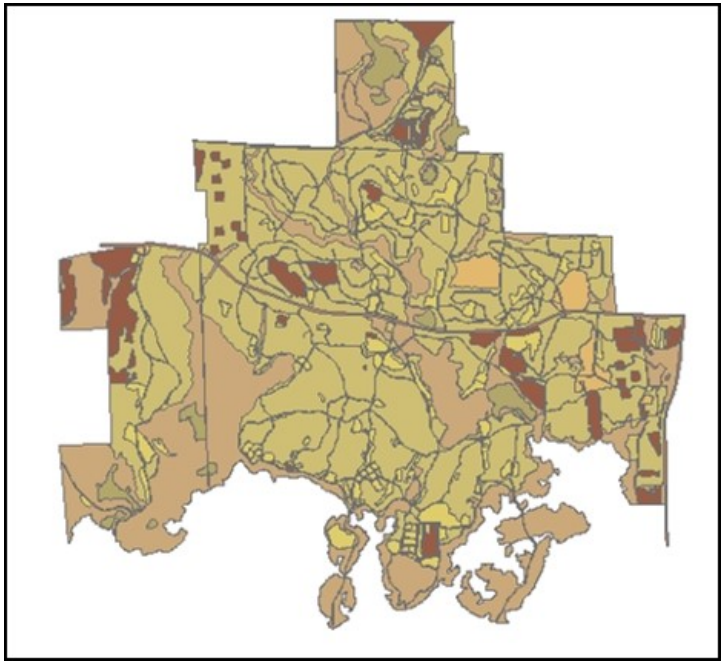
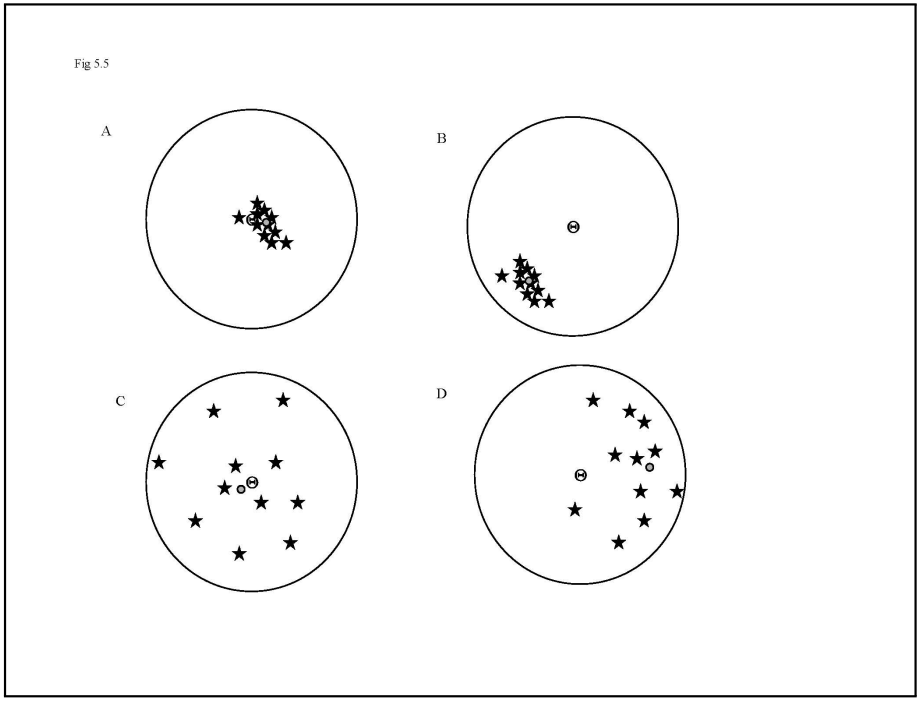
Sampling and Estimation





Key concepts

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- Parameters are almost never known. Why?
  - We usually have to sample
  - Animals are hard to detect
- Good sampling designs yield accurate estimates of unknown parameters

Parameter
A characteristic of a population

Parameters, estimates, and statistics

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Statistic
A characteristic of a dataset (often used to estimate a parameter)

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	Population parameter	Parameter estimate
Population size	N_t	$\hat{N}_t$
Growth rate	r	$\hat{r}$
Occurrence probability	ψ	$\hat{\psi}$

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(4) Controls (when conducting an experiment)

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Target population
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Sampled population
The sampled portion of the population of interest, usually defined in terms of the sample units (such as plots, quadrats, etc.).

Accuracy has two components:

(1) **Bias**: The difference between the average estimate and the true parameter

(2) **Variance**: The variability of the estimates.

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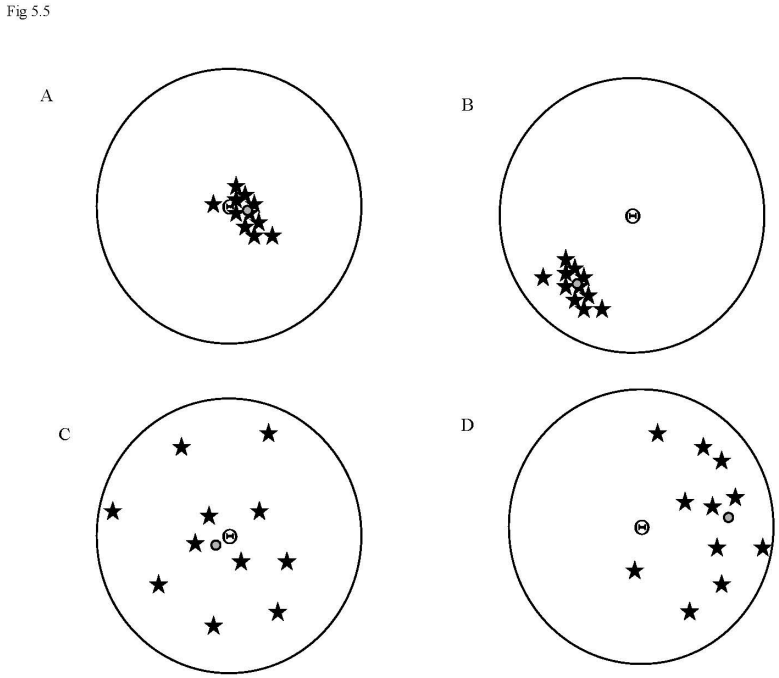


