Internal Report

An exploratory survey of the macroinvertebrate fauna of the Mpofana and Lions Rivers, KwaZulu-Natal, to assess the possible impact of a proposed inter-basin transfer from the Mooi River to the Mgeni River system.

by H.M. Barber-James and F.C.de Moor

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September 1995

From: "Leslie D. Ter Morshuizen" <LTM@guppy.ru.ac.za>
To: amhj@warthog.ru.ac.za
Date: Tue, 5 Sep 1995 12:19:28 GMT+0200
Subject: Fish inventry - Umgeni and Mooi Rivers, Natal
Priority: normal

Hi Helen

Herewith the requested search. I found the details for the Umgeni River system without hickups. However as we having nothing from the Natal Mooi River in our collection, I have included a species list for the Tugela River system.

	Umgeni River	Tugela River
Amphilius natalensis		*
Amphilius uranoscopus		*
Anguilla mossambica		*
Awaous aeneofuscus	*	
Barbus anoplus		*
Barbus natalensis	*	*
Barbus viviparus	*	
Carassius auratus	*	
Gilchristella aestuaria	*	
Glossogobius callidus	*	
Glossogobius giuris		*
Hypseleotris dayi	*	
Labeo molybdinus		*
Labeo rubromaculatus		*
Microphis brachyurus	*	
Microphis fluviatilis	*	
Oreochromis mossambicus	*	
Poecilia reticulata	*	
Pseudocrenilabris philander	*	

The ranges of several estuarine species given to be present in these systems, such as Monodactylus falciformis, are restricted to the immediate vacinity of the estuary and have therefore not been included on this list.

I trust that this helps you.

Regards,
Leslie

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SUMMARY

An examination of aquatic macroinvertebrate species collected from the Mpofana and Lions Rivers, KwaZulu-Natal, by staff of Umgeni waters was carried out. This survey was conducted prior to the construction of a tunnel which will transfer water from the Mooi River via these two rivers into the Mgeni River system. A relatively low diversity of invertebrates was found, when compared to the known fauna of the Mooi River. It is suggested that this is partially the result of low collecting effort, and limited collecting techniques. The large mesh size of nets used may also have allowed many species, present as small larvae or nymphs, to escape from collecting nets. The Mpofana River is also a much smaller river than the Mooi River and would naturally have a lower diversity of species.

Certain invertebrate species, particularly some Simuliidae (Diptera), may pose problems with increased flow regimes. Invertebrates such as certain species of Chironomidae (Diptera) prefer slow-flowing water, and their numerical abundance will probably decrease in regions of increased flow rates. Others Diptera which prefer faster flow, such as *Antocha* sp. (Tipulidae) may prosper, but are unlikely to have any negative effects. The relative abundance of certain species may also change in response to altered flow and community composition will change. Species which will be influenced include some of the Tricorythidae and Heptageniidae (Ephemeroptera).

Other issues, such as the influence of a new impoundment, and the inter-basin transfer (IBT) of invertebrate and fish species via the Mpofana and Lions River into the Tugela and Mgeni systems, are also considered. If the proposed impoundment lowers oxygen content in the water, and reduces natural sediment load, various natural communities will be affected in different ways. For example, Elmidae (Coleoptera), which require highly oxygenated water, and *Dipseudopsis* spp. (Trichoptera), which requires sediments to construct their cases and function as a filter feeder, may both be adversely affected. The incidental translocation of certain fish species from the Mgeni, particularly species alien to natural aquatic South African aquatic ecosystems, will be detrimental to the invertebrates and naturally found fish species in the Mooi River.

A detailed prediction of the impact of various flow regimes to the faunal community of the recipient river systems is beyond the scope of this study. The lower diversity of Ephemeroptera and the greater diversity of Dytiscidae (Coleoptera) in the recipient river system indicate a marshy swampy environment a very different river system to that that

surveyed along the Mooi River. Increased flows will modify the stream channel of the Mpofana River and may lead to greater inundation of existent floodplains along the Lions River.

It is recommended that the proposed increase of the flow regime in the Mpofana and Lions Rivers should follow a natural seasonal pattern and not become a steady or constant release of water as this will lead to pest species problems. The effects of increased flow through the inter-basin transfer on aquatic invertebrate communities should be closely monitored. Further sampling is needed to determine more accurately what the faunal composition of the Mpofana and Lions Rivers are as this will refine predictive capacity. It is recommended that efforts should be made to keep unwanted alien fish out of the Mooi River.

Although not analysed independently for this survey aquatic biotopes have been sampled separately and with more sampling effort a more detailed analysis of various faunal assemblages will improve the predictive value of determining the impact of increased flow regimes.

STUDY AREA AND METHODS

Invertebrate samples were collected by staff of Umgeni Waters from two sites along the Mpofana River (March 1995) and from two sites on the Lions River (July 1995) (Fig. 1; Table 1). These samples were sorted and identified in the Albany Museum. The aim of the study was to comment on possible effects of increased flow rates on the invertebrate communities of these rivers which will result from an inter-basin transfer of water from the Mooi River via the Mpofana and Lions Rivers in to the Mgeni system.

The results of this survey may be compared with a survey of the Mooi River (de Moor, 1995), to see if species currently not present could be introduced into either the Mgeni or Mooi Rivers through this inter-basin transfer of water. The possible consequences of such introductions may be detrimental. The receiving rivers have, however, been supplied with Mooi River water via a pipeline for some years already, and it is likely that species from the Mooi River are already established in these rivers.

All invertebrates collected were identified to the greatest detail possible to give an accurate idea of the present biodiversity of the rivers. Certain groups are better known than others, and hence emphasis will be placed on those in the discussion. Groups such as Copepoda,

Cladocera, Ostracoda and some Coleoptera, Hemiptera and Diptera fall beyond the expertise of museum staff, or the time required to get them identified by specialists. They will be identified by outside specialists in due course. However, the presence or absence and abundance of certain keystone species can give an indication of the general well-being of a river, and may be used to predict changes in response to man-induced manipulations.

