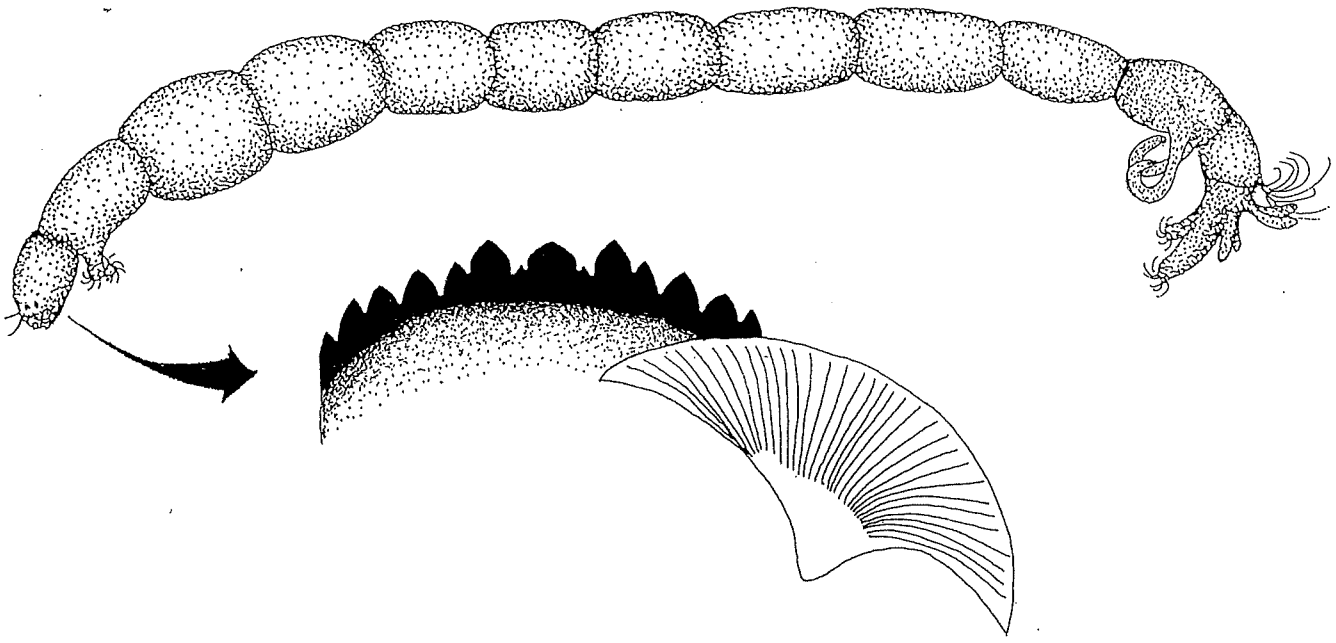
early instar (immature) larvae <7.5mm
late instar (mature) larvae 7.5 - 15mm

Chironomus alternans larva



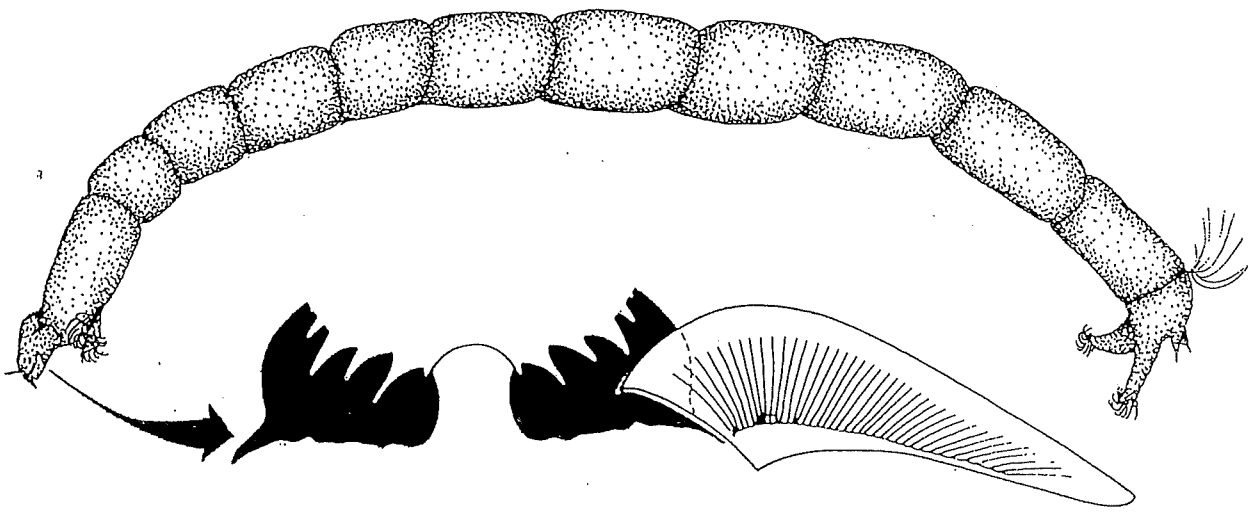
- Red when alive
- 2 pairs of ventral tubules, one coiled
- 1 pair of lateral tubules