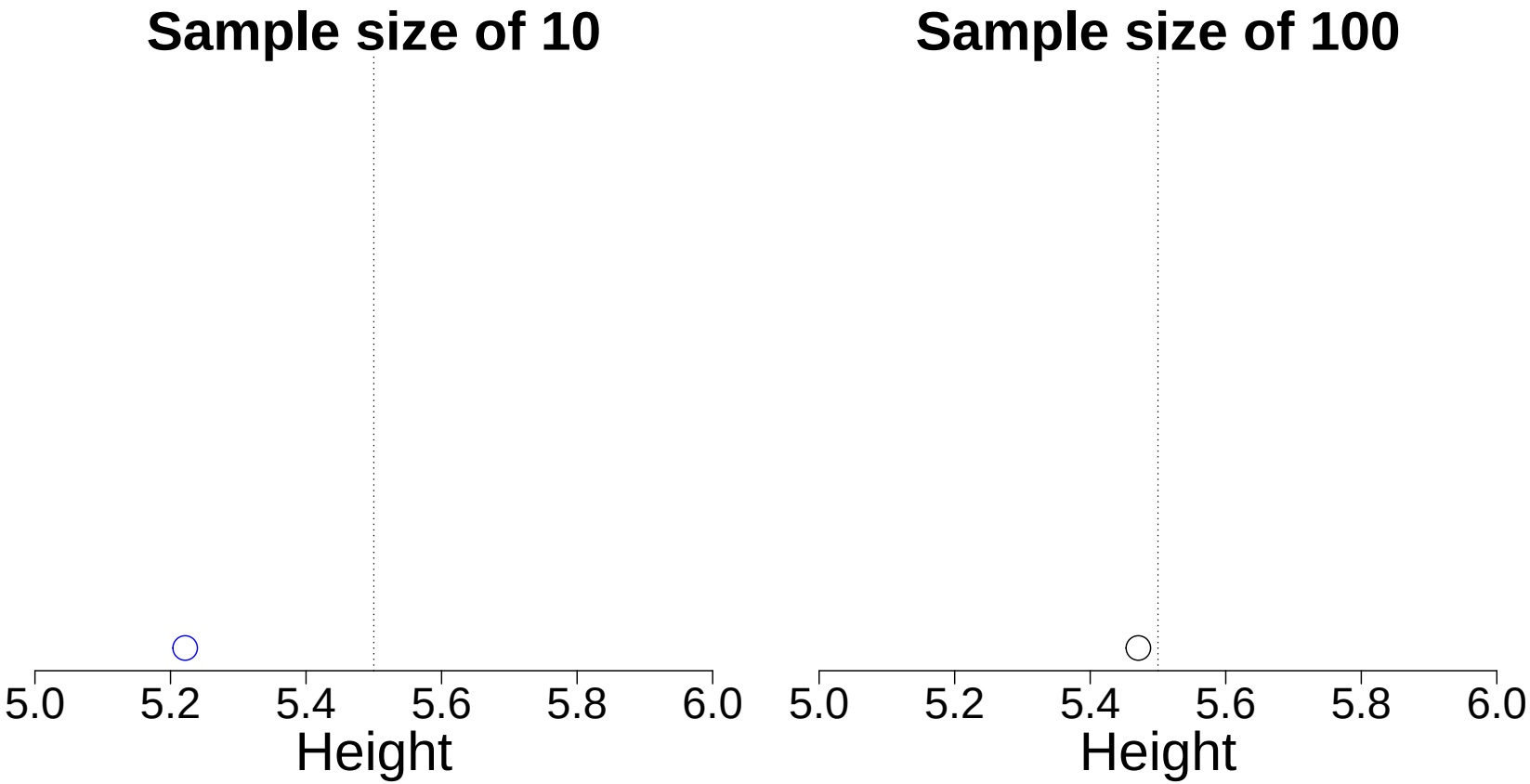
How do we reduce variance?

Huge sample size

Effect of sample size

Suppose we want to estimate the height of students on campus, and we have enough resources to repeat a survey many times.

Each point below is an estimate.



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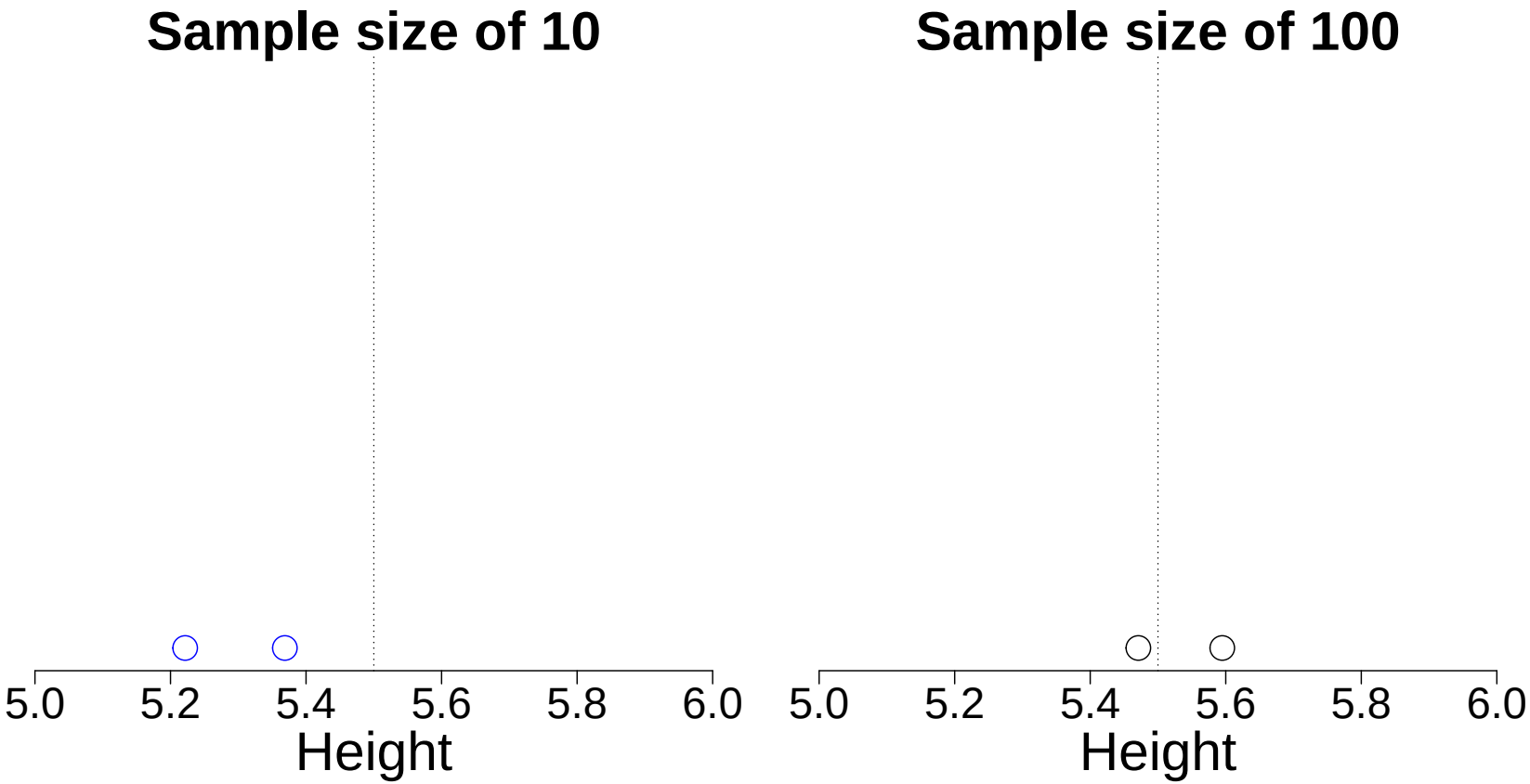