The fish species present in each system are also briefly considered, to see if inter-basin migrations may negatively affect the invertebrate and indigenous fish communities, and the rivers as a whole. This information was obtained by consulting records held by the Albany Museum and JLB Smith Institute of Ichthyology.

RESULTS

A total of 71 species were collected from the Mpofana River, and a combined total of 96 species from two sites on the Lions River, with 81 species from the site at Weltevreden and 41 from the floodplain (Table 3). As the two sites on the Lions River are very different to each other, and indeed have a different fauna, they have been separately analysed. A floodplain has unique dynamics dependent on river flow, and may be particularly sensitive to flow manipulations.

DISCUSSION

Very little is known about the direct flow requirements of South African macroinvertebrates. Optimum flow requirements have been documented for only three species in a river in the western Cape (an elmid larva and two chironomid larvae) (King and Tharme, 1994). It is therefore only possible to use general terms, such as slow, medium or fast flow, to describe flow preferences for certain species discussed. The rate of flow of any river is obviously dependent on its gradient, width and depth at any point, so the three proposed volumes to be released, 3.2, 6.0 and 10.0 cumecs, will have different effects in different parts of the rivers.

A detailed hydrological report (Le Roux, 1995) gives an indication of the flow conditions of the receiving rivers, based on forty years of records. Both "normal" flows and flood peaks are presented. These values are an important consideration since they give an indication of the natural variation in flow. This will assist in assessing how the receiving rivers and their fauna

will respond to the additional water from the inter-basin transfer. These values have been summarised in Table 2 for easy reference.

The regions that are likely to be the most impacted by these additions are the upper reaches of the Mpofana River which have the lowest natural flow, and the lowest flood maximums. However, even if 10 cumecs are added to the receiving rivers, the volume of water will be below the level of the five year flood peak at the tunnel outlet. As a result of the increased flow in natural low flow areas, parts of the river that were suitable for habitation by certain invertebrates before the water transfer will become suitable for other species in the system. It is only those species which prefer lower flow that are under threat, but they may be able to survive if the peak flows follow a natural, seasonal cycle. It is well known that fish, in times of flooding, move to backwaters to avoid being washed away. Invertebrates are either sessile or cannot swim strongly enough for this and therefore drift downstream. Drift is a natural phenomenon in aquatic macroinvertebrates and is important in the colonisation of river reaches. Certain species, such as Simuliidae, control their drift by spinning threads anchored on to upstream substrates. The adult stages of most aquatic insects fly upstream to lay their eggs to compensate for the effects of drift. Whether or not the juvenile stages can find suitable slower flowing reaches, or can establish themselves in faster flowing, deeper water, is the critical question.

The maximum proposed flow of water through the Mpofana and Lions Rivers is up to 10 cumecs, and will change the nature of these rivers to some extent. If this is on a fairly continuous basis, the erosional states of these rivers may be altered, deepening the channel in parts, and leading to increased deposition of material in slower flowing regions such as the floodplain on the Lions River. However, the most important factor likely to affect the floodplain is seasonality of flow, and extrapolations can be made from studies on the Pongola floodplain, where fish species have been unable to breed because of unseasonal releases of water (James, per comm).

It is interesting to note that the Lions and Mpofana Rivers have already been receiving water from the Mooi River via a pipeline since 1982 (Dickens pers comm). This has a capacity to pump up to 3.5 cumecs when necessary, though usually the flow does not exceed around 1.5 cumecs (Dickens, pers comm). The inter-basin transfer tunnel will flow in to the Mpofana River above the pipeline point of entry. As the invertebrates in these rivers have not been studied prior to the pipeline transfer, there is unfortunately no historical base-line data available for these rivers, so pre- and post-translocation comparisons cannot be made.

The invertebrate material collected for this analysis gives an unrealistically low faunal representation for the two rivers. The Lions River material was collected in mid-winter, and only two sites were considered, and only one site was taken on the Mpofana. A one-off survey does not give enough detailed information to make sound judgements, and it is important to consider seasonal patterns before the fauna of any system can be described in detail.

Certain invertebrate species are more susceptible to flow changes than others. This discussion will focus on the better known groups, although it is always important to know the full species complement occurring in a river, since a high biodiversity is a good indication that a river is in a healthy state. The record of species diversity provided by this survey is the first step towards building a database which will allow a comparison after a period of time to see what effect external influences such as inter-basin transfers have had on a river.

EPHEMEROPTERA

The diversity of Ephemeroptera was surprisingly low in both rivers, with 12 species from the Mpofana and 15 from both sites on the Lions. These figures are very low when compared to the 53 mayfly species known from the Mooi River (de Moor, 1995). Low numbers of species along the floodplain are not unexpected, since only mud and marginal vegetation biotopes, presumably in still to slow flowing water, were available for sampling. However, *Baetis harrisoni*, a widespread species known for its tolerance to poor water quality and varied flow conditions, dominated the community at the Weltevreden site. This could be in part due to the fact that sampling was carried out in mid winter, and other species may have been too small to catch or were over-wintering as eggs. Little is known about the detailed life histories of African mayflies. The low collecting effort would also account in part for the low diversity, and light-trapping for adults would doubtless increase the recorded diversity considerably. The possible effect of the intensive farming, predominantly dairy and some timber (Dickens, pers comm) must not be overlooked. The dominance of a tolerant species such as *Baetis harrisoni* indicates that the river is already degraded to some extent. The burrowing mayflies, which were of note in the Mooi River (de Moor, 1995), were only represented by *Eatonica schoutedeni*, a species which is widespread in Tropical Africa (Demoulin, 1970). The Mooi River is the only recorded locality of the genus *Ephemera* in Africa, and it is hoped that more careful collecting along the Mpofana and Lions Rivers may increase its known distribution.

