

https://dspace.org/

A Community of simulium species in the Vaal River near Warrenton

De Moor, Ferdinand Cornelis

2015-03-04
http://hdl.handle.net/10539/17113

Downloaded from a DSpace repository. https://dspace.org/

bed, has given rise to a large number of fast-flowing stretches of river interspersed with many stony rapids and slow-flowing pools. The flat country upstream of the weir has caused the waters of the Vaal River to be pushed back for almost 35 km creating a long narrow impoundment (Chutter, 1968).

Around Warrenton the surrounding country when not influenced by the irrigation scheme consists of central Kalahari thornveld and mixed *Tarchonanthus* - thornveld (Acocks, 1975). The grassland in its climax is dominated by *Themeda triandra* Forsk. but due to overgrazing this grass has been mostly replaced by less palatable 'white' grasses.

Climatically the region falls under the influence of the high pressure zone of the Southern Hemisphere and there is consequently considerable seasonal and daily variation in temperature. The average annual rainfall varies between 250 and 450 mm and is usually precipitated in thunderstorms, most of the rain falling in February and March. Frost can be expected from May to September and the average maximum temperatures range between 18 °C in winter and 33 °C in summer. Westerly to north-westerly winds prevail causing hot dry conditions for most of the summer months.

The low annual rainfall has restricted agricultural exploitation of the regions along the Vaal River mostly to cattle and sheep farming.

3. THE BENTHIC INVERTEBRATES OF THE VAAL RIVER IN THE WARRENTON AREA

3.1 INTRODUCTION

The fauna of South African rivers has been studied in considerable detail in the past. Harrison and Elsworth (1958) working on the Great Berg River in the Western Cape Province, showed that this river could be divided up into a number of zones from its source to the estuary. They ascribed faunal changes along these zones to variations in temperature, flow characteristics, turbidity, and silt loads. Seasonal variation within zones was affected by flow instability in winter caused by rainfall. Flooding in particular caused a decrease in numbers of most of the species encountered. Oliff (1960a) in his studies on the Tugela River found a succession of faunal communities along the course of this river. He also suggested that changes in the fauna along the various zones he described depended mostly on physical features such as changes in temperature, rate of flow, gradient of the river bed and altitude. Seasonal changes in faunal densities were also influenced strongly by rainfall, and floods during the wet season caused the numbers of animals to be reduced to about one twentieth of the dry season total. During the dry winter season nutrient levels and subsequently algal and diatom growth in the Tugela River increased. This also caused the highest densities of faunal organisms to be attained in the late winter to early spring period. Hynes (1972) reported that allochthonous material was the main supply of organic matter for most of the year although autochthonous primary production would also increase as fine particulate detritus would be broken down into nutrients which could be utilized by plants in addition to nutrients introduced by run-off waters.

Chutter carried out intensive studies of the Vaal River catchment area (Chutter, 1970a, 1971a & b), the Vaal River near Vereeniging (Chutter, 1963) and the lower Vaal River near Warrenton (Chutter, 1968). Chutter (1970a) attributed changes in the faunal groupings in the Vaal Dam catchment to alterations of the river bed and silt loads and found that temperature had no discernible effect. The abundance of autochthonous food matter was believed to be one of the main reasons for the high density of animals in the early dry summer. Harrison (1958) and Chutter

(1971a) also noted that pollution had a more pronounced effect on the stones-in-current fauna than on the fauna normally associated with marginal vegetation. Chutter concluded that marginal vegetation fauna was able to adapt to a wider range of ecological conditions than the stones-in-current fauna. Pollution severely affected the fauna of the Little Bushmans River (Oliff, 1960b) and the Jukskei River (Allanson, 1961) which are tributaries of the Tugela and Crocodile Rivers respectively. Mild organic pollution generally led to an increase in the density of faunal groups but excluded some of the less tolerant species from a community (Oliff, 1960b; Allanson, 1961; Chutter, 1963, 1971a).

Chutter (1963) in his studies on the Vaal River near Vereeniging analysed the seasonal occurrence of species on the basis of the percentage contribution a species made to the total number of animals collected in a sample. Baetid Ephemeroptera and simuliid larvae did not favour any particular season but *Pseudocloeon maculosum* Crass and *Choroterpes (Euthraulus) elegans* (Barnard) had distinct peaks of abundance in summer. The net spinning Hydropsychidae, *Cheumatopsyche thomasseti* (Ulmer) and *Amphipsyche scottae* Kimmins, appeared to decrease in numbers in the winter period and showed an increase in numbers again from September through to November in 1958. Peak densities of *C. thomasseti* apparently occurred when their food supply was at a maximum. In the Berg River (Harrison and Elsworth, 1958) and Vaal River (Chutter, 1963) peak densities of larval *C. thomasseti* occurred in summer, whereas in the Tugela River (Oliff, 1960a) and Jukskei River (Allanson, 1961) they occurred in winter. Wet season floods and increased silt were probably factors responsible for limiting the abundance of this species. In the Vaal River (Chutter, 1963) the construction of dams probably buffered the effect that floods would normally have nad on *C. thomasseti* and peak densities occurred in the wet summer period. Chutter concluded that depending on the ecological conditions of the larval habitat it appeared that peak densities of the imago of *C. thomasseti* could occur either in the spring or autumn.

Chutter (1968) found that the Vaal River below the Vaalhartz Diversion Weir was similar in its faunal composition to the unstable depositing zone he described for the Vaaldam catchment area (Chutter, 1970a) and was comparable to the rejuvenation zone of Oliff (1960a). The flow of the Vaal River in this lower region was higher in the dry early summer

than it would have been prior to the construction of dams. Weekly flow however fluctuated considerably due to increased flow over weekends when water was not diverted from the impoundment for irrigation purposes. These altered flow characteristics were apparently favourable for *Simulium chutteri* Lewis which was found to occur in great densities at semi-permanent biotopes where other *Simulium* species and hydropsychid Trichoptera occurred in lower numbers.

