SOME MORPHOMETRIC DIFFERENCES BETWEEN CONTAINER AND POOL BREEDING CULICIDAE

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ABSTRACT. A morphometric comparison was made between container and pool breeding culicid larvae which show some structural differences in the head capsule and the lateral palatal brushes. These are interpreted as expressions of the different feeding strategies the larvae use to optimize food intake in relation to available space.

INTRODUCTION

Mosquitoes have the ability to breed in containers with a very small volume of water. This is a common way to establish subpopulations in the tropics. Some species prefer to lay their eggs in tree holes, others in empty broken nuts, or in certain flowers (Istock et al. 1976a, 1976b; Chadee 1983, Chadee et al. 1985). Despite the small size of these natural containers, they may yield extremely high larval densities. Co-existence between different species seems to occur to a certain extent, although the competition for nutrients should be intense. Because of the high larval density, one may hypothesize that feeding strategies in containers might be different from those species living strictly in pools. Obligate suspension feeders should be absent from container habitats as this mode of feeding needs space around the larva for creating particle flow (Dahl et al. 1987). If brushing is the prevailing feeding strategy in containers, the species found there should have short lateral palatal brushes (LPB). To test this hypothesis, a morphometric comparison of five variables between container and pool breeding species was made and a correlation between head capsule size and feeding behavior was shown as suggested by Pucat (1965). Such a correlation might facilitate vector control by indicating the type of feeding behavior used by mosquito larvae.

METHODS

Qualitative samples were taken in March 1986 on Trinidad from more than 20 different kinds of containers, both natural and artificial (Fig. 1). The most frequently inhabited containers were cut bamboo, *Heliconia* flowers, various leaf axils and various species of the epiphytic Bromeliacae. Among the artificial containers, discarded tires, tin cans and buckets were sampled most often. Larvae were brought to the Caribbean Epidemiology Centre (CAREC) in Port of Spain for identification and feeding behavior studies. They were fixed in 70% ethanol, and mounted with the dorsal side up on slides in Euparal for morphometric analysis. The major length of the lateral palatal brushes (LPB), the antennal length and the head capsule length and width were measured with a Leitz Orthoplan microscope using the method of Dahl et al. (1987). The head capsule was measured at the widest part and from the anterior margin (clypeolabral ridge, CIR) to the posterior margin of the head capsule. The total body length was measured from the CIR to the anus. For measuring, the LPB was magnified 20×, the antennae and the head capsule 10× and the body length 2×. One filament was measured from each LPB (total of 2 measurements). The mean LPB length for 16 larvae of *Aedes communis* (De Geer) was 0.2616 mm (SD = 0.0365). This method was checked by measuring 60 separate randomly chosen filaments of 8 *Ae. communis* larvae. This gave the mean length of 0.2655 mm (SD = 0.0360). As the difference is not significant, the first measuring technique was used. For comparison, samples of pool breeding larvae were made from the forests around Uppsala, Sweden. These were collected during May and September the previous year. The samples included *Culiseta morsitans* (Theobald), *Culex territans* Walker, *Culex torrentium* Martini, *Culex pipiens* Linnaeus (which sometimes occurs in containers) and *Ae. communis*. Measurements were analyzed by a Canonical discriminant analysis.

RESULTS

Eighteen species of Culicidae were collected from different habitats. Fourteen of these were sampled on Trinidad (Table 1; Fig. 1). The results of the comparison between Caribbean container species and Palearctic pool breeders are expressed as length of LPB (Fig. 2), and as mean values of five morphometric parameters in 11 species (Fig. 3). Five of these are strictly tropical species; *Haemagogus celeste* Dyar and Nunez Tovar, *Haemagogus equinus* Theobald, *Limatus durhamii* Theobald, *Trichoprosopon digitatum* (Rondani) and *Wyeomyia* sp.

The LPBs of *Cx. territans* and *Cs. morsitans*, both Palearctic pool breeding suspension feed-

