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The Effects of Helicopter Applied Adulticides for Riverine Tsetse Control on *Simulium* Populations in a West African Savanna Habitat. II. Effects as Estimated by Non-biting Stages of *Simulium damnosum* s.l. and other Blackfly Species Caught on Aluminium Plaque Traps

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Abstract. The effects of a tsetse control programme on *Simulium* spp. on the Komoe river in the Guinea savanna of Upper Volta have been investigated by sampling *Simulium* populations using sticky aluminium plaque traps. Flies were taken in several physiological states, among which gravid, non-gravid and newly emerged individuals could easily be recognised. Daily sampling began two days before insecticide application and continued for 10–12 days afterwards, and the results were compared with a parallel study using human bait to sample *S. damnosum* s.l. populations only. Applications of deltamethrin at 12.5 g a.i./ha caused immediate reductions in the numbers of *Simulium* trapped. Endosulfan at 100 g a.i./ha gave an immediate reduction of 30–50%, increasing to 70% after three days. Populations had recovered after 12 days. The use of endosulfan at 10 g a.i./ha, deltamethrin at 12.5 g a.i./ha and dieldrin at 400 g a.i./ha to form an insecticidal 'barrier' on the river had relatively little effect. Dieldrin had a limited effect on the day of spraying only, and only on gravid females of species other than *S. damnosum*. It is possible that flies were traversing the barrier without coming into contact with the insecticide.

Introduction

The effect of anti-tsetse spraying on biting females and aquatic stages of *Simulium damnosum* s.l. (probably *S.damnosum* s.str. Theobald) has been described in a previous paper (Davies *et al.*, 1982), in which details of the experimental area in Upper Volta, insecticides used and application techniques are given.

This paper describes a parallel study in which *Simulium* populations were estimated by means of sticky aluminium plaques (Bellec, 1976), a method which has the advantage over human bait of capturing other species of *Simulium* as well as *S. damnosum*. Flies are taken in several physiological states, amongst which gravid, non-gravid and newly emerged individuals can readily be recognised.

Methods

The spraying techniques and the study areas on the River Komoe in the Guinea savanna zone of Upper Volta in West Africa are described in Part I of this series (Davies *et al.*, 1982).

The daily densities of *Simulium* populations were estimated by trapping on 1 m^2 aluminium plates coated with an adhesive material (equal parts of Tween 20® and 90% ethanol). The traps were placed on rocks close to small cascades which formed the *Simulium* breeding sites. Fourteen plates were distributed as follows: one pair at the southern limit of the northern barrier, two pairs in Block N and four pairs in Block C (Fig. 1). Entrapped flies were collected three times a day (0700, 1500 and 1830 h) from the barrier traps and one pair of plates in each of

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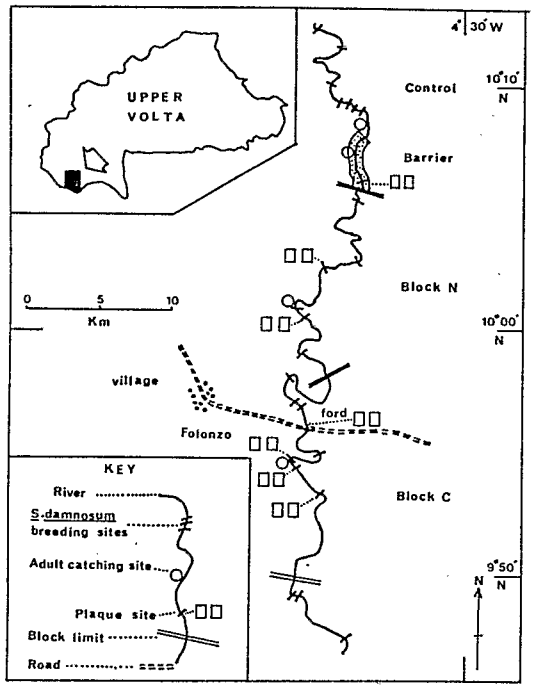

Fig. 1. Map of the River Komoe experimental area, showing the location of the spray application blocks and trapping sites.

Blocks N and C. All other traps were cleared hourly between 0700 and 1830 h. A day's catch comprised all flies caught between 0700 and 1830 h. Evaluation began two days before the insecticidal applications and continued for 10–12 days after.

