Journal of the Lepidopterists' Society
43(4), 1989, 289–298

AN INEXPENSIVE PORTABLE TRAP FOR MONITORING BUTTERFLY MIGRATION

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ABSTRACT. Seven types of low-cost flight traps for monitoring migrating butterflies were designed, built, and tested. The most efficient type caught ca. 7–55% of the migrants crossing a 3- or 6-m line perpendicular to the direction of migration. Traps of polyester mosquito netting, monofilament shrimp netting, or a combination of the two did not differ significantly in capturing spring migrating *Precis coenia*. Trios of 3-m traps yielded consistent estimates of variation in numbers of *P. coenia* migrating during spring. Portable traps can be used in mark-and-release studies of migrating butterflies and for quantifying distribution of migrants in time and space. Instructions for building the most efficient type of portable trap are given in the Appendix.

Additional key words: *Precis coenia, Phoebis sennae,* phenology, Florida, trap efficiency.

Migrating butterflies generally fly in a straight line within a few meters of the ground. When they encounter an obstacle, their response is to fly up and over rather than around (Williams 1930). This behavior can be exploited in devising traps that intercept and capture migrants (Walker 1978, 1985a, Gyotoku et al. 1987).

Early traps were inefficient and expensive to maintain; later ones were elaborate, permanent structures costing ca. $500 each for materials (Walker 1985a). Our long-term goal in the present study was to develop an inexpensive, portable trap that would encourage and facilitate studies of butterfly migration. For the short term, we needed traps to quantify the phenology of butterfly migration at numerous stations on transects along and across the Florida peninsula and to enable high school science classes to catch migrants for marking and release.

Our study compared five variations of the most promising of two prototype portable traps (Part I) and tested three fabric coverings of the most promising variation (Part II).

I. PROTOTYPES AND PILOT TESTS

During spring 1987, we built and tested two prototype traps that contrasted in complexity and cost but that proved similar in efficiency. That fall we tried five variations of the less expensive design.

Materials and Methods

All traps were of gray polyester mosquito netting supported by end frames largely of thin-wall metal electrical conduit. Cross members and guys were braided nylon rope. Cages that retained the trapped but-

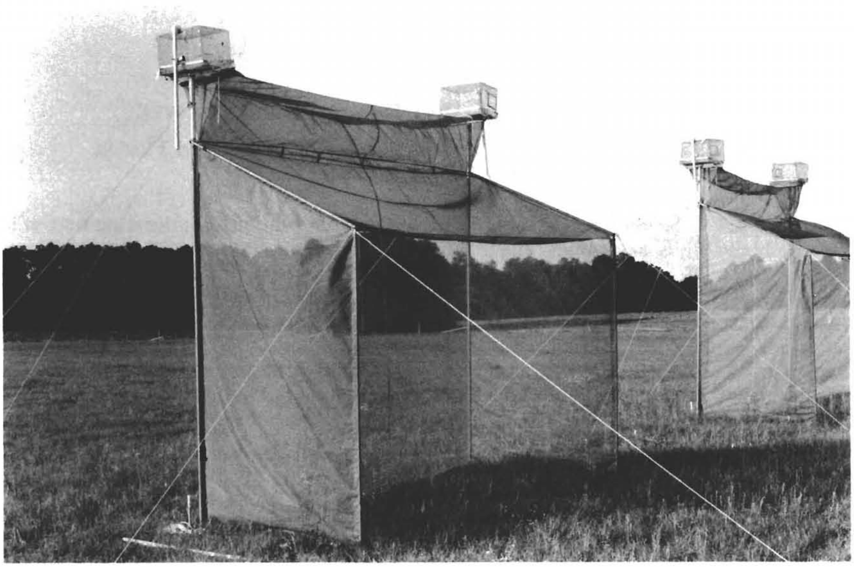

FIG. 1. Standard traps. Trap in foreground is of polyester mosquito netting; the other has the main wall and back of duct of monofilament shrimp net.

terflies were made of 6.4 mm (¼″) hardware cloth held together by pop rivets. Traps were generally 3 m long with openings 2 m tall.

During the 1987 fall migration, we tested these five variants of the simpler prototype trap:

(1) Standard trap. This variant (Fig. 1) was most similar to the prototype and is described in detail in the Appendix. It was designed to catch butterflies coming from one direction.