Chutter (1968) considered the seasonal occurrence and abundance of species, and differences in community structures at various sites along the Vaal River near Warrenton to be caused by fluctuations of the effects of different water discharges. At sites where the river was narrow the range of rising and declining water levels would be the greatest. The greatest density of *S. chutteri* was recorded at the sampling station where the river was at its narrowest (Chutter's 1968 Station 54a). At the sampling station where the river was at its widest (Chutter's Station 52) the other *Simulium* species reached their greatest densities and *C. thomasseti* and *A. scottae* reached their second highest densities. At station 56 further downstream, the greatest density of *C. thomasseti* and *A. scottae* was recorded. Although this site was intermediate in width between stations 52 and 54a, Chutter mentioned that it was probably sufficiently far downstream for factors other than water level fluctuations to have had an appreciable effect on the faunal community.

Since Chutter's (1968) studies the construction of Bloemhof Dam upstream of the Vaalhartz Weir in 1970 has considerably altered the pattern of flow variation. The flow of the Vaal River below the weir can now be kept steady both during weekends when no irrigation water is drawn, and also during the week when water is drawn from the impoundment. This is done by controlling the amount of water released at Bloemhof Dam to keep the level at the Vaalhartz Weir more or less constant irrespective of water demand.

As a background to a detailed study on the Simuliidae in the Vaal River on the farm Witrand, it was decided to carry out a seasonal survey along the river at various sites from the Vaalhartz Diversion Weir downstream to 'Witrand'. This study would allow for a comparison to be made with Chutter's (1968) work, and would indicate if any major changes in the faunal composition had occurred since his studies were completed.

GAcsir 62H4040*8208

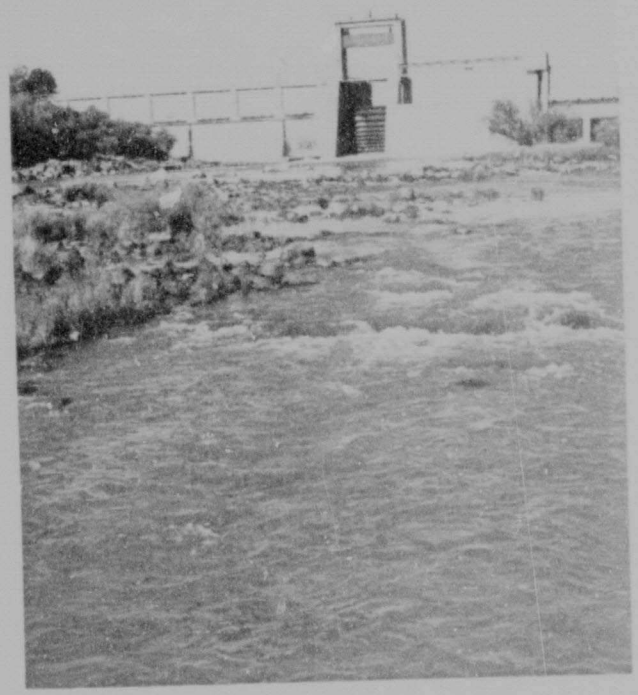


PLATE 1: The Vaal River below the Vaalhartz Diversion Weir showing the sluice gate nearest to the northern bank of the river. Samples were collected where the water is broken in the foreground. Note sedges and stones.

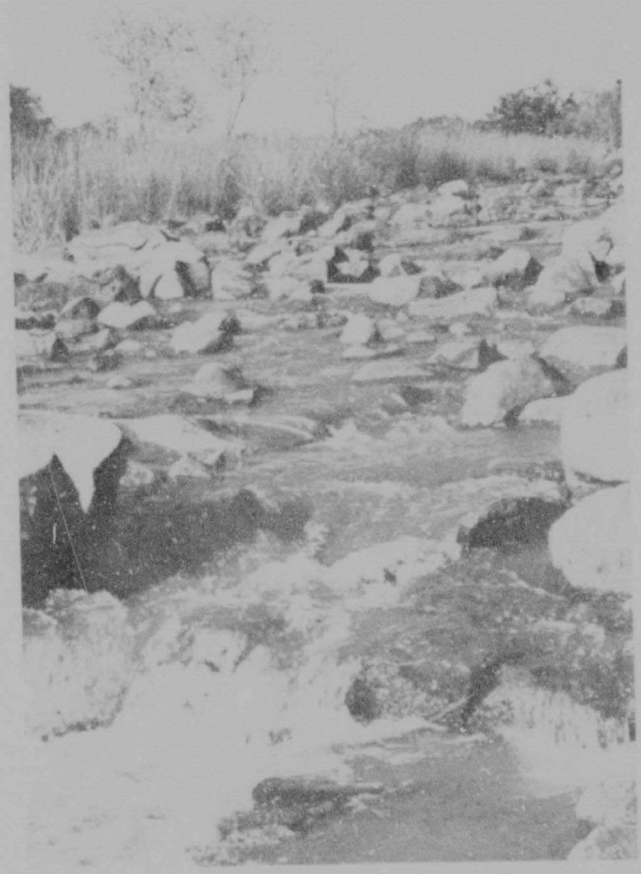


PLATE 2: The Vaal River on the farm Witrand. Benthic samples were collected in the region upstream of the small waterfall in the foreground.

3.2 MATERIALS AND METHODS

For the purposes of this survey four sampling sites were selected in the river (Fig. 1). They were: Below the 'Vaalhartz Weir' (Plate 1), at the 'Margaretha Prinsloo Bridge', a rapid on the farm 'Sydney's Hope' and a rapid on the farm 'Witrand' (Plate 2). Samples were collected to cover each season i.e. in May 1979, October 1979, February 1980 and July 1980. At each site and on each sampling occasion three stones from the fast flowing current were taken and fauna collected from these stones were combined into one sample. The samples were collected within one week of each other to exclude the possibility of variation due to seasonal changes. The samples were also collected over a year when no water flow manipulation programmes to control population levels of *S. chutteri* were carried out. Water discharge, velocity and temperature were recorded. The depths of stones below the water surface were measured and the surface areas of individual stones were estimated. A more detailed description of the sampling sites and methods used to obtain details on biological and physical data is given in Appendix 1 and Appendix 2.2.3 and 2.3.