Adult *S. damnosum* were separated into four categories: males, gravid females, non-gravid females and newly emerged females. Other species, which were predominantly *S. adersi* Pomeroy, were classed as males and gravid or non-gravid females. All adult *S. damnosum* were identified by the method of Quillévéré *et al.* (1977) as belonging to the *S. damnosum* s.str. and *S. sirbanum* Vajime & Dunbar species pair.

Results

The total numbers of *Simulium* spp. caught on the several traps in each block are shown in Figs 2, 3 and 4.

1. Block C (placement application of endosulfan at 100 g a.i./ha)

Adult *S. damnosum* s.l. collections were not immediately affected by the endosulfan application, although there was a drop in numbers of gravid flies caught during the day of application (Fig. 2a). Two days after spraying there was a sharp drop in numbers of gravid and non-gravid flies. Thereafter numbers caught remained low at between ten and 16 per day from the fourth to eleventh days after spraying, when they began to increase. Newly emerged *S. damnosum* s.l. of both sexes were observed nearly every day until the thirteenth day after spraying.

With other species of *Simulium* the application was made at a time of increasing catches (Fig. 2b), but on the day of application a reduction of about one half in numbers of both gravid and non-gravid flies was observed. This was followed by a steady decline until the eighth day. From the ninth day populations rapidly built up to normal.

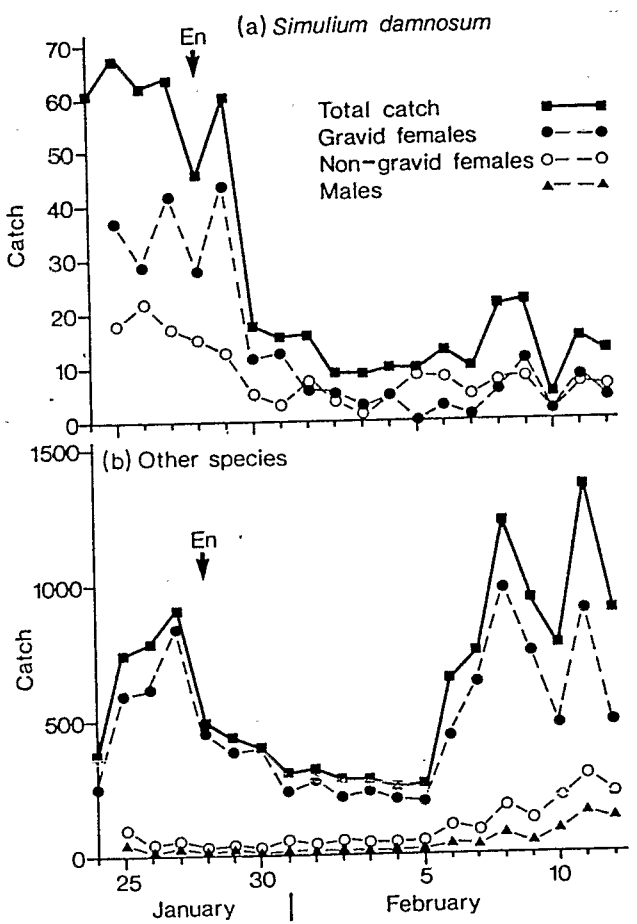

Fig. 2. Numbers of *Simulium damnosum* (a) and other species of *Simulium* (b) caught on aluminium plaques sited in Block C before and after a placement application of endosulfan (En).

2. Block N (placement applications of deltamethrin at 12.5 g a.i./ha)

Although catches of *S. damnosum* had been declining at the time of spraying (Fig. 3a) it appears that the spray caused a further decrease of all categories, which recovered slightly over the next two days (31 January, one male and one non-gravid female; 1 February, one male and one newly emerged female) and then remained at almost zero until eight days after the application.

A similar decrease was observed in other species of *Simulium* on the day of application (Fig. 3b), after which a steady recovery took place.

