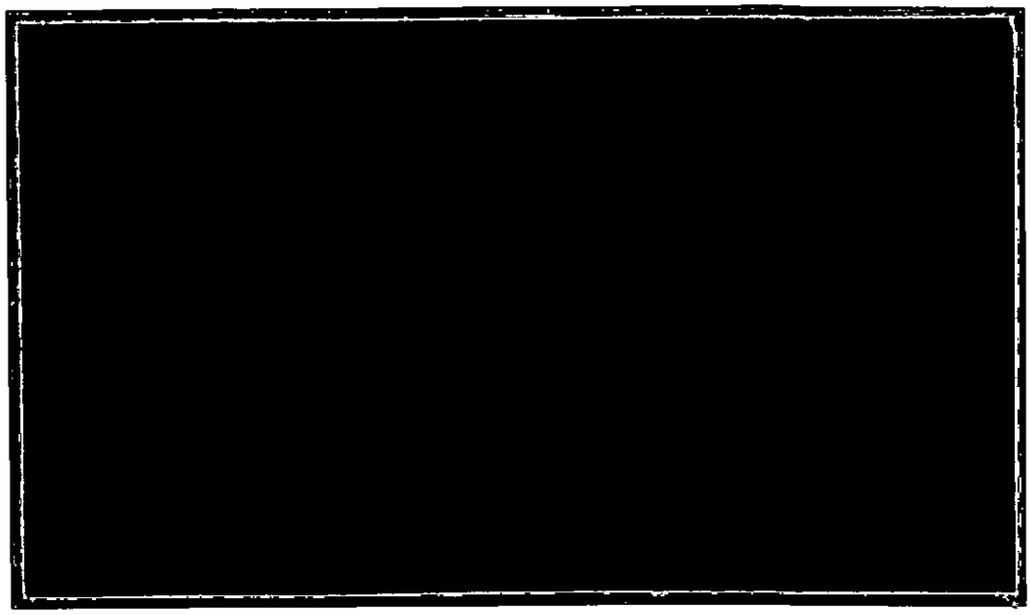
Institute of Freshwater Ecology



Natural Environment Research Council

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Proposed measures for control of *Simulium posticatum* 1990

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1. INTRODUCTION

1.1 Background

The "Blandford fly" problem has been under surveillance by local authorities since the latter part of the 1960s. Research by IFE scientists has shown that the problem is caused by the females of *Simulium posticatum* (formerly *Simulium austeni*) which often bite humans to obtain a blood meal. The larvae of these flies are aquatic and live in the River Stour. At present, about 40 kilometres of river are affected. Although other species of *Simulium* occur in the River Stour there are usually several weeks, in March, April and May, when the larvae of the "Blandford fly" are virtually the only ones present.

The life history of the fly has also been researched and it is known that the eggs are laid in June-July, above the water in specific areas of vertical, loamy river bank, shaded by trees and frequently dissected by desiccation cracks. This is a unique egg laying strategy for this group of insects. The eggs undergo a series of environmentally triggered changes, including a resting stage or diapause, before hatching in late winter or early spring.

Upon hatching, the larvae of the "Blandford fly" drift downstream and attach, by a combination of silk threads and abdominal hooks, to water plants in the more swiftly flowing reaches of the river. They feed by filtering suspended solids out of the river water. By comparison with other Simuliidae the larvae of the "Blandford fly" are slow feeders and may take one or two hours to completely exchange their gut content.

Larvae pupate on the water plants between late April and June, emerging as adults after a few days. The pupae are sedentary and do not feed. After emergence the male flies (which do not bite) form swarms near trees, houses and other convenient visual "markers". The female flies have their blood meal, mate and ultimately return to the river to lay their eggs.

1.2 Potential control measures

In theory the "Blandford fly" could be controlled at any stage in its life cycle. Many potential control measures have been considered.

The eggs are possibly the stage which is most susceptible to control being immobile, concentrated in well-defined locations and present *in situ* for about eight months. The disadvantage of attacking this stage is that it is the most numerous phase of the insect's life. There is no known means of control for the egg stages of *Simulium*. In the present case physical removal has been tested by IFE but it would be extremely labour intensive and the length of river bank to be treated is very large.

