ECOLOGICAL STUDIES ON THE BLACK FLIES OF THE SOURIS RIVER, MANITOBA

A Thesis

Submitted to the Faculty

of

Graduate Studies

The University of Manitoba

by

Arthur Richard Westwood

In Partial Fulfillmemt of the

Requirements for the Degree

of

Master of Science

Department of Entomology

October 1979

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ARTHUR RICHARD WESTWOOD

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ACKNOWLEDGEMENTS

I wish to express my gratitude to my supervisor, Dr. Reiny Brust for his patience, guidance and encouragement throughout this study.

I am grateful to Dr. Terry Galloway for his valuable advice and assistance.

Others who have helped me directly with the project include Mr. John Serger, Mr. Jack Harlos, Mr. Pat Copps and my fiancé Miss Sandra Venus. To these people I extend my thanks for their help during my work in the field and laboratory.

I would also like to thank Mr. and Mrs. G. J. Copeland and Mr. and Mrs. D. N. Fenwick for kindly letting me live and work on their farm at Bunclody, Manitoba during the summers of 1977 and 1978. My thanks to Mr. Hartly Fredeen for verifying my black fly identifications and providing me with advice. Thanks are also due to Mr. Dave Smith, Mr. Andy Kolach, Dr. N. Holiday and Dr. I. Morrison for their valued advice. Special thanks is due to Miss Janice Dingwall for her care and long hours in typing this manuscript.

Financial assistance for the project was provided by the Canada Department of Agriculture Grant No. 8070 to Dr. R. A. Brust, and the Manitoba Department of Agriculture Grant to

the Faculty of Agriculture, Department of Entomology, University of Manitoba.

TABLE OF CONTENTS

CHAPTER I

CHAPTER II

CHAPTER III

CHAPTER IV

CHAPTER V

CHAPTER VI

LIST OF TABLES

LIST OF FIGURES

Page

Page

LIST OF APPENDICES

ABSTRACT

Westwood, Arthur Richard. M.Sc., The University of Manitoba, October, 1979.

Ecological Studies of the Black Flies in the Souris River, Manitoba. Major Professor: R. A. Brust

Nine species and one subspecies of black flies were collected in the Souris River. These were Cnephia dacotensis, Simulium johannseni, Simulium johannseni duplex, Simulium venustum, Simulium verecundum, Simulium tuberosum, Simulium vittatum, Simulium decorum, Simulium luggeri and Simulium meridionale. Five species, Simulium luggeri, Simulium meridionale, Simulium venustum, Simulium verecundum and Simulium johannseni are potential pest species. These five were observed to take blood meals from humans, cattle, horses and poultry. Simulium vittatum was the most abundant species. Simulium luggeri, Simulium meridionale and Simulium johannseni were less abundant than Simulium vittatum, but more numerous than Simulium venustum, Simulium verecundum and Simulium decorum. The least common species were Simulium tuberosum, Cnephia dacotensis and Simulium johannseni duplex.

Simulium johannseni, Simulium johannseni duplex, Simulium venustum, Simulium verecundum, Simulium tuberosum and Cnephia dacotensis were univoltine in the Souris River; the remaining species were multivoltine.

In an outbreak year, it appears that two larvicide treatments would be needed to control black flies in the Souris River. The first should be aimed at late instar larvae of Simulium johannseni and the Simulium venustum/ verecundum complex. The second treatment, approximately 10 to 14 days later, should be aimed at late instar larvae of Simulium luggeri and Simulium meridionale.

Four different artificial sampling devices were employed to collect black fly larvae and pupae. Of the four samplers tested; (cones, plates, ropes and wire cages), cone samplers are recommended for future larval population assessment in the Souris River. The characteristics that make cone samplers more desirable than the others tested include ease of handling, versatility and high performance in collecting immature simuliids. Comparison between samplers showed cone and plate samplers to collect significantly more black fly larvae and pupae than wire cage samplers. There was no significant difference in the collection of immature simuliids between cone and plate samplers. Rope samplers were not compared to the others because a true 2.5 cm^2 sample could not be obtained.

CHAPTER I

Introduction

The serious nature of the black fly populations along the Souris River in Manitoba was first noted in 1949 when livestock between Hartney, Deleau and Souris, Manitoba were severely attacked by black flies. At Hartney, Manitoba, A. V. Mitchener (unpublished report) recorded the appearance of "clouds" of black flies which attacked horses, cattle and humans on 18 May, 1949. The black flies were originally identified as Simulium occidentale Townsend, but a recent examination of the specimens showed that they belong to the Simulium venustum/verecundum complex. R. D. Bird (unpublished report) collected black flies several miles north of Hartney, at Deleau, Manitoba, on 16 May, 1949. These simuliids were attacking cattle, horses, humans and poultry. Bird reported that cattle suffered heavily from black fly bites, especially around the head and udders. The flies were identified as Simulium venustum Say, but a later examination showed that only about one-half of them were S. venustum, while the rest were Simulium verecundum Stone and Jamnback.