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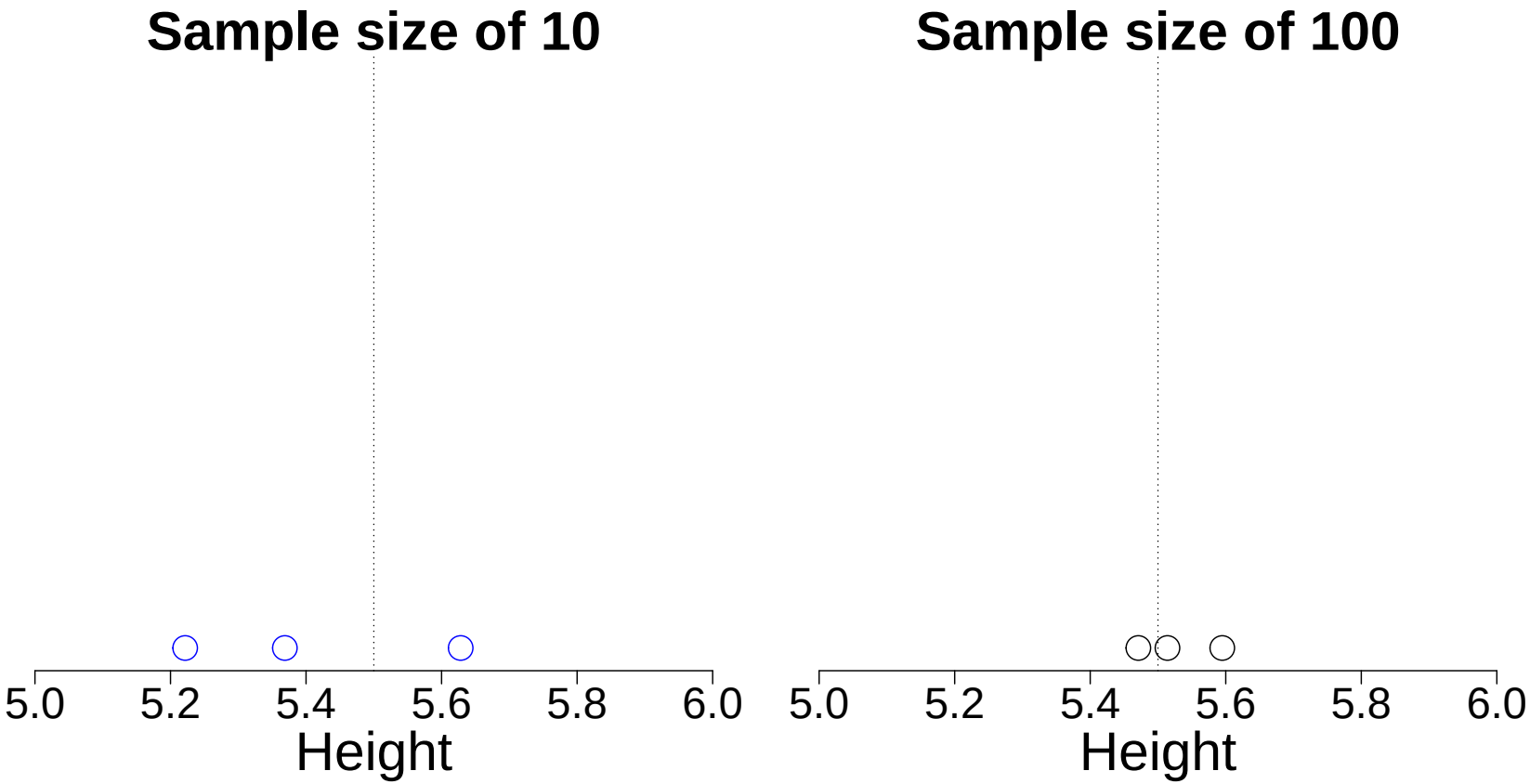

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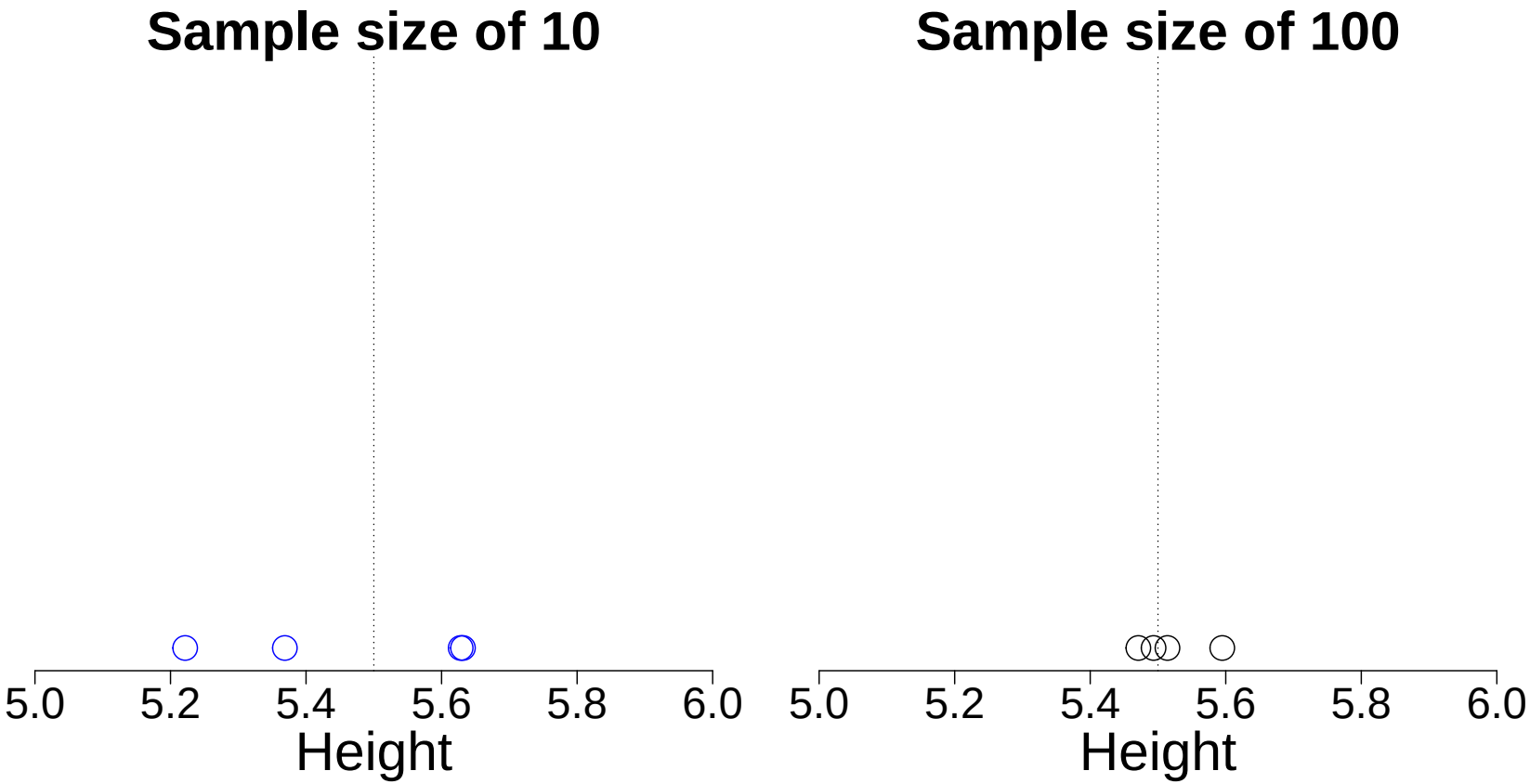