Adult flies are widely dispersed and, although they are vulnerable to sprayed insecticides, it is improbable that any form of chemical control could be applied at this stage because of the dangers to human beings and to the environment.

The aquatic stages, being confined within the river, are susceptible to some specialised forms of control. In the past weed cutting has been used as a means of removing pre-emergent larvae and thus reducing the numbers of emerging adults. However, this method is very expensive and the removal of large quantities of aquatic plant material and the associated fauna is extremely damaging to the environment. Most chemical controls are illegal in this country and, in general, the addition to river waters of materials damaging to fish and/or fish food organisms is forbidden.

The material Bti is a biologically produced insecticide which is very specific in its action. Essentially it consists of a crystalline protein which, when swallowed by certain insects, is activated by conditions in the gut to become a lethal toxin. The larvae of Simuliidae, including those of the "Blandford fly" are known to be susceptible to Bti. A formulation of Bti produced by the Sandoz Company and trade named "TEKNAR HP-D" was used in a small scale trial in 1989.

1.3 Trial control in 1989

The conclusions of this trial were:-

(1) "TEKNAR HP-D" is an effective larvicide when used against the larvae of *Simulium posticatum* (the "Blandford fly") under the conditions prevailing in the River Stour, with more than 90% reduction in numbers following the two applications.

(2) The efficacy of "TEKNAR HP-D" varies with river conditions and it is much more effecive in low discharge and clear water than in high discharge and turbid water.

(3) Assay using mosquito larvae, indicated that the sample of "TEKNAR HP-D" used in the present trial had a slightly lower toxicity than was expected on the basis of a standard internationally recognised Bti preparation.

(4) Water samples taken from the carrier stream during application of "TEKNAR HP-D" were assayed and had only very low levels of Bti activity.

(5) Sediment samples taken from the carrier stream following application of "TEKNAR HP-D" showed no Bti activity at any time.

(6) From (4) and (5) above it is concluded that the toxic properties of "TEKNAR HP-D" are rapidly lost in association with River Stour water and sediments.

(7) Samples of drifting invertebrates from the stream often contained both living and dead *Simulium posticatum* larvae even when no "TEKNAR HP-D" had been applied.

(8) The numbers of living *Simulium posticatum* larvae drifting increased sharply following application of "TEKNAR HP-D" but only at the sampling point 10 m downstream of the application point.

(9) The proportions of dead *Simulium posticatum* larvae in drift samples increased after applications of "TEKNAR HP-D". The increase was most evident at sampling points 100 m and 200 m downstream of the application point following the second application. With regard to this it should be noted that drifting larvae (whether living or dead) are derived from the treated population upstream of the sampling point and, in consequence, more are available are 100 m and 200 m than at 10 m.

(10) There was no increase in drifting activity of any group other than *Simulium posticatum* following treatment with "TEKNAR HP-D".

(11) With the exception of *S. posticatum* there was no change in the proportion of dead to live organisms of any group (including chironomid larvae) in the drift following application of "TEKNAR HP-D".

(12) Samples of drift collected on 21 April 1989 from 10 m and 200 m downstream of the application point and returnedto the laboratory for incubation showed no mortality of invertebrates other than four individuals of three taxa. One hundred chironomid larvae in the samples were still alive on 3 May 1989 when the experiment terminated.

(13) To detect any changes in the character of the stream fauna following treatment with "TEKNAR HP-D", biotic indices were calculated. There were no significant changes in the BMWP and ASPT values, both of which are widely accepted as indicators of water quality, following treatment. Control and treatment sample sites all showed high values indicating the presence of rich and diverse communities of bottom-living animals including a high proportion of pollution sensitive species.

(14) Samples of chironomid larvae taken from the river bed showed no increases in the proportion of dead larvae following treatment with "TEKNAR HP-D". The proportion of dead larvae varied considerably from site to site and seemed to be directly associated with local differences in river bed conditions.