No Heptageniidae were found in the Mpofana or Lions Rivers, although they are present in the Mooi and Mgeni Rivers. It has been observed in the Elands River at Mpumalanga, that

Tricorythidae dominate upstream reaches while Heptageniidae dominate downstream (James and Barber, 1991). This agrees with the observations of Oliff (1964), who noted that deposits of silt limit the distribution of tricorythids. It is possible, with the additional flow from the inter-basin transfer, that Heptageniidae, which are present in both the Mooi and Mgeni systems, will become established, and maybe even dominate over the Tricorythidae, in the Mpofana and Lions Rivers.

The Prosopistomatidae require specialised collecting techniques and would otherwise be missed.

ODONATA

Adult dragonflies and damselflies are strong fliers, and their distribution is hence not confined by river courses. A few nymphs of various species were collected (Table 3), all of which also occur in the Mooi River. It is unlikely that the inter-basin transfer will have much, if any, effect on the Odonata. Nymphs of Gomphidae burrow in silt and soft sediments, and increased flow may reduce these sediments, but the floodplain should provide a refuge for these nymphs.

TRICHOPTERA

Few Trichoptera were found in these samples, which were limited both in diversity and in number. Only two species were found in the Mpofana and seven in the Lions. Again, this may be a product of under-sampling or seasonal abundance, or may suggest that the rivers are in a poor state of conservation. *Cheumatopsyche afra* is a widespread species tolerant of strong flow. The leptocerid caddis were found in the marginal vegetation in the Lions River floodplain, and should not be greatly influenced by water-flow increase, except perhaps by changes in seasonality of flow. The Dipseudopsidae will probably be more affected by the construction of the impoundments, since this will reduce the amount of sediment in the water, material on which these caddis are dependent for case construction. However, they may find suitable conditions within the impoundment. *Hydroptila cruciata* (Hydroptilidae) can survive in moderately swift flow conditions. This species requires filamentous species of algae from which it constructs its case, and the lentic algal species more common in impoundments would be unsuitable. *Oxyethira* does not have this algal requirement, but may be unable to adapt to high flow conditions.

DIPTERA

A) SIMULIIDAE

Thirteen species of simuliid are known from the Mooi River, while eight have been found in the Mpofana and Lions Rivers, one of which is not known from the Mooi River (Table 3). Some Simuliidae (blackflies) are notorious pests species on livestock since the adult females require a blood meal before their eggs can mature. The main simuliid pest in South Africa, *Simulium chutteri*, sucks blood from cattle and sheep, causing losses in stock production and occasional deaths in young animals (Car and de Moor, 1984). This species is dominant in the Orange and Vaal River systems, and has become a problem in the Great Fish River in the eastern Cape as a result of changed flow conditions following an inter-basin transfer. *S. chutteri* has not been recorded in the Mooi River (de Moor, 1995) and according to existing museum records, it is not present in the Mgeni system so it poses no threat.

Simulium nigritarse is a pest of poultry and humans. This species has a preference for moderate to slow flow and is abundant in small rivers, so is less likely to pose a problem if flow is increased.

Simulium bovis prefers swift flow. It is mammalophilic and regarded as a pest of livestock it has been recorded as biting humans in West Africa. Numbers will probably increase with higher flow.

Simulium damnosum s.l. a species complex with over 40 species known was represented by one species and is likely to become one of the main pest species. Certain species of the complex are voracious biters of man in many parts of Africa and some carry the dreaded vector parasite *Onchocerca volvulus* which causes "river blindness". So far no man biting species has been recorded in South Africa. Their preference is for fast flow, especially if there is trailing vegetation, and numbers are likely to increase with the inter-basin transfer.

Simulium unicornutum and *S. rotundum* are both fairly uncommon species. Numbers are seldom, if ever, high, and they are likely to diminish with the IBT. They prefer slow flow and leafy substrates. The adults are ornithophilic.

Simulium medusaeforme and *S. hargreavesi* both prefer fast flow. They are mammalophilic although never seem to pose much of a problem (Palmer, pers comm). Population densities are

often very high. They are extremely common species throughout Africa.

Simulium vorax lives in very fast flow, but prefer clean water and rocky substrate. They are mammalophilic, and reported to be troublesome on donkeys (Palmer, pers comm). However, they are unlikely to be a major problem.

Simulium mcmahoni has a preference for moderate to slow flow, particularly if there is trailing vegetation. It is a pest on poultry particularly along the Orange River, where numbers can get very high particularly during low flow periods. *S. adersi* also prefers moderate to slow flow, and tolerates polluted water it has been recorded as biting man in the eastern Cape. Like *S. mcmahoni*, it is ornithophilic and can be a pest of poultry. With increased flow, they may become a problem.

Simulium impukane and *S. rutherfoordi* both prefer slow flow, are ornithophilic and seldom common. *S. rutherfoordi* is usually restricted to clear mountain streams, and seems to be very sensitive to development and pollution.

Simuliidae have a rapid life cycle and very good colonising abilities (strong flyers and high fecundity) and if conditions are suitable they will increase in numbers very quickly. In the event of increased flow conditions, the main problem species are likely to be *S. damnosum s.l.* and *S. bovis*. Under reduced flow conditions, *S. adersi*, *S. nigritarse* and *S. mcmahoni* would dominate, but with the increased flow from an inter-basin transfer, they are not likely to become a problem to the poultry farms in the area. They may, however, pose a problem in the Mooi River area if flow becomes significantly lower. One of the major factors will be a more regular year round flow which will strongly favour certain Simuliidae. Flow management must be carried out to prevent this.