3.3 RESULTS AND DISCUSSION

Water temperatures taken at approximately the same time of the day became progressively warmer from the Vaalhartz Weir downstream to 'Witrand' (Appendix 1, Tables 1.1 to 1.4). The range in temperatures encountered at the four sites was also more pronounced in the early summer period (October) than at other times of the year. Water current velocities where samples were taken, were similar at the four sampling stations in May when the flow was at its lowest (Appendix 1, Table 1.1). On the other occasions when the flow was greater the increase in current velocity would be similar for all four sites as the nature of the river bed was similar at the four sites where samples were collected, and maximum water velocities would therefore remain more or less of the same order.

A comparison of the general faunal abundance of species over the four seasons recorded in this study with those recorded by Chutter (1968) is

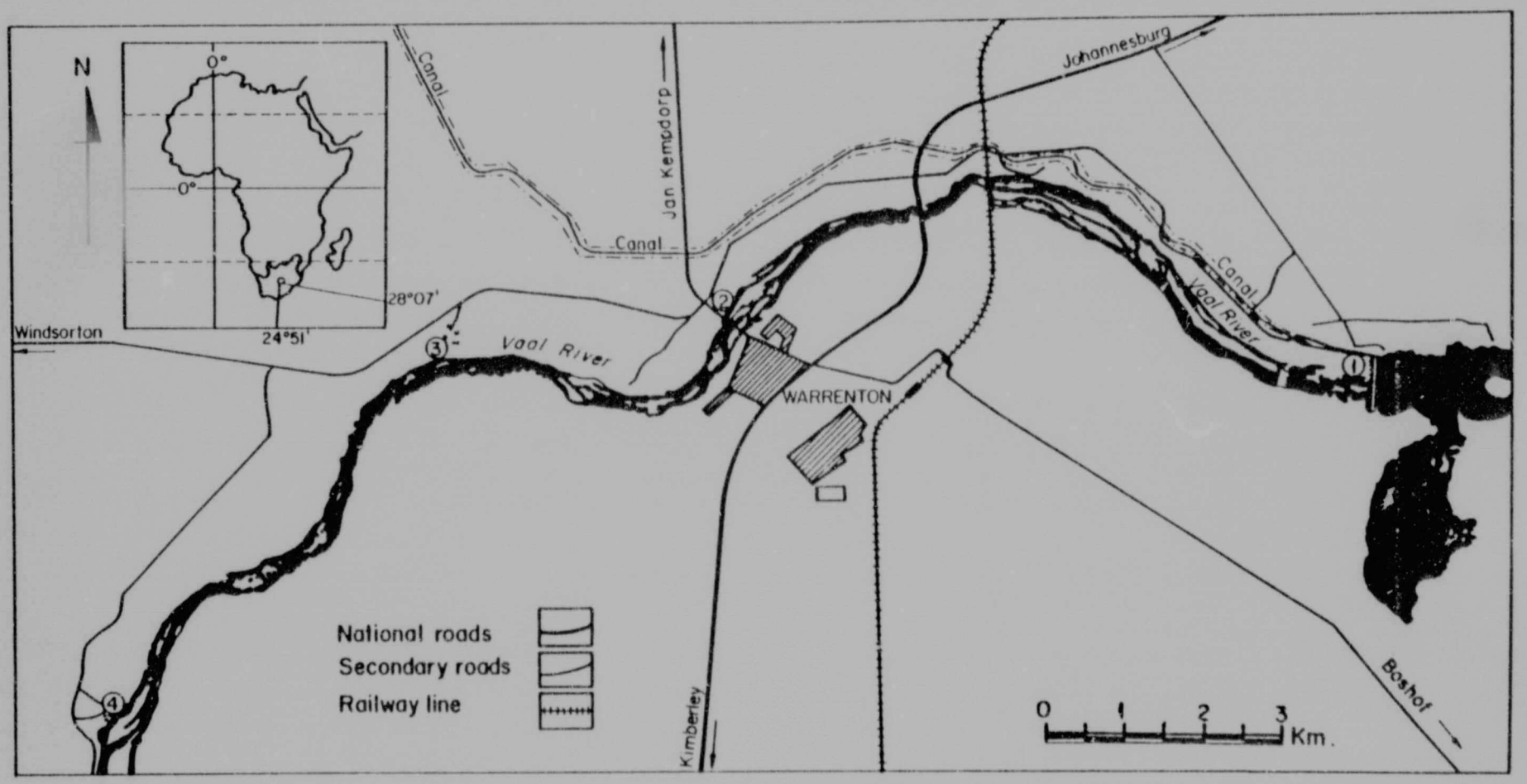


FIGURE 1: Sampling stations on the Vaal River (1) Vaalhartz Diversion Weir (2) Margaretha Prinsloo Bridge (3) Sydney's Hope (4) Witrand

summarized in Table 1. Abundance was determined by comparing the numbers of animals per 1 000 cm^2 stone surface area from the sampling points at the Margaretha Prinsloo Bridge and Witrand for each season and noting if the species recorded were more or less abundant during this survey than during Chutter's (1968) survey. If differences were small they were ignored.