Continued black fly outbreaks during the early 1950's prompted insecticide treatment of the Souris River with DDT in order to control black fly larvae. Some limited

investigations on the biology of black flies breeding in the Souris River were conducted prior to and following treatment. The black fly levels subsided after 1956 and little attention was paid to black fly activity along the Souris River during the 1960's.

In 1970, serious black fly outbreaks again became prevalent along the Souris River from the Hartney area east to Wawanesa, Manitoba. In 1974, the rural municipality of Cameron petitioned the Manitoba Department of Agriculture to provide assistance to alleviate the black fly outbreaks in the Hartney - Souris area. The problem was especially serious to both humans and livestock in 1975. Several area residents were admitted to hospital for treatment because of black fly bites (Kolach 1977). Black flies were responsible for numerous deaths in chicken flocks in the Hartney area and cattle were noticeably stressed during the outbreak. The Manitoba Department of Agriculture treated the Souris River south of Hartney with methoxychlor (24% emulsifiable concentrate at 0.1 ppm for 15 minutes) on 11 May, 1976.

The present study was undertaken during the summers of 1977 and 1978, to learn more about the biology and ecology of the Simuliidae in the Souris River and to provide background data for future studies. The taxonomy, breeding habits and seasonal and geographical distribution of nine species of black flies were examined. The criteria affecting

the control of pest species were also investigated. Finally, an assessment of larval and pupal sampling techniques was undertaken to determine those best suited for the river, and those which might be used in the future to help monitor and predict black fly outbreaks.

CHAPTER II

Literature Review

Section A - Review of General Biological Studies of North American Black Flies

A large number of studies on black flies have been conducted in North America. In the United States, Malloch (1914), Jobins-Pomeroy (1916), Dyar and Shannon (1927) and Stains and Knowlton (1943) were among the first authors to describe simuliid biology, taxonomy and ecology. Stone and Jamnback (1955) pointed out that while these early contributions were often based on erroneously determined material, they paved the way for a more in-depth study of North American Simuliidae.

Studies initiated after 1950 in the United States to investigate simuliids have had several recurrent themes. Each study was confined to the fauna of distinct areas because of the often restricted habitat of Simuliidae. While emphasizing taxonomic representation of simuliids, these studies have also made an effort to present black fly bionomics. Nicholson and Mickel (1950) dealt extensively with the economic importance and biology of black flies in Minnesota and included keys and species descriptions for the adults collected. Stone (1952) and Sommerman et al.

(1953) followed much the same format as the previous authors in their examination of Alaskan Simuliidae. Unlike Nicholson and Mickel (1950), Stone (1952) and Sommerman et al. (1953) concentrated not only on adults, but also included pupal and larval biology, taxonomy and keys to immature stages. Stone and Jamnback (1955) produced a major work on the black flies of New York State, and combined taxonomic descriptions pertinent to the black fly fauna of this region with limited amounts of biological information. Stone (1964) published a paper, similar in content to that of the previous authors, in which he reported his investigations on the black flies of Connecticut. This publication included important biological and ecological data accompanied by updated taxonomic keys and descriptions of many species not fully dealt with by Nicholson and Mickel (1950) or Stone and Jamnback (1955). Studies by Snow et al. (1958) and Stone and Snoddy (1969) provided taxonomic and biological descriptions of the black flies of the Tennessee River basin, and of Alabama respectively. Anderson and Dicke (1960) investigated the biology and occurrence of the immature stages of Wisconsin black flies in detail and provided information on the life cycles of numerous species. Recently, Merritt et al. (1978) and Pinkovsky and Butler (1978) have added further biological information, taxonomic descriptions and keys to the black flies of lower Michigan and Florida.

Parallel studies on taxonomy and bionomics of Canadian black flies can be divided into two categories. The first includes woodland simuliids, encompassing eastern and northern Canada and the west coast. The second major area of investigation has been the black fly fauna of the Canadian prairies.

Twinn (1936) and Hearle (1932) were among the first to study woodland black fly species in Canada. Wolfe and Peterson (1959) updated Twinn's work (1936) on the black flies of Quebec, and added new biological information. Hocking and Richards (1952) and Hocking and Pickering (1954) examined the taxonomy and bionomics of northern black flies in Labrador and Manitoba. Davies et al. (1962) and Wood et al. (1963) made important contributions to the taxonomy and biology of black flies of Ontario. They revised the descriptions and outlined new life history findings for many species. Recent efforts in Newfoundland by Lewis and Bennett (1973; 1974a) have added to the biology of woodland black flies.