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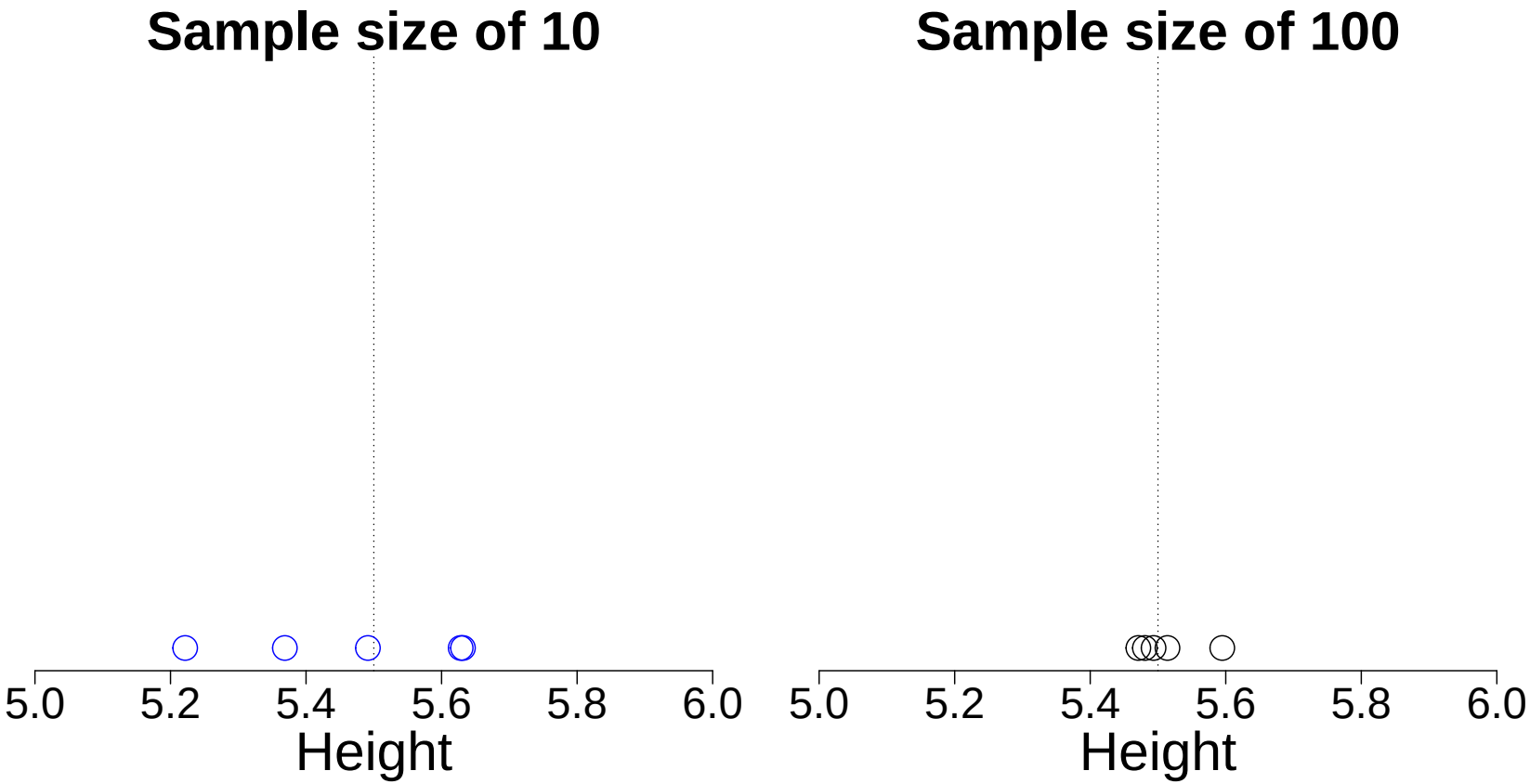

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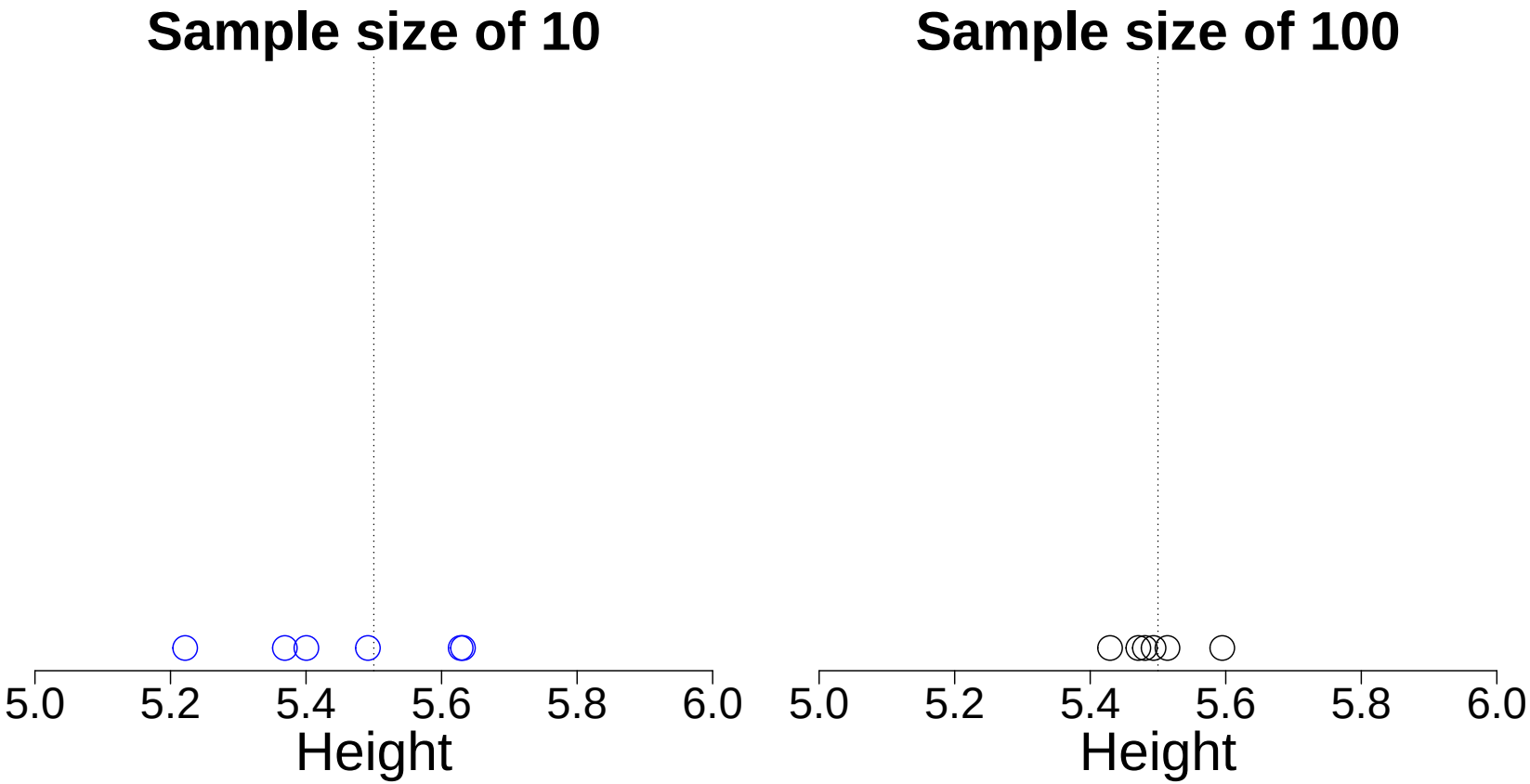

