BIONOMICS OF THE BITING MIDGE, *LEPTOCONOPS* (*STYLOCONOPS*) *SPINOSIFRONS* (CARTER) (DIPTERA: CERATOPOGONIDAE) IN MINDORO OCCIDENTAL

Leopoldo M. Rueda and Cecille D. Ebuenga

ABSTRACT

Using human bait traps, sticky traps, emergence traps and flotation techniques, the biting midges particularly *Leptoconops* (*Styloconops*) *spinosifrons* (Carter) and *Culicoides* species, were collected from Mamburao beach, Mindoro Occidental.

The breeding areas of *L. (S.) spinosifrons* included open sand and grass and other vegetation-covered sand, between the high tide mark and sandy sites landward. The incubation period of *L. (S.) spinosifrons* lasted from 5 to 9 days (average 6.72), and larval to adult stage about 17 to 29 days (average 24.88). The total developmental period from egg laying to emergence of the adult midge ranged from 26 to 45 days (average 38.87). A female midge laid about 8 to 90 eggs (average 28.85). The unengorged and fully engorged female midge lived up to 3 and 7 days, respectively. Under laboratory conditions, about 55, 35 and 10% of the midge larvae inhabited the sand depths of 0–2, 2–5 and 5–8 cm, respectively. In the natural sand habitat, about 90% of the midge larvae were recovered at depth of 0.5 cm, and no larva was found beyond 8 cm deep.

Adults of *L. (S.) spinosifrons* mated in flight in swarms, about 30 to 100 individuals/swarm, usually along the shoreline areas. The diurnal biting activity and weekly population fluctuations of the adult midges as affected by various environmental factors such as wind velocity and direction, temperature, relative humidity, rainfall, and cloudiness, were also studied.

Key Words: *Leptoconops* (*Styloconops*) *spinosifrons*, *Culicoides* species, life history, behavior, biting activity, abundance

INTRODUCTION

The biting midge, *Leptoconops* (*Styloconops*) *spinosifrons* (Carter), locally known as “niknik” or “bakung-bakong”, is a serious threat to Philippine tourism in places with beautiful beaches. It is a vicious biter and causes annoyance to people. The skin bites often leave an itchy sensation which lasts for several days. Secondary bacterial infection can result from scratching the itchy skin; in severe cases, infected persons are hospitalized.

Occidental Mindoro has beaches with enormous potential as tourist venues but the presence of *L. (S.) spinosifrons* prohibit their extensive deve-

1Received for publication 25 November 1986 and in revised form 10 August 1987.
2Assistant Professor and Research Assistant, respectively, Department of Entomology, U.P. at Los Baños, College, Laguna, 3720.
loment. Large investments had been made in the past to control the midge with pesticides and physical means. However, these control attempts were not successful. Several reasons could possibly be cited: 1) the inappropriate selection and use of insecticides, 2) inadequate information on the habits and habitats, life history and other biological attributes, and dynamics of the midge populations, and 3) lack of technical entomological expertise of those in-charge of the midge control operations.

The study was conducted in Mamburao, Occidental Mindoro to investigate the problems pertinent to the identity, biology and incidence of the biting midges.

**MATERIALS AND METHODS**

**Survey of the midge breeding areas**

A survey of the breeding habitats of the biting midges around Mamburao Beach Resort complex and adjacent areas was conducted. Possible breeding habitats were examined for immature and adult stages of the midges.

Techniques used for midge collections included flotation method, direct collection method, and emergence trap technique. Flotation method involved placing a sample of sand or material from suspected breeding habitat into a one-liter plastic container filled with tap water mixed with one tablespoonful of magnesium sulfate. After 5-10 minutes of thorough stirring, the specimens that floated were collected and examined under a dissecting microscope. Direct collection method, on the other hand, involved getting sand and debris samples from the breeding habitats and directly picking the specimens using camel hair brush and fine forceps with the aid of a glass magnifier. Emergence trap technique utilized a cone-shaped galvanized iron trap (68 cm diam base, 48 cm h, with 5 cm diam opening on top) (Figure 1A). The trap was positioned on the ground breeding habitat with the wide-mouth base covered with sand or debris. An 8-oz, screw-capped glass bottle, coated with petroleum jelly inside, was fitted on the top opening of the trap. Since the midges were attracted to light, they moved upward and were inside the jelly-coated bottle. The collected specimens were placed in vials with kerosene for 6-8 h and transferred to vials with 95% ethyl alcohol.

All specimens collected using the above techniques were mounted on slides and identified.