B) CHIRONOMIDAE

The larvae of this group of insects are well known as indicators of water quality in the northern hemisphere, where much is known about their ecological requirements. However, in Africa, detailed flow requirements have only been determined for two species, both from the Olifants River, western Cape (King and Tharme, 1993). *Rheotantarsus* sp. was found to prefer a flow of 0.3-0.9 cumecs, and *Polypedilum* sp. 0.6-0.7 cumecs. The problem with extrapolating this data to the Mpofana and Lions Rivers is that although the same genera are present, different species are represented, and the quality of water in the two areas differs. If

these figures were true for the KwaZulu-Natal rivers and species, then these particular genera of chironomids would not prosper.

C) OTHER DIPTERA

Several other dipteran families make use of the aquatic environment in their larval stage. The tipulid *Antocha* sp. was not found in either of the recipient rivers. It favours rapidly flowing water, and may become established after the transfer. It would, however, pose no problem either to the ecosystem or to man. The Culicidae are more likely to pose a problem under reduced than under increased flow conditions. Expansion of the floodplain may however lead to an increase of suitable breeding habitat for Culicidae species. Little can be said about the other families recorded in Table 1.

COLEOPTERA

Many more species of Coleoptera were recorded from the Mooi River (de Moor 1995) than were found in the Mpofana and Lions Rivers during this survey. However, Dytiscidae were more dominant in the Lions River floodplain than at any other site. Elmidae respond well to high flow, and require water with a high dissolved oxygen content. Water released from the bottom of an impoundment has a low oxygen content. If the proposed Dartington Dam should become a bottom release impoundment, the elmids could be adversely affected.

The Hydraenidae and Hydrophilidae species that have been identified from the Mooi River are all species known only from flowing water. It is likely that the hydraenid and hydrophilid fauna from the Mpofana and Lions Rivers are similar, but it has not been possible to identify those collected during this survey beyond family level.

INVASIVE BIOTA.

It is important to consider the possible effect of the inter-basin transfer of fish species in the two river systems, and the possible impacts of introductions on the ecosystem. Only species present in the Mgeni system are of concern as potential problem species. Three indigenous fish are recorded from the Mooi River, which are not present in the Mgeni system, but these are unlikely to cause problems when introduced (Cambray, pers comm). Several species present in the Mgeni River system and not currently recorded from the Mooi River may migrate upstream and along the tunnel once the two systems are connected. These include the

alien predator *Oncorhynchus mykiss* introduced for angling purposes and the smaller *Xiphophorus helleri* (sword-tail) and *Poecilla reticulata* (guppy), introduced from the aquarium trade, feed on invertebrates and fish eggs. Once a system is disturbed in a way that disadvantages the indigenous fish these species may be able to spread (James, pers comm).

Another important effect of incidental translocation is that previously separated stocks of indigenous fish will become sympatric this will result in the hybridisation of different genetic stocks. This will alter speciation events which would have taken place under natural conditions.

CONCLUSIONS

It is necessary to undertake more comprehensive sampling preferably over a number of seasons to obtain a true reflection of the faunal diversity.

The consequence of the inter-basin transfer of water from the Mooi River to the Mgeni River system will be the reduction of flow in the Mooi and concommitant increase in the Lions, Mpofana and Mgeni Rivers. It is recommended that flows be managed such that the natural balance of aquatic fauna is affected as little as possible. Too much water extracted from the Mooi or too much added to the receiving rivers can influence the communities of both systems negatively. Certain species will increase and others decrease in numbers. Seasonal timing of extractions must also be considered. However, many other factors come into play. A number of alien fish species are present in both river systems, especially the Mgeni, and these if these move upstream they may have a negative impact on the invertebrate communities and ecology of the Lions, Mpofana and Mooi Rivers. Once more detailed knowledge of the invertebrate fauna has been obtained, it will be possible to draw stronger conclusions and make management recommendations to ensure the future of freshwater macroinvertebrates and sound ecological functioning of these rivers.

RECOMMENDATIONS

Further sampling is needed to determine more accurately what the faunal composition of the Mpofana and Lions Rivers are as this will refine predictive capacity.

Although not analysed independently for this survey aquatic biotopes have been sampled and recorded separately and with more sampling effort a more detailed analysis of various faunal

assemblages will improve the predictive value of determining the impact of increased flow regimes.

It is recommended that the proposed increase of the flow regime in the Mpofana and Lions Rivers should follow a natural, seasonal and fluctuating pattern. It should not become a steady or constant release of water as this will lead to pest species problems developing.

The effects of increased flow through the inter-basin transfer on aquatic invertebrate communities should be closely monitored. This will enable refinement of flow regime management for optimising environmental conditions.

It is recommended that efforts should be made to keep unwanted alien fish out of the Mooi River. Fish barriers and control centres should be considered.

ACKNOWLEDGEMENTS

The following people are thanked for their contributions: Mr S.J. Mangold and Mr S.C. Zingela sorted the samples, and Mr Mangold drew up tables and maps and commented on the manuscript. Dr R.W. Palmer (Onderstepoort Veterinary Institute) provided information on Simuliidae. Mrs P. Black extracted information about fish from the Albany Museum database, and Dr J.A. Cambray ably commented on these lists. Mr L. Ter Morshuizen extracted additional fish information from the JLB Smith Institute of Ichthyology database. Mr N.P.E. James commented on the effects of water releases on the fish of the Pongola floodplain, and the dispersal of exotic aquarium fishes in natural river systems.

LITERATURE CITED

Car, M. and de Moor, F.C. 1984. The response of Vaal River Drift and Benthos to *Simulium* (Diptera: Nematocera) control using *Bacillus thuringiensis* var *israelensis*. *Onderstepoort J. vet. Res.* 51: 155-160.

Demoulin, G. 1970. Ephemeroptera des faunes éthiopienne et malgache. *South African Animal Life* XIV: 24-170.

