A new tabanid fly trap with automatic CO₂-emission apparatus run by weather sensors

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Abstract: A new type of tabanid fly trap which is basically a mosquito-net shape with special collection containers installed inside was constructed, and used with a CO₂-emission apparatus which is run automatically according to temperature, illumination and/or rainfall. When compared with a CO₂-baited mosquito-net trap, the new trap collected 1.8 times more tabanid flies.

INTRODUCTION

A variety of highly effective traps for collecting tabanid flies such as Malaise trap (Townes, 1962), Manitoba trap (Thorsteison *et al.*, 1965), Sticky trap (Watanabe and Kamimura, 1973), Gressitt trap (Thompson and Holmes, 1977) have been reported. At present, two types of tabanid fly traps baited with CO₂ are available commercially in Japan: One is an umbrella shape with sticky fly ribbons inside, developed by Tabuchi *et al.* (1971); the other is a combination of box and pyramid shapes with a collection cage on the top, devised by Taniguchi *et al.* (1976). A mosquito-net trap (Hayakawa, 1988) is used generally in this country for sampling collection of tabanid flies.

For the purpose of controlling tabanid flies in the field, higher efficiency and easier disposition of the flies are required of these traps. Also a crucial problem is how to supply CO₂ as an strong attractant to the flies for a long period in an out-of-the-way field. With these aims in mind, we developed a new type of trap and devised an apparatus which emits CO₂ automatically from a cylinder, according to the activities of the target flies.

MATERIALS AND METHODS

Description of trap. The trap is basically a similar design to a standard mosquito-net trap (Hayakawa, 1988). The structural plan for the trap is shown in Fig. 1 and a photograph of the completed trap in Fig. 2. The frame of the trap is constructed of lightweight iron angles, and is 180 cm long, 150 cm wide, 160 cm high. The V-shaped top and the upper four sides consist of transparent plastic boards, and the lower four sides of black plastic boards, with a wide trap opening underside (80 cm high from the bottom).

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Fig. 1 A schematic diagram of the new trap and its dimensions (in centimeters).

A: bird's-eye view, B: cross section. a, collection container filled with soapy water; b, decoy box.

Fig. 2 The new trap in use with CO₂-emission apparatus (arrow).

The collection containers, which are triangular in shape and filled with soapy water when in use, are attached to both inner sides of the trap, making a gap about 16 cm between the top board and the edge of the containers. For convenience in pouring the water into the containers and taking out the flies killed, the upper side boards are hinged for easy opening. A black decoy box made of styrofoam is hung from the center of the top to make a visual silhouette and to generate heat from solar energy for attracting the flies.

CO₂-emission apparatus. The apparatus consists of a solenoid valve system and a

Fig. 3 CO₂-emission apparatus.

Top: a CO₂ cylinder and a solenoid valve (arrow), bottom: function board of emission apparatus equipped with optical, temperature and rain sensors (arrows A, B and C), and solar charger (arrow D).

Fig. 4 Outline of control circuit with optical sensor in CO₂-emission apparatus.

sensor system. As shown in Fig. 3, the CO₂ supplied from a cylinder is adjusted by regulators to 1.5 kg/cm² pressure and 0 to 10,000 ml/min flow. Emission of the CO₂ is controlled by a solenoid valve which opens and shuts according to the weather sensors. The present apparatus is equipped with optical, temperature and rain sensors. Figure 4 shows an outline of the control circuit of the optical sensor. The three sensors can work independently or optionally in specific combination. The sensitivity of optical sensor and temperature sensor is adjustable in the range of 0–20,000 lx and 0–50°C, respectively. This system is very useful for collecting target flies according to their behaviour patterns. For example, the flight activity of tabanid flies in most species is enhanced in daytime and at over 20°C. Activity of *Hirosia iyoensis*, however, is generally in crepuscular time and at lower temperature (Hayakawa, 1980).

Power to the circuits is supplied from a 12 V battery, which is charged spontaneously by solar energy. The CO₂ through the solenoid valve is led to the inside of the trap, when in use.

Field study. Tests on the trap were carried out at the Omyojin Farm, Faculty of Agriculture, Iwate University, at Shizukuishimachi, Iwate Prefecture, in 1989. At first, collection efficiency was examined by changing the component dimensions of a prototype trap. Also, the attractiveness of a decoy to the flies was checked. Secondly, trap efficiency was compared between a completed new trap and a standard mosquito-net trap (Hayakawa, 1988). Both traps baited with the same amount of CO₂ (2,000 ml/min) were installed in a pasture 10 m apart, and

the locations were exchanged every hour. Thirdly, performance of the new trap with or without CO₂ was tested.