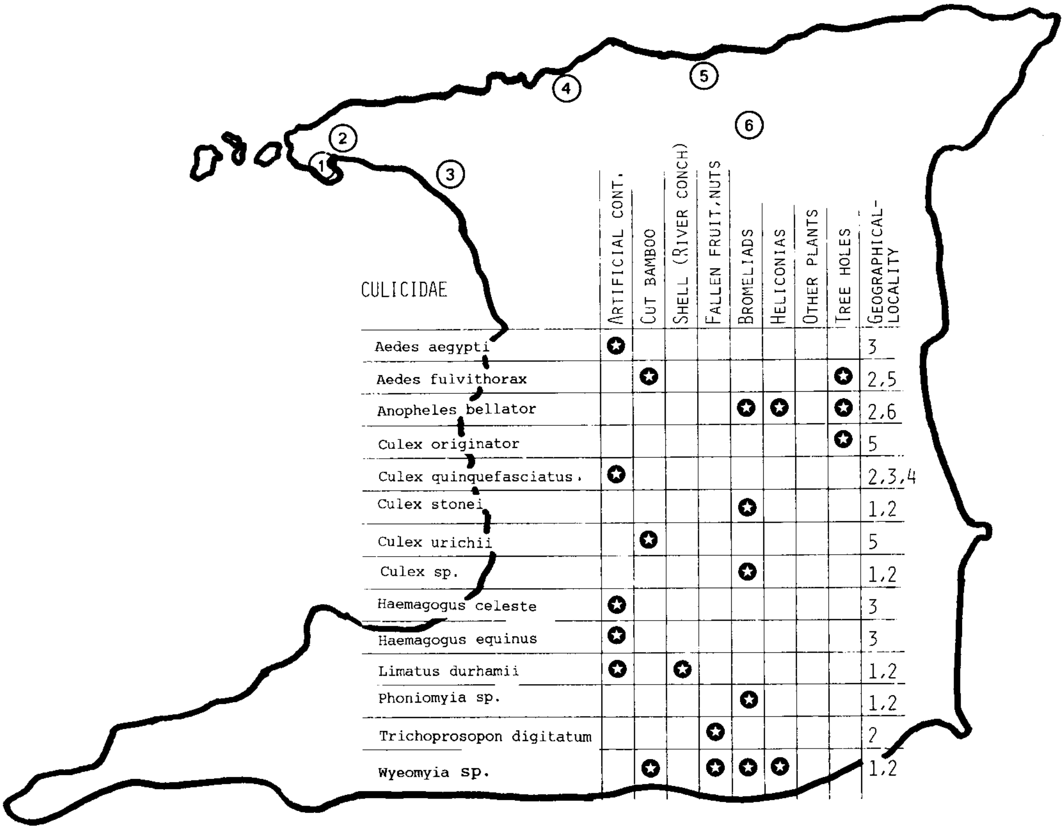

Fig. 1. Map of Trinidad. The numbers 1–6 indicate the different sampling localities; 1) Pt. Gourde, 2) Chaguaramas, 3) Port of Spain, 4) Las Cuevas, 5) Blanchisseuse, 6) Guanapo valley. Localities plotted against containers in which mosquito larvae were sampled on Trinidad in March 1986. Classification according to Dr. Ray Martinez (personal comments).

Table 1. Measurements for 11 species of Culicidae larvae. LPB: lateral palatal brushes, AL: antenna length, HCW: head capsule width, HCL: head capsule length, BL: body length, SD: standard deviation. Number of observations in parentheses.

Species	LPB	SD	AL	SD	HCW	SD	HCL	SD	BL	SD
Ae. aegypti	0.20 (18)	0.01	0.36 (14)	0.05	0.90 (24)	0.06	0.82 (22)	0.04	8.40 (17)	0.45
Ae. communis	0.26 (16)	0.04	0.47 (18)	0.05	1.14 (19)	0.06	1.00 (19)	0.06	6.90 (20)	1.38
Cx. pipiens	0.42 (14)	0.02	0.64 (14)	0.03	1.10 (14)	0.04	0.79 (14)	0.03	6.90 (14)	0.34
Cx. territans	0.59 (8)	0.04	0.78 (8)	0.02	1.22 (8)	0.06	0.79 (8)	0.09	5.56 (9)	0.53
Cx. torrentium	0.40 (8)	0.03	0.59 (8)	0.05	1.17 (8)	0.04	0.90 (8)	0.04	5.55 (10)	0.50
Cx. morsitans	0.90 (20)	0.03	1.13 (20)	0.06	1.70 (20)	0.06	1.20 (20)	0.04	7.38 (20)	0.47
Hg. celeste	0.19 (8)	0.03	0.35 (8)	0.04	0.88 (9)	0.06	0.88 (9)	0.05	8.60 (9)	0.44
Hg. equinus	0.19 (8)	0.02	0.32 (8)	0.05	0.87 (9)	0.03	0.80 (9)	0.04	7.40 (9)	0.11
Li. durhamii	0.20 (18)	0.02	0.24 (22)	0.02	0.86 (24)	0.07	0.75 (24)	0.05	7.40 (15)	0.71
Tr. digitatum	0.28 (22)	0.02	0.30 (21)	0.05	1.24 (22)	0.06	1.04 (21)	0.03	10.7 (15)	1.04
Wy. sp.	0.22 (9)	0.03	0.27 (10)	0.03	0.89 (10)	0.08	0.80 (10)	0.06	6.25 (10)	0.43