James, N.P.E. and Barber, H.M. 1991. A survey of the fishes of the Elands and Crocodile Rivers in the vicinity of the Sappi Kraft pulp and paper mill at Ngodwana, Eastern Transvaal. JLB Smith Institute of Ichthyology Investigational Report no. 37. 13pp.

King, J.M. and Tharme, R.E. 1993. Assessment of the Instream Flow Incremental Methodology and initial development of alternative instream flow methodologies for South Africa. Water Research Commission Report No. 295/1/94. 590pp

Moor, F.C. de. 1995. A survey and synthesis of previous surveys conducted along the Mooi and Klein Mooi Rivers to advise on instream flow requirements of the aquatic biota, with particular reference to the macroinvertebrates. Albany Museum Internal Report. 40pp.

Oliff, W.D. 1964. Hydrobiological studies on the Tugela River system. Part IV. The Mooi River. *Hydrobiologia* 24(4): 567-583.

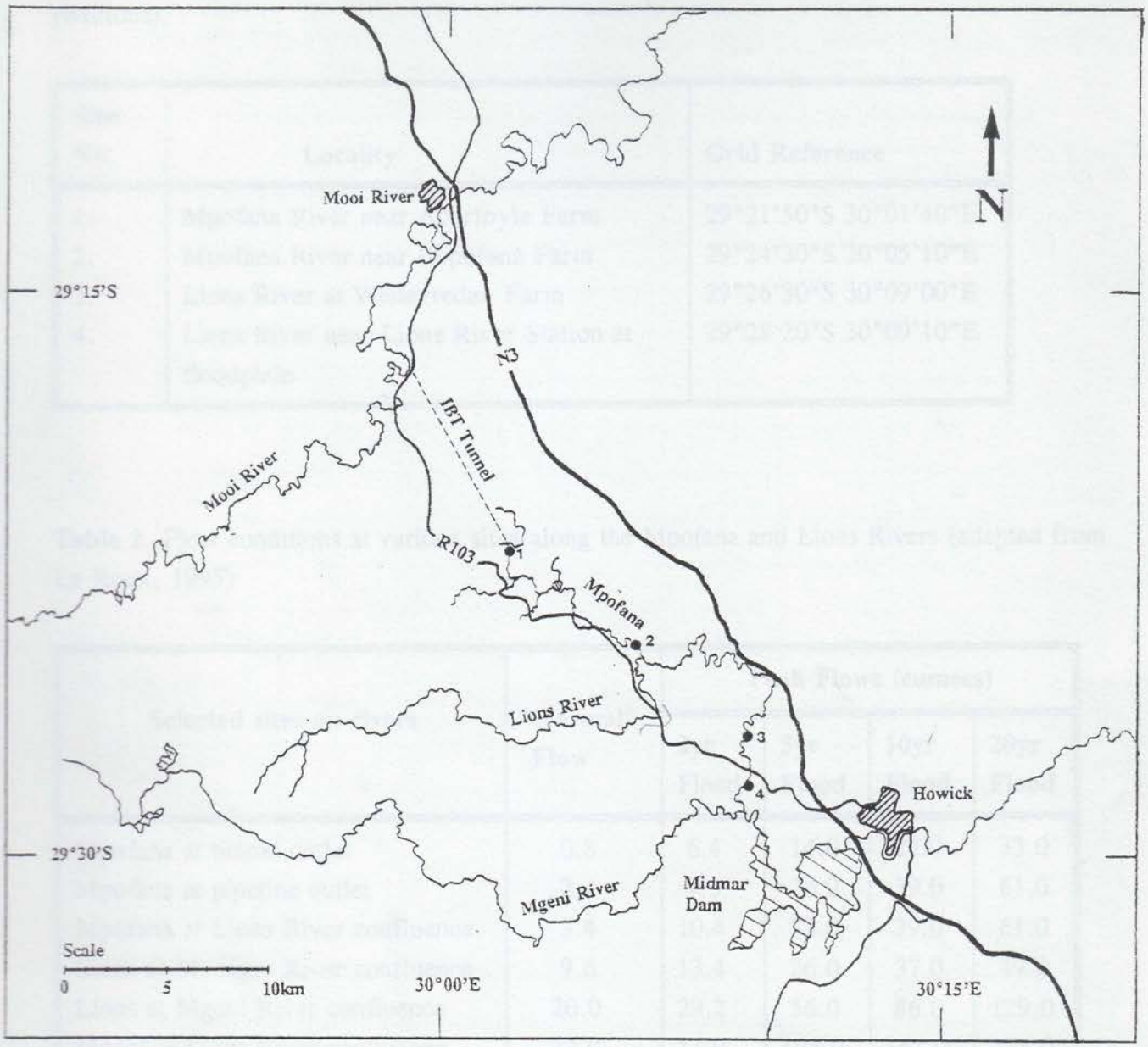

Figure 1. Map showing positions of collecting sites and proposed Interbasin Transfer scheme from the Mooi River to the Mgeni River system.

Table 1. Grid references of collecting sites sampled during this survey (see Fig.1 for site positions).

Site No.	Locality	Grid Reference
1.	Mpofana River near Aberfoyle Farm	29°21'50"S 30°01'40"E
2.	Mpofana River near Impofana Farm	29°24'30"S 30°05'10"E
3.	Lions River at Weltevreden Farm	29°26'30"S 30°09'00"E
4.	Lions River near Lions River Station at floodplain	29°28'20"S 30°09'10"E

Table 2. Flow conditions at various sites along the Mpofana and Lions Rivers (adapted from Le Roux, 1995)

Selected sites on rivers	"Normal" Flow	Peak Flows (cumecs)			
		2yr Flood	5yr Flood	10yr Flood	20yr Flood
Mpofana at tunnel outlet	0.8	6.4	14.0	22.0	33.0
Mpofana at pipeline outlet	2.4	9.3	23.0	39.0	61.0
Mpofana at Lions River confluence	3.4	10.4	23.0	39.0	61.0
Lions at Mpofana River confluence	9.6	13.4	26.0	37.0	49.0
Lions at Mgeni River confluence	20.0	29.2	56.0	86.0	129.0
Mgeni at Lions River confluence	22.0	51.0	105.0	161.0	238.0