Kiefferulus intertinctus larva



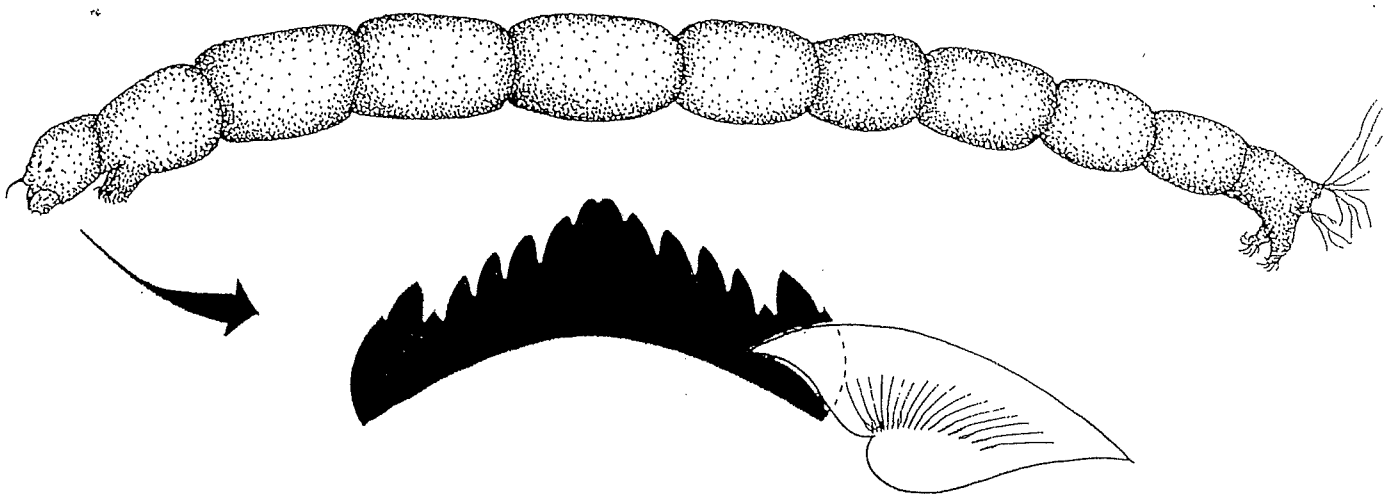
- Red when alive
- 1 pair of coiled ventral tubules