TABLE 1: The faunal groups encountered in this survey compared with Chutter's (1968) survey

More abundant than in Chutter's study	Less abundant than in Chutter's study	The same as in Chutter's study
Planariidae	Oligochaeta	Porifera
Pseudocloeon maculosum Crass	*Salifa perspicax* Blanchard	*Choroterpes* sp.
baetid juveniles	*Baetis glaucus* Agnew	Sisyridae larvae
Amphipsyche scottae Kimmins	*Centroptilum* sp.	*Cheumatopsyche thomasseti* (Ulmer)
hydropsychid juveniles		
Aulonogyrus sp. larvae	*Tricorythus* sp.	*Orthotrichia* sp.
Chironomidae		
Simulium chutteri Lewis	*Catoxyethira* sp.	*Simulium nomahoni* de Meillon
Simulium adersi Pomeroy	Elmidae larvae and adults	
Simulium damnosum sensu lato Theobald		
Simulium hargreavesi Gibbins		

In Table 1 only the animals found to occur on more than one sampling occasion or at more than one sampling site were compared. Only *Macronema capense* Walker, *Hydroptila* sp., *Caenodes* sp. and Hydrachnellae found by Chutter were not encountered in this survey. The only species encountered in this study but not in Chutter's study was *Simulium hargreavesi* Gibbins.

Oligochaeta and Chironomidae were not further broken down into groups or species for this study and Crustacea were also not included.

The *Tricorythus* sp. described as *Neurocaenis* sp. in Chutter's (1968) paper, was present during all seasons except July during this survey. Chutter (1968) also noted the absence of this species in August and it could be that it was present in the adult form in the late winter period. The occurrence of sponge and Sisyridae larvae in late winter also seemed to be seasonal.

The seasonal occurrence and succession of species from the Vaalhartz Weir donwstream to Witrand is given in Figure 2. The various faunal groups or species are presented as a percentage of the total on each date at each site. This does not indicate the abundance of species but does indicate the dominant groups found in each season. For further details see Appendix 1, Tables 1.1 to 1.4.

The dominant faunal group at the four sampling stations, when samples were collected, was the Simuliidae. The only exception occurred at the Vaalhartz Weir in July 1980 when Chironomidae became the dominant taxon. There were four *Simulium* spp. that were numerous enough to be considered as important and their abundance varied according to sampling point and season.

Simulium chutteri was the dominant species during all four sampling occasions at Sydney's Hope and Witrand but was noticably scarce below the Vaalhartz Weir where it was never the dominant simuliid. It also only became the dominant species at the sampling station near the Margaretha Prinsloo Bridge in October, which was also the time of the year when it attained its greatest abundance at all the sampling stations (Appendix 1, Tables 1.1 to 1.4).

Simulium adersi Pomeroy was the dominant species below the Vaalhartz Weir in May and shared dominance with *S. nomahoni* de Meillon and *S. damnosum* sensu lato Theobald at that site in October. *Simulium adersi* also reached a measure of shared dominance at the Margaretha Prinsloo Bridge in May. The greatest abundance of *S. adersi* was also in May and July (Appendix 1, Tables 1.1 to 1.4). This species was more abundant during this survey than it was during Chutter's (1968) study. Although *S. adersi* reached a large population density at Witrand in July 1980 (Appendix 1, Table 1.4) it only represented a small percentage of the total faunal numbers (Fig. 2).