**Determination of the kinds of the biting midges**

Immature stages of the midges were collected using flotation and direct collection methods described above. For adult midges, the following collection techniques were used: human bait traps, sticky traps, emergence traps, and light traps. Human bait trap consisted of exposing humans in open or shaded areas and catching the midge specimens using glass vial as they alighted on or bit the humans. The sticky trap (Figure 1B) was made of bamboo pole (30 cm high, 10.5 cm diam) with a bamboo stick stand about 60 cm
Figure 1. Traps used in the study. A. emergence trap. B. sticky trap.
long. The pole was wrapped around with black cardboard or cartolina, covered with plastic bag and coated outside with petroleum jelly. The midges that were attracted to the sticky trap were collected using a camel hair brush. On the other hand, the light trap consisted of white pan or basin half-filled with 20% ethyl alcohol, and a kerosene lantern on top. The trap was usually operated from 1900-0500 h. The midges that were attracted to the light would float on the alcohol solution and were collected using a camel hair brush.

All collected specimens were preserved in vials containing 80-95% ethyl alcohol until ready for mounting. The mounted specimens were labelled and properly identified (Tokunaga and Murachi 1959, Charthawanich and Delfinado 1967, Delfinado 1961).

**Bionomics of L. (S.) spinosifrons**

Life history and behavioral studies. The midges were mass-reared for life history and related studies in the temporary laboratory set-up in the beach resort. The initial or stock cultures of the midges were established from adult midges collected by human baits. In order to produce eggs, the midges were allowed to feed on human blood.

For the life history study, about 100 newly mated, fully engorged females were individually placed in 25 x 5 cm glass vials half-filled with slightly moist beach sand for midge oviposition. The number of eggs laid by each female midge was recorded daily.

To determine the duration of each life stage, 100 newly laid eggs were placed separately in glass crucibles and examined daily for hatching. The insects were further observed for larval molting.

To determine the depth of larval location on the breeding sites, about 100 samples were collected from these sites at various depths. In the laboratory, about 10 newly hatched larvae were placed in an 8 oz glass jar filled with slightly moist sand. The jar was calibrated from 0 to 8 cm deep. The larvae, initially released on top of the sand, were examined and counted at various depths 3 days after release. The laboratory experiment was replicated six times.

To determine the biting preference of the adult midges on human legs and arms, three human baits were exposed on the open beach while sitting or standing for 5 h/day, (5 min/h), for 10 days. The number of adult midges that attacked the legs or arms was counted.

**Diurnal biting activity of L. (S.) spinosifrons.** Preliminary trials using human baits and light traps showed that L. (S.) spinosifrons is active shortly before sunrise until shortly after sunset. Based on this information, a 14-h activity (0500-1900 H) of the midges was monitored once a week for six consecutive weeks using human baits positioned on the open beach area. The number of biting midges within 10 minutes exposure/hour was recorded. Hourly data on wind direction, wind velocity, temperature, relative humidity, cloudiness and rainfall were also recorded.
Weekly abundance of *L. (S.) spinosifrons*. Weekly abundance of *L. (S.) spinosifrons* was monitored using sticky traps and human baits. The sticky traps were positioned along the 4-km stretch of the beach (from northwest to southeast with benchmark as the key point at the middle of the beach stretch) and about 2 kilometers northeast from the benchmark area towards inland. Midge specimens were collected and counted twice a week. Human baits were exposed three times daily on the beach (about 30 meters south of the benchmark area). Data on temperature, relative humidity, cloudiness, rainfall, wind velocity and wind directions were recorded daily.

**RESULTS AND DISCUSSION**

**Biting midges in Mamburao, Occidental Mindoro**

Using various collection techniques, survey of the Mamburao beach areas and their immediate surroundings was conducted. Two genera of the midges belonging to family Ceratopogonidae (Order Diptera): namely, *Leptoconops* and *Culicoides*, were collected. Under the genus *Leptoconops* only one species, *L. (Styloconops) spinosifrons* (Carter), was identified. This species was recovered using all the techniques listed above except light traps.

*L. (S.) spinosifrons* was reported in Brunei (Zacariah and Noordin 1976), East Africa, India, Indonesia, Malaysia (Chanthawanich and Delfinado 1967), and Sychelles Islands (Laurence and Mathias 1972). The distribution of *L. (S.) spinosifrons* complex was noted by Laurence and Mathias (1972). To date, the work of Takaoka et al. (1976) is the only published record indicating the occurrence of *L. (S.) spinosifrons* in the Philippines. However, in 1974 Chan Kai Lok (Ministry of Environment, Singapore) through correspondence with Mr. R. Lehmann, President, Mamburao Beach Corporation, Makati, Metro Manila noted the presence of *L. (S.) spinosifrons* in Mindoro and even provided recommendations for its control.

About three species of *Culicoides* were collected in Mamburao using light traps. However, their exact species identity are still under study. Delfinado (1961) and Hardy and Delfinado (1977) provided a comprehensive list of *Culicoides* species found in the Philippines.

