A TELESCOPING COLLECTION CUP CHANGER FOR INSECT TRAPS[1, 2]

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ABSTRACT. A description is provided of a time interval insect sampler that has been used in suction traps but would also be useful with light traps. The device is capable of taking 27 successive samples. Principle of operation involves 2 telescoping concentric cylinders. The collection cups, mounted in the motor driven inner cylinder, are closed by the wall of the outer cylinder as the inner cylinder spirals inward about a helix screw.

INTRODUCTION

When researchers use mechanical devices to sample insect populations, it may be necessary to examine trap catches at multiple time intervals each day. Light and suction traps which concentrate insects at the apex of a screen cone by means of an air stream can be modified to take interval catches. To accomplish this, 2 different mechanical principles have been used.

The turntable type is composed of 6–12 jars attached below a row of matching holes bored just within the circumference of a large disc. The disc is mounted horizontally and is rotated once by small increments, this movement bringing each jar successively beneath the trap (Hutchins 1940, Nagel and Granovsky 1947, King et al. 1965, Standfast 1965, Koch et al. 1977, Mitchell 1982). More recently, Holub (1983) mounted 3 jars on a linear slide to take light trap catches automatically over weekends.

Johnson (1950) and Taylor (1951) developed a suction trap that divided the catch into 25 subsamples by dropping discs. A cylinder replaced the usual collection jar. The discs were strung on a vertical rod which extended from the bottom of the cylinder to well above its upper end, where a releasing mechanism suspended the discs. Horsfall (1962) described a similar device. Bast (1960) also employed a metal tube beneath the trap. However, he mounted 6 solenoids vertically at equal distances along the outside of the tube. Each solenoid, when activated, pulled a thin separator through a matching narrow slot in the side of the tube which divided the tube into compartments. Recent studies on the effect of wind upon mosquito flight activity required a collection cup changer that would operate in a horizontal air stream and also be adaptable to the confines of the suction traps used here (Bidlingmayer and Hem 1979). These needs led to the development of a collection cup changer employing a different principle from those previously used.

DESCRIPTION

The collection cup changer consists of 3 major components: A. a base assembly, B. a pair of telescoping cylinders with a helix screw and C. a motor drive. Detailed descriptions follow (Fig. 1).

A. THE BASE ASSEMBLY. A plywood base plate (1) measuring approximately 16 × 16 × ¾ in, was furnished with 2 clamps to hold the basal disc of the helix screw (to be described). Four hollow aluminum columns, each 12¼ in. in length by 1 in diameter (2), were firmly fastened to the base by 14 in × ¼ in threaded rods (3) passing through their centers. The columns were placed just outside the circumference of a 6 in diameter circle at intervals of 0°, 118°, 180° and 242°. Two 31 in × ¾ in guide rods (4) were clamped to the 2 columns located at 0° and 180°. A slotted collar (5) bound the tops of the 4 columns together.

B. THE CYLINDER ASSEMBLY. The telescoping cylinders were machined from cast acrylic plastic tubing. The outer cylinder (6) measured 15⅛ in × 4½ in (inside diameter) with ⅛ in wall thickness and was open at both ends. An opening, the inlet port (7), 3 in (tangential distance) × ¾ in, was made ¼ in below the upper edge of the cylinder. A notch (8), 3 in × ⅜ in was cut 180° opposite the inlet port in the upper edge of the cylinder. A small block (9), approximately 1 in long, served as a key and was glued 2½ in below the upper edge of the cylinder. In Fig. 1 the lower half of the outer cylinder is cut away to show the inner cylinder.

The inner cylinder (10) measured 15⅛ in × 4½ in (outside diameter) × ¼ in wall thickness. It was turned down on a lathe until it telescoped easily within the outer cylinder. Plastic end plates (11), ¼ in thick, were cemented into both ends of the cylinder. An upper spindle (12) was made on a lathe from a 1⅜ in diameter rod by