(2) Two-way trap. This trap was two standard traps on opposite sides of a shared main wall. The duct and cages were partitioned to segregate butterflies entering the trap from opposite directions, thus permitting calculation of net movement in the migratory direction (as in earlier traps; e.g., Walker 1985a).

(3) Six-meter trap. This trap was identical to the standard trap except it was 6 m instead of 3 m wide.

(4) Taller-opening trap. The roof of the standard trap sloped from 2.6 m to an opening 2.0 m tall. The roof of the taller-opening trap was horizontal, producing a 2.6 m opening.

(5) Deeper trap. This trap had roof and side walls twice as deep as in the standard design (3 m vs. 1.5 m for the roof). The opening was still 2.0 m tall, reducing the slope of the roof to half that of standard.

In early October 1987, traps were erected randomly along an ENE–WSW line in an 8-ha open field at the University of Florida's Green

TABLE 1. Relative trapping efficiencies of portable traps for *Phoebis sennae*: fall migration, 1987.

Trap	Days[a]	Relative efficiency[b] n = 555[c] (501)
Standard	38	0.66[d]
Standard	30	0.83
Two-way	29	0.72
6-meter	31	0.95
Taller-opening	21	0.4
Deeper	11	(0.4)[e]
1st four combined	128	0.78

[a] Portable traps were in service for various periods during 1 Oct to 8 Nov.
[b] (Number caught flying southward per meter by portable trap)/(number caught flying southward per meter by permanent trap).
[c] Total caught in north-facing portable traps. Value in ( ) is total for first four traps listed.
[d] Efficiencies with no ( ) are for >40 individuals caught in the portable trap.
[e] Efficiency based on 12 individuals caught in the portable trap.

Acres Farm (29°41'N, 32°20'W) near Gainesville. Two standard traps, the two-way trap, and the 6-meter trap were run simultaneously for 29 days or more; the taller-opening and deeper traps were run sequentially (Table 1). All traps faced NNW, into the migratory stream (Walker 1985b). Captures were recorded daily for all traps: after 1600 h or before 1000 h of the next day. For the standard traps, captives were marked on the wings with a silver marking pen and returned to the trap cages except on Mondays and Thursdays, when they were permanently removed. Captives were removed daily from the remaining traps. The marked captives were used to estimate the rate at which butterflies disappeared from the cages by predation or escape. This was an important consideration in evaluating the effects of reducing the trap service interval to twice weekly.

Two permanent traps, Walker's (1985a) model #3 and a minor modification of it, continuously monitored the migration across 12 m of ENE–WSW line at a site 4.4 km ESE of the portable traps. For species that cannot pass through 1.3 cm mesh hardware cloth, these traps catch 22 to 70% of migrants.

Results and Discussion

Numbers of fall migrants per meter caught by the various portable traps were compared to the numbers caught per meter by the two permanent traps (Table 1). This method of expressing results in terms of relative trapping efficiency was used for two reasons. First, the absolute trapping efficiencies of the model #3 trap had been estimated through direct observations (Walker 1985a), making possible estimations of the absolute efficiencies of the portable traps. Second, direct comparisons among portable traps were complicated by small catches and by different durations of service. The permanent traps ran continuously and sampled more of the migratory front than any single type of portable trap.

Phoebis sennae (L.) (Pieridae) was the only migrant caught by the portable traps in substantial numbers. The taller-opening and deeper traps ranked lowest in catching this species, and the 6-m trap ranked highest (Table 1). When results from the four traps that were standard in height of opening and depth of walls and roof were combined, the estimate of relative efficiency became 0.78. If the rates of migration at the portable and permanent traps are assumed to be the same, the estimated absolute efficiency of standard portable traps in catching *P. sennae* becomes 38 to 55%. (The permanent traps caught 49 to 70% of *P. sennae*: Walker 1985a.)

The two-way trap caught 81 *P. sennae* flying south and 3 flying north, for a southward consistency of 96%, not significantly different from the consistency of 98% (447 south and 9 north) for the permanent traps during the same 29-day period.

Marked butterflies disappeared from the cages of the standard traps at an average rate of 12% per day ($n = 147$ butterflies and 284 butterfly-cage-days). The rates of disappearance for the two traps were similar (chi square: $P > 0.50$). Rates of disappearance between day 0 (=day of marking) and day 1, between days 1 and 2, and between days 2 and 3 were similar (chi square: $P > 0.95$).

