

estimates from representative samples

may reproduce) under thick snow cover. And most other species are so small, or cryptic, or hidden, or fast moving that they are even more difficult to count.

Ecologists, therefore, are almost always forced to estimate rather than count. They may estimate the numbers of aphids on a crop, for example, by counting the number on a representative sample of leaves, then estimating the number of leaves per square meter of ground, and from this estimating the number of aphids per square meter. Sometimes more complex methods are used (Box 5.1), and at other times we may rely on indirect 'indices' of abundance. These can provide



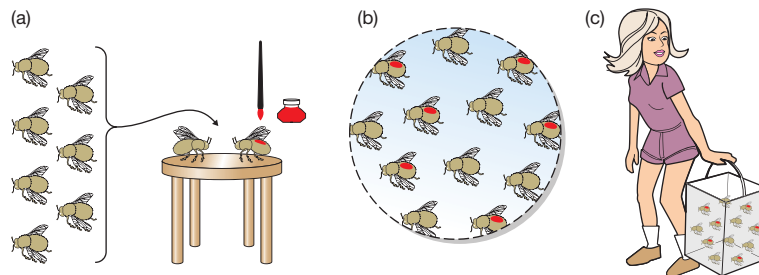
## 5.1 Quantitative aspects

### 5.1 QUANTITATIVE ASPECTS

#### Mark-recapture methods for estimating population size

An estimate of the size of a population can sometimes be made by capturing a sample of individuals, marking them in some way (paint spots, leg rings) and then releasing them. Later, another sample is captured, and the proportion that is marked gives some estimate of the size of the whole population (Figure 5.2). For example, we might capture and mark 100 individuals from a population of sparrows and release them back into the population. If we later sample a further 100 individuals from the population and find half are marked, we could argue in the following way: half the sample are marked; the sample is representative of

the whole population; therefore half the population are marked; 100 individuals were given a mark; therefore the whole population is composed of about 200 individuals. But this technique of mark and recapture is far less straightforward than it appears at first sight. There are many pitfalls in the sampling process and in interpretation of the data. Suppose, for example, that many of the individuals we marked died between our first and second visits. Modifications of the method would be needed to take account of this. For many organisms, however, it is the only technique that we have to estimate the size of a population.



**Figure 5.2**

The mark and recapture technique for estimating the size of a population of mobile organisms (in simplified form). (a) On a first visit to a population of unknown total size  $N$ , a representative sample is caught ( $r$  individuals) and given a harmless mark. (b) These are released back into the population, where they remix with the unknown number of unmarked individuals. (c) On a second visit, a further representative sample is caught. Because it is representative, the proportion of marks in the sample ( $m$  out of a total sample of  $n$ ) should, on average, be the same as that in the whole population ( $r$  out of a total of  $N$ ). Hence  $N$  can be estimated.