Cryptochironomus griseidorsum larva



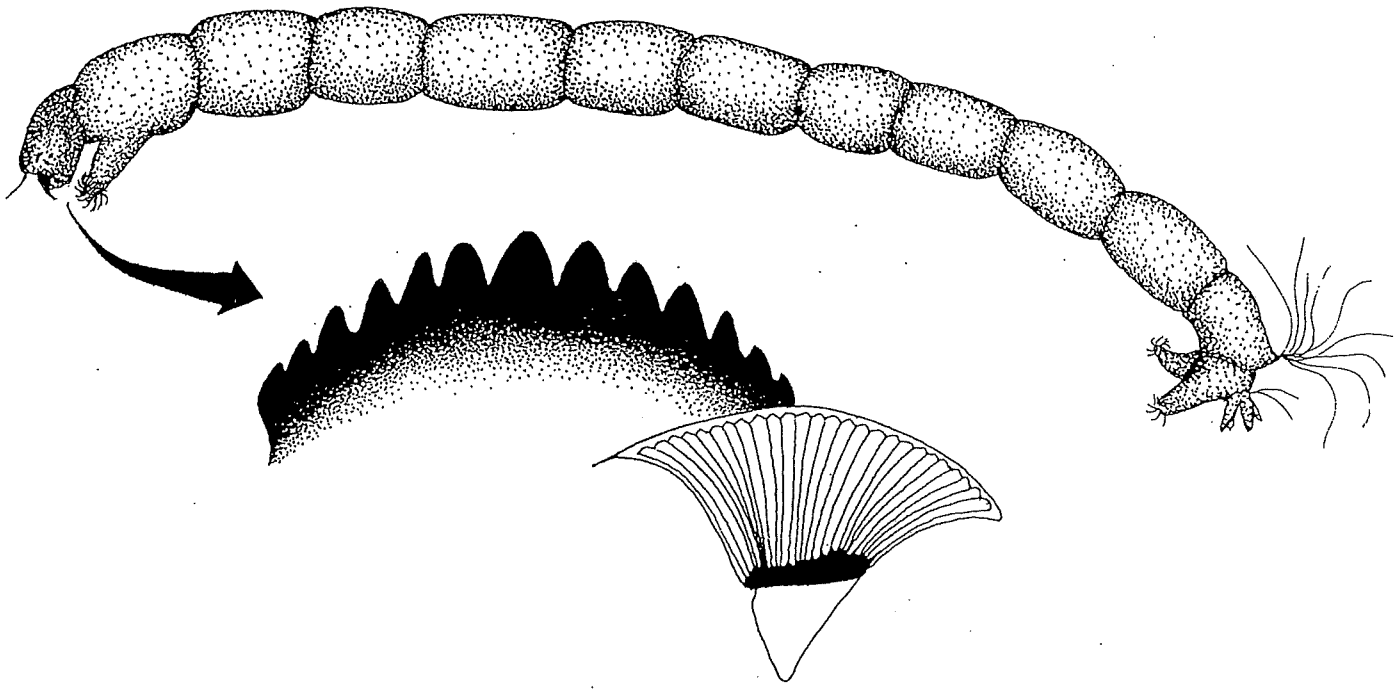
- Small head, often held back
- Teeth concave in general outline, separated by pale area

Cladopelma curtivalva larva



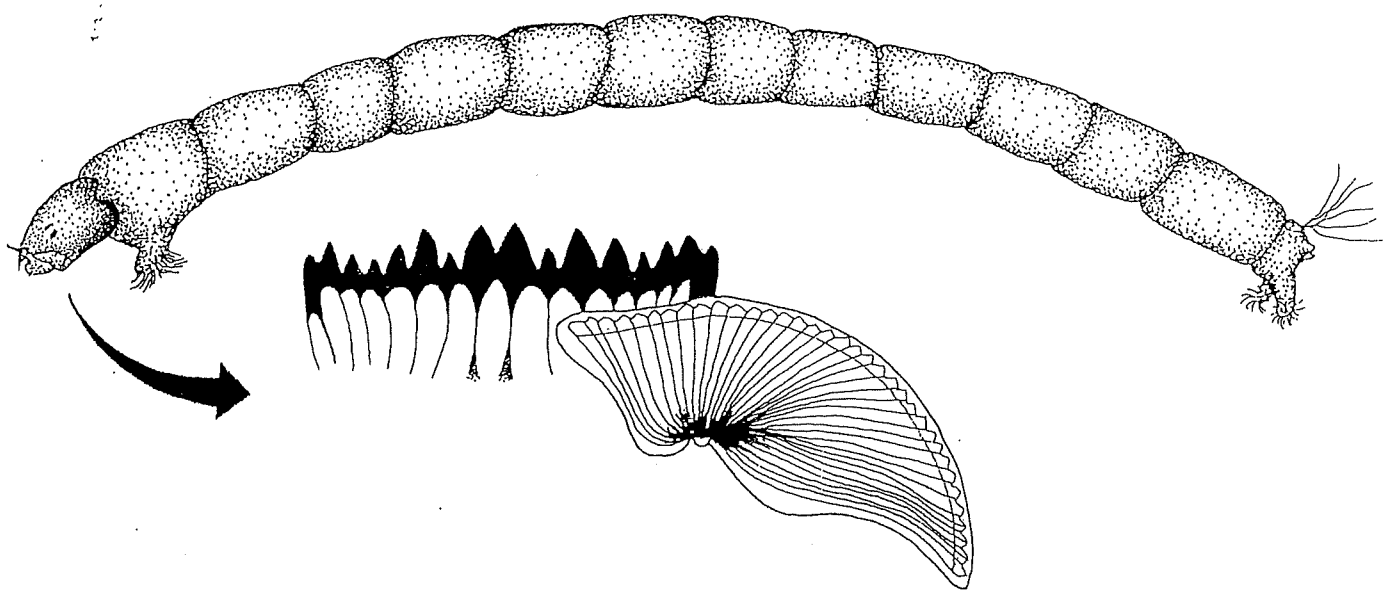
- Difficult species - need to look at head squash
- Outer teeth long