The standard trap equaled or exceeded the performance of its variants in the the fall 1987 tests—with the possible exception of the 6-m trap, which caught 28% more *P. sennae* per meter than the mean of the two standard traps.

II. Replicated Tests of Trap Fabrics

During the spring of 1988, we tested standard traps made of different fabrics. This was prompted by two problems noted the previous fall: polyester netting tore easily after a few months of exposure to sunlight, and migrating butterflies seemed to detect and avoid portable traps made of polyester more frequently than permanent traps made of 1.3 cm mesh hardware cloth.

Materials and Methods

The fabrics tested were polyester mosquito netting; shrimp net (9.5 mm square mesh made of knotted 0.28 mm diameter nylon monofilament); and a combination of polyester netting and shrimp net. The polyester traps were from the previous fall; the shrimp net traps were made by stretching the monofilament netting on a frame and gluing edges together with silicon caulking; the combination traps were made

TABLE 2. Number of *Precis coenia* captured by standard portable traps of three fabric types, Green Acres Farms: spring migration, 1988.[a]

Date	Block	Type of fabric			
		Polyester	Combination	Shrimp net	Mean
6–22 April					
	(Blocks in sequence: west to east)				
	I	7	19	20	15
	II	2	7	12	7
	III	31	9	17	19
	Mean	13	12	16	14
23 Apr–31 May					
	(Block I moved to east end of array)				
	I	18	19	13	17
	II	4[b]	28	9	17
	III	30[b]	25	11	19
	Mean	17	24	11	17
6 Apr–31 May					
	Mean (n)	30.7	35.7	27.3	31.2
	Mean (n/m)	9.7	11.3	8.7	9.9

[a] Analysis of variance for effect of fabric type showed no significance. (F value = 0.77, P = 0.46; model degrees of freedom = 3 fabrics − 1 = 2; error degrees of freedom = 504 trap-days − 1 = 503.)
[b] These numbers are for the traps, which were exchanged in position 11 May. The numbers for the trap positions are 14 and 20.

by cutting out the main wall and the back of the duct of polyester traps and gluing shrimp net in their places.

Three traps of each material were erected along a 67-m ENE–WNW line in the field at Green Acres Farm. The traps were assigned to three randomized blocks with the constraint that the first trap in one block could not be of the same material as the last trap in the previous block. Traps were separated by 5 m, and the mouth of each trap was made 3.15 m wide.

Traps were serviced daily starting 6 April 1988. After 17 days, traps in Block II had caught fewer than half the numbers of migrants caught in the outside blocks, and the eastmost trap (Polyester III) had caught >1½× as many migrants as any other trap. On 23 April, to test for possible effects of relative or absolute trap position, we removed the three traps of Block I from the west end of the array and erected them east of Block III, thereby making Block II an end block and Block III the middle block. By 10 May, Polyester II and Polyester III, which had caught 2 and 31 butterflies, respectively, before Block I was moved, had caught 3 and 19 more, indicating that relative position of blocks had not caused the discrepancy. To distinguish between an individual trap effect and an absolute position effect we exchanged the two traps.

