Sexual Dimorphism and Allometry in Primate Ossa Coxae

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KEY WORDS Sexual dimorphism, Allometry, Pelvis

ABSTRACT Five measurements were taken on the ossa coxae of 454 adult primates representing Ceboidea, Cercopithecoidea and Hominoidea. Sex differences in these variables and their relationships to overall body size and sexual dimorphism were tested by means of Student's t-test and regression analysis. The study attempts to clarify the nature of primate pelvic sexual dimorphism, including allometric effects, and more specifically, test the assertion made by Mobb and Wood (1977) that sexual dimorphism in body size is not an important determinant in pelvic sex differences.

Variables that contribute to the size of the birth canal tend to be larger in females than males in all taxa studied except two. In these, *Hylobates* and *Alouatta*, there were no significant differences between the sexes for any of the five variables. In general, sexual dimorphism in variables contributing to the size of the birth canal was correlated ($r = 0.8$) with sexual dimorphism in body size. Furthermore, the coefficients of allometry underlying pelvic sex differences were shown to be moderately correlated ($r = 0.5$) with sexual dimorphism in size. The influence of other adaptive factors on primate pelvic sexual dimorphism are also briefly discussed.

Since the pelvis in female mammals serves as birth canal in addition to its roles in support and locomotion, it seems reasonable to expect that this added function would also influence structure. One would expect that any pelvic differences between males and females would be enhanced in those species in which the size of the fetus at term was large in relation to the female pelvic inlet. If, however, the birth canal is roomy in relation to the size of the newborn, it would seem that other adaptive requirements would be primarily responsible. In all cases, of course, any obstetrical adjustments in female pelves must be such that they do not seriously interfere with locomotor functions, so that structural compromise between these forces may be common.

A number of workers have been concerned with pelvic sex differences among primates. Schultz (1930), Washburn (1948), and Black (1970) have focused on sexual differences in the relative elongation of the pubic bone in relation to ischial length seen in many female primates. They were not so much concerned, however, with explaining observed differences as with the utility of that index as a means of sexing skeletal material. Mobb and Wood (1977) have looked at allometric variation of these variables in several primate species, and Schultz (1949) and Leutenegger (1974) have considered the relationship between female pelvic inlet diameters and newborn head size. Thus far, however, the nature of the response of the female pelvis to such factors as overall body size, degree of sexual dimorphism, and fetal size is still a matter of speculation.

The object of the present study is first, to clarify the nature and degree of sexual dimorphism in the ossa coxae of a series of primate taxa and second, to see whether pelvic sexual dimorphism and allometry in these taxa follow some recognizable pattern.

MATERIALS Measurements of a series of pelvic variables were made on a total of 454 adult primate skeletons. The specimens were measured at the following institutions: Powell-Cotton Museum, Birchington; British Museum (Natural History), London; Anthropologisches Institut,
Some measurements were also taken on the personal collection of Dr. N. C. Tappen, University of Wisconsin, Milwaukee. The list of taxa and their samples sizes can be seen in Table 1. The samples were composed of approximately equal numbers of each sex except for Nasalis. Here I was able to measure only five male skeletons although 13 females were available. Only specimens whose sex had been recorded in the museum collections were included in this study.

A series of pelvic variables were chosen for their influence on the size and shape of the birth canal or for their contribution to overall pelvic size. These measurements were taken on each specimen:

1) **Iliac length.** The distance from the most superior point on the iliac crest to a point on the external wall of the acetabulum defined by an imaginary line passing through the center of the acetabulum perpendicular to the long axis of the ilium.

2) **Ischial length.** The distance from the center of the acetabulum to the most distal point on the ischial body.

3) **Pubis length.** The distance from the center of the acetabulum to the most medial point on the body of the pubis.

4) **Lower iliac height.** The distance from the posterior inferior iliac spine to the point where the acetabular margin of the ilium meets the acetabular rim.

5) **Pelvic diameter.** The distance from the posterior inferior iliac spine to the most superior point on the pubis at the symphysis. This measurement approximates the sagittal diameter of the birth canal though not precisely, since the shape and size of the sacrum are not included. Figure 1 is a visual key to these measurements.

### Data analysis

To determine whether or not any of these variables showed significant differences between the sexes, Student's t-tests were run for each variable pairing males and females of each taxon. If performed on untransformed data, the results of each test would be determined primarily by sexual differences in overall size. To discover whether or not males and females differ in ways other than absolute size, each variable in each individual was divided by a measure of overall size for that individual.