RESULTS AND DISCUSSION

In the test field, *H. humilis*, *T. nipponicus* and *T. chrysurus* were the dominant species. The present size of the trap opening (80 cm high from the bottom) was favourable for most of the tabanid species. *H. humilis*, however, which is a small-sized species and an attacker on the lower parts of the host (Hayakawa, 1980), could smoothly enter into the trap through a much narrower opening (up to 40 cm from the bottom). The gap between the collection container and the top board also affected the collection efficiency. The present size of the gap (about 16 cm) was most appropriate for the flies to be guided to the collection container. When the gap was larger than this, the number of escaping flies increased. Once the flies dropped into the soapy water in the container, all of them were killed instantly. A decoy attracted most of the flies, especially *T. chrysurus*, *T. rufidens* and *T. trigeminus*. The presence of the decoy often helped these species enter into the collection containers upwards, after alighting on it for a while. The color, size or position of the decoy, however, are subject to further study.

The new trap provides much larger entrance to the collection container, compared with those of the Malaise trap (Townes, 1962), Manitoba trap (Thorsteinson *et al.*, 1965) and Gressitt trap (Thompson and Holmes, 1977). Also, the collection method, *i.e.*, in soapy water, adopted by the new trap is thought to be superior to the sticky type (Tabuchi *et al.*, 1971; Watanabe and Kamimura, 1973) in respect to instant lethality. Therefore, the new trap is expected to be more advantageous, structurally and methodologically, for collecting tabanid flies.

Table 1 shows the number of each tabanid species collected by the new trap, compared with a standard mosquito-net trap. The new trap collected 1.8 times as many flies as the latter trap. The biggest difference in numbers (3.4 times) was observed in *T. chrysurus*, a large-sized species and an attacker on the upper parts of the host. For this species, the

Table 1 Comparison of number of tabanid flies collected by the two types of traps baited with CO₂.

Species	New trap (A)	Mosquito-net (B)	Ratio (A/B)
<i>Hirosia humilis</i>	513	246	2.1
<i>Tabanus nipponicus</i>	161	170	0.9
<i>T. chrysurus</i>	152	45	3.4
<i>H. sapporoensis</i>	24	14	1.7
<i>T. trigeminus</i>	18	8	2.3
<i>T. trigonus</i>	15	9	1.7
Other species	19	22	0.9
Total	902	514	1.8

Date: August 3-4, 1989.

Table 2 Number of tabanid flies collected by the new trap baited with (+) or without CO₂ (-).

Species	Aug. 5-11 —	Aug. 12-16 +	Aug. 29-Sept. 9 +
<i>Hirosia humilis</i>	241	1,386	167
<i>Tabanus nipponicus</i>	42	523	242
<i>T. chrysurus</i>	6	456	35
<i>H. iyoensis</i>		486	28
<i>H. sapporoensis</i>	2	361	3
<i>T. trigeminus</i>	13	70	56
<i>T. rufidens</i>	3	96	15
<i>Chrysops basalis</i>		21	10
<i>T. katoi</i>		7	8
<i>T. kinoshitai</i>		4	7
<i>C. suavis</i>		1	2
<i>Atylotus horvathi</i>		1	
<i>T. trigonus</i>			3
<i>T. inaensis</i>		1	
Total	307	3,413	576
(per day)	(44)	(683)	(48)

opening of the mosquito-net trap was positioned a little lower and narrower.

Table 2 shows the collection data of the new trap, when baited with or without CO₂ as an attractant. Only a few flies, averaging 44 flies a day, were collected without CO₂, from August 5 to 11, although this was the peak period of fly occurrence in the test area. When baited with CO₂, from August 12 to 16 in the peak period, the new trap collected a promising number of flies, averaging 683 flies a day. The numbers collected, however, decreased remarkably in the late occurrence

season, from August 29 to September 9.

In the field study, the CO₂-emission apparatus worked well as planned. The favourable amount of CO₂ for attracting tabanid flies is about 1,500 ml/min (Hayakawa, 1988). On this emission level, the trap could be operated for 20-30 days, under normal weather conditions, using the CO₂ stored in a 30 kg cylinder. As regards the collecting function, the new trap is somewhat similar to the walk-through trap reported by Robert and Doisy (1989) for control of horn flies on pastured cattle. With minor structural

adjustment, the present trap may be applicable as a walk-through trap for the same purpose. A report on comprehensive study on the seasonal collection by the new trap is planned for a later paper.

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摘 要

炭酸ガス自動放散装置を備えた
アブ捕獲用の新型トラップ

新型トラップの本体は蚊帳に似た形（高さ 160 cm, 長さ 180 cm, 幅 150 cm）で、天井はV字型透明板、上半分をおおう周囲の側壁は上方が透明板、下方が黒色板からなり、上半室部の両側内部に捕虫用の三角トレー（洗剤を入れた水盤）を備え、中央には黒色のデコイ（アブ誘引用の箱）を吊り下げた構造をしている。アブ誘引用の炭酸ガスは、照度、湿度（いずれも設定範囲可変）、降雨センサの制御による電磁バルブの自動開閉装置（ソーラー・バッテリー使用）により、30 kg ボンベで20~30日間、人手を介さずに放散可能である。炭酸ガス誘引の蚊帳トラップと比較して、この新型トラップでは1.8倍のアブ捕獲数が得られた。