**Breeding areas**

The breeding areas of *L. (S.) spinosifrons* included those between the high tide mark and sandy sites landward. The areas included shaded and unshaded open sand, and sand covered with grasses [e.g. *Cynodon dactylon* (Linn.) Pers., *Imperata cylindrica* (Linn.) Beauv., *Saccharum spontaneum* Linn.], beach creeper (*Ipomea* sp.) and other vegetation (e.g. coconuts, aroma plants) (Figures 2A and 2B). No midge was found breeding on open sandy areas directly wetted by waves. Examination of landward areas such as those with sandy and organic soil, clay soil (either open or covered with grasses and other vegetation), and mangrove sites yielded no immature stage of *L.
Figure 2. Breeding habitats of Leptoconops (S.) spinosifrons: (A) covered with Ipomea sp. and (B) near a cottage.
(S.) spinosifrons.

It would be interesting to correlate midge larval abundance with the physical and chemical features of the sand and its associated microorganisms. When the stretch of the Mamburao beach (from the town proper of Mamburao up to San Vicente, Sta. Cruz) was surveyed, some apparent differences in the coloration and physical features of the sand samples from breeding and non-breeding sites were observed. However, laboratory analysis of the samples is necessary to make accurate conclusions.

For control measures against midges, the knowledge of the type and location of their breeding sites is very important. Pesticides would not be effective for midge control if not properly applied to the desired target. Failures to control midges in the past could be attributed to the inadequate information on the breeding habitats of these pests.

Life history and behavior

Under laboratory conditions (average 28.15°C, 82.98% RH), the incubation period of L. (S.) spinosifrons lasted from 5 to 9 d (average 6.72). The duration from larval stage to adult stage ranged from 17 to 29 d (average 24.88).

The total developmental period, from egg-laying to emergence of L. (S.) spinosifrons, ranged from 26 to 45 d (average 35.87). Pre-reproductive, reproductive and post-reproductive periods lasted from 4 to 7 d (average 4.53).

The adult female midges became fully engorged with human blood in 6 to 10 min (average 7.6). After engorgement, they dropped on the sand and quickly burrowed into it. When placed in a glass vial containing damp sand, it was observed that the engorged females usually burrowed to a depth of 5 mm, using their head and legs. They then remained immobile in the sand until the eggs were laid. The number of eggs laid by a female midge varied from 8 to 90 (average 28.85 based on 30 females). They usually laid eggs in batch. The fully engorged female lived up to 7 d while the unengorged female lived for only 3 d.

Based on our knowledge of the life cycle, two generations were produced every 2 to 3 months. The life cycle might be longer during the colder months.

In the laboratory, the larvae were found to inhabit the sand at various depths. About 55% of the midge larvae tested were concentrated at 0-2 cm. depth, and about 35% and 10% of the larvae at 2-5 cm. and 5-8 cm. depth, respectively. In about 50 sand samples from the field, 90% of the midge larvae were recovered at 0-5 cm. depth. Only a few midges (about 10%) were collected at 5-8 cm. depth. No midge was found beyond 8 cm. depth.

L. (S.) spinosifrons, like other species of Leptoconops, mated in flight during aggregations or swarms. The swarm, usually on the shore line area as observed in Mamburao beach, consisted of a group ranging from about 30 to 100 (based on sweep net catch). They sustained rhythmically repeated flight at visually recognized land marks such as seashell, small rocks, coconut
fruit, standing stick. The swarm was maintained predominantly by the males. The females were captured quickly on entering the swarm and not rejoining it after mating. Downes (1959) noted that the recognition of the capture of the females within the swarm is initiated by an auditory response to the wing beat tone, mediated by the specialized plumose antenna of the male.

*L. (S.) spinosifrons* is attracted to human beings. Only female adult midges suck blood. The bites are very irritating, and often the infested persons suffer intense skin reactions (Figure 3) which may persist from 3 d to more than a week. Inflammation of the skin on scattered exudates from the bite may occur after about 24 hours. Secondary bacterial infection is very common on persons who could not help but scratch their itchy skin. Female midges bite all parts of the body, particularly the legs and arms, whether the human baits were in sitting or standing position. While in sitting position, the human baits were bitten by an average of 2 and 12 adult midges on the arms and the legs, respectively. However, an average of 2 and 8 adult midges bit the arms and the legs of human baits while in standing position, respectively.