Table 3. Comparative list of macroinvertebrate species obtained during various surveys of the Mooi River catchment and Mpofana and Lions Rivers. Lions R. (W) refers to Lions River at Weltevreden and Lions R.(F) refers to Lions River at Floodplain. Where + occurs, denotes species from the upper reaches of the Mooi River.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
TURBELLARIA				
Planariidae				
Planaria sp.	*	*	*	*
NEMERTEA				
Tertastemmatidae				
Prostoma sp.	*			
NEMATODA				
Mermithidae				
Gen. spp. indet.	*	*	*	*
NEMATOMORPHA				
Parachordodidae				
Paragordius sp.	*		*	
ANNELIDA				
HIRUDINEA				
Glossiphoniidae				
Glossiphonia sp.?	*			
Marsupiobdella africana?	*			
Helobdella scutifera	*			
Gen. spp. indet.	*	*	*	*
OLIGOCHAETA				
Naididae				
Chaetogaster sp.	*	*		
Nais spp.	*	*	*	
Gen. spp. indet.			*	*

Table 3. Continued.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
Lumbriculidae				
Gen. spp. indet.	*	*	*	
Tubificidae				
Tubifex sp.	*			
Branchiura sowerbyi	*		*	
Limnodrilus sp.	*			
Gen. spp. indet.			*	*
MOLLUSCA				
GASTROPODA				
Planorbidae				
Bulinus tropicus	*			
Bulinus spp.	*	*		
Gyraulus sp.	*			
Biomphalaria sp.	*			
Lymnaeidae				
Lymnaea natalensis	*			
Lymnaea spp.	*		*	
Ancylidae				
Burnupia ponsonbyi	*			
Burnupia caffra	*			
Burnupia spp.	*		*	
Ferrissia sp.	*			
Gen. sp. indet.			*	
PELECYPODA				
Sphaeriidae				
Pisidium spp.	*	*	*	
Gen. spp. indet.			*	

Table 3. Continued.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
Corbiculidae				
Corbicula sp.	*			
CLADOCERA				
Daphniidae				
Ceriodaphnia sp.			*	*
Daphnia spp.	*			
Simocephalus vetulus	*			
Simocephalus sp.	*			
Chydoridae				
Leydigia quadrangularis	*			
Alona rectangula	*			
Alona affinis	*			
Alona guttata^{+}	*			
Alona sp.	*			
Chydorus gibsoni^{+}	*			
Chydorus sphericus	*			
Chydorus sphericus form minor	*			
Gen. sp. indet.	*			
COPEPODA				
Cyclopidae				
Cyclops agilis	*			
Cyclops prasinus	*			
Macrocyclops albidus	*			
Tropocyclops confinis	*			
Eucyclops eucanthus^{+}	*			
Eucyclops hadjebenis^{+}	*			
Paracyclops finitinius	*			

Table 3. Continued.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
Paracyclops poppei	*			
Mesocyclops sp.	*			
Microcyclops varicans	*			
Cyclopoidea spp.	*			*
OSTRACODA				
Ilyocyprididae				
Ilyocypris australiensis	*			
Cyprididae				
Herpetocypris chevreuzi[+]	*			
Cypridopsis gregaria	*			
Cypridopsis hirsuta	*			
Cypretta sp.	*			
Stenocypris olivicea	*			
Stenocypris sp.	*			
Limnothricidae				
Gomphocythere obtusa	*			
Gomphocythere sp.?	*			
Fam. Gen. spp. indet.	*		*	*
DECAPODA				
Potamonidae				
Potamonautes perlatus	*	*	*	
Atyidae				
Caridina nilotica			*	
Caridina sp.			*	*
COLLEMBOLA				
Poduridae				
Gen. sp. indet.				*

Table 3. Continued.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
Fam. Gen. spp. indet.	*			
ARACHNIDA				
ARANAEIDA				
Fam. Gen. spp. indet.	*	*	*	*
Tetragnathidae				
Tetragnatha sp.	*			
HYDRACARINA				
Fam. Gen. spp. indet.	*			
INSECTA				
EPHEMEROPTERA				
Baetidae				
Cloeon africanum	*	*		
Cloeon virgiliae	*			
Cloeon spp.	*		*	*
Cloeodes inzingae^{+}	*			
Pseudocloeon vinosum	*			
Pseudocloeon maculosum	*			
Pseudocloeon sp.?	*			
Potamocloeon sp. nov.	*			
Baetis harrisoni	*	*	*	
Baetis bellus	*			
Baetis glaucus	*			
Baetis latus	*	*		
Baetis quintus	*	*	*	
Baetis ?quintus	*		*	
Baetis cataractae^{+}	*			
Baetis parvulus	*			

Table 3. Continued.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
Baetis spp.	*	*	*	
Acentrella natalensis	*			
Acentrella monticola+	*			
Afroptilum sudafricanum	*		*	*
Afroptilum excisum	*	*	*	
Afroptilum indusii	*			
Afroptilum medium	*			
Afroptilum flavum	*			
Afroptilum falcatum	*			
Afroptilum parvum	*			
Afroptilum spp.	*			
Acanthiops varius	*			
Centroptiloides bifasciata	*			
Demoulinia crassi	*	*		
Gen. spp. indet.	*	*	*	
Caenidae				
Caenis ?edwardsi	*			
Caenis capensis	*	*	*	
Caenis (ex-*Caenodes*) sp.			*	*
Caenis spp.	*	*	*	*
Heptageniidae				
Afronurus harrisoni+	*			
Afronurus barnardi	*			
Afronurus peringueyi	*			
Afronurus sp.+	*			
Afronurus spp.	*			
Compsoneuria bequaerti	*			