Dicrotendipes conjunctus larva



- Head dark brown in later instar larvae, except for pale area around eyes
- Dorsal setae very long and like fine copper wire

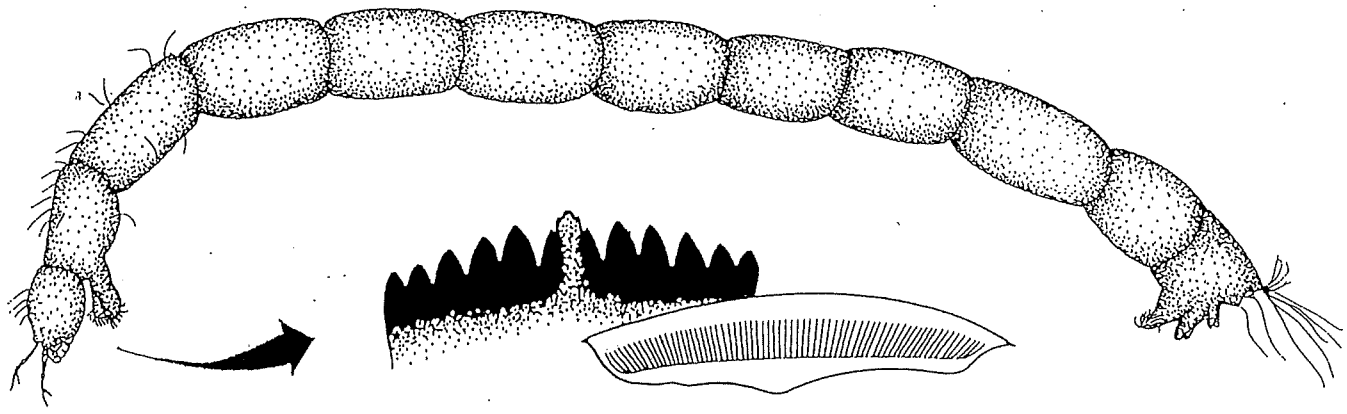
Polypedilum nubifer larva



- Dark area on "chin", head small
- Teeth forming straight line

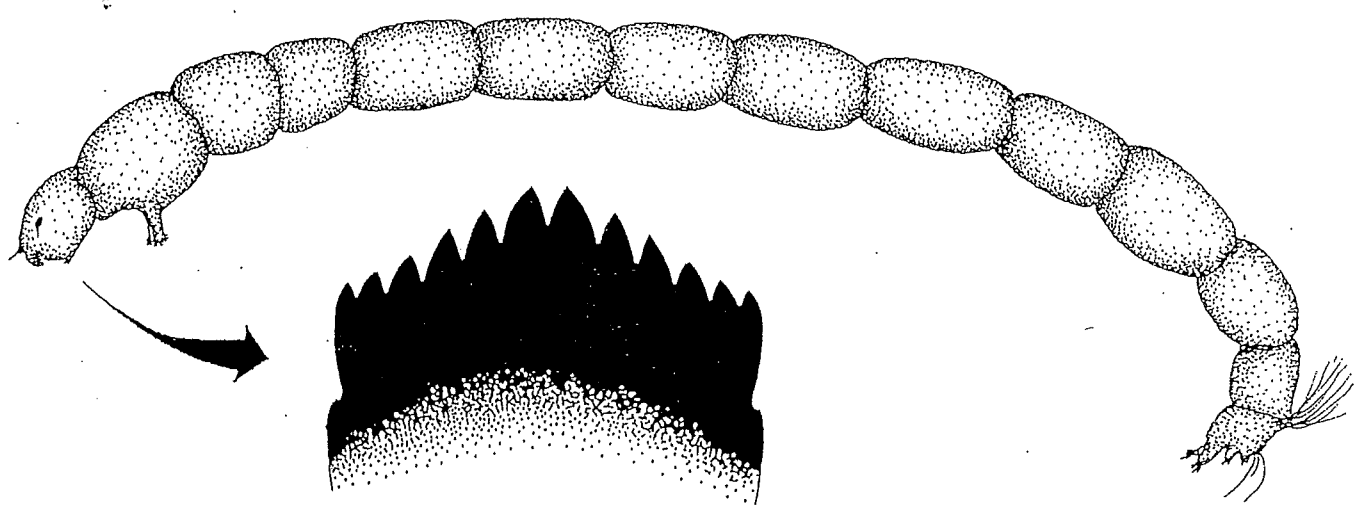
early instar (immature) larvae <5mm
late instar (mature) larvae 5 - 10mm