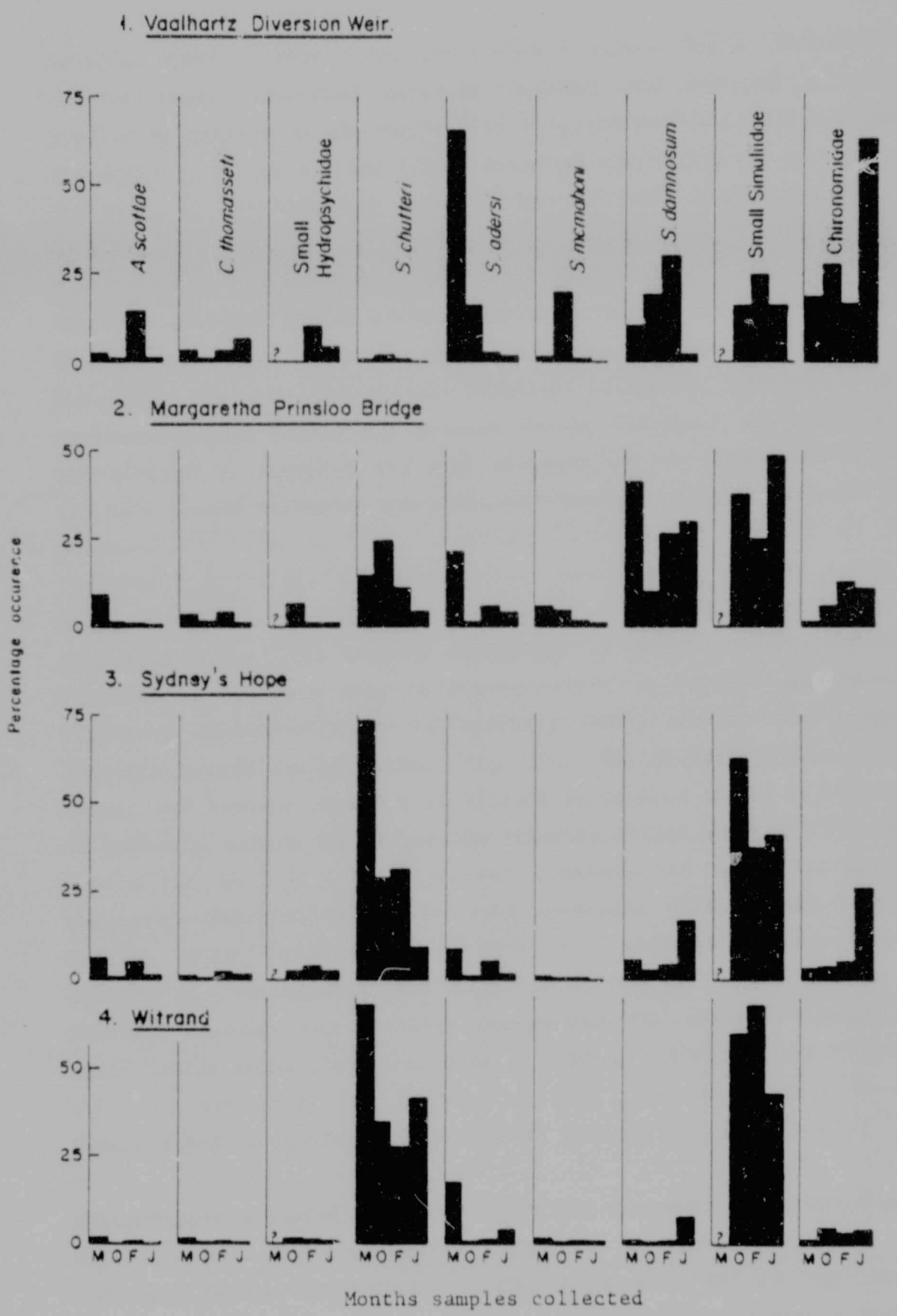


FIGURE 2: The composition of the stones-in-current benthic fauna at the four sampling stations on the four sampling occasions (May 1979, October 1979, February 1980, July 1980). Only dominant taxa are shown and counts are expressed as percentages of the total number of individuals in each sample

Simulium nomahoni shared dominance with *S. adersi* and *S. damnosum* below the Vaalhartz Diversion Weir in October and reached a moderate population density at th rgaretha Prinsloo Bridge in May and October (Appendix 1, Tables 1.1 and 1.2). *Simulium nomahoni* occurred throughout the year at all sampling stations but was most abundant in May and October.

Simulium damnosum shared dominance with *S. adersi* and *S. nomahoni* below the Vaalhartz Weir in October and became the dominant simuliid there in February. At the Margaretha Prinsloo Bridge *S. damnosum* was the dominant species during all seasons except October. At Sydney's Hope and Witrand *S. damnosum* was most abundant in July (Appendix 1, Tables 1.1 to 1.4) and it became the dominant simuliid at Sydney's Hope in that month.

Small simuliid larvae although collected were not enumerated in May 1979 (Appendix 1.2). The highest percentage of small simuliid larvae was recorded at Sydney's Hope in October 1979, at Witrand and below the Vaalhartz Diversion Weir in February 1980, and at the Margaretha Prinsloo Bridge in July 1980 (Fig. 2). The highest number of small larvae was however recorded at Witrand in October at the Vaalhartz Weir in February, and at the Margaretha Prinsloo Bridge in July (Appendix 1, Tables 1.1 to 1.4). The greatest abundance of small larvae at the Margaretha Prinsloo Bridge in July coincided with a peak population density of *S. damnosum* and it can be reasonably assumed that that species was responsible for peak abundances of small larvae then. *Simulium chutteri* was probably responsible for observed abundances of small larvae at most sites in October. Both *S. chutteri* and *S. damnosum* s.l. may have been responsible for high numbers of small larvae at Sydney's Hope and Witrand in July 1980 (Appendix 1, Table 1.4).

Chironomidae appeared abundant throughout the year below the Vaalhartz Diversion Weir and reached their greatest density (Appendix 1, Table 1.4) and became the dominant faunal group at this site in late July (Fig. 2). At the Margaretha Prinsloo Bridge and at Sydney's Hope they were recorded in low numbers in October and February and also reached their greatest densities in July (Appendix 1, Table 1.4). At Witrand the highest density of Chironomidae occurred in October (Appendix 1, Table 1.2) but the representation of this group was below 10 per cent on all four occasions (Fig. 1).

Amphipsyche scottae was moderately abundant at most sites in May but reached its greatest density below the Vaalhartz Weir and at Sydney's Hope in February. It occurred in very low numbers in October and July. *Thaumatopsyche thomasseti* occurred in moderate densities at all sites in May, decreased in October and appeared in larger numbers again in February. It reached a peak population density at all the sampling sites in July. Hydropschid juveniles reached their greatest densities at all the sites except the Vaalhartz Weir in October. At the Vaalhartz Weir a peak in small hydropschid larvae was seen in February and a fairly large number was found in July.

It appeared that both species of Hydropsychidae would have had a spring and late summer emergence of adults at the Vaalhartz Weir whereas at the other sites *A. scottae* had an emergence of adults in late autumn, and *C. thomasseti* an emergence of adults in spring.

The greatest densities of *A. scottae* and *C. thomasseti* were found below the Vaalhartz Weir. This is in agreement with Chutter (1963) in that this site is immediately below an impoundment and provides an abundance of planktonic material for these filter feeding Hydropsychidae. Even though no flow manipulation programmes were carried out, between May 1979 and July 1980, minor flow variations did occur during this period (see Ch. 4, Fig. 8). The site below the Vaalhartz Weir was in an area where the greatest fluctuations in water levels occurred during the alteration of river flow rates from the sluice gates. It therefore follows that this observation contradicts Chutter's (1968) finding which was that large water level fluctuations caused a reduction in the numbers of Hydropsychidae.

The low abundance of *S. chutteri* below the Vaalhartz Diversion Weir, during all four seasons when samples were collected, and the relatively high abundance of the other three *Simulium* species made it apparent that the habitat requirements of *S. chutteri* must in some ways differ markedly from those of the other species encountered.

It appeared that lower weekly fluctuations of water discharge (Ch. 4, Fig. 8) led to an increase in the numbers of *S. adersi* and *S. damnosum*. This was in agreement with Chutter's (1968) prediction that these

species are less mobile and would be more suited to a habitat where flow rates fluctuated little. The increase of *S. chutteri* at most sites in October cannot yet be explained.