Table 3. Continued.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
Leptophlebiidae				
Adenophlebia auriculata[+]	*			
Castanophlebia calida[+]	*			
Euthraulus elegans	*		*	
Tricorythidae				
Tricorythus discolor	*		*	
Tricorythus reticulatus	*	*		
Tricorythus spp.		*		
Polymitarcyidae				
Afroplocia sampsoni	*			
Ephoron savignyi	*			
Ephemeridae				
Ephemera mooiana	*			
Eatonica schoutedini	*		*	
Afromera natalensis	*			
Oligoneuriidae				
Elassoneuria trimeniana	*			
Oligoneuropsis lawrencei	*			
Prosopistomatidae				
Prosopistoma crassi	*			
PLECOPTERA				
Perlidae				
Neoperla spio	*			
ODONATA				
ZYGOPTERA				
Coenagrionidae				
Pseudagrion ?natalense	*			

Table 3. Continued.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
Pseudagrion acaciae	*			
Pseudagrion citricola	*			
Pseudagrion kersteni	*			
Pseudagrion salisburyense	*			
Pseudagrion spp.	*	*	*	*
Enallagma elongatum	*			
Gen. spp. indet.	*			*
Chlorolestidae				
Chlorolestes sp.	*	*		
Chlorocyphidae				
Platycypha caligata	*			
Chlorocypha spp.	*			
Platycnemididae				
Allocnemis sp.	*			
ANISOPTERA				
Gomphidae				
Mesogomphus sp.	*			
Paragomphus spp.	*	*	*	
Corduliidae				
Macromia sp.	*			
Syncordulia sp.?	*			
Libellulidae				
Zygonyx sp.	*			
Trithemis sp.	*			
Tetrathemis spp.	*	*	*	
Aeshnidae				
Aeshna subpupilata	*			

Table 3. Continued.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
Aeshna spp.	*	*	*	
Anax sp.?				*
Gen. sp. indet.			*	
Lestidae				
Lestes sp.			*	
HEMIPTERA				
Belostomatidae				
Diplonychus sp.	*			
Gen. spp. indet.		*		*
Gerridae				
Gen. spp. indet.	*	*		
Nepidae				
Ranatra spp.	*		*	
Veliidae				
Rhagovelia nigricans[+]	*			
Rhagovelia spp.	*	*		
Ocellovelia sp.	*			
Microvelia sp.?	*			
Gen. spp. indet.	*		*	
Mesoveliidae				
Mesovelia sp.[+]	*			
Mesovelia sp.	*			
Pleidae				
Plea pullula	*			
Plea picanina	*			
Plea sp.				*

Table 3. Continued.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
Naucoridae				
Laccocoris sp.	*			
Gen. spp. indet.	*	*		
Notonectidae				
Gen. spp. indet.	*	*	*	
Corixidae				
Micronecta piccanin	*			
Micronecta spp.	*	*	*	*
Sigara sp.	*			
Aphididae				
Gen. spp. indet.	*	*		
NEUROPTERA				
Sisyridae				
Sisyra sp.	*			
TRICHOPTERA				
Lepidostomatidae				
Goerodes sp.+	*			
Leptoceridae				
Oecetis spp.	*			
Athripsodes harrisoni	*			
Athripsodes prionii = Leptocerina sp.	*			
Athripsodes ps. group	*			
Athripsodes sp.				*
Parasetodes sp.	*			*
Leptocerina ?spinigera	*			
Hydropsychidae				
Cheumatopsyche afra	*	*	*	

Table 3. Continued.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
Cheumatopsyche thomasseti	*			
Cheumatopsyche sp.?		*		
Hydropsyche ulmeri	*			
Amphipsyche scotti	*			
Macrostemum capense	*			
Polycentropodidae				
Pseudoneureclipsis sp.			*	
Pisuliidae				
Dyschimus ensifer	*			
Dipseudopsidae				
Dipseudopsis spp.	*		*	*
Ecnomidae				
Ecnomus thomasseti	*			
Ecnomus spp.	*			
Philopotamidae				
Chimarra near *ambulans*+	*			
Hydroptilidae				
Hydroptila capensis	*			
Hydroptila ?cruciata	*	*		
Hydroptila spp.	*		*	
Oxyethira sp. nov.	*			
Oxyethira sp.			*	
Catoxyethira sp.+	*			
Catoxyethira sp.	*			
Orthotrichia ?barnardi	*			

Table 3. Continued.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
LEPIDOPTERA				
Pyralidae				
Nymphula sp.	*			
Petrophila sp.	*	*	*	*
Gen. sp. indet.			*	
COLEOPTERA				
Helodidae				
Scirtes sp.[+]	*			
Haliplidae				
Haliplus sp.	*			
Gen. sp. indet.	*			
Dytiscidae				
Guignotus harrisoni	*			
Hydroporus sp.	*			
Laccophilus lineatus	*			
Laccophilus sp.	*			
Gen. indet. sp.1 (adults)	*	*		
Gen. indet. sp.2 (adults)	*			
Gen. indet. sp.3 (adults)				*
Gen. indet. sp.4 (adults)				*
Gen. indet. sp.5 (adults)				*
Gen. indet. sp.6 (adults)				*
Gen. indet. sp.7 (adults)			*	*
Gen. indet. sp.8 (adults)			*	*
Gen. spp. indet. (larvae)		*		