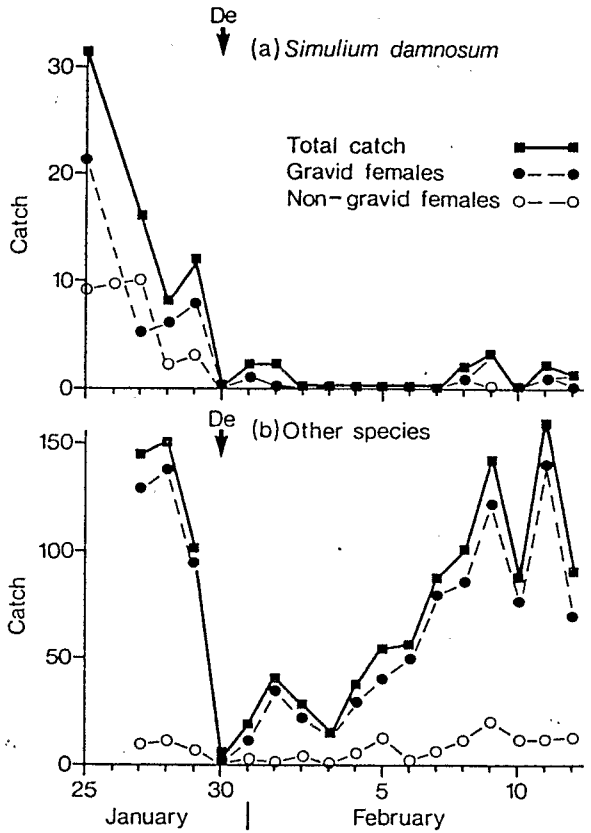

Fig. 3. Numbers of *Simulium damnosum* (a) and other species of *Simulium* (b) caught on aluminium plaques sited in Block N before and after a placement application of deltamethrin (De).

3. Barrier

(a) Dieldrin (placement application at 400 g a.i./ha)

No apparent effect was observed on the numbers of *S. damnosum* caught (Fig. 4a). However, there was a sharp decrease in the numbers of gravid *Simulium* of other species which recovered the following day (Fig. 4b).

(b) Endosulfan (space spray at 10 g a.i./ha)

The application was followed by a reduction in numbers of gravid *S. damnosum* s.l. collected, which was maintained for the first and second days afterwards. There was no really noticeable effect on non-gravid flies. With other species, a decrease in numbers of gravid flies was apparent only on the second day after spraying.

(c) Deltamethrin (placement application at 12.5 g a.i./ha)

Simulium damnosum s.l. populations were probably further decreased by this application, although as the population was already on the decline this cannot be certain. Twenty-eight adults (two males and ten neonates, 12 non-gravid and four gravid females) were taken the following day and a few were collected on all subsequent days.

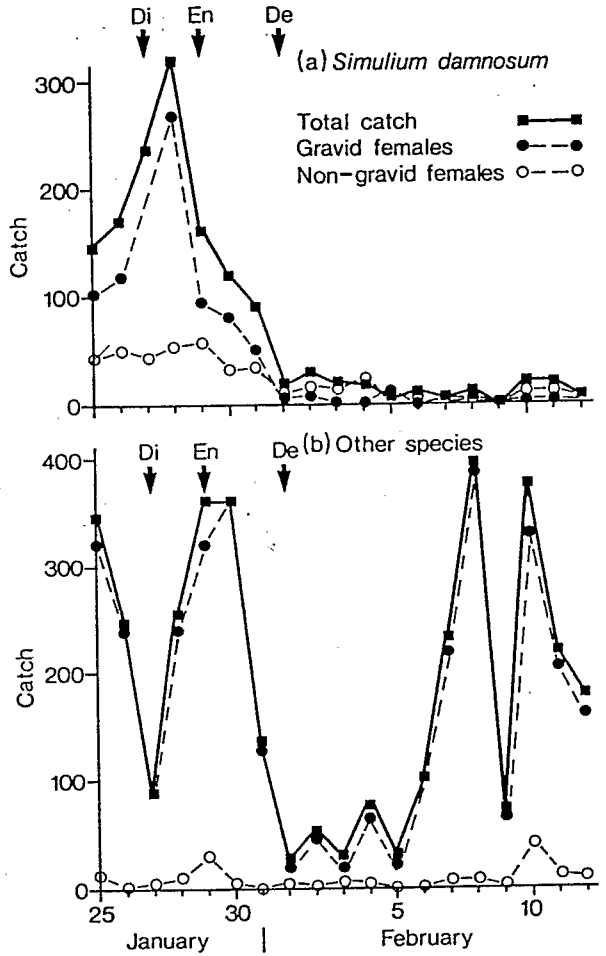

Fig. 4. Numbers of *Simulium damnosum* (a) and other species of *Simulium* (b) caught on aluminium plaques sited in the barrier before and after applications of dieldrin (Di), endosulfan (En) and deltamethrin (De).