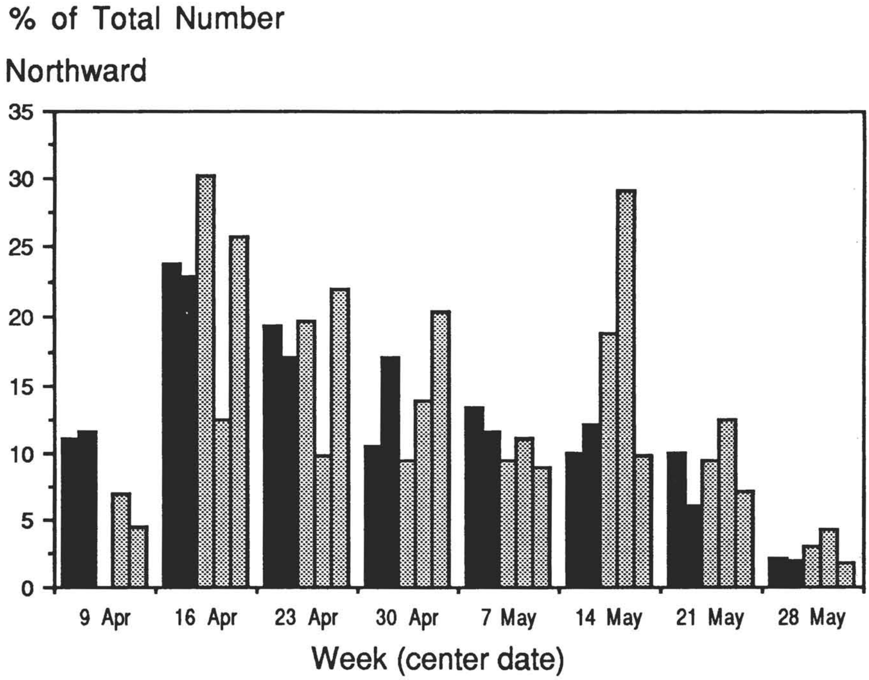

FIG. 2. Seasonal course of migration of *Precis coenia*, spring 1988, as recorded by two permanent traps (black bars) and by three trios of portable traps (stippled bars, representing traps of Blocks I, II, and III).

We concluded the test 31 May, when spring migration had ended. As before, two permanent traps were operated continuously.

Results

As expected from previous studies (e.g., Walker 1985a), *Precis coenia* (Hübner) (Nymphalidae) was the only spring migrant numerous enough to yield data useful in comparing trapping efficiency. Analysis of variance revealed no significant differences among fabric types (Table 2).

During 11–31 May, the Polyester II trap (moved to Block III) caught 1 migrant; Polyester III (moved to Block II) caught 11. These numbers are similar in ratio to the total catches of 5 and 50 prior to swapping, indicating that the trap rather than the position caused the variation.

The mean number of *P. coenia* caught per portable trap 6 April to 31 May was equivalent to 9.9 individuals flying south across each monitored meter (mean no. caught per trap/meters per trap = 31.2/3.15). During this time, the permanent traps caught 381 *P. coenia* or 31.8 per monitored meter. If the migration rate was the same at the two sites, the portable traps were 31% as efficient as the permanent traps. For the three most numerous migrant species, the permanent traps are

22 to 70% efficient (Walker 1985a). Applying these figures to the present data, the estimated absolute efficiency of the portable traps in catching *P. coenia* is 7 to 22%.

The three trios of portable traps and the two permanent traps produced similar estimates of weekly changes in numbers of migrating *P. coenia.* A chi square test of the weekly total catches for the five estimators (Fig. 2) did not refute the hypothesis that all had come from the same distribution (chi square = 19.2, df = 28, $P > 0.75$).

Discussion

Shrimp net did not result in a significant increase in the standard trap's ability to catch *P. coenia,* but it lasted longer outdoors and had less wind resistance.

An unexpected result of the tests was that supposedly identical traps of polyester differed greatly in numbers of migrating *P. coenia* caught: 6, 25, 61. The totals for the other traps were much more uniform—viz., 34, 35, 38 for combination traps and 21, 28, 33 for shrimp net traps. Inspection of the poorly performing polyester trap revealed that its throat was narrowed at one end and that its catching cages fitted loosely into the holding trays. Loose fitting catching cages were evident on other traps, and on three occasions we watched a *P. coenia* escape through a crack rather than enter a catching cage. Polyester III (n = 61) had a uniform throat and snug fitting cages.

The efficiency of the traps for smaller migrants (such as *P. coenia*) could probably be increased and the variance in catches reduced by redesigning the trays and building the cages to closer tolerances. A substantial improvement might also be obtained by experimenting with the width and uniformity of the throat. Traps of greater width, such as the 6-meter trap, offer a cost-effective means of increasing the catch.

Unless the variance in catch among traps is reduced, groups of about 5 traps are needed to achieve a 95% chance of detecting a twofold difference in numbers of migrants at two sites (Snedecor & Cochran 1980: 102; formula adjusted for variance being an estimate).

Standard portable traps have been used to capture fall migrants for marking and release at four high schools in southern Georgia (J. J. Whitesell pers. comm.) and to quantify fall migration at five stations along a north–south transect from Valdosta, Georgia, to Lake Placid, Florida (B. Lenczewski pers. comm.).