**Diurnal biting activity of *L. (S.) spinosifrons***

Two peaks of biting activity occurred during the 14-h period (Figure 4). The first peak was immediately after sunrise around 0700 h and the other peak shortly before sunset about 1700 h. On February 6, 1976, Takaoka et al. (1976) also found two major peaks of activity after sunrise and before sunset for *L. (S.) spinosifrons* at Mamburao beach. In Brunei, Zachariah

*Figure 3. Human skin with swelling one week after being bitten by *Leptoconops (S.)* spinosifrons.*
Figure 4. Diurnal biting activity of Leptoconops (S.) spinosifrons.
and Noordin (1976) noted that the main peak of midge biting activity was from 0700 to 1000 h. with small peak from 1700 to 1900 h. On the other hand, in the Seychelles Islands, Laurence and Mathias (1972) observed the midges biting activity from just after sunrise to just before sunset, with biting peak around 1700 h.

Among parameters included in the analysis, wind velocity, temperature and relative humidity significantly (P ≤ 0.05) affected the biting activity of the midges in the open beach area (Figure 4). Increasing winds around noon-time were accompanied by decreasing biting activity until around 1400 h towards sunset when the wind decreased to substantial level. Similarly, temperature increased substantially during noon-time up to shortly before sunset. Relative humidity increased during sunrise, decreased to low level during noon-time, then started to increase reaching the peak level during sunset. Cloudiness did not change much during the experiments, and consequently was not significantly correlated with the biting activity of L. (S.) spinosifrons.

Kettle (1969 a, b) observed that the biting activity of the midge, Culicoides fures (Poey) was unaffected by wind velocities below 3.2 km/h but ceased at 9.6 km/h. Koch and Axtell (1979) collected C. fures at wind speed of 12.2 km/h in suction traps. In the present study, we found that the biting activity of L. (S.) spinosifrons paused at 9.5 km/h. At low wind speeds (≥ 5.5 km/h), L. (S.) spinosifrons was very active. When wind speeds at open beach were high, many adult midges sought protection on the vegetation, fallen coconut trunks, logs and cottages in the immediate area.

Abundance of L. (S.) spinosifrons

The seasonal activity of L. (S.) spinosifrons using human baits is shown in Figure 5. Fluctuations in temperature, relative humidity, wind velocity, and rainfall are also indicated. Limited insecticidal fogging activities in the open beach areas during the later part of February, first and last week of March, early and middle parts of April and early May, probably have slightly influenced the decrease in the populations of L. (S.) spinosifrons during the course of the experiments. The midge population decreased to zero during the third week of May. Then suddenly the midge population increased to a higher level during early to middle parts of June. Wind velocity and other environmental factors also might have affected the midge population. However, rainfall reaching up to 64 mm during the third week of May could have triggered emergence of adults. This explains the sudden upsurge in midge populations during the later part of May and early to middle parts of June. It would be worthwhile if populations of the midges could be monitored for at least one year to clearly correlate the effects of environmental parameters to midge population fluctuations.

Using sticky traps, more midges were found along the beach (northwest to southeast) than those towards inland (Figure 6). Since the breeding habitats of the midges are concentrated on the sandy sites along and near the beach areas, then it is expected that most of the midges stay in or near those areas. For midges collected on traps positioned inland, only about 17% of
Figure 5. Weekly counts of Leptoconops (S.) spinosifrons using human baits at Mambuburao, Occidental Mindoro (January 18-June 14, 1986).
Figure 6. Weekly counts of *Leptoconops* (S.) *spinosifrons* using sticky traps at Mamburao, Occidental Mindoro (January 18-June 14, 1986).
the total midges were found beyond 1 kilometer distance from the beach area. This shows the limited dispersal of *L. (S.) spinosifrons*.

Wind directions may be important in distributing host odors at low to moderate wind velocities to unfeud midges, thus stimulating flight toward inland. The winds mostly came from the east (49% of the time), northeast (31% of the time) and southeast (9%). Weaker winds from the west and southwest in some cases, resulted in midge capture in the inland, especially beyond 1-km distance from the beach area.

Midges are also capable of alighting on the clothes and other body parts of humans, thereby facilitating their free transport from place to place. This might greatly influence the future increase in their populations especially in areas of destination with optimum breeding grounds. Female midges alighting on the skin of travelling human host, may continuously suck blood until fully engorged and then drop on the ground to oviposit. If the ground site is sandy and optimum for development, then the midges could easily build up their population on that site. Other animals, such as carabao and cows may also act as a transport vehicle for dispersal of the adult midges.

ACKNOWLEDGMENT

We acknowledge with deep gratitude the financial assistance of the Mamburao Resort Corporation (MRC). We are grateful to Mr. Raymond W. Lehmann, President and Board Chairman of MRC, for his valuable assistance. Special thanks to Mr. Ben Nacu and MRC staff at Mamburao, Occidental Mindoro for their kind help. Thanks also to Mr. Mateo Zipagan for illustrations.

REFERENCES CITED