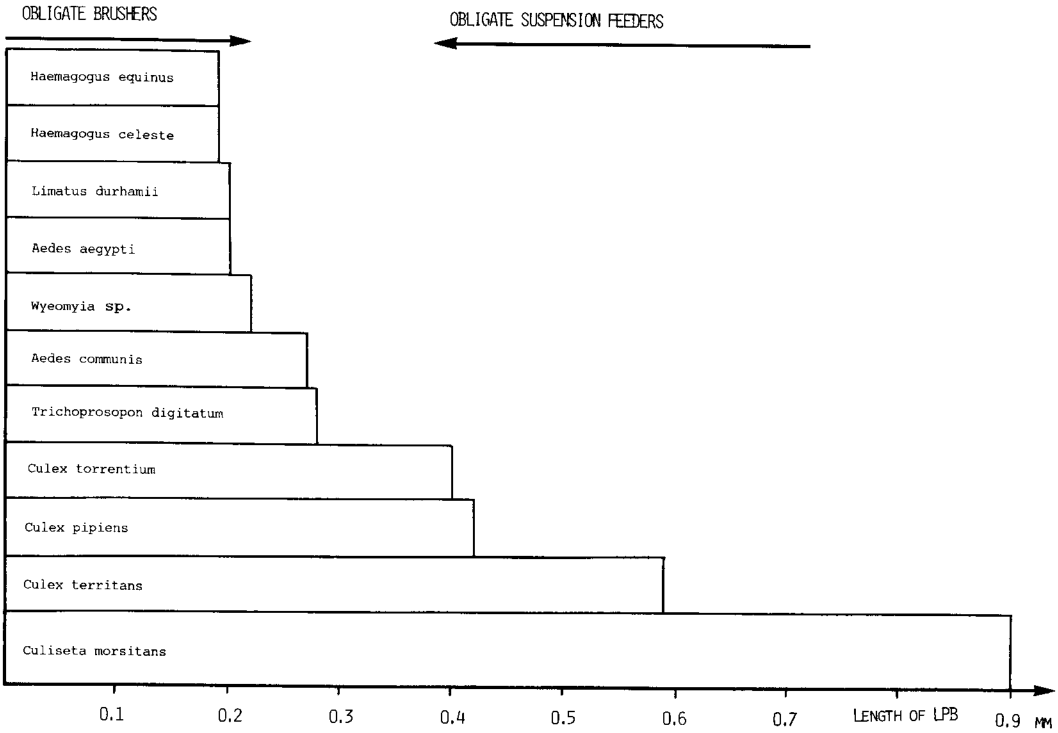

Fig. 2. LPB length of 11 sampled species (measurements are in mm). Container living larvae are generally obligate brushers with LPB length shorter than 0.2 mm while obligate suspension feeders often have a LPB length longer than 0.4 mm.

ers, are significantly longer than those of the rest. The morphological differences are visualized by double rectangles with a diagonal line (Fig. 3). When container species are compared with pool breeders, it is obvious how different the relationship is between body length and size of the head capsule. The body length is symbolized by the diagonal line BL. In relation to the outer rectangle, the BL gives immediate, although approximate, information about what kind of feeding behavior is used and an indication in what habitat the species is living. If the diagonal line BL is longer than the hypotenuse of the outer rectangle, the larvae is a brusher. The same result was obtained by comparing the two rectangular areas. If the inner area was larger than 23% of the outer, the larva was a suspension feeder. If the area of the inner rectangle was less than 10.5% of the outer area, the larva was a brusher.

In the "Mahalanobis distance between classes"-test (See Rao 1968) (Fig. 4) the different species were significantly separated from each other except for *Ae. aegypti* (A)/*Hg. celeste* (G) and *Ae. aegypti* (A)/*Hg. equinus* (H). Looking at *Tr. digitatum* (J), we find it far above and well separated from the rest. Despite the moderate length of its LPB set, its long body places it well up on the CAN 2-axis (briefly the body size axis). *Aedes communis* (B), a facultative suspension feeder, is found as expected, between the tight gathering on the negative CAN 1-axis and the positive side of the same axis. The four pool breeding suspension feeders; *Cs. morsitans* (C), *Cx. pipiens* (D), *Cx. territans* (E) and *Cx. torrentium* (F), are found on the positive CAN 1-axis, (briefly, the LPB size axis) distinctly separated from the rest. *Culex pipiens* and *Cx. torrentium* in Sweden are facultative suspension feeders, generally breeding in pools, but they may also occur in containers.