ACKNOWLEDGMENTS

We thank J. J. Whitesell for help with construction of the combination and monofilament traps and R. C. Littell and G. S. Wheeler for help with statistical analysis. The suggestions of S. Malcolm, J. J. Whitesell, and Oakley Shields substantially improved the manuscript. Florida Agric. Exp. Sta. Journal Series No. 9481.

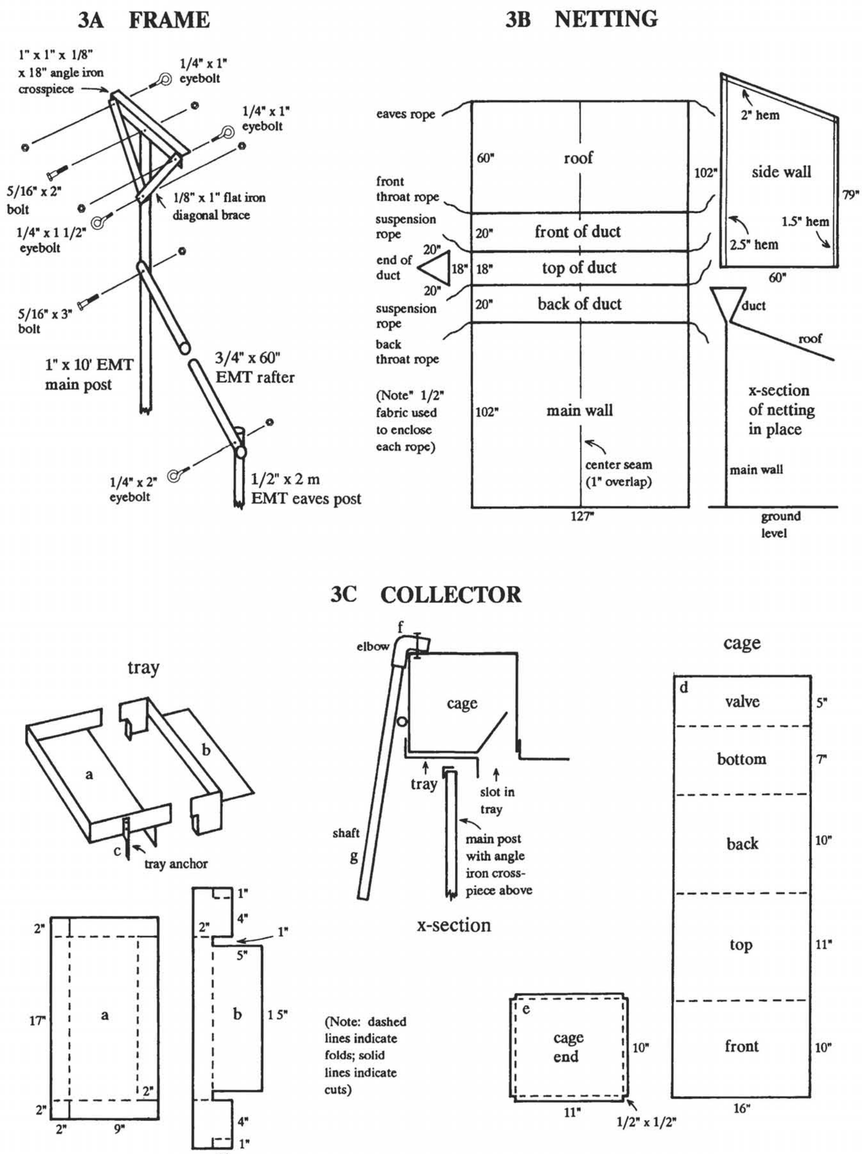

FIG. 3. Construction details of standard trap. (Dimensions are in inches: 1″ = 2.54 cm.)

APPENDIX: BUILDING A TRAP

The standard portable trap (Fig. 1) consists of a frame, netting, and collectors that are built separately and then assembled (Fig. 3). Total cost of materials (1988) is ca. $68 per trap. (Most measurements are in inches: 1″ = 2.54 cm.)