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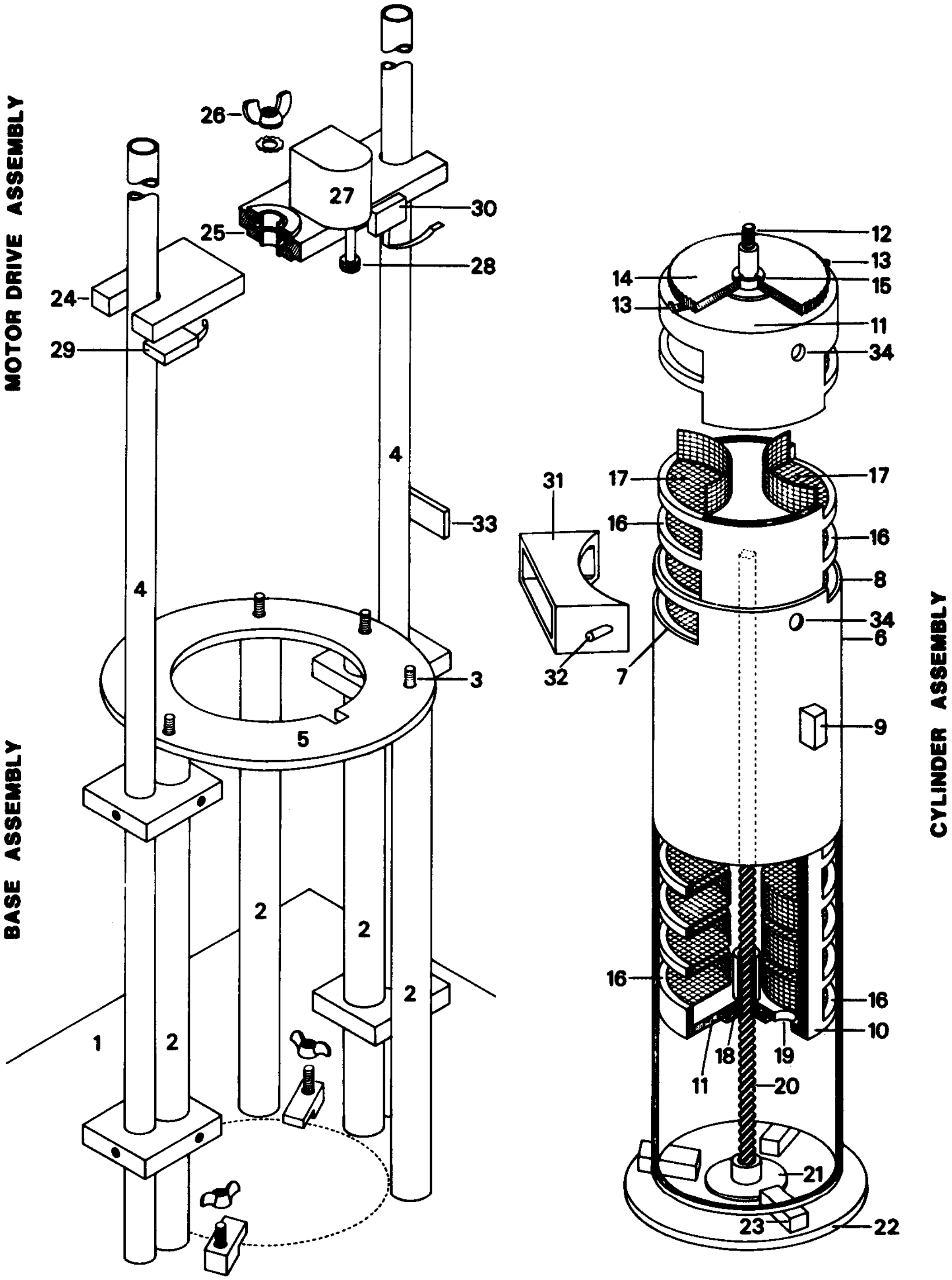
MOTOR DRIVE ASSEMBLY
BASE ASSEMBLY
CYLINDER ASSEMBLY
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cutting a 1⅜ in × 1/16 in basal flange, then reducing the rod diameter to ⅝ in for a distance of 3/16 in, reducing the diameter to ½ in for a distance of 13/16 in and reducing the rod again to ⅜ in for a distance of ½ in. The last section was then threaded to receive a wing nut. The spindle (12) was mounted in the center of the upper end plate (11). Two eared tabs (13), to engage a microswitch, each fastened by a single screw, were set on opposite sides of the upper end plate just within the edge of the cylinder. A 256-tooth gear (14), 4 in diameter with a ⅝ in center hole, was placed over the spindle (12). A ⅞ in washer with a ½ in center (15) was also placed on the spindle. A total of 28 openings (16), 3 in (tangential) × ¾ in were cut horizontally in the inner cylinder wall. Fourteen openings were positioned ¼ in apart, the lowest ¼ in above the bottom edge of the cylinder. On the opposite side of the cylinder a second row of identical openings, but starting ¾ in above the bottom edge, was made along the length of the cylinder. The rows were identical other than the second row was offset ½ in above the first. Screen wire collection cups, 1/16 in mesh, (17), 1¾ in deep and approximately semicircular in shape, were cemented into each opening except the uppermost. A flanged helix nut (18) extending 2 in inside the cylinder, was fastened to the center of the lower end plate (11). Three ¾ in diameter holes (19), spaced equidistantly around the periphery of the end plate, provided drainage.