(15) No dead fish were observed in the stream before or after treatment with "TEKNAR HP-D". In the course of sampling for invertebrates thirty-one fish of three species were caught; these included both fry and adults of the bullhead (*Cottus gobio*) and fry of the perch (*Perca fluviatilis*) and of a cyprinid (Cyprinidae). There was no evidence that treatment with "TEKNAR HP-D" had any adverse effect on these species even though it is likely that some of them feed on the larvae of *Simulium posticatum* at times.

(16) Dixidae were not present in the stream either before or after treatment with "TEKNAR HP-D".

1.4 Objectives

The ultimate objective is to reduce populations of *Simulium posticatum* in the River Stour to a level at which the biting problem in the area is substantially lessened.

This proposal takes into account the 'Guidelines for biological monitoring' put forward by the Pesticides Registration Section, 28 February 1990.

1.5 Permissions

HSE has given the North Dorset District Council permission to experimentally treat eight sites on the River Stour in 1991 with a Bti preparation ("TEKNAR HP-D") as the next phase in the control of *Simulium posticatum*, following the successful trial in 1989. Although the treatment is to be restricted to the area of the main river downstream of Blandford but no less than 7km upstream of the Longham intake of Bournemouth Water Co., it should be noted that large populations of *Simulium posticatum* occur downstream of this section.

2. TREATMENT SITES

Sites 1, 2, 3 and 4 (Figure 1) will be treated initially and sites 1a, 2a, 3a and 4a will be treated only if significant populations of *S. posticatum* are found in the preliminary survey.

2.1 Preliminary survey

Samples of weed will be taken from various sites on the main river starting in early March 1991. The number of larvae per gram of weed and consequently the population density will be calculated at each sampling point. This will identify the main areas of larvae and will be used to locate the treatment points precisely.

2.2 Number of monitoring sites

Although a maximum of eight sites may be treated in the present trial the cost and effort of monitoring all of these would be prohibitive. It is suggested that only the most upstream site and the most downstream site treated should be monitored. Absolute controls for experiments can only be carried out above the upstream site but additional controls would be set up above any other sites monitored. The reasons for choosing these two sites are that the upstream one has the only true control and the furthest downstream should reveal any cumulative effect of the treatments.

3. Bti ASSAY

Mosquito larva assays of sequential water samples will be organised by Dr Lehane on behalf of NDDC. If required, samples could be taken for assay at frequent intervals from the surface of the water and from within the water column over the peak period of Bti passage as determined by salt dilution (see section 4). It should be noted that the costs of this excercise are likely to be high if a great many samples need to be examined.

4. HYDRAULIC MODEL

If a hydraulic model of Bti dispersal in the river is believed to be essential, the applicant should contact the Institute of Hydrology or some other hydraulics consultant for advice. However, the cost of such investigations would probably be prohibitive and since the Bti would only be applied in areas of turbulent water where mixing occurs, we believe that such detailed studies should not be necessary.

The use of an inert tracer, having similar physical characteristics to the bacterial spores, to simulate the translocation of Bti in the river in relation to the potable water intake at Longham is, in our opinion, not practicable. The use of detritus as suggested in the committee's guidelines would not be possible (we have 25 years experience of detritus studies in rivers).

The use of a 'stream indicator' to show when water samples should be taken was in fact done in the 1989 trial when sodium chloride was used as an indicator prior to application to fix the most suitable sampling times. This approach is the most precise and practicable one available. Salt dilution is a British standard method and as far as we are aware is an excellent approach to tracing the timing of passage of any body of water. The use of Fluorescein (as suggested by the committee) would give no advantage in physical properties over salt and could, because of its high visibility and carcinogenic properties , cause adverse public reaction. Even using salt dilution, the problems of tracing in a large volume of water and over long distances will be considerable. This problem would be compounded if detailed modelling was required for all treatment sites.

Practicalities of salt dilution need to be considered. The method can provide a/ information on timing of translocation from treatment point to water sampling points b/ information on the discharge of the river (if adequate data are not available from the NRA) to permit precise calculation of *Bti* volumes required for treatment.

5. THE POSSIBILITY OF Bti IN WATER SUPPLY

Testing for the presence of Bti in the "effluent" of the treatment plant at Longham by Bournemouth Water Co. would largely negate the requirements for 3 and 4 above.