In Chutter's (1968) study dense growths of benthic algae and diatoms were found during periods of low flow and low turbidity. In the present study phytobenthic growths, though not quantified, were noted to be higher in the winter and spring of 1979 than at any other time. Possible reasons for this could have been the low flow of the river during that period or else the faunal density which was notably lower then than at corresponding times in 1978 or 1980 (Ch. 4). This low faunal density in the winter of 1979 was undoubtedly strongly influenced by an extended water flow manipulation programme carried out in 1978 and 1979 (Ch. 4). It would thus appear that a lower faunal density led to increased phytobenthic growth. The opposite effect of an increased phytobenthos preventing colonization of substrates by Simuliidae seemed unlikely as a dense population of *S. damnosum* was found colonizing stones-in-current covered with filamentous algae immediately downstream of the Vaalhartz Diversion Weir in February 1980 (Fig. 2 and Appendix 1, Table 1.3).

Besides the greater abundance of Simuliidae during this survey, it can generally be concluded that no major faunal change had taken place in the Vaal River below the Vaalhartz Weir since Chutter carried out his survey in 1964 (Chutter, 1968). Further conclusions regarding the variation in the faunal communities along the river, or the seasonal occurrence of certain groups cannot be made at present. A more detailed survey of the community structures and population levels of Simuliidae at a selected sampling site is presented in subsequent chapters. The implications of this more detailed study for understanding the downstream and seasonal variation in the simuliid fauna will be considered after presentation of the results.

4. FLUCTUATIONS IN THE DENSITY OF SIMULIIDAE AND OTHER BENTHIC FAUNA AT THE FARM 'WITRAND'

4.1 INTRODUCTION

From the survey reported on in the previous chapter it was obvious that Simuliidae, and in particular *Simulium chutteri*, dominated the invertebrate fauna in this lower stretch of the Vaal River. Population studies in this thesis were directed towards the Simuliidae and were aimed at determining the reasons for their abundance in this section of the Vaal River.

A sampling site to study fluctuations in population levels and the community structure of Simuliidae should have an abundant flow of water throughout the year, be easily accessible and preferably situated near a road to facilitate easy transport of apparatus to and from the river. The site should also contain natural removable substrata in order to estimate population densities. Chutter (1968) found stones in the current to be the main sites of *Simulium* spp. larval and pupal attachment and this was obviously the habitat most suited for colonization by Simuliidae in this part of the Vaal River.

Current velocity is a major factor influencing the distribution of larval blackflies (Wu, 1931; Ambühl, 1959; Phillipson, 1956; Carlsson, 1967; Hynes, 1972) and a rapid on the farm Witrand, with suitable substrates and water flow conditions was selected as the site for more detailed studies on the population levels and community structure of Simuliidae in the Vaal River.

From life cycle studies (Ch. 6) it was decided that samples taken at weekly intervals would indicate any changes or trends in population levels before they had developed too far. Several problems however arose with repetitive samples being taken at short intervals. Removal of a number of natural substrates (stones-in-current) at regular intervals might deplete the population of Simuliidae and other benthos and introduce another unnatural mortality factor (Price, 1975). The analysis of stones-in-current samples is also a long and tedious exercise as samples are often large. Chutter (1968) found that there

was no correlation between the number of Simuliidae and stone surface area. It would thus be unrealistic to calculate population densities of Simuliidae only from stone surface area as there are other factors, like suitability of regions in the river, obviously more important than surface area in determining density of larvae and pupae on substrates. There are also problems associated with re-sampling a stone which has been recently sampled and has not had enough time to allow for a natural recolonization to have occurred.

Hynes (1972) stressed the difficulty of getting valid quantitative data on population densities of benthic fauna from running waters. Chutter (1972a) in discussing the reliability of the Surber square foot sampler found that even for an estimate of population density in a stony run within 20 per cent of the mean at the 95 per cent level of confidence, depending on the depth of the water, from eighteen to thirty-two replicate samples were necessary. If the potential sampling area was restricted to regions where similar physical conditions prevailed then variability would be considerably reduced and Chutter and Noble (1966) found that three samples from a stony run, using a Surber sampler, usually gave statistically comparable results. Chutter (1968) could not use a Surber sampler in the lower regions of the Vaal River to collect samples because the stones in the river were too large. Simuliidae also tend to cling to stones and so other methods such as 'kicking' and sampling for a standard period of time (Hynes, 1961; Mauch, 1963) were also not suitable. The use of artificial substrates would have required sampling at frequent intervals which was not feasible during Chutter's (1968) study. Chutter (1968) initially collected the fauna from twenty stones at each sampling site on each occasion but later reduced the number of stones from which fauna was analysed in the laboratory to five. Data obtained from samples using this method, indicated that progressive changes in population density at different sites in the river, were statistically comparable.

Because of the above-mentioned problems, it was decided to use standardized artificial substrate units to monitor simuliid population levels at weekly intervals. Monthly stones-in-current samples were however still collected to test the correlation between simuliid population levels on

artificial substrates and stones as well as to monitor the other benthos which do not so readily occupy artificial substrates as Simuliidae. The stones-in-current samples were also collected over a longer span of time and would allow any repetition of annual cycles to become apparent. Disney (1972a) explained that in selecting the type of substrate to be used for population studies on Simuliidae, consideration must be given to any preferences that the species being studied may show for a variety of substrates available. *Simulium chutteri*, the most abundant species, appeared to occur predominantly on stones-in-current during the periods of lower flow and at first this appeared to be their ideal habitat. It was however discovered that, during periods of increased flow in summer when the river extended into areas where sedges and reeds were growing, the density of pre-imaginal Simuliidae on this newly available trailing vegetation was even higher than that on stones-in-current in the same area. This would indicate that trailing vegetation is also a suitable natural habitat for colonization by *S. chutteri* (see Ch. 7).