A stainless steel helix screw (20) that provided 1 in of linear travel per revolution (1:1) was attached by a flange (21) to the center of a 6 in × 3/16 in basal disc. (22). The helix screw passed through the nut of the lower end plate and into the inner cylinder. Glued equidistantly around the disc between 1 in and 1½ in from the screw were three 1½ in × 5/16 in × 5/16 in spacers (23), which held the outer cylinder above the basal disc.

C. THE MOTOR DRIVE ASSEMBLY. A yoke (24), 10¾ in × 2 in × ½ in, was notched at both ends to fit loosely between the ¾ in guide rods (4). Centered in the yoke were 2 ball bearings (25), mounted vertically to receive the ½ in diameter section of the spindle (12). A lock washer and wing nut (26) secured the yoke to the inner cylinder. A 115 volt, 5-watt timing motor (27), with an output shaft of 12 revolutions per min (rpm), was mounted on the yoke. The output shaft turned a 32-tooth gear (28). Two microswitches (29, 30), were mounted on the yoke to turn off electric current to the timing motor. Motor and microswitches were furnished with shields to deflect rain drawn into the traps (not shown in Fig.).

The complete unit consisted of 1 base assembly, 2 cylinder assemblies and 1 motor drive assembly.

OPERATION

To prepare for a night's operation, a telescoped cylinder assembly was placed on the base assembly within the 4 columns (2). The collar (5) was fitted over the cylinder assembly and the 4 columns, the slot in the collar engaging the key (9) of the outer cylinder. The key prevented the outer cylinder from turning. The basal disc of the helix screw (22) was rotated until the collection cups were brought into exact alignment with the inlet port (7) of the outer cylinder. The basal disc was then clamped to the base (1). A connector (31), which hooked into the inlet port (7), was held in place by a large rubber band looped over pegs (32) and about the outer cylinder (6). The connector linked the inlet port with the apex of the screen cone of the suction trap. The inner cylinder (10) was now rotated until fully extended with the lowest collection cup opening into the inlet port. The motor drive assembly was placed on top of the inner cylinder between the guide rods (4), the gears meshed (14, 28), and the yoke (24) secured to the cylinder assembly with the lock washer and wing nut (26). An assembled unit is shown in Fig. 2.

The air stream within the suction trap forced mosquitoes toward the apex of the trap's screen

Fig. 1. Telescoping collection cup changer. For details, see text.

Base assembly.	1. Base plate with 2 clamps, wing nuts. 2. Columns.
	3. Threaded rods. 4. Guide rods. 5. Slotted collar.
Cylinder assembly.	6. Outer cylinder. 7. Inlet port. 8. Notch.
	9. Key. 10. Inner cylinder. 11. End plates.
	12. Upper spindle. 13. Eared tabs. 14. Gear, 256 teeth. 15. Washer. 16. Cup openings.
	17. Collection cups. 18. Helix nut. 19. Drain holes. 20. Helix screw. 21. Flange, helix screw.
	22. Basal disc. 23. Spacers.
Motor drive assembly.	24. Yoke. 25. Ball bearings. 26. Lock washer, wing nut. 27. Motor. 28. Gear, 32 teeth. 29. Microswitch. 30. Microswitch.
Other	31. Connector. 32. Pegs. 33. Stop. 34. Locking holes.

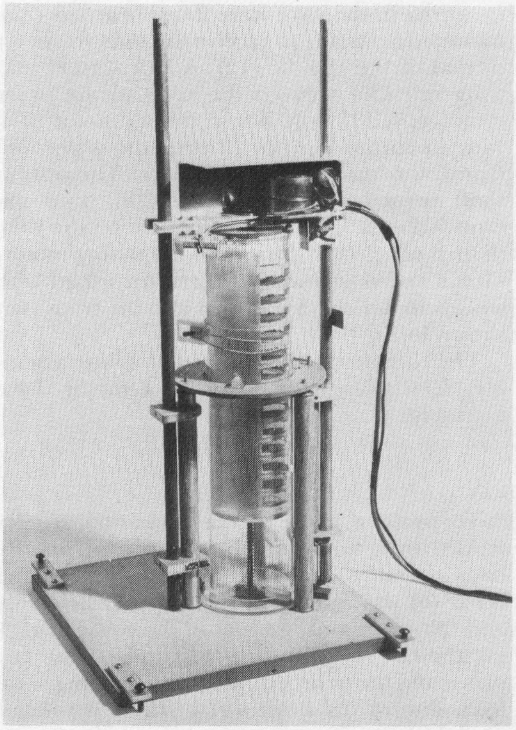

Fig 2. Telescoping collection cup changer assembled. Rain shields in place about motor drive assembly.

