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# MEASURING ANIMALS THROUGH A TELESCOPE

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Abstract.—We describe a simple, inexpensive method of measuring animate and inanimate objects at a distance using a gradicule mounted in a spotting telescope eyepiece. Estimated lengths read off a ruler held perpendicular to the viewer between 25 and 150 m were within 1.7 and 3.2 mm of the actual length 95% of the time. We estimated that of all Great Blue Herons (*Ardea herodias*) encountered in the field within 25 m, about 65% of the females and 73% of the males could be sexed with 95% confidence by measuring culmen lengths using this method. At 150 m, the respective percentages fell to about 38% and 46%.

## USO DE UN TELESCOPIO PARA MEDIR TAMAÑOS EN ANIMALES

Sinopsis.—En este trabajo se describe un metodo simple y de bajo costo para medir a distancia objetos animados e inanimados utilizando un micrómetro montado en el ocular de un telescopio. Las longitudes estimadas, al leer el largo en reglas colocadas perpendicularmente al observador a distancias entre 25 y 150 m, estuvieron entre 1.7 y 3.2 mm del tamaño real en el 95% de los casos. A 25 m de distancia y utilizando el tamaño del culmen de individuos de *Ardea herodias,* el método nos permitió determinar el sexo del 65% de las hembras y del 73% de machos observados con un 95% de confiabilidad. A 150 m de distancia el porcentaje de identificación se redujo a 38% y 46%, respectivamente.

Studies of wild animals frequently require measuring body parts or objects such as prey items or nests. However, capturing some animals or reaching some objects can be difficult, time consuming, costly, and disruptive to the animals. Here we describe an inexpensive and reasonably accurate method to measure well-defined animal body parts or objects from a distance.

A measuring micrometer eyepiece (gradicule) 1 cm long with 0.01 cm divisions was inserted at the base of the focusing tube of a 15× eyepiece of a Bushnell Spacemaster II spotting telescope. The gradicule was mounted within the focal plane of the eyepiece. The eyepiece must have its own

TABLE 1. Average difference (mm) between actual and observed readings of estimates of ruler lengths versus distance using the gradicule method.

| | Distance from telescope (m) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 25 | 50 | 75 | 100 | 125 | 135 | 150 |
| Average difference[a] | 0.1 | 0.7 | 0.6 | 0.2 | −0.3 | −1.8 | 0.6 |
| SD | 1.7 | 1.9 | 1.8 | 2.5 | 2.1 | 3.1 | 3.2 |
| $n$ | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| ±95% conf. int. | 3.4 | 3.7 | 3.6 | 5.0 | 4.2 | 6.2 | 6.3 |

[a] Mean of the difference above (+) and below (−) the actual length of gradicule measurements.

focusing ring so that the gradicule can be brought into focus after the telescope has been focused. It is also important that the gradicule face the inside of the eyepiece so that it does not wear when the eyepiece is removed. Various types of gradicules are available from scientific supply companies and all can be mounted into regular spotting scope eyepieces.

The method involves converting readings off the gradicule into actual units and estimating (or measuring) the distance between the telescope and subject. To do this the animal must remain motionless for a few seconds while gradicule measurements are made and the distance between telescope and subject must be estimated or measured directly on the ground. Alternately, if an animal habitually uses one site, gradicule measures can be read directly off a ruler placed beside the subject. If the distance between the telescope and subject varies with each reading, it is necessary to determine the gradicule measures over a range of distances. This can be done by taking gradicule readings of a fixed length off a ruler at increasing distances. These results are then plotted and each gradicule reading is read directly off the graph after estimating or measuring the distance to the subject.

We illustrate this method here by using it to sex Great Blue Herons (*Ardea herodias*). About 10% of culmen lengths of male Great Blue Herons ($n$ = 24) collected on the British Columbia coast (*A. h. fannini*) overlap female culmen lengths ($n$ = 29) (K. Simpson, pers. comm.). The actual overlap might be slightly greater than what Simpson (Unpubl. M.Sc. thesis, Univ. Brit. Col. Vancouver, 1980) showed because his samples are not large.