The black fly species inhabiting the Canadian prairies have been the object of several studies. Fredeen (1956) listed black flies of the agricultural areas of Manitoba, Saskatchewan and Alberta and outlined the life cycles of both abundant and important pest species. Fredeen and Shemanchuk (1960) investigated the black fly fauna of irrigation canals in Saskatchewan and Alberta.

Abdelnur (1968) discussed species biology and presented comprehensive keys to all stages of the black flies found in his study on Alberta simuliids. Fredeen (unpublished 1972) revised his earlier checklist of the Simuliidae of Manitoba, Saskatchewan and Alberta and also provided keys to both adult and pupal stages.

Research on black flies in Alberta and Saskatchewan has been far more intensive than in Manitoba. The only published study concerning biology, ecology and seasonal occurrence of Manitoba black flies in that of Hocking and Pickering (1954). These authors reported on simuliids found in Churchill. The study deals with black flies of the boreal forest - tundra ecotone, and therefore adds little to our knowledge of prairie species.

Section B - Sampling Techniques for Adult and Immature Black Flies

Immature stages of black flies (ova, larvae and pupae) can be collected from natural substrates, or by the use of artificial sampling devices. Sampling techniques for adult black flies can be divided into two categories: selective sampling methods which capitalize on behavioral characteristics of Simuliidae (eg. attraction to host via odor, movement or sight) and non-selective sampling techniques that provide a general cross-section of the simuliid population.

Ova. Sampling for black fly eggs is the method least practised for ecological, taxonomic or control purposes. Marr (1962) suspended small flat sticks from a rope onto the surface of the river. These sticks acted as oviposition sites for females of several black fly species, including Simulium damnosum Theo. The sticks were replaced periodically and provided an effective means for sampling eggs of certain simuliids. Golini and Davies (1975a; 1975b) used polyethylene strips suspended on the water surface to sample for eggs laid by gravid black flies. By adding sticky adhesive to the strips, Golini and Davies were also able to trap the adult females when they landed to oviposit. Egg samples have also been collected along the shores of pools, streams and rivers from trailing and standing vegetation and debris (Tarshis 1968a). A third method used by Tarshis (1968a) and Fredeen (personal communication) was to sample the river bottom with an Eckman dredge or equivalent device. Simuliid eggs were then separated using a salt flotation process. The main drawback to this method is the low return in number of eggs relative to the large number of samples that must be taken.

Larvae and Pupae. Sampling for black fly larvae and pupae can be done using either artificial or natural substrates. In regard to the former, a set of guidelines to ensure the effectiveness of artificial substrates was proposed by Lewis

and Bennett (1974b). The samplers (all types) should have nearly equal attractiveness, or their degree of attractiveness should be established in relation to other substrates. Samplers should be easily positioned and retrieved, and should be of uniform dimensions. Samplers should hold a stable position throughout the season under a variety of conditions and the larvae should be easily removed with minimum specimen damage. In addition to this, there should be no significant disturbance to the immediate environment.

An artificial substrate used by Lewis and Bennett (1974b) consisted of fine-textured ceramic tiles (10 cm^2) fixed at various depths to obtain samples of larvae and pupae. Fredeen (in press) utilized 10 cm^2 polyethylene-covered plates or 10 cm^2 aluminium wire mesh squares. Fredeen emphasized that smooth, hard surfaces were best for collecting large numbers of black fly larvae and pupae, while the wire mesh grids acquired higher numbers of Trichoptera and Plecoptera than simuliids. Wolfe and Peterson (1958) utilized 10 cm^2 solid metal plates and Baldwin et al. (1977) used 30 cm^2 floor tiles to evaluate the effect of insecticide treatments on simuliids in streams.

The need for standardized sampling techniques to be used worldwide was emphasized by Lewis and Bennett (1974b). They felt that with the large number of sampler types being used, population comparisons from one study to another were impossible and suggested that the tile method should become a standard black fly sampling technique for ecological and

control studies in small streams or shallow rivers. (Obviously this method would not be suitable for large, deep rivers.)

