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EGGSHELL SAMPLING: QUANTITATIVE OR QUALITATIVE DATA?

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ABSTRACT. This research evaluated the use of qualitative presence/absence data compared with quantitative real number counts of *Aedes vigilax* eggshell data to obtain information on the spatial distribution of eggshells in several salt marsh vegetation types. Eggshells were extracted by subsampling and flotation, a method that does not recover all eggshells. The results of the analysis of presence/absence data were compared with those of real numbers. The general conclusions were similar by either method, suggesting that presence/absence data may be sufficient to rapidly determine eggshell distribution patterns.

KEY WORDS *Aedes vigilax,* eggshells, qualitative data, habitats, salt marsh

In Australia, the incidence of arbovirus diseases such as Ross River virus is growing. A major vector is the salt-marsh mosquito *Aedes vigilax* (Skuse), which breeds in isolated pools in intertidal wetlands. Mapping the distribution of the species is a major task and one that is essential for management. Larval survey is a common method but can only be carried out during times of flooding, which are also times when active control is necessary. Eggshell (and unhatched egg) distribution provides a reliable indicator of aedine breeding sites. It is independent of conditions necessary for larval presence and so sampling can be carried out at times when larval control is not a top priority for a program and survey resources are available. However, counting eggshells can be very time consuming. From a practical perspective, what is needed is a method that is rapid and will reliably indicate mosquito breeding. Simply recording whether or not eggshells are present at a particular site rather than counting actual numbers may be sufficient. The purpose of this communication is to compare the use of qualitative (presence/absence) and quantitative (real numbers) data to analyze eggshell distribution patterns.

Addison et al. (1992) showed that eggshell density was proportional to larval production, at least for *Aedes taeniorhynchus* (Wied.). Aedine species oviposit on the substrate, and the eggshells appear to be spatially stable, even in areas that are tidally flooded (Ritchie 1994).

Several methods of extracting eggshells were described in Service (1993). One of the simplest ways to extract eggshells is by sieving and flotation. Although eggshells are not generally dislodged in the field during flooding (Ritchie 1994), the sieving and flotation method dislodges eggshells from the substrate by agitation and so they float when flooded in the laboratory. The method involves subsampling and will not recover all the eggshells. The method was described in Ritchie and Addison (1991) and the subsampling in Ritchie and Jennings (1994). These authors reported that recovery rates, from a known number of eggshells, are variable. Ritchie and Addison (1991), by the flotation method, found a fairly consistent 62% recovery rate, and concluded that the method would also be suitable for aedine species other than those they had tested. Ritchie and Jennings (1994) reported recovery rates of 48–55% in clay soils, and Turner and Streever (1997) recovered an estimated mean of 44% (SE 6.8). Turner and Streever (1997) used a similar technique to that of Ritchie (1994) and concluded that "little information was lost when subsampling and flotation were used" (p. 45). Also, the procedure resulted in considerable savings in time over processing whole samples.

Simply recording presence and absence of eggshells from sites may be sufficient. This method would save a great deal more time and would avoid the concerns of the novice observer that some eggshells may not have been recognized. In other discipline areas, it has long been known that even complex associations may be recovered by using presence/absence data rather than quantitative data (e.g., Williams and Dale 1962). This paper compares the analysis of qualitative and quantitative eggshell data to assess the effectiveness of the simpler presence/absence data.

Sediment samples (n = 102) were collected from salt marshes distributed along approximately 150 km of coast in southeastern Queensland. At the general level, there were 3 habitats: lower marsh, upper marsh pool margins, upper marsh surfaces within 10 m of pools (n = 32, 42, and 28, respectively). We also recorded the dominant land cover in 4 classes: *Sporobolus virginicus, Sarcocornia quinqueflora,* mixed *Sporobolus* and *Sarcocornia,* and bare (n = 59, 6, 20, and 17, respectively). Each sample was a pooling of 15 × 15-cc substrate samples taken with a 60-ml sawn-off syringe as described in Ritchie and Addison (1991). This method collected the top 1.5 cm of substrate. The samples were stored in sealed plastic bags in a cool room until processed. Processing followed the sieving