Frame (ca. \$23 for materials). Each end of the trap is supported by a 120″ main post (1″ thin-walled metal electrical conduit = EMT), a 2 m eaves post (½″ EMT), and a 60″ rafter (¾″ EMT) (Fig. 3A). Attach 18″ crosspiece of 1 × 1 × ⅛″ angle iron to top of each main post with $\frac{5}{16}$ × 2″ bolt. Strengthen crosspiece with diagonal braces (Fig. 3A) or with a welded 8″ length of 1 × ⅛″ flat iron (Fig. 1). Secure bottom of braces to main post with ¼ × 1½″ eyebolt. At each end of each cross piece attach ¼ × 1″ eyebolt. Attach rafters to main posts at 102″ with $\frac{5}{16}$ × 3″ bolts and to top of eaves posts with ¼ × 3″ eyebolts. Make eight guys (4 @ 120″ and 4 @ 144″) of ⅛″ braided nylon rope. Make eight 15″ guy stakes of ½″ EMT; to keep rope from slipping off, put a ¼″ bolt through each stake at 2″ from top. Optional: Prepare four "feet" for the posts by cutting short pieces of ¾″ EMT that can be driven into the ground or welded to $\frac{3}{32}$ × 2 × ½″ pieces of flat iron. The posts fit over or into the ¾″ EMT.

Netting (ca. \$33). (We used 653″ of 64″ wide "silvergray polyester mosquito netting".) The main wall, duct (except ends), and roof are two 222.5″ lengths of fabric joined lengthwise by sewing with nylon thread. At the indicated intervals (Fig. 3B), sew the fabric around five 130″ lengths of ⅛″ braided nylon rope. Cut two pieces for side walls from 185″ of netting (81″ short side, 104″ tall side) (Fig. 3B). In each, sew 1.5″-wide front hem (for eaves post), 2.5″ rear hem (for main post), and 2″ top hem (for rafter). Cut two 20 × 20 × 18″ triangles. Sew top hems of side walls to roof, triangles to ends of duct, and wide hems of side walls to main wall. (The trap can be made wider by using more than two 222.5″ lengths of netting and longer ropes.)

Collectors (ca. \$12). Each collector consists of a 10 × 11 × 16″ cage resting in a 2 × 12 × 17″ tray (Fig. 3C). To make the tray, join two pieces of ¼″-mesh hardware cloth, cut and bent as shown (Fig. 3C: a + b), to leave a 4 × 17″ opening in the bottom with flaps of hardware cloth projecting downward for attachment of the netting. Make tray anchors (c) of $\frac{1}{16}$ × ½ × 3″ aluminum pieces and rivet to each end of tray at center. Drill ¼″ holes in tray anchors for attachment to frame. To make the cage, fold a 16 × 43″ piece of ¼″-mesh hardware cloth as shown (d) and use pop rivets with backup washers to attach ends (e) made of two 11 × 12″ pieces. If desired, cut 4 × 5″ access in one end and fit piece of hardware cloth to serve as closure. (Cages can be emptied through the bottoms.) Longitudinally folded 1″ strips of sheet metal may be crimped over principal edges of the cages and trays for strength and safety. All other rough edges should be taped with 1″ pressure sensitive tape. Bolt to each cage 1″ PVC elbow (f) with downward projecting 30″ shaft of 1″ PVC pipe (g) to permit removing and replacing the cage from the ground (Fig. 1). Make tool for servicing cages from 36″ of 1″ PVC pipe with female fitting on one end, from which projects 4″ of 1 × 8″ dowel (not figured).

Erecting the trap. (Two persons recommended.) Determine the orientation and position of the trap; place feet or markers at the four corners. Set stakes for guys in approximate positions. Insert main posts, rafters, and eaves posts into appropriate hems. Attach rafters to posts. Tie guy ropes to appropriate eye bolts. Tie suspension ropes to 1″ eye bolts. Erect one end of trap and temporarily guy; then erect other end. Tie ends of front and back throat ropes around each main post. Tie ends of eaves rope to 2″ eyebolts. Adjust ropes, guys, and stakes until trap is trim. Make three ¼ × ¾ × 2″ wooden spacers with $\frac{1}{16}$″ holes at each end. Sew across the throat at even intervals.

Once trap is up, install collectors from a tall step ladder. Cut fabric in top of duct and insert flaps that surround slot in tray bottom. Insert shank ends of 1″ eye bolts (Fig. 3A) into tray anchors and secure tray to main post crosspiece with two ¼″ nuts. Sew fabric to flaps. Position cage in tray, making sure it fits snugly but is loose enough to service from ground.

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Received for publication 22 November 1988; accepted 30 May 1989.