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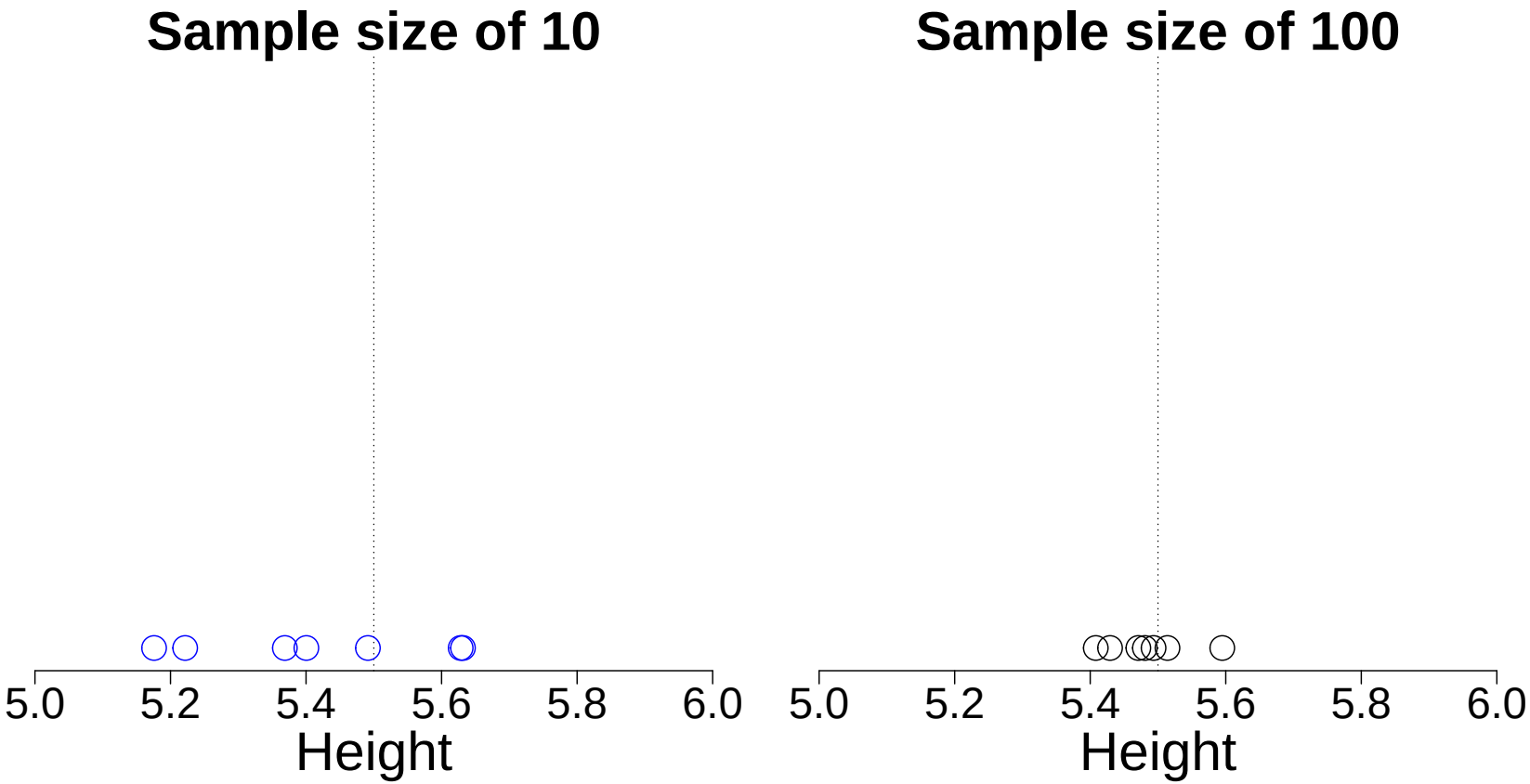

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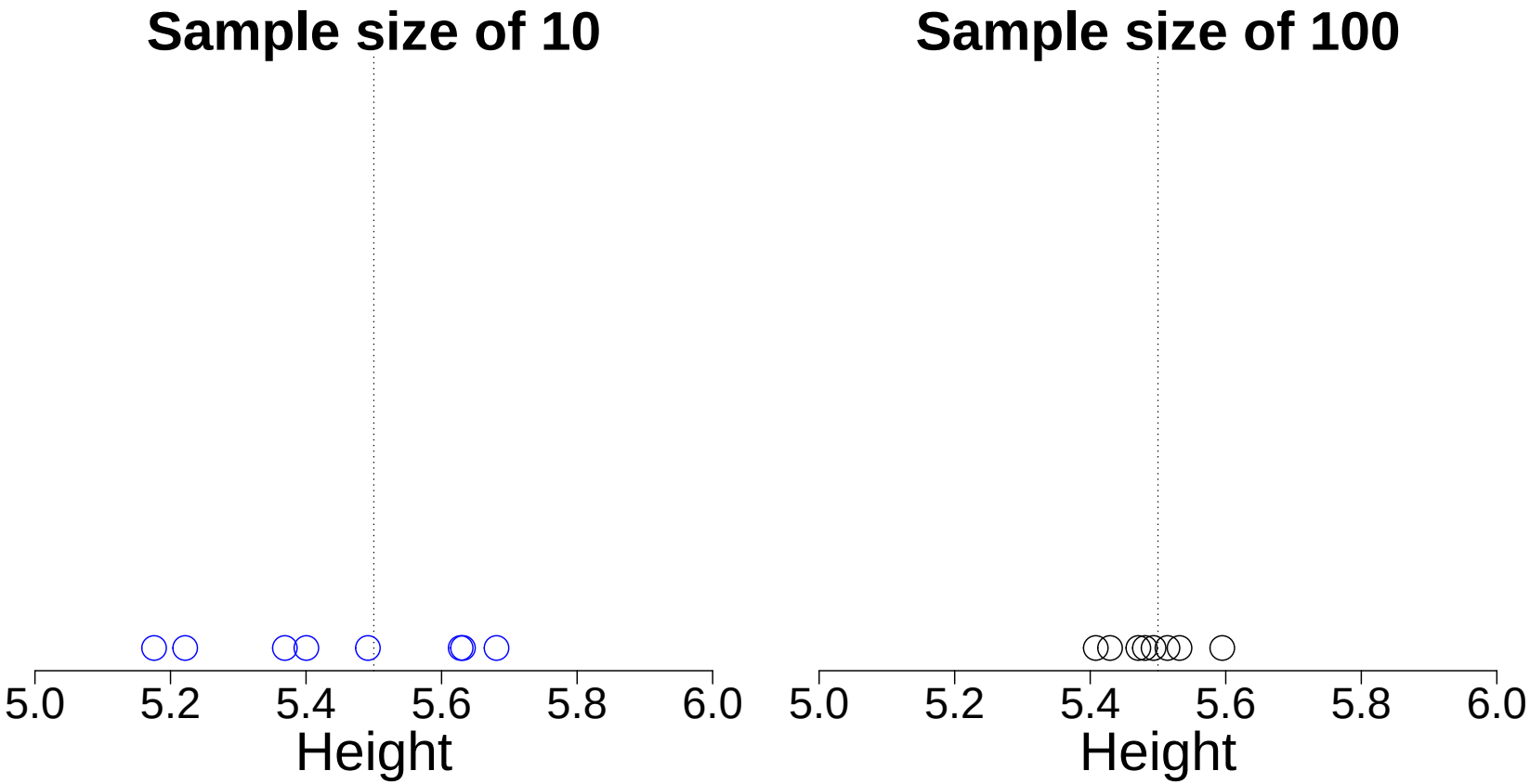