The t-tests were done using these transformed data. The measure of size consisted of the average of variables 1, 2, 3, and 5 from this study, a measure of the width of the iliac blade and the diameter of the acetabulum (these latter measurements are defined more fully in Steudel (in press). This statistic, calculated for each individual in the study, is a good indicator of the overall size of the pelvis. Although it has not been established whether or not pelvic size varies isometrically with overall body size, it seems likely that this relationship would be a reasonably close one. But even if the relationship should be allometric, the variation in each dimension will at least be separated from variation in overall pelvic size.

A number of authors have discussed statistical difficulties that may arise through the testing of ratios (e.g. Pearson, 1897; Atchley et al., 1976). Because of this it seemed possible that the results of the previous tests might not be totally reliable. Atchley et al. (1976) suggest that a more appropriate technique is the use of residuals as a substitute for ratios. To make use of this alternative, I removed the variation due to size from each of the tested variables according to a method described elsewhere (Steudel, 1978). This technique is similar to that used by Manaster (1979) and results in values that are essentially the residuals of the regression of each variable on size. Student's t-tests were then performed on these data in the same way as on the ratios.

Next, least-squares regressions were used to determine the nature of variation of each variable, transformed to natural logarithms, with

### Table 1. Taxa studied and their sample sizes

<table>
<thead>
<tr>
<th>Taxon</th>
<th>N♂</th>
<th>N♀</th>
<th>N combined</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Homo sapiens</em></td>
<td>18</td>
<td>18</td>
<td>36</td>
</tr>
<tr>
<td><em>Gorilla gorilla</em></td>
<td>29</td>
<td>31</td>
<td>60</td>
</tr>
<tr>
<td><em>Pan troglodytes</em></td>
<td>24</td>
<td>21</td>
<td>45</td>
</tr>
<tr>
<td><em>Pongo pygmaeus</em></td>
<td>17</td>
<td>12</td>
<td>29</td>
</tr>
<tr>
<td><em>Hylabates larvatus</em></td>
<td>12</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td><em>Cebus sp.</em></td>
<td>13</td>
<td>12</td>
<td>25</td>
</tr>
<tr>
<td><em>Saimiri sciureus</em></td>
<td>5</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td><em>Alouatta sp.</em></td>
<td>7</td>
<td>9</td>
<td>16</td>
</tr>
<tr>
<td><em>Papio anubis</em></td>
<td>8</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td><em>Nasalis larvatus</em></td>
<td>5</td>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td><em>Colobus sp.</em></td>
<td>14</td>
<td>14</td>
<td>28</td>
</tr>
<tr>
<td><em>Cercopithecus albigena</em></td>
<td>17</td>
<td>16</td>
<td>33</td>
</tr>
<tr>
<td><em>Macaca mulatta</em></td>
<td>19</td>
<td>19</td>
<td>38</td>
</tr>
<tr>
<td><em>Cercopithecus mitis</em></td>
<td>12</td>
<td>10</td>
<td>22</td>
</tr>
<tr>
<td><em>Cercopithecus aethiops</em></td>
<td>11</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td><em>Presbytis cristatus</em></td>
<td>20</td>
<td>15</td>
<td>35</td>
</tr>
</tbody>
</table>
pelvic diameter were tested against body size and percent sexual dimorphism as taken from the literature, and percent sexual dimorphism in pelvic size. These two estimators of size sexual dimorphism were both used in order to be able to cross-check the results. If either estimator is unreliable the results obtained in the two analyses should be discordant. However, an agreement would allow one to have considerable confidence in the results. *Homo sapiens* was not included in these calculation because of the lack of reliable body weight and sexual dimorphism values on the population studied. Given the differences in size between human populations, it seemed unwise to substitute modern values for this population of old English individuals.

**RESULTS**

Fig. 1. Visual key to measurements taken.

respect to ln size, separately for each sex of each taxon. The 95% confidence intervals were calculated so that any sexual differences in allometric variation would be noted. As will be discussed below, there were in most cases no significant differences in the slopes ($\alpha$) of these lines between males and females. Consequently the same analyses were done combining males and females of each taxon. The corresponding correlations ($r$) were also determined.

For each taxon, the average female value for each variable was expressed in percent of the average male value since this statistic has often been used for comparison and since it does show the relationship between males and females without removing size. Data on percent sexual dimorphism in body weight were taken from the literature (Post, 1980; Napier and Napier, 1967; Schultz, 1956). The percent sexual dimorphism in pelvic size based on the present data was also calculated.

To determine whether or not the various aspects of pelvic variation were closely related to overall body size or sexual dimorphism in body size, correlations between pairs of statistics were determined using each species' values as the data points. Specifically, species values for female in percent male values and the coefficients of allometry of pubis length and
difference. Exceptions to this were in lower iliac height and pubis length in Cebus. Saimiri was not tested because of inadequate sample size, but its being a small, closely related species, one would expect it to be similar to Cebus in this respect. Wood (1976) found sexual differences in ischial length for Homo, Papio and Colobus. These differences do not appear in the present data, but perhaps Wood's use of bicondylar femur length (taken as the minimum distance between the condylar plane and the most proximal point on the femoral head) as a measure of size accounts for this difference.