There was no sign of a strong recovery during the period of observation, although newly emerged flies were caught on four occasions.

With other species of *Simulium* an 82% reduction was observed on the day of treatment, caused entirely by loss of gravid females. Only small numbers of flies of other categories were caught before treatment so it was not possible to assess the effect on these groups. Over the fifth and sixth days after treatment there was a complete recovery in the numbers of gravid flies.

Conclusions

A comparison with the catches of *S. damnosum* on human bait (Davies *et al.*, 1982) shows that with the deltamethrin application in Block N a similar pattern was observed for biting females, gravid and non-gravid females. The application was followed by zero catches on the day of treatment. Recovery was slow, but because of the low numbers it is not clear whether it was due to any residual effect of the insecticide.

After the application of endosulfan in Block C biting *S. damnosum* densities fell to nearly one third, stayed at this level for three days and then decreased further until the tenth day when a recovery began. In contrast, catches on the plaque traps did not fall until the second day after spraying. At no time were any of the collections reduced to zero.

The situation on the barrier is confused, probably because of the influx of *Simulium* from the untreated river upstream. Dieldrin had no immediate effect on *S. damnosum* but might have killed gravid *Simulium* of other species on the day of application only. The effect of endosulfan here was also limited, and deltamethrin did not show the dramatic reduction in flies demonstrated in Block N. It is possible that *Simulium* of all species were traversing the short length of the barrier as far as the traps without coming into contact with the insecticide.

Final conclusions on these experiments are given in the third paper of this series (Davies *et al.*, 1983).

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The Effects of Helicopter Applied Adulticides for Riverine Tsetse Control on *Simulium* Populations in a West African Savanna Habitat. III. Conclusions: the Possible Role of Adulticiding in Onchocerciasis Control in West Africa

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Abstract. The partial success of applications of dieldrin, deltamethrin and endosulfan for tsetse control in also reducing populations of *Simulium* spp. in a riverine Guinea savanna habitat in Upper Volta has been established. However, there is insufficient information available concerning the resting sites of adult *Simulium* to determine the best location of spray swaths to achieve the maximum effect. Further trials based on knowledge of the biology of adult *Simulium* could improve the success of the technique for blackfly control. It is suggested that localised adulticiding in onchocerciasis control schemes could be effective, particularly where a high level of reinvasion causes unacceptable levels of disease transmission for short periods of the year.

Introduction

Applications of endosulfan and deltamethrin by helicopter to 30 km lengths of the Komoe river and dieldrin to a 5 km length of the river in Upper Volta during the dry season of 1978, as part of a series of trials to determine their effect on the tsetse fly *Glossina tachinoides* Westwood, have been described by Baldry *et al.* (1981). The effect of a single application of these insecticides on biting adults and aquatic stages of *Simulium damnosum* Theobald has been described by Davies *et al.* (1982), and the effect on other physiological stages of *S. damnosum* s.l. and other species of *Simulium* caught on aluminium plaque traps is given by Bellec *et al.* (1983).

In these studies it was not possible to assess the persistent effect of the insecticide on biting *S. damnosum* because in some cases the residues which fell into the river killed all the larvae, thereby interrupting the production of newly emerged adult flies. There was evidence to suggest that flies were traversing a 5 km insecticide barrier into the sprayed area. However, of the three insecticides applied, deltamethrin applied at 12.5 g a.i./ha had the greatest effect and considerably reduced the biting population of flies for four days.

Discussion

In considering the effects of the insecticide applications it is important to remember that the spraying was specifically designed to kill tsetse, using a refined technique against a pest whose life cycle and biology was well known. The target species, *G. tachinoides*, produces a single larva in each gonotrophic cycle, which develops *in utero* and is only briefly exposed to the environment before pupating below ground. The adult rests on vegetation at sites which are relatively restricted.

In contrast, *S. damnosum* s.l. is highly fecund, producing 400 to 900 eggs per cycle with aquatic larval and pupal stages. Little is known of the habits of the adult female between the times of blood feeding and oviposition.

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