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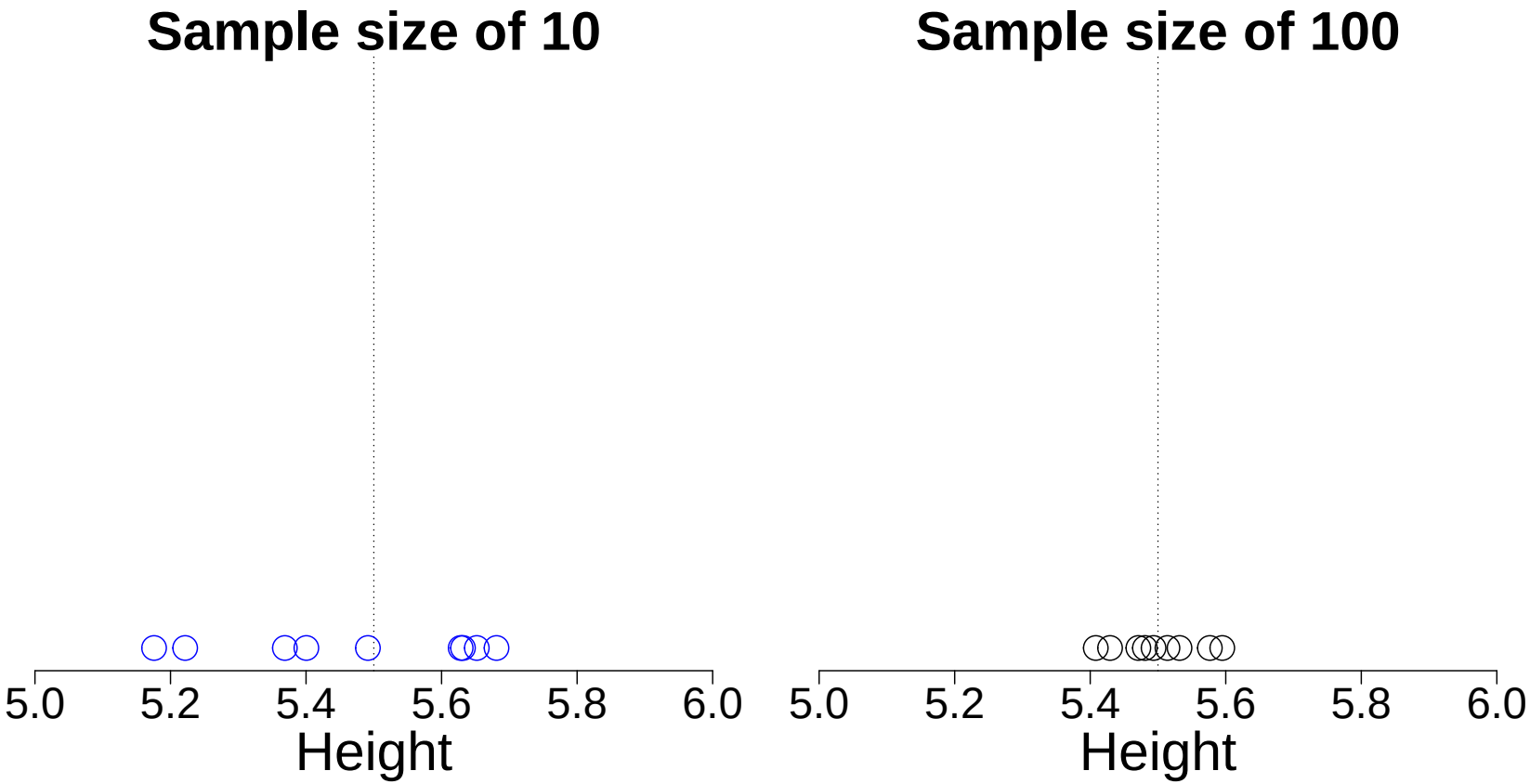

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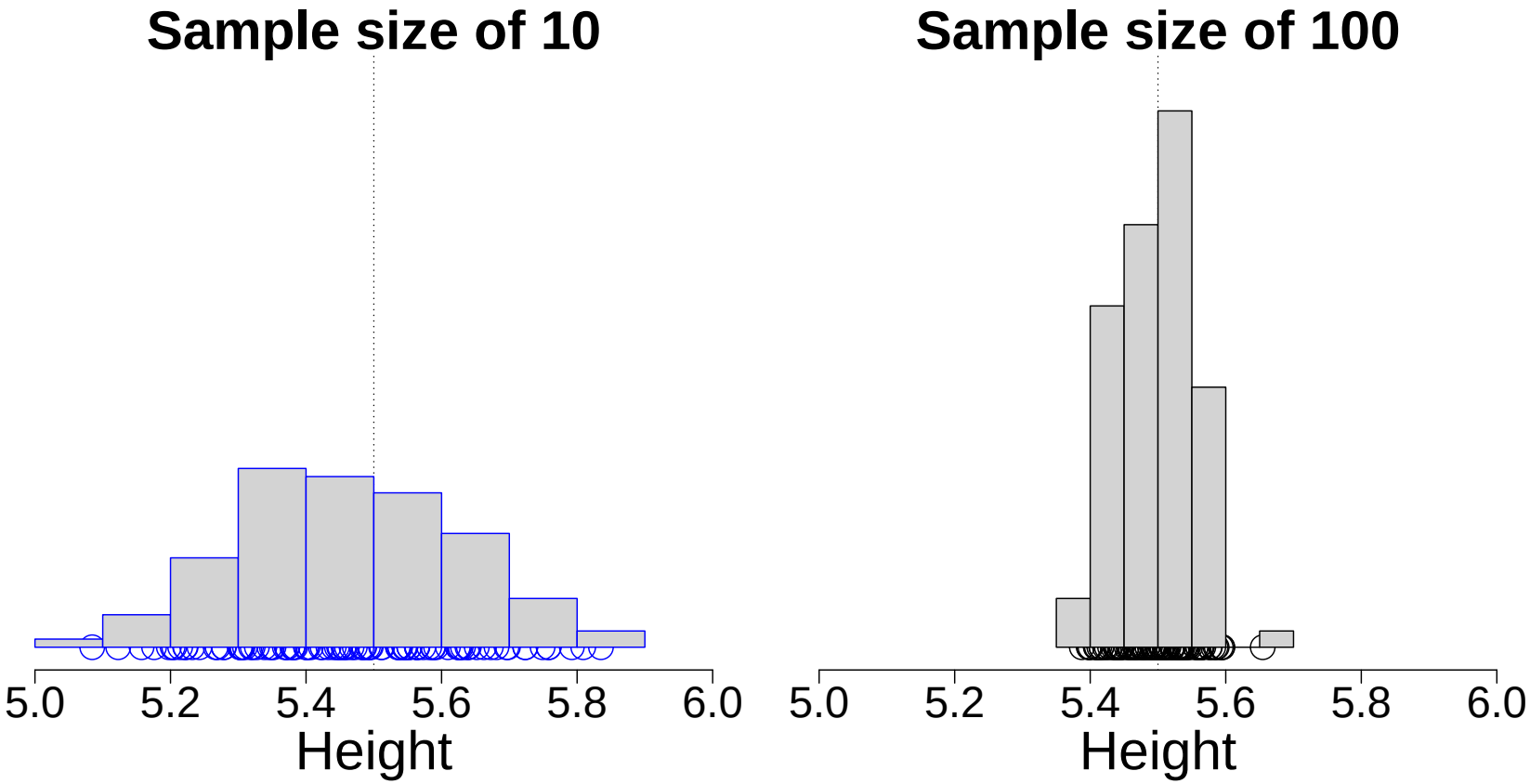