DISCUSSION

The hypothesis that container living larvae should have shorter LPBs than pool breeders, is substantiated to the point that no container breeding larvae were found with LPBs larger than those of *Cx. quinquefasciatus* (0.40 mm). In container habitats the closely related *Cx. pipiens* normally feeds by the brushing technique

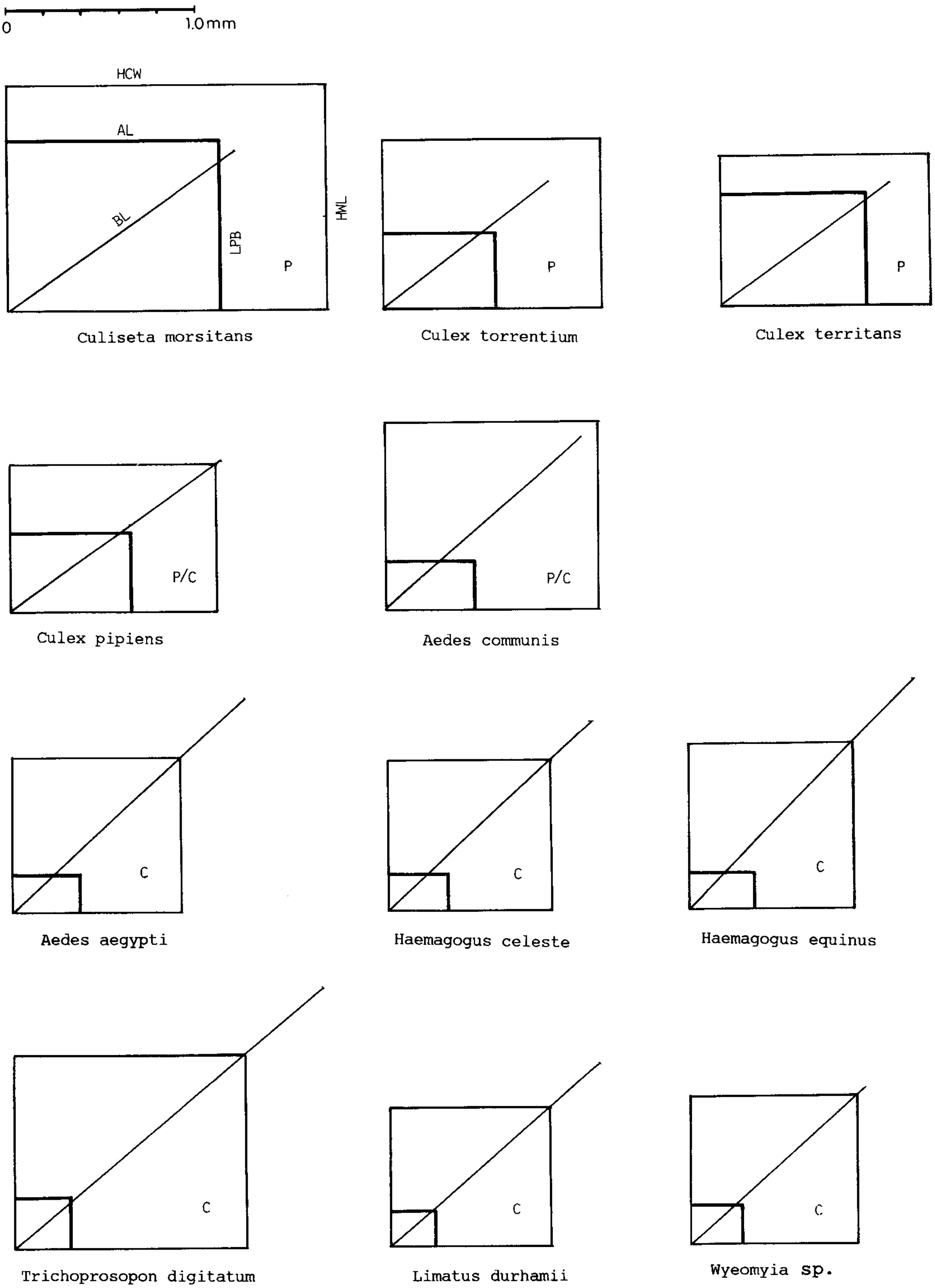

Fig. 3. Morphometric differences between container and pool breeding mosquitoes. The measurement in mm are enlarged 50 times except for BL (the diagonal) which is 10×.
C = container breeder, P = pool breeder, BL = body length, AL = antennal length, LPB = lateral palatal brushes, HCL = head capsule length, HCW = head capsule width.