Female culmen lengths reported by Simpson (1980) were ≤131 mm and male culmen lengths were ≥129 mm. We chose the median (130 mm) to separate the sexes and assumed an equal number of both sexes fell in the unknown category. Next we determined the corresponding reading of the 130 mm boundary on the gradicule scale read off a ruler placed at distances measured with a tape measure between 25 and 150 m from the telescope. The gradicule readings were then plotted against distance to produce a line from which any gradicule reading could be converted to real measures.

The accuracy of this method was tested as follows. We repeated the

TABLE 2. The probability of Great Blue Heron being correctly sexed at different distances using the gradicule method.

| Distance (m) | Boundary dividing sexes ± error | | Percent error | Percent of encounters correctly sexed[a] | |
|---|---|---|---|---|---|
| | Female | Male | | Female | Male |
| 25 | 125.8 | 134.3 | 2.49 | 64.8 | 72.9 |
| 50 | 125.1 | 134.9 | 2.99 | 59.1 | 68.1 |
| 75 | 124.5 | 135.6 | 3.49 | 54.4 | 62.6 |
| 100 | 123.8 | 136.2 | 3.99 | 48.4 | 57.1 |
| 125 | 123.2 | 136.9 | 4.49 | 43.3 | 54.0 |
| 135 | 122.9 | 137.1 | 4.69 | 41.0 | 46.0 |
| 150 | 122.6 | 137.5 | 4.99 | 38.2 | 45.6 |

[a] With 95% confidence.

method described above, but in this case we masked the markings on the ruler from the view of the observer. One of us then indicated with a pencil twenty points on the ruler within the range (112–146 mm) of culmen lengths for male and female herons reported by Simpson while a second observer read those points off the gradicule scale in the telescope. This was repeated at seven stops between 25 and 150 m from the ruler. Later we converted the gradicule readings at each stop to millimeters and calculated the standard deviation of the twenty readings per stop (Table 1). The results indicate that this method is accurate to within ±1.7 mm at 25 m and ±3.2 mm at 150 m, 95% of the time (Table 1).

The mean of the 24 male Great Blue Heron culmen lengths reported by Simpson was 137 mm (SD = 4.4, range = 129–146) and the 29 female culmen lengths was 124 mm (SD = 4.7, range = 112–131). The best fit of the percent error (Y) at different distances (X) in meters was:

$$Y = 0.02X + 1.99 \quad (1)$$

($r^2 = 0.733$, $t = 3.702$, $P = 0.014$) or about 0.02%/m. Using that average error we calculated the percentage of males and females that could be sexed with 95% confidence up to 150 m away (Table 2). This value was calculated as follows:

$$\text{Percent males} = \frac{\bar{X}_m - (C + Y_x)}{SD}$$

where $\bar{X}_m$ is the mean male culmen length (=137 mm), C is the shortest male culmen length that could be identified as a male in the hand, Y is the error at distance X from equation (1) and SD is the standard deviation of male culmen lengths (=4.4). The resulting figure was used to determine the balance of the area under the normal curve. The same method was used for females except instead the error was subtracted from the longest culmen length (129 mm) that could be identified in the hand as belonging to a female. Using the gradicule, the percent error increased as we moved away, so the percentage of males and females that could be confidently sexed decreased (Table 2). We were generally able to walk to within 65 m and to drive a vehicle to within 25 m of a heron. Thus, over half the population could be sexed in the field using this method.

An additional error will occur if the culmen is not perpendicular to the viewer. It was nearly impossible to detect if the bill was less than about ten degrees off the perpendicular. Nevertheless, the percent error can be estimated using the formula $(1 - \cos a)\ 100\%$ where a is the number of degrees off the perpendicular. At five, ten and 20 degrees off the perpendicular the respective error is about 0.4, 1.5 and 6.0%.

The gradicule method has wide application where comparative measurements will suffice. For example, we were able to sex a large number of feeding herons by comparing culmen lengths, and then determining how many fell above (male) or below (female) a single gradicule scale reading of the 130 mm boundary read off a ruler placed where the herons fed. The method also has wide applications including measuring animals that are sometimes difficult to catch (e.g., growth studies of post-fledged birds) or objects out of reach (e.g., nest dimensions in tall trees) and as a range finder.

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