The use of metal and polystyrene cones for black fly larval sampling has been widespread (Peterson et al. 1955; Wolfe and Peterson 1958; Phelps and Defoliart 1964; Johnson and Pengelly 1966; Abdelnur 1968; Wallace et al. 1973; Depner 1977 personal communication). Cones are suspended at various depths pointing into the water flow. This keeps them relatively stable and allows attachment for larvae and pupae to the outside surface. Peterson et al. (1955) used metal cones (20 cm in height and 10 cm in base diameter and a 30° apex) while Abdelnur (1968) utilized hollow white polystrene cones of the same dimensions. Cones fixed in the current gave very low numbers of black fly larvae at all depths, while cones allowed to move freely with the current collected many more larvae. Abdelnur and Peterson et al. (1955) also found that higher numbers of larvae attach to "brighter" surfaces, with white cones giving the highest catches of larvae. Peterson et al. (1955) listed six types of information that could be obtained using cone samplers. These were: a) determination of the level of infestation at a particular locality, b) estimation of larval growth, c) determination of periods of migration and spread of small larvae throughout a watercourse, d) determination of periods of peak abundance of larvae and pupae, e) indication

of river and stream suitability for larval growth and f) assessment of the effectiveness of larvicidal control procedures.

Nets and polyethylene strip samplers have been used to collect larval samples. Tarshis (1965, 1968b) collected larvae with nets made from organdy nylon mesh and coarse mesh cheesecloth. Nets, 0.6 by 0.9 meters, were anchored to the base of streams and collected up to 3,000 Simulium and Cnephia spp. larvae per screen within days of immersion. Wallace et al. (1973, 1976) used drift nets of varying mesh sizes to sample Simuliidae and other aquatic invertebrates. Boobar and Granett (1978) collected 1,500 to 2,000 black fly larvae per m^2 using polyethylene strip samplers.

Larvae and pupae can also be collected from natural surfaces, eg. rocks, vegetation, stream bottoms and from man-made structures. In fact, whenever artificial substrates are used, sampling from vegetation, rocks and dam faces is nearly always carried out as well (Peterson et al. 1955; Marr 1962; Abdelnur 1968; Boobar and Granett 1978).

Adult Black Flies. Sampling for adults has been attempted using both non-selective and selective techniques. Selective sampling techniques utilize attraction to hosts by visual and olfactory stimuli.

The simplest selective method is the use of humans or animals as bait for blood-seeking female black flies (Dalamat 1950; Muirhead-Thompson 1968; Thompson et al. 1972; Service

1977). Females are either aspirated or netted from or around the host. Black flies can also be captured by constructing traps around mammalian and avian hosts. Anderson and Defoliart (1961) used animal bait traps constructed with dark sides and a bright apex to lure adults inside and upward to be captured. Shemanchuk (1978) suspended a large mammalian host (eg. steer) in an open steel framework. The tops of the framework held netting which was dropped over the sides of the enclosure to capture blood-seeking females attracted to the bait. A very effective method used on African black flies was to surround a host in a fine gauze mesh framework. Blood-seeking females would enter through the mesh, but once their abdomens swelled with blood, they could not leave (Service 1977). Service stated that suction traps placed around bait can also be used to collect black fly adults. The window-type exit trap has also been used successfully to capture adult black flies. These traps are often placed in barns and buildings where animals are housed to capture those flies attracted to hosts for feeding (Service 1977).

Fallis et al. (1967) experimented with odoriferous animal extracts and carbon dioxide gas to attract blood-seeking female black flies. While these studies concentrated on behavior and attraction, they are an effective means of sampling the adult female population. Common loon extract and carbon dioxide gas attracted large numbers of Simulium

euryadminiculum Davies. Peschken and Thorsteinson (1965) and Golini and Davies (1970) also experimented with carbon dioxide, color, shape and movement of artificial samplers to attract black flies. Baits, animal or bird extracts and carbon dioxide have been used as attractants in the sampling of blood-seeking female black flies, but are of no use in examining male or non-blood seeking female populations.

Another selective sampling method employs visual cues used by black fly females to orient toward a host. Fredeen (1961) constructed traps in the form of a) a cow silhouette (a four-legged frame two-thirds covered with dark cloth and the underside open), b) sheep silhouette (smaller version of the cow trap) and c) a small pyramidal trap. Black flies were attracted to the dark undersides mistaking the traps for live animals. The traps effectively provided a cross-section of the female black flies attracted to the silhouettes. Fallis et al. (1967) used Fredeen's idea of visual traps shaped as hosts and constructed colored animal and bird silhouettes of various shapes and sizes and captured black flies attracted to them. The attractiveness of the silhouettes was enhanced by adding carbon dioxide gas and heat. Baldwin et al. (1977) experimented with suspended lard tins (22.5 kg) painted dark blue with white vertical contrasting stripes. A thin layer of clear adhesive was applied to the surface of the tins to catch adult female black flies as they alighted. Carbon dioxide, in the form