Standardized artificial substrate units have been utilized by various workers to estimate population levels of pre-imaginal Simuliidae. Among devices used were nets, wooden floats and sealed tins (Wanson and Henrard, 1945), white tiles (Zahar, 1951), plastic cones (Phillipson, 1956; Johnson and Pengelly, 1966), white plates and metal cones (Wolfe and Peterson, 1958, 1959), wooden boards (Carlsson, 1962) polythene tapes (Williams and Obeng, 1962; Doby *et al.*, 1967; Pegel and Rühm, 1976) strips of white painted hardboard (Curtis, 1968), lengths of fabric (Tarshis, 1968) palm fronds, bamboo strips and mango leaves (Disney, 1970, 1972a, 1975) and bricks (Kovalak, 1978).

Wolfe and Peterson (1958) noted that simuliid larvae preferred white substrata to black and that their artificial substrates always had denser populations than the surrounding natural substrata, which consisted of stones and trailing vegetation. Pegel and Rühm (1976) also noted that smaller and narrower polythene tapes had a greater density of larvae and pupae per unit surface area than larger broader artificial substrates. Rabeni and Minshall (1977) found that current velocities around larger stones varied more than those around smaller ones and that smaller stones also had higher densities of larval Simuliidae per unit of surface area. The wider range of current velocities around larger

substrata may hence have accounted for a greater diversity of conditions and led to lower overall concentrations of Simuliidae. Artificial substrates also may not be as rapidly colonized by potential predator and competitor species of Simuliidae as the Simuliidae themselves and this may also have led to a greater concentration of Simuliidae on artificial substrates than on their natural substrata. Lewis and Bennett (1974) suggested that artificial substrates should be as attractive as natural substrates to the animals being studied and should be easily retrievable, of uniform dimensions, hold a stable position under conditions of spate and low water flow, be usable in a variety of stream depth conditions, particularly in shallow waters, and be as unobtrusive as possible within the natural environment to reduce the possibility of vandalism. For their studies they used ceramic tiles and gave several reasons for not using polythene tapes as artificial substrates. Among these were that they were easily washed away in spates, they got entangled in natural stream substrates or vegetation, and they were easily twisted and folded through stream current action. Zahar (1951) found that white ceramic tiles became fouled up with silt and algae, when exposed in the current for periods of a month or more and were then unsuitable substrates for *Simulium* attachment.

For a detailed and intensive study of population changes in Simuliidae, polythene tapes as artificial substrates appeared to be the only practical means of monitoring a stretch of rapid repetitively at short intervals. Placing and collection of ceramic tiles or other types of artificial substrate would have caused too great a disturbance in the rapid and it was found that by attaching the polythene tapes to metal rods most of the problems encountered by Lewis and Bennett (1974) above did not arise.

A number of workers have carried out studies of organisms drifting downstream in rivers to estimate population densities. Elliott (1965) showed that the percentage of invertebrates found in the drift in a column of water in relation to that on stones occupying a surface area equal to that of the column, was low and represented less than 0,5 per cent of the total population. If it was however taken into account that the water was flowing and this was taken over a twenty-four hour period Pearson and Franklin (1968) showed that Simuliidae in the drift would be



PLATE 3: The study rapid on the Vaal River at Witrand. Note the broken flow and the small waterfall divided by a large boulder.

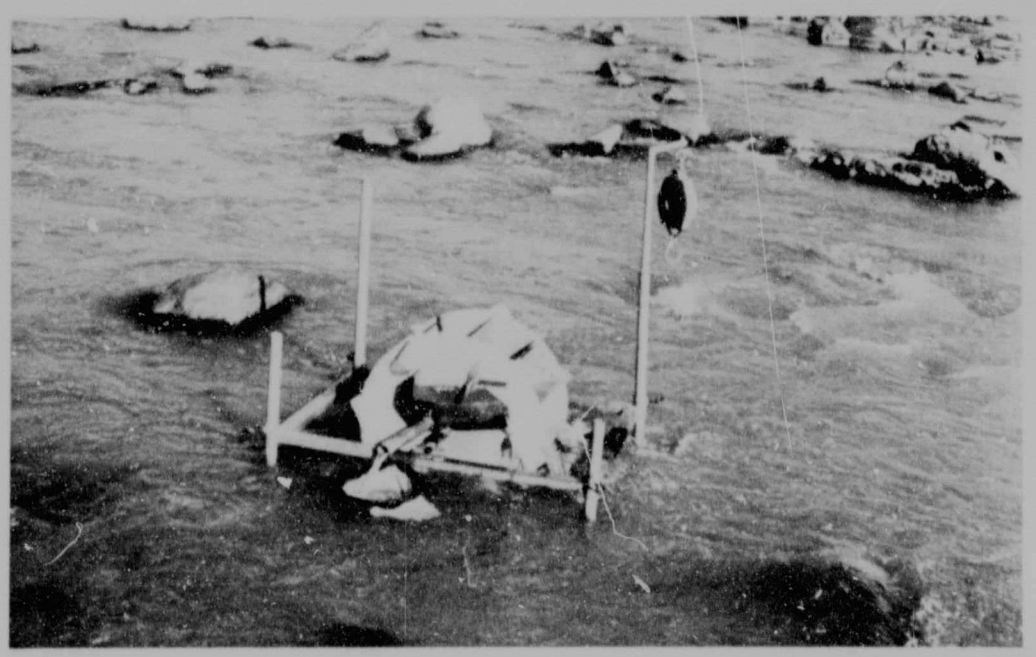


PLATE 4: The paddle-wheel sampler collecting drifting organisms from the Vaal River *ca.* 35 m upstream of the top end of the study rapid. Note star shaped revolution counter, net, and scale used to calibrate sampler.

GAcsr 62H4040/8208

thirty five times more numerous than on stones. Waters (1972) found that drift of organisms acted to keep the standing crop of benthic animals near to its carrying capacity. It also allowed for the widest possible utilization of suitable available areas. Drift also dispersed growing larvae which required more space than smaller larvae, and had slightly different ecological requirements to larger larvae and pupae.