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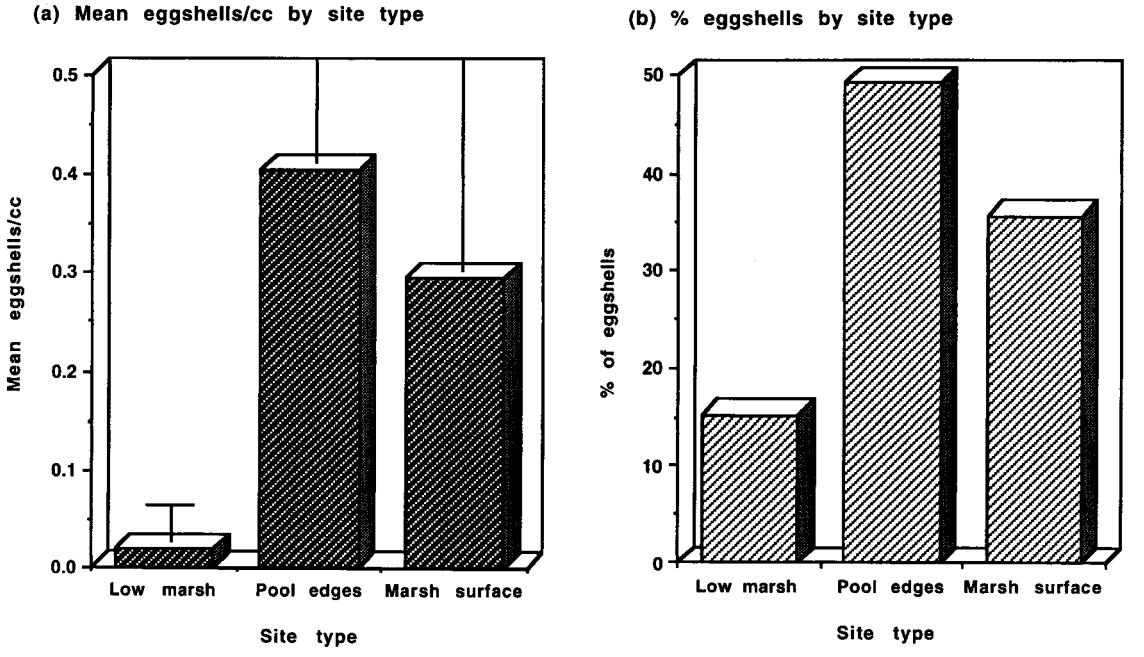

Fig. 1. The relationship between eggshells and site type. (a) Quantitative analysis; (b) qualitative analysis.

and flotation method of Ritchie and Addison (1991) and Ritchie and Jennings (1994).

Data were recorded as eggshell numbers/cubic centimeter. These were later converted to presence or absence data as well. As a simple quantitative test, we evaluated the relationships between eggshell numbers/cubic centimeter and site type and separately with cover type with 1-way ANOVAs. We repeated the evaluation qualitatively by Chi-squared analysis on the presence/absence data. For the latter, we used the likelihood ratio Chi-squared value. The test of the qualitative analyses was to see if the data yielded similar results to those of the quantitative analysis. If an enquirer would have reached the same conclusion from both analyses, then this would justify the use of a simple qualitative analysis.

Significant relationships were found between eggshells and site type and cover for all analyses. Figure 1 shows the results for the site type analysis. The quantitative analysis resulted in a significant relationship between site type and eggshell numbers/cubic centimeter (df 2,99, $F = 3.8173$, $P = 0.0253$). The qualitative results were highly significant (df 2,99, Chi squared 17.394, $P = 0.0002$). Both showed a similar relationship. From the quantitative perspective, most eggshells were found around pool margins and on the marsh surface, and from the qualitative perspective, it also appeared that eggshells were found more frequently in these habitats than in the low marsh. This result is consistent with the literature (e.g., Dale et al. 1986, Ritchie and Jennings 1994). Thus, by either method, one would tend to reach similar conclusions about the relationship between eggshells and site types.