Tanytarsus fuscithorax larva



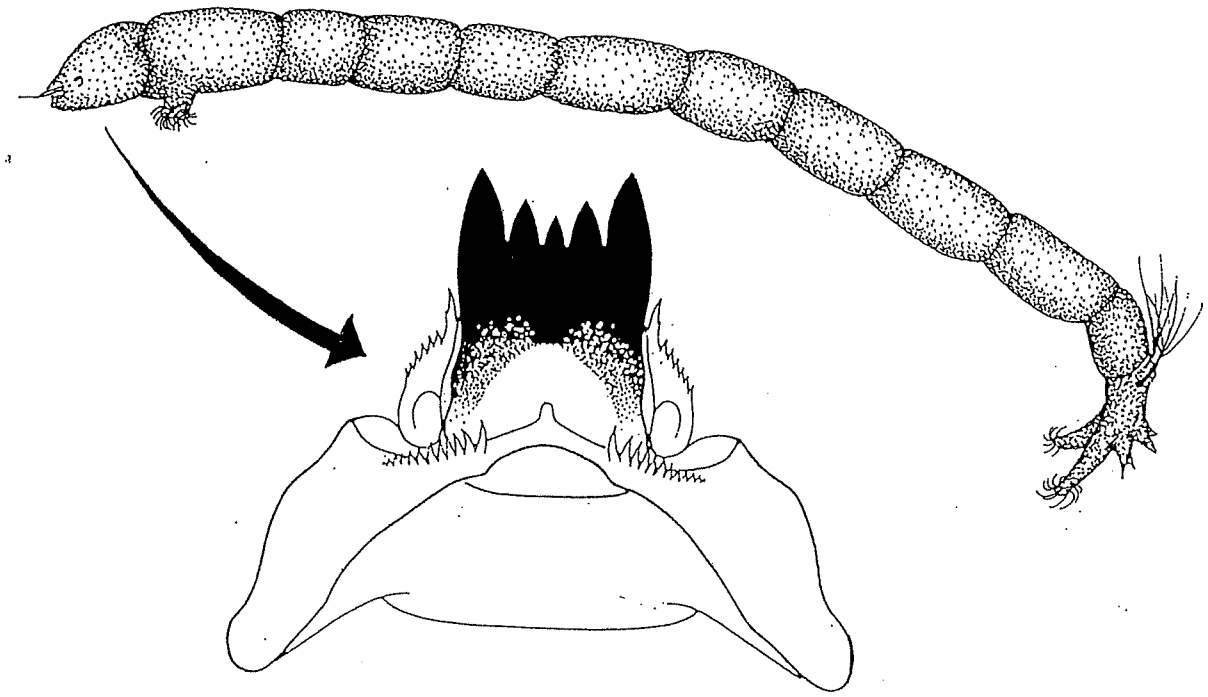
- Long antennae
- Small gap in teeth row, due to paler area
- Long straight paralabial plates