Drift could also indicate an excess of production causing organisms to exceed the carrying capacity of the stream and hence enter the drift in larger numbers. If this theory is extrapolated drift could be used to measure production levels of streams (Pearson, 1970). Waters (1972) found that in streams where population levels of fauna were decimated by insecticides significant levels of drift occurred only once the standing crop of benthos was large again. Elliott (1967, 1968) noted that drift was greatest in organisms at the stage in which their population levels were growing rapidly. Minshall and Winger (1968) found that a decrease in depth of the water caused an increase of individuals per unit of surface area and that this overcrowding also caused drift. The presence of stone flies (Plecoptera) also led to an increase in the drift of Simuliidae (Kureck, 1969). Carlsson (1968) reported remarkable peaks in drift at dawn and dusk. He also found that the relatively lower number of drifting organisms in African watercourses, when compared with European rivers, was probably due to the existence of fewer large lakes. Simuliid larvae form a significant proportion of the organic drift in rivers and this is undoubtedly one of their major dispersion and colonization activities (Rühm, 1970; Ladle, Bass and Jenkins, 1972; Waters, 1972; Hall and Edwards, 1978).

4.2 MATERIALS AND METHODS

A rapid in the Vaal River on the farm Witrand (Ch. 3, Fig. 1; Appendix 2.1, Fig. 2.1; Plates 2,3 and 9) was selected as the site where regular sampling of Simuliidae and associated fauna was carried out. The suitability of this rapid for colonization by Simuliidae is discussed in greater detail in Appendix 2.1. To determine the frequency of sampling, the type, suitability and number of standardised artificial substrates required to obtain statistically comparable estimates of population levels of Simuliidae, a number of tests were carried out (Appendix

2.2.1 a to e). From these experiments and also from studies on the duration of the aquatic stages of *S. chutteri* (Ch. 6) it was determined that artificial substrates had to be left exposed in the river for three weeks to allow for representative colonization to occur before retrieval. The collection and replacement of artificial substrates is described in detail in Appendix 2.2.2.

The numerical distribution of Simuliidae on artificial substrates was statistically determined to be contagious. The natural $\log_e$ transformation adequately transformed the data to approach a normal distribution (Appendix 2.2.1 d) and average counts of simuliid numbers per artificial substrate unit are expressed as the Sichel mean (Appendix 2.2.1 d).

Owing to the limited size of the study rapid, the frequency of sampling carried out, and the amount of work involved in analysing data, the fauna from a sample of only five stones from the stones-in-current habitat was collected at monthly intervals. The technique carried out in collecting fauna from stone samples is described in Appendix 2.2.3. Because of the small number of replicate stone samples it was not possible to determine the underlying statistical distribution of Simuliidae per unit of stone surface area. However a close relationship between the population fluctuations of larval Simuliidae on artificial substrates and stones-in-current occurred throughout 1979 (Appendix 2.2.1 e, Fig. 2.2), it was therefore assumed that the distribution of Simuliidae on natural stones also fitted a negative binomial (contagious) distribution and that the natural $\log_e$ transformation used for artificial substrates also normalized the simuliid counts on stones.

To determine if regular removal and replacement of stones after collection of the fauna had a deleterious effect on the general community in a stones-in-current habitat, a comparison of fauna collected from the stones in the study rapid was made with the fauna from an adjacent undisturbed rapid. This study not only indicated that continuous monthly sampling had very little effect on the community structure and density of organisms in a stones-in-current habitat, but that the weekly placing of artificial substrates in a rapid also did not lead to any drastic changes of simuliid population levels on the stones (see Appendix 2.2.4 for details).

To ascertain the role which organisms drifting onto the rapid might play in recruitment of faunal populations within the rapid, samples of water were collected with a paddle wheel sampler (Chutter, 1975; Plate 4). A site 35 metres upstream of the tree in Appendix 2.2.1, Figure 2.1 was selected for regular collection of faunal drift in the river. The collection procedure and an evaluation of this are discussed in Appendix 2.2.5.

The time most suitable for regular collection of drift samples was determined as the late afternoon 15h00 to 17h00 (Appendix 2.2.6). Daily drift samples over sixteen days at a time when population levels were high, showed that no systematic change in drift abundance which would be masked by weekly sampling occurred (Appendix 2.2.7). Minor fluctuations in drift rates were probably due to daily climatic fluctuations in wind and relative humidity affecting adult ovipositing activity.

To summarize, three approaches to estimate faunal population fluctuations were undertaken:

a) At weekly intervals over a period of one year estimates of simuliid population densities in a rapid were obtained from artificial substrates (polythene tapes) (Plates 5 and 6). During this period no water flow management programmes to control population levels of Simuliidae were carried out.

b) Over a period of thirty three months all the fauna from a monthly sample of five stones from the stones-in-current habitat were collected and enumerated.

c) At weekly intervals when artificial substrates were collected and at less frequent intervals at other times, quantitative samples of the fauna drifting in the river upstream of the study rapid were taken with a paddle wheel sampler (Plate 4).

A description of the analysis of faunal samples collected from the stones, artificial substrates and drift is given in Appendix 2.3. There were some problems encountered in the sub-sampling techniques devised and a discussion of these and a statistical evaluation of the accuracy of sub-sampling methods is presented in Appendix 2.4.

Author De Moor F C
Name of thesis A Community of simulium species in the Vaal River near Warrenton 1982

PUBLISHER:
University of the Witwatersrand, Johannesburg
©2013

LEGAL NOTICES:

Copyright Notice: All materials on the University of the Witwatersrand, Johannesburg Library website are protected by South African copyright law and may not be distributed, transmitted, displayed, or otherwise published in any format, without the prior written permission of the copyright owner.

Disclaimer and Terms of Use: Provided that you maintain all copyright and other notices contained therein, you may download material (one machine readable copy and one print copy per page) for your personal and/or educational non-commercial use only.

The University of the Witwatersrand, Johannesburg, is not responsible for any errors or omissions and excludes any and all liability for any errors in or omissions from the information on the Library website.