Figure 2 shows the results from the cover type analyses. The quantitative analysis indicated a highly significant relationship (df 3,98, $F = 4.8749$, $P = 0.0033$) between eggshells and cover type. The qualitative results were still significant but less so (df 3,98, Chi-squared 9.658, $P = 0.0217$). The quantitative results indicated that eggshells were most numerous in the mixed *Sporobolus/Sarcocornia* cover and then, but less so, in the *Sporobolus*. The qualitative results showed that eggshells were found more frequently in *Sporobolus*, with a lower frequency in the mixed *Sporobolus/Sarcocornia* cover. Both methods showed few eggshells in the upper marsh surface with a *Sarcocornia* cover type. These results reflect not only that the *Sarcocornia* cover is not favoured for oviposition but also that there were relatively few sites with this species because it more commonly occurs in lower marshes in the study area. The quantitative analysis generally tends to support the observations of Dale et al. (1986) and of Ritchie (1994), who found more eggshells in *Sarcocornia* than in *Sporobolus*, whereas the qualitative results support the conclusions of Kay and Jorgensen (1986). In fact, neither is in conflict because they represent slightly different ways of viewing the problem and both do identify the major cover types in which *Ae. vigilax* eggshells are usually found.

From a practical perspective, it might be argued that, because the qualitative analyses do not miss

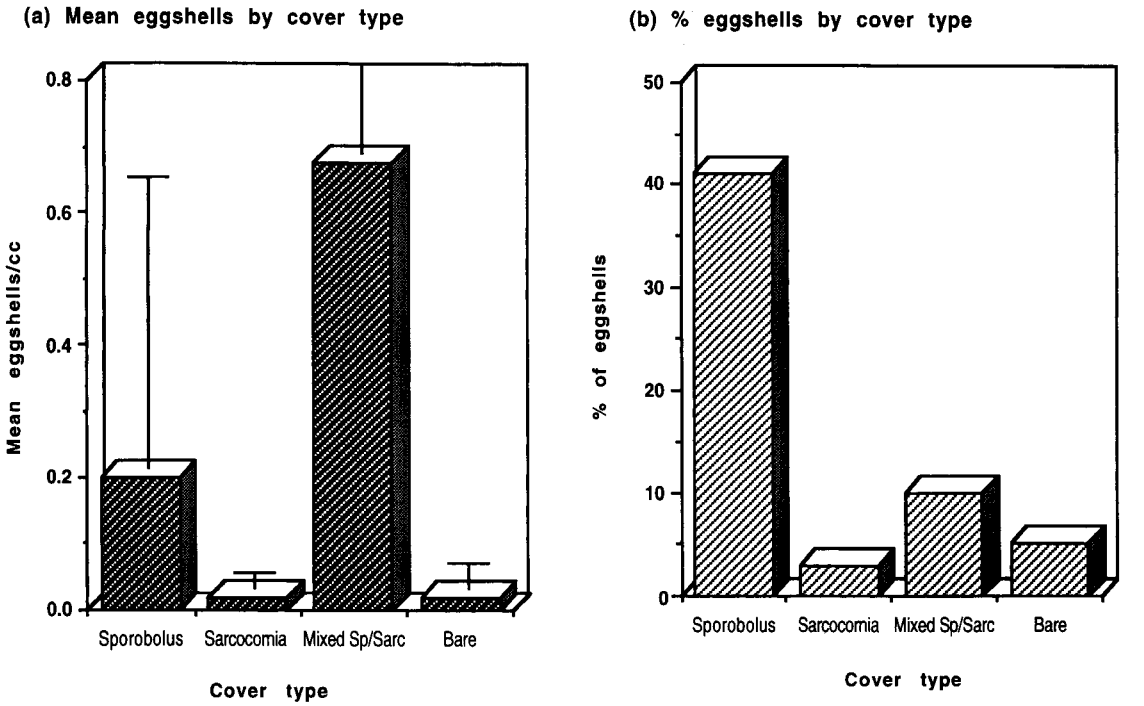

Fig. 2. The relationship between eggshells and cover type. (a) Quantitative analysis; (b) qualitative analysis.

any of the significant relationships and the data are obtained rapidly and cheaply, this is an efficient method to use. Moreover, this approach may be better than a quantitative one for identifying the types of environment in which eggshells (and hence breeding) occur frequently, as opposed to having large numbers of eggshells. From a management perspective, absolute numbers may not be essential (and the sampling method does not provide accurate assessment of numbers). What may be of more value than having real numbers, perhaps from relatively few sites, is the ability to process samples from a large number of areas, confident that, having found one eggshell, there are likely to be others! In theory, once an eggshell presence has been recorded, the sample could be discarded without further inspection. In practice, a prudent observer would be advised to ensure that more than one eggshell was present!

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