Table 3. Continued.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
Gyrinidae				
Aulonogyrus alternatus	*			
Aulonogyrus sp.1		*		
Aulonogyrus sp.		*		
Aulonogyrus spp.	*	*	*	
Orectogyrus conformis	*			
Orectogyrus spp.	*	*		
Hydrophilidae				
Berosus sp.1	*			
Berosus sp.2	*			
Berosus sp.3	*			
Berosus spp.	*			*
Gen. indet. sp.1		*		
Gen. indet. sp.2		*		
Gen. sp. indet.	*			
Hydroscaphidae				
Gen. sp. indet.+	*			
Hydraenidae				
Hydraena sp.			*	
Limnebius sp.+	*			
Limnebius sp.1	*			
Limnebius sp.2	*			
Limnebius sp.3	*			
Gen. spp. indet.	*			*
Curculionidae				
Gen. sp. indet.	*			

Table 3. Continued.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
Dryopidae				
Helichus sp.			*	
Gen. sp. indet.	*			
Elmidae				
Potamodytes sp.	*			
Gen. indet. sp.1 (larvae)	*	*	*	
Gen. indet. sp.2 (larvae)	*			
Gen. indet. sp.3 (larvae)	*			
Gen. indet. sp.4 (larvae)	*			
Gen. indet. sp.5 (larvae)	*	*		
Gen. indet. sp.6 (larvae)	*		*	
Gen. indet. sp.7 (larvae)			*	
Gen. indet. sp.1a (adults)	*			
Gen. indet. sp.2a (adults)	*		*	
Gen. indet. sp.3a (adults)	*			
Gen. spp. indet.	*			
Gen. indet. sp.A^{+}	*			
Gen. indet. sp.B	*			
Gen. indet. sp.C	*			
Gen. indet. sp.D	*			
Gen. indet. sp.E	*			
Gen. indet. sp.F	*			
Gen. indet. sp.G	*			
Staphylinidae				
Gen. spp. indet.	*			
Psephenidae				
Gen. sp. indet.$^{+}$	*			

Table 3. Continued.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
Gen. sp. indet.	*			
Ptilodactylidae				
Gen. sp. indet.?		*		
Sphaeridiidae				
Megasternum sp.?		*		
DIPTERA				
Fam. Gen. spp. indet.			*	
Psychodidae				
Psychoda sp.	*			
Dixidae				
Dixa sp.+	*			
Dixa sp.		*		
Chaoboridae				
Gen. sp. indet.?		*		
Culicidae				
Aedes sp.	*			
Anopheles sp.	*			
Culex sp.+	*			
Culex spp.	*			
Gen. sp. indet.			*	
Simuliidae				
Simulium nigritarse	*		*	
Simulium bovis	*			
Simulium bequaerti		*		
Simulium damnosum s.l.	*	*		
Simulium unicornutum	*			
Simulium rotundum	*	*	*	

Table 3. Continued.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
Simulium medusaeforme	*	*	*	
Simulium vorax	*			
Simulium mcmahoni	*			
Simulium hargreavesi	*	*		
Simulium dentulosum+	*			
Simulium impukane	*	*		
Simulium rutherfoordi+	*			
Simulium adersi	*	*	*	
Simulium (Nevermannia) sp.			*	
Simulium spp.	*		*	
Chironomidae				
Gen. spp. indet. (pupae)	*	*	*	*
Tanypodinae				
Pentaneura appendiculatus+	*			
Pentaneura dusoleli	*			
Pentaneura nigromarmorata+	*			
Pentaneura tinctoria	*			
Pentaneura sp. nov.	*			
Pentaneura sp.	*			
Pentaneura sp.?		*		
Procladius brevipetiolatus+	*			
Procladius sp.	*			
Gen. spp. indet.	*	*	*	*
Orthocladiinae				
Corynoneura spp.	*	*		*
Cricotopus bizonatus	*			
Crictopus flavozonatus	*			

Table 3. Continued.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
Cricotopus obscurus	*			
Cricotopus harrisoni+	*			
Cricotopus sp. indet.	*			
Trichocladius micans	*			
Nanocladius brevitarsus	*			
Nanocladius ephippium+	*			
Nanocladius niveipluma	*			
Pseudorthocladius similis+	*			
Orthocladius bergensis	*			
Thienemanniella antennata	*			
Thienemanniella sp.?	*			
Limnophyes spinosa	*			
Gen. spp. indet.	*	*	*	*
Chironominae				
Gen. spp. indet.	*			
Chironomini				
Chironomus forcipatus	*			
Chironomus monilis	*			
Chironomus palistris	*			
Chironomus sp.		*		
Microtendipes taitae	*			
Polypedilum kibatiense+	*			
Polypedilum scotti+	*			
Polypedilum natalensis	*			
Polypedilum pruina	*			
Polypedilum tridens	*			
Stictochironomus festivus	*			

Table 3. Continued.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
Cryptochironomus coronatus+	*			
Gen. spp. indet.	*	*	*	*
Tanytarsini				
Cladotanytarsus sp.+	*			
Tanytarsus furcus+	*			
Tanytarsus nigricornis	*			
Tanytarsus sp. nov.	*			
Tanytarsus sp.	*			
Rheotanytarsus spp.	*	*		
Gen. spp. indet.		*	*	*
Ceratopogonidae				
Atrichopogon hirsutipennis	*			
Atrichopogon sp.?	*			
Bezzia spp.	*	*		
Ceratopogon sp. nov.+	*			
Forcipomyia spp.	*		*	
Gen. sp. indet.	*			
Empididae				
Wiedemannia sp.	*			
Gen. spp. indet.	*		*	*
Tabanidae				
Gen. spp. indet.	*		*	*
Tipulidae				
Antocha sp.	*			
Ptychoptera sp.	*			
Gen. indet. sp.1			*	
Gen. indet. sp.2			*	

Table 3. Continued.

TAXA	Mooi River	Mpof. River	Lions R.(W)	Lions R.(F)
Athericidae				
Atherix sp.+	*			
Dolichopodidae				
Gen. sp. indet.			*	
Ephydridae				
Gen. sp. indet.		*		
Muscidae				
Limnophora spp.	*	*		
Gen. sp. indet.	*			
Total number of taxa:	**311**	**71**	**81**	**41**