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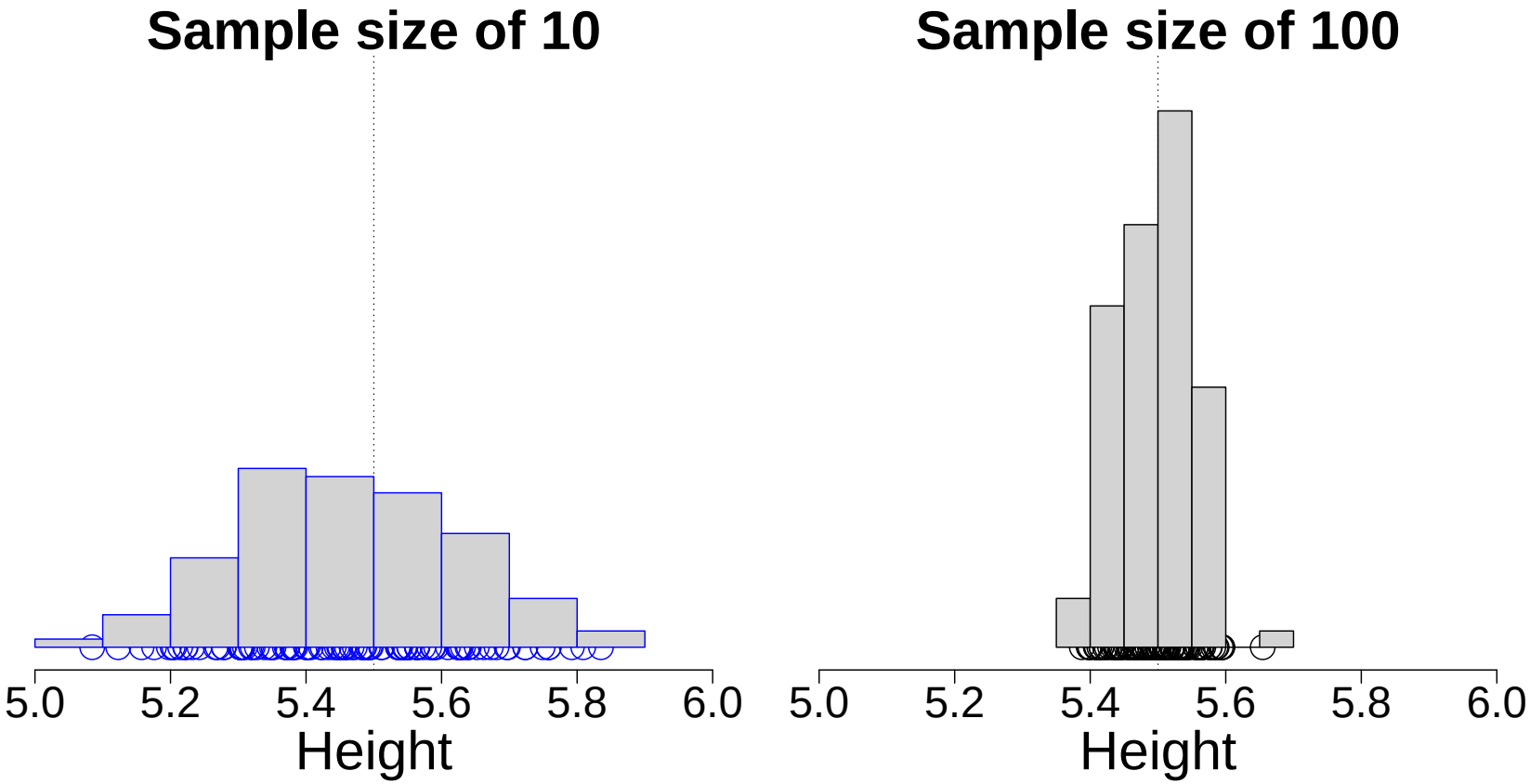


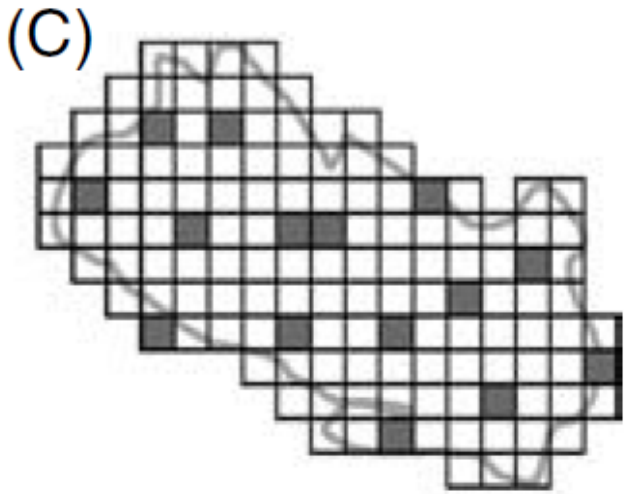
The standard deviation of the sampling distribution is called the standard error (SE)

How do we reduce bias?

Randomization

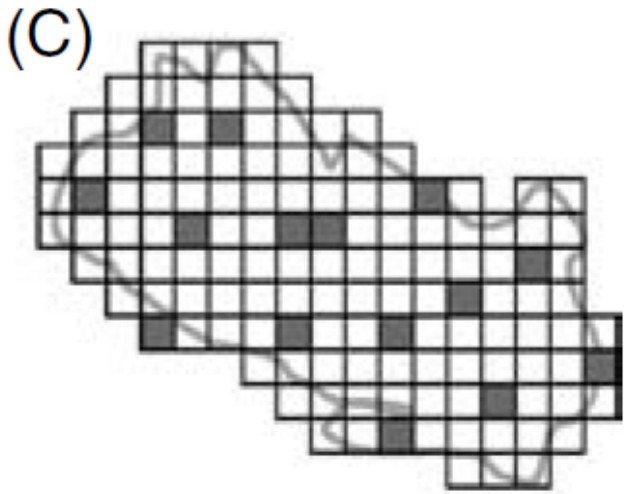
Simple random sampling

- All sample units have the same inclusion probability



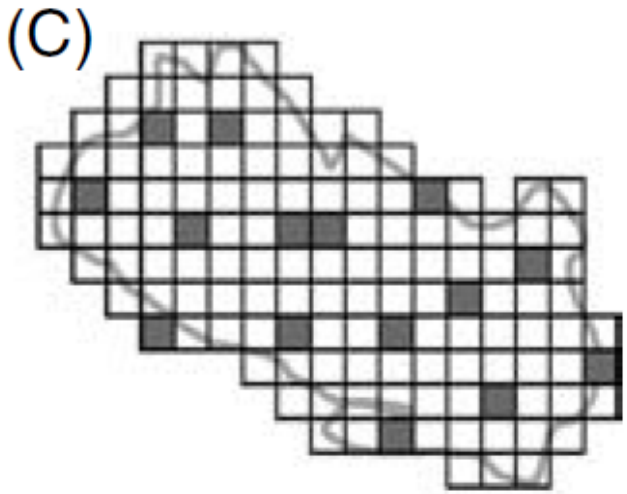
Simple random sampling

- All sample units have the same inclusion probability
- Easiest and most reliable method