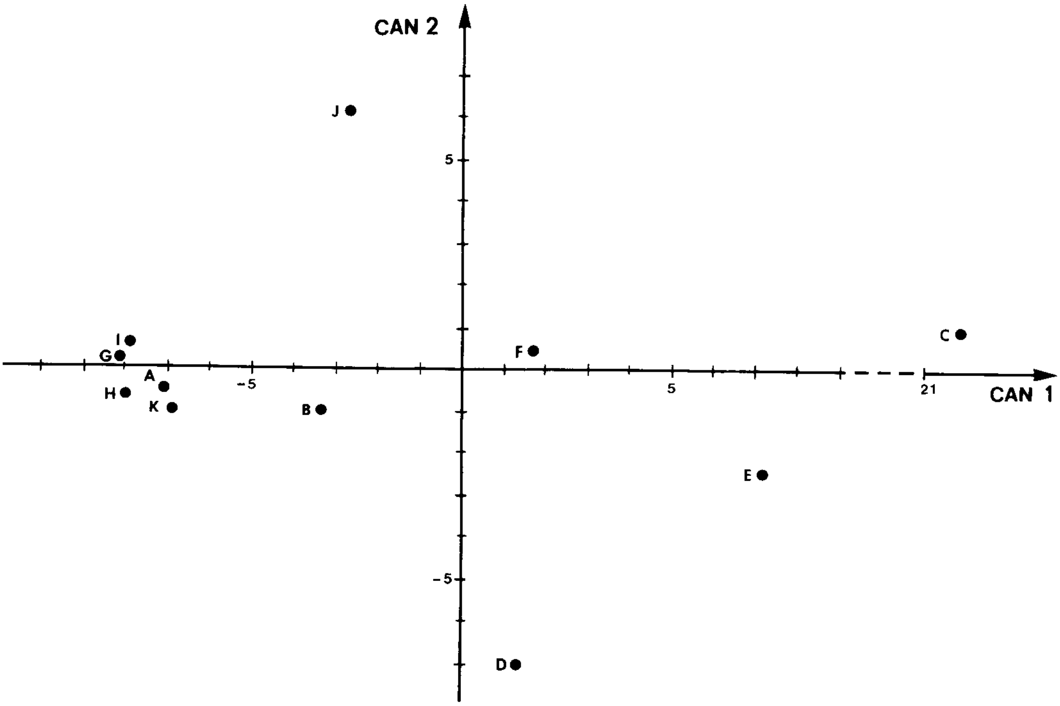

Fig. 4. Canonical discriminant analysis. Class means on canonical variables. Each dot represents the class mean of the variables Can 1 and Can 2. According to Mahalanobis distances between classes, all species were significantly separated except for *Haemagogus celeste* (G) and *Hg. equinus* (H).

The four species on the CAN 1-axis are pool breeders. The tight gathering at −7 to −9 are the tropical container species. *Aedes communis* (B) is situated between the container species and the pool breeding larvae, indicative of its facultative character. *Trichoprosopon digitatum* (J) is found on the negative side of the CAN 1-axis like the rest of the container species, but also very far above the CAN 2-axis because of its long body.

(A) = *Ae. aegypti*, (B) = *Ae. communis*, (C) = *Cs. morsitans*, (D) = *Cx. pipiens*, (E) = *Cx. territans*, (F) = *Cx. torrentium*, (G) = *Hg. celeste*, (H) = *Hg. equinus*, (I) = *Li. durhamii*, (J) = *Tr. digitatum*, (K) = *Wyeomyia* sp.

(Nilsson 1987). Although the container living larvae have smaller LPBs than pool living ones, this does not necessarily mean that the body length of container larvae has to be shorter (Table 1). For instance when *Tr. digitatum* is compared to the suspension feeding pool living *Cs. morsitans*, the table shows that *Tr. digitatum* is about 32% longer than *Cs. morsitans* but has at the same time approximately 69% smaller lateral palatal brushes. There appears to be an indistinct threshold of the LPB size for suspension feeding. The upper limit for obligate brushers might be close to 0.20 mm and the lower limit for obligate suspension feeding about 0.40 mm. Between these limits we find the facultative species which are able to use both feeding techniques. The hypothesis should be tested on subtropical and tropical pool breeders to confirm that there are morphological differences compared to palearctic pool breeders.

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