6. APPLICATION OF Bti

As in the 1989 trial there is a possibility that any treatment could be vitiated by adverse flow or weather conditions. In view of this possibility it would be appreciated if, as in 1989, flexibility could be given for a second treatment if only limited success was achieved in the first instance.

7. MONITORING THE EFFECTS OF Bti ON RIVER FAUNA

7.1 Effect on *Simulium posticatum* larvae.

Take 30 weed samples each from a control section (upstream of the application point) and four sections at approximately 20, 50, 100 and 1000m below the application point. The exact distances will depend on the depth and velocity of the river and the availability of significant numbers of larvae before treatment. Samples will be taken on days -1, 0, +1 (we consider that a single daily sample would be adequate and do not understand the rationale of three samples as suggested by the committee) 1 week, 2 weeks, 6 weeks and 12 weeks. Count and assess the population density from all samples. Examine all samples from each location on each day to determine the proportion of living and dead simuliids. Samples taken after 6 and 12 weeks are unlikely to contain *Simulium posticatum* larvae but are likely to include other *Simulium* species which can be used to monitor any residual effects of Bti.

The alternative suggestion (of the committee) of experimentally testing the residual toxicity of *Bti* on weed samples taken three months after treatment could be difficult. Weed beds would change extensively over the period following treatment and it might be problematical to obtain suitable samples to test.

7.2 Effect on chironomid larvae

Take thirty 10-second kick samples each from 1 control and 3 sections at 20, 100 and 1000m downstream of each application site to assess proportions of living and dead chironomid larvae (using ten samples from each section) and abundance of Chironomidae (using thirty samples from each section). Samples to be taken on days -1, 0, +1, +3, 1week, 2 weeks, 4 weeks, 6 weeks, 8 weeks, 10 weeks and 12 weeks.

Many species of riverine chironomids have extremely short generation times of 2-4 weeks. Consequently after this time it is considered extremely unlikely that many individuals present in the river would have been present at the time of treatment. However, samples taken after this period may enable detection of residual Bti activity (if any) in the epiphytes on which many of these insects graze.

7.3 Effect on benthic fauna

Take triplicate 3-minute kick samples each from 1 control section and three treatment sections, 20, 100 and 1000m below the application site of *Bti* on days -1, 0, +1, 2 weeks, 6 weeks and 12 weeks. Sort, identify and analyse at family level for BMWP and ASPT scores and RIVPACS community analysis to assess any changes taking place in the fauna.

This analysis will be more informative than simple diversity indices. RIVPACS is the nationally used standard method for comparing observed community structure with that expected to be present.

7.4 Effect on Dixidae

Dixidae live in the surface film of the water along river margins and would not be sampled by any of the other methods used. A separate pond-net search will be conducted for these insects at each site prior to treatment to be repeated after treatment if any are found.

7.5 Drift samples

Take 1 hr drift samples from a control section and four sections at 20, 50, 100 and 1000m downstream of the treatment point, at each treatment site on three occasions during the hours of daylight on days -1, 0, +1, 4 weeks and 10 weeks. Sort and count for drifting fauna and assess proportions of living and dead Simuliidae and Chironomidae. Examine for other taxa which might be in a dead or distressed condition.

Take drift samples in the hours of darkness on days -1, 0 and +1 from control and four sections at 20, 50, 100 and 1000m downstream of the treatment point. Samples to be taken for 1hr at dusk, midnight and dawn approximately. Sort and count for drifting fauna and assess proportions of living and dead Simuliidae and Chironomidae. Examine for other taxa in a dead or distressed condition.

Drift sampling is a difficult and time consuming activity and particular problems arise because of the spatially variable nature of drifting activity. It is improbable that several suitable sampling points will be found in each stretch at which there will be no interference between nets. Because of this only a single drift net will be sited at each point and reliance will be placed on the differences between control and treatment samples. An attempt will be made to site drift nets in positions having similar depths and velocities. To reduce the effort required without detriment to the data it is proposed that no attempt should be made to quantify the drifting *Simulium* but simply to estimate the live:dead ratio in samples. Weed sampling should provide satisfactory estimates of any displacement of living Simuliidae which may occur.