Paralimnophyes pullulus larva



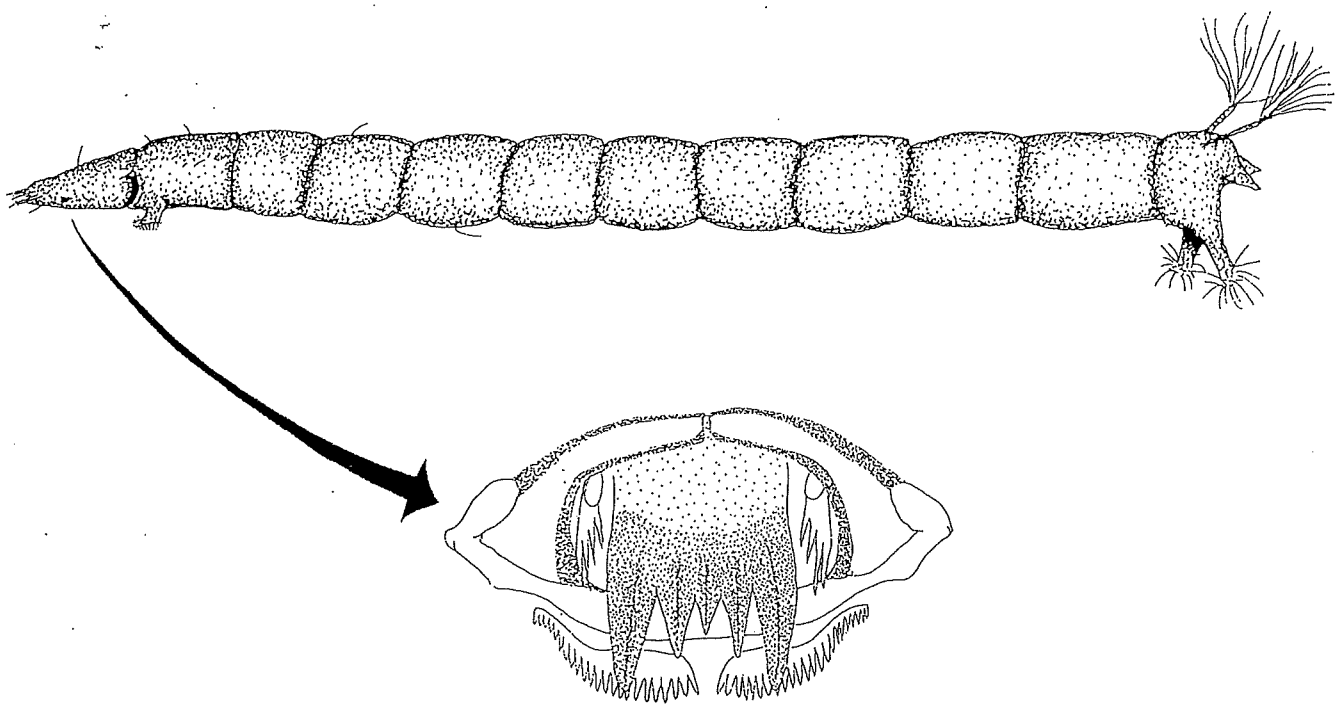
- Anal appendages reduced
- Darkened area of teeth very extensive

Procladius villosimanus larva



- Large head with ligula
- Taught, "bead-like" body segments

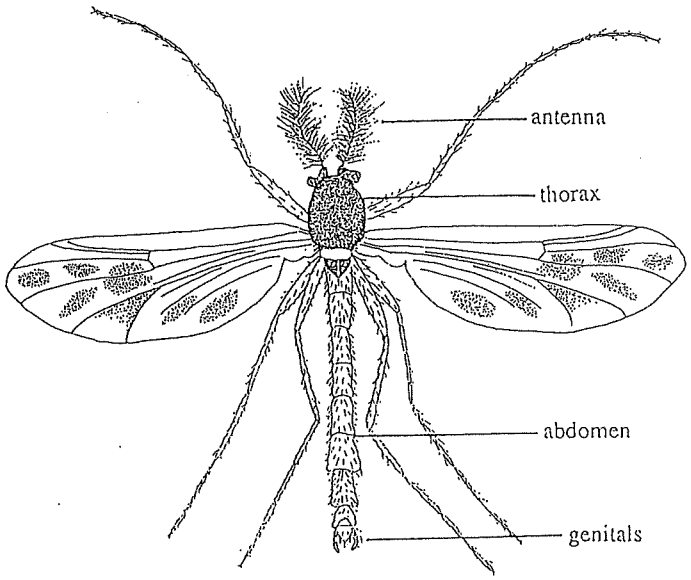
Coelopynia pruinosa larva



- Flat pointed head with ligula
- Mouthparts pale (honey colour) with long sickle-like mandibles