cone, through the connector, and into the collection cup. Air entering the interior of the inner cylinder escaped through the empty cups above, through the uppermost opening which lacked a collection cup, or through the drain holes in the lower end plate (19). A time clock transmitted electricity to the timing motor (27) at the end of each collection period. When the motor was activated, the inner cylinder simultaneously turned and descended within the outer cylinder, whose wall confined the catch. When the cylinder had rotated 180°, a tab (13) on the inner cylinder contacted a microswitch (29) which interrupted the current to the motor at the moment the next collection cup was aligned with the inlet port. Sealing the catch and aligning the next cup required 20 sec. After the 27th collection was taken, a stop (33) fastened to one of the guide rods contacted the second microswitch (30) which prevented further delivery of current to the motor.

After all catches were taken a peg was inserted through the locking holes (34) of the inner and outer cylinders, to prevent the inner cylinder from turning and accidental loss of collections. Inner and outer cylinders were removed as a unit, the procedure being the reverse sequence of its installation. An alternate cylinder assembly could now be installed, if desired.

Captured mosquitoes were killed by placing the cylinder assembly in a freezer. After killing, the inner cylinder was rotated in the opposite direction to re-expose the collection cups. The mosquitoes were swept with a camel's hair brush from the collection cup and through the inlet port onto a shallow tray. The tray had one side curved to fit against the outer cylinder and was held in place with a large rubber band.

DISCUSSION

Two important requirements of any time interval collection device are: 1. Insects captured during a collection period must be promptly delivered into the appropriate collection cup. As collection jars or other containers with closed ends preclude a through passage of air, a turbulent air pocket is formed within the jar. In traps equipped with such jars, many insects may be observed, often for long periods, clinging to the wire screen just above the jar. Collection containers that do not permit the airstream to carry the catch into the container are unsuitable for taking time interval catches. 2. Once within the container, the catch should not be able to escape after the airstream is no longer present. At the end of the collecting period, most of the catch is alive. In turntable collection devices toxic chemicals are often relied upon to kill the catch, as the jars are not usually sealed. The numbers of insects that may escape before being overcome is unknown. The telescoping cup changer meets both these requirements. The airstream passes through the collection cups and the cups are closed after exposure.

Most Florida mosquitoes are crepuscular with a large peak of flight activity occurring after sunset and a smaller peak before sunrise. Catches from suction traps located adjacent to a salt marsh were examined during a 4-hr period centered about sunrise to establish whether mosquitoes were appearing in the current or in a subsequent collection cup (Table 1). The expected morning peak of activity before sunrise, and the rapid decline thereafter as mosquitoes sought daytime resting sites, were indicated clearly. It was concluded that the suction trap-telescoping cup changer combination provided a reliable tool for measuring mosquito flight activity.

If additional units were to be built, only a few changes would be made: 1) Wall thickness of the outer cylinder would be increased to ¼ in. Cylinders that had telescoped freely had the tendency to bind, with further sanding of the inner cylinder necessary. Our machinist attrib-

Table 1. Mean$_w$ number (Williams' mean) of female mosquitoes (mostly *Culex nigripalpus* Theobald and *Deinocerites cancer* Theobald) taken at 15 min intervals on 74 trap nights. The cup changer was operated in a suction trap from 2 hr before sunrise (−2:00 hours) until 2 hr after sunrise (2:00).

Time		Number captured
−2:00–1:45		8.0
−1:45–1:30		7.3
−1:30–1:15		7.6
−1:15–1:00		6.3
−1:00–0:45		7.1
−0:45–0:30		11.6
−0:30–0:15		10.6
−0:15–0:0		2.8
<	sunrise	>
0:00–0:15		0.9
0:15–0:30		0.4
0:30–0:45		0.2
0:45–1:00		0.1
1:00–1:15		0.2
1:15–1:30		0.2
1:30–1:45		0.2
1:45–2:00		0.1

uted this to slight changes with time in the shape of the outer cylinder and believed a more rigid wall would solve the problem. Although made from cast acrylic tubing, the dimensions of the tubes were far from true and it may be advisable to seek another material. 2) The collection cups in the inner cylinder could be arranged in three rows at intervals of 120° rather than in two rows at 180°. Taking 3 instead of 2 catches per revolution would reduce the cup changer's overall height from 32 in to 22 in. This would require a third tab on top of the inner cylinder.

Although this sampler was used in a vertical position to take mosquitoes from a horizontal airstream, as the telescoping cylinder is motor driven it should also operate satisfactorily in a horizontal position, i.e., to sample a vertical airstream. Four of these units were used for 50 nights during July to November, 1983 and, except during an earlier period of 2 to 4 weeks when some adjustments were necessary, have proven highly reliable.

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