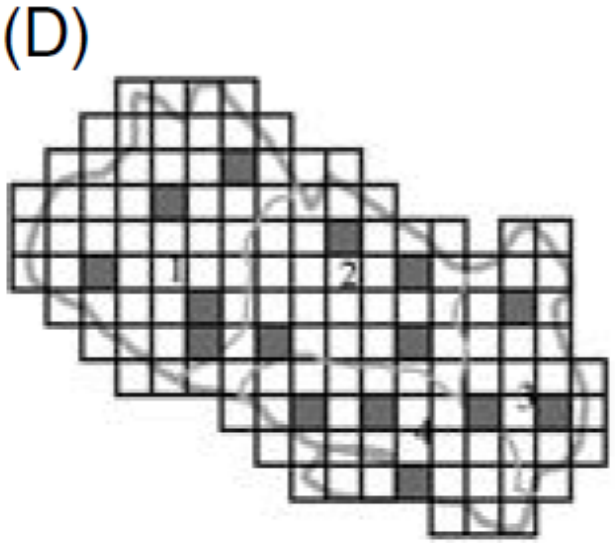
Simple random sampling

- All sample units have the same inclusion probability
- Easiest and most reliable method
- But not always cost effective



Stratified random sampling

- Useful when study area is characterized by several homogeneous regions



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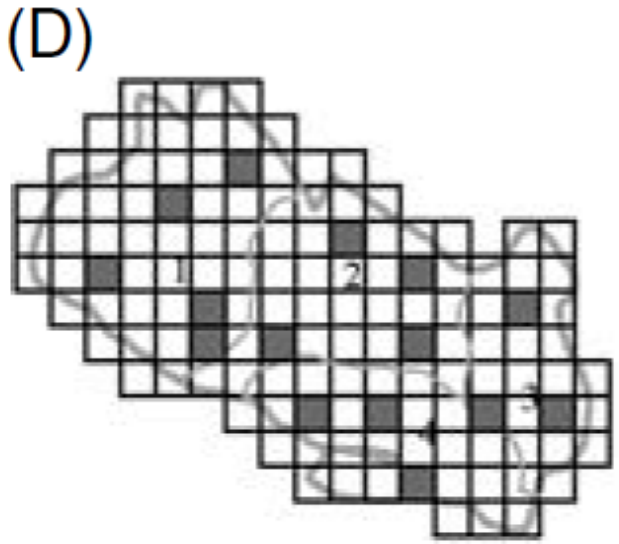
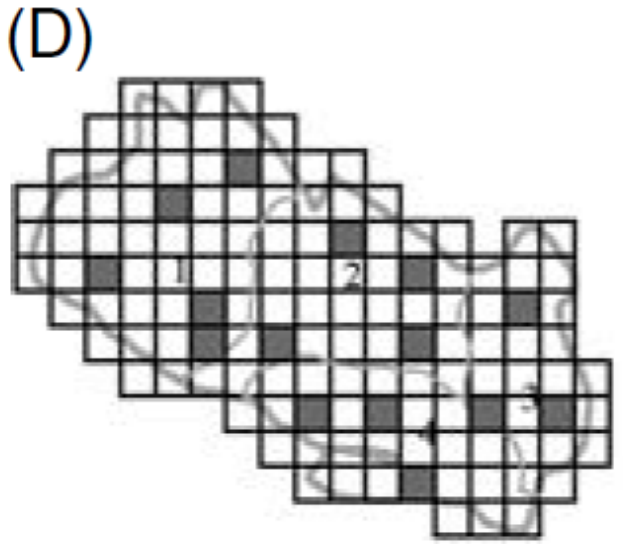


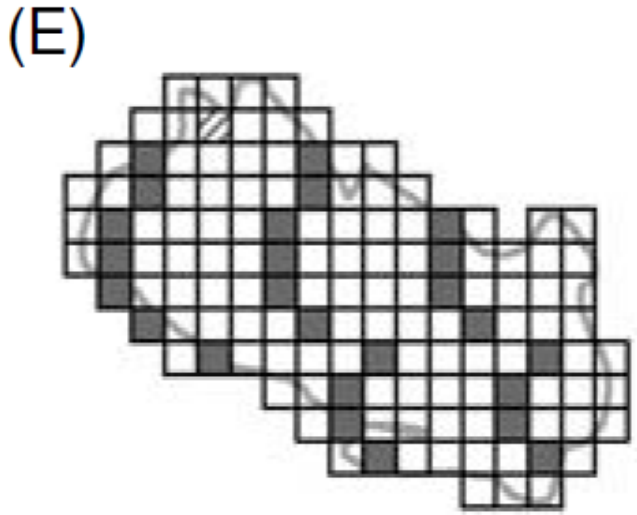
Stratified random sampling

- Useful when study area is characterized by several homogeneous regions
- Regions with higher variability should be sampled more intensively than regions with low variability
- Often more cost effective than simple random sampling



Systematic sampling

- Sample units are selected according to a regular, ordered scheme with the first unit being sampled randomly.



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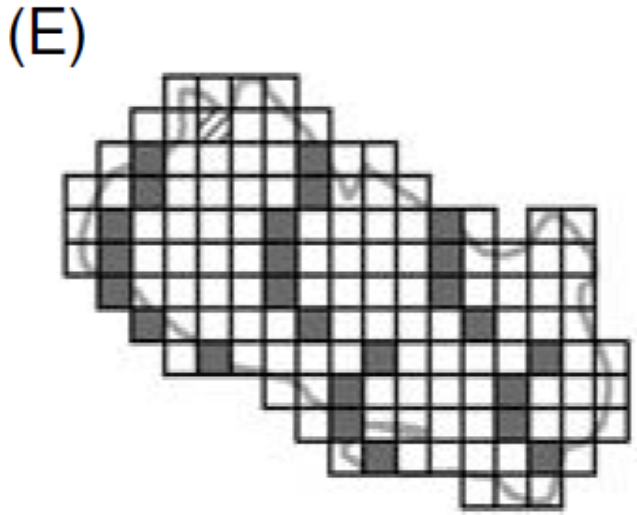

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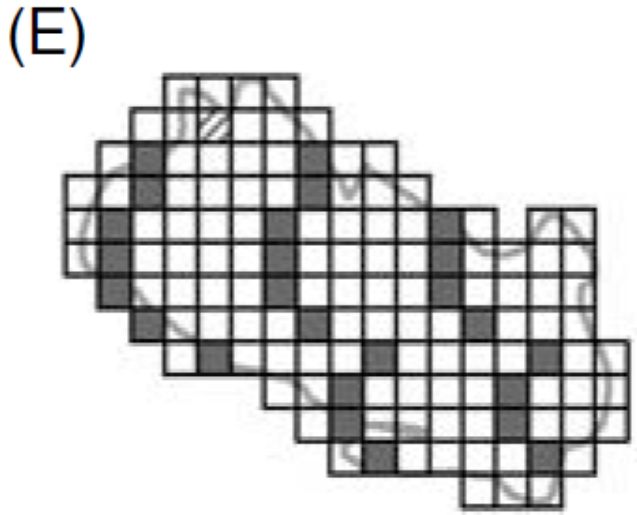
- Easy to implement in the field
- Potentially dangerous because sample unit spacing could coincide with natural spacing of environmental features



Main points

- We have to estimate model parameters
- Reliable estimates require good sampling design
- Replication reduces variance
- Randomization reduces bias