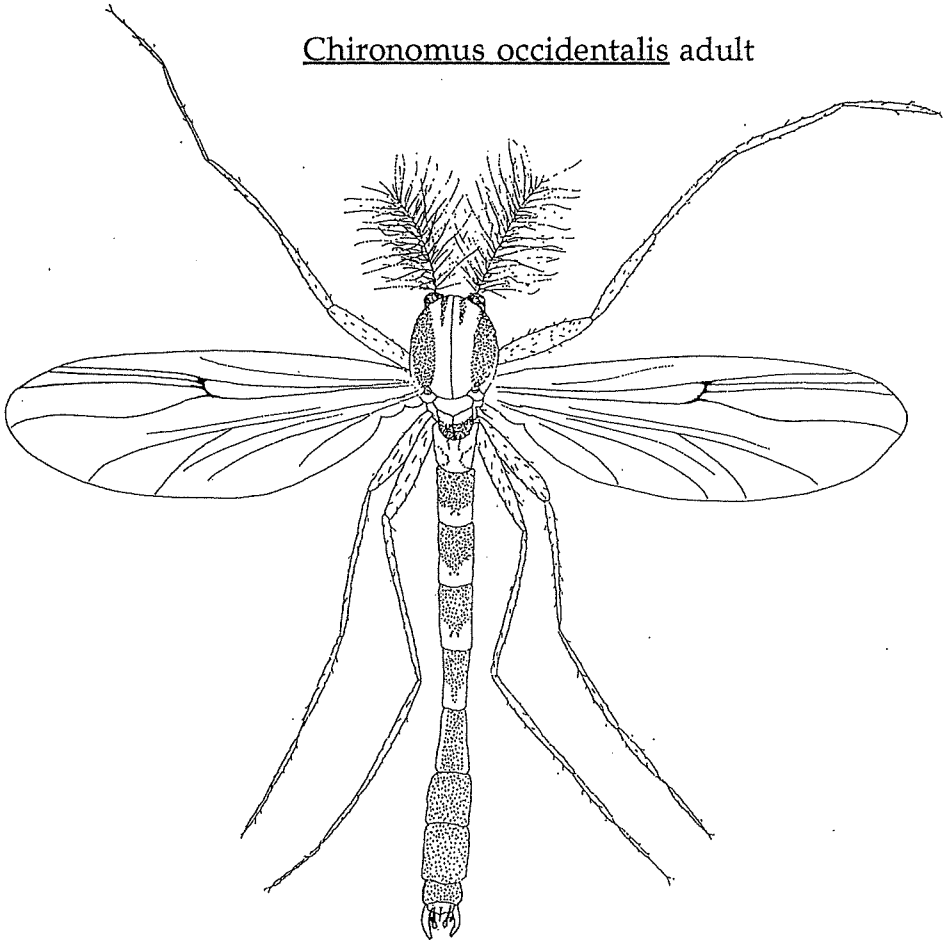
ADULT MIDGES

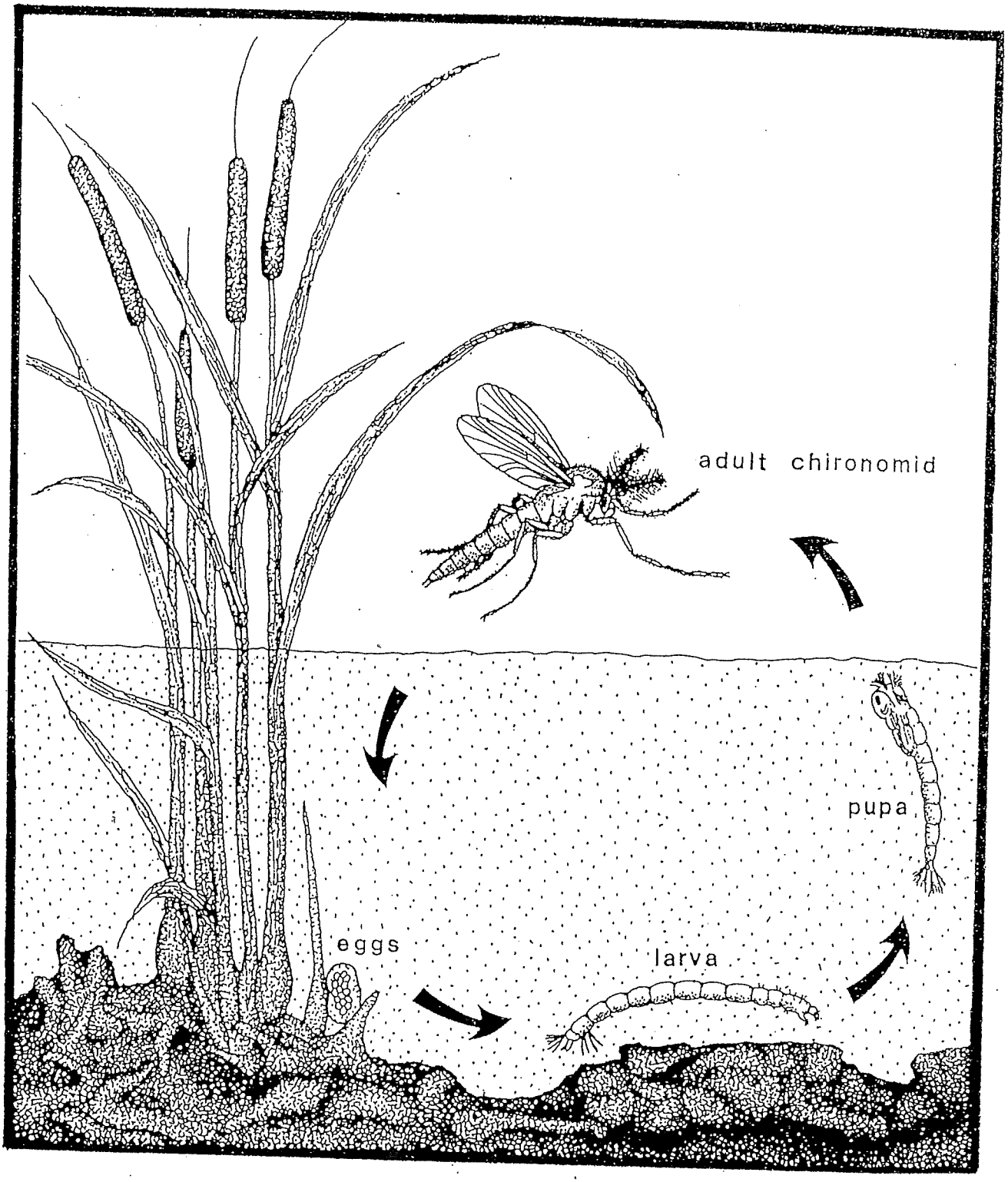
Polypedilum nubifer adult



1mm

Chironomus occidentalis adult




adult chironomid
pupa
eggs
larva

LAKE: FORRESTDALE

DATE: 20-1-91

SAMPLE TYPE: OPEN WATER

	NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				
	COOR.	272	289	328	48	62	78	63	337	320	298	273	290	32	342	359	332	46	50	58	89	MEAN	S.E.	TOTAL	%COMP
	DEPTH																								
SPECIES																									
P. nubifer		54	6	6	5	1	1	1	10	10	38	4	23	76	33	6	24	61	113	9	7	24·4	6·76	488	67·6
P. villosimanus		34	3	2	2	1	4	1	13	13	19	2	3	10	19	12	23	4	13	1	3	9·1	2·04	182	25·2
D. conjunctus		8	5	2	0	2	1	0	4	3	8	1	1	1	2	0	1	0	1	0	1	2·05	0·54	41	5·7
T. fuscithorax		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0·1	0·07	2	0·3
C. alternans		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0·05	0·05	1	0·1
C. occidentalis		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0·1	0·07	2	0·3
C. griseidorsum		0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	1	1	0	0	0	0·3	0·21	6	0·8
TOTAL		97	14	10	8	4	6	2	27	26	65	7	27	92	54	18	50	66	128	10	11	36·1	8·16	722	100

↑ × 127·4

= 4599 ± 1040 larvae/m²

SAMPLE TYPE: TYPHA

	NO.	1	2	3	4	5	6	7	8	9	10														
	COOR.																					MEAN	S.E.	TOTAL	%COMP
	DEPTH																								
SPECIES																									
P. villosimanus		0	0	0	0	1	0															0·17	0·17	1	100
TOTAL																						0·17	0·17	1	100

APPENDIX 5

MIDGE NUISANCE SURVEY SHEET

LEVEL OF NUISANCE	(tick appropriate box)
Low	
Moderate	
High	
Extreme	

DATE: (Please give the dates for the period which this data sheet covers)

From: To:

OTHER COMMENTS:

NOTE

Low: Very few or no midges present

Moderate: Midges present but causing little nuisance to you

High: Many midges present & causing a nuisance to you in & around your home

Extreme: Midges highly abundant and nuisance at an intolerable level