These data show that male and female samples can be validly combined in almost all cases. Table 3 shows the coefficients of allometry for the main dimensions of the os coxae that contribute to the size of the birth canal for each species with the corresponding correlation coefficient in brackets. The table also includes average female values in percent average male values for the same dimensions, published data on species body weights and percent sexual dimorphism, and the percent sexual dimorphism for pelvic size based on present data. Table 4 presents the actual data on which the ratios for each variable were based. As can be seen from Table 3, the percent sexual dimorphism values for variables 3 and 5 are correlated with percent sexual dimorphism for overall body size taken from the literature. The actual correlations are 0.80 and 0.78, respectively. The correlations are somewhat higher if pelvic size dimorphism is used as the independent variable, 0.91 and 0.89, respectively. But in either case the correlations are substantial. Average body weight is moderately correlated with sexual dimorphism of pubis length (r = 0.54) but not with sexual dimorphism in the sagittal diameter of the pelvis (r = 0.07).

When one looks at the coefficients of allometry, however, they are not so readily explained by either body size or sexual dimorphism. Correlations between the $\alpha$ values for both variables 3 and 5 are virtually uncorrelated with overall size ($r = 0.07$ and 0.18, respectively). The $\alpha$ values for both variables are, however, moderately correlated with sexual dimorphism ($r = 0.53$ and 0.50), with slightly higher values if pelvic size dimorphism is used ($r = 0.65$ and 0.66).

To achieve the observed end result, that of females being relatively the larger in dimensions increasing the circumference of the birth canal, one would expect taxa in which the female is substantially smaller than the male to show negative allometry of these dimensions, whereas isometry should be approximated when males and females are subequal. However, these coefficients of allometry do not fall into clearly separable categories. Those taxa among the cercopithecidae that show the highest level of sexual dimorphism also show comparatively low coefficients of allometry for dimensions affecting the birth canal. This relationship is not closely linear but does show the general pattern predicted above. When the great apes are considered, however, the relationship between the coefficients and sexual dimorphism in size breaks down. The gorilla and orangutan, with similar levels of sexual dimorphism, show marked differences in their coefficients of allometry. Furthermore, the cercopithecoids show markedly higher coefficients for a given level of size sexual dimorphism than do cercopithecoids. This results in the moderate correlations between these coefficients and sexual dimorphism seen above.

**DISCUSSION**

My data do not confirm the growth pattern groupings of species reported by Mobb and Wood (1977). The coefficients of allometry obtained for ischial length with sexes combined in the present study are very similar to those reported by Mobb and Wood (1977) in which femur length was used as the indicator of size. Our respective values for pubis length, however, differ widely for many species. This is
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TABLE 3. Allometric coefficient (α) of variables in relation to pelvic size, correlation coefficient (r), and female mean in percent male mean shown in relation to species body weight and sexual dimorphism of body and pelvis size

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Average body weight (kg)</th>
<th>% Sexual dimorphism in body weight</th>
<th>% Sexual dimorphism in pelvic size</th>
<th>Variable 3</th>
<th>Variable 5</th>
<th>Variable 3</th>
<th>Variable 5</th>
<th>( \frac{X^2 \times 100}{X.5} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gorilla</td>
<td>126.0¹</td>
<td>58%¹</td>
<td>83.8</td>
<td>0.92 (0.83)</td>
<td>0.83 (0.91)</td>
<td>86.8</td>
<td>88.8</td>
<td>0.75</td>
</tr>
<tr>
<td>Pan</td>
<td>44.8²; 1.3</td>
<td>87%¹; 1.3</td>
<td>98</td>
<td>1.13 (0.75)</td>
<td>0.81 (0.60)</td>
<td>101.9</td>
<td>103.8</td>
<td>0.97</td>
</tr>
<tr>
<td>Pongo</td>
<td>36.9²</td>
<td>54%³</td>
<td>90.6</td>
<td>0.75 (0.79)</td>
<td>0.68 (0.84)</td>
<td>94.5</td>
<td>94.8</td>
<td>0.78</td>
</tr>
<tr>
<td>Hylabates</td>
<td>5.5¹</td>
<td>93%¹</td>
<td>102.8</td>
<td>0.97 (0.84)</td>
<td>0.70 (0.66)</td>
<td>105.1</td>
<td>105.8</td>
<td>0.73</td>
</tr>
<tr>
<td>Papio</td>
<td>21.0¹</td>
<td>55%¹; 1.3</td>
<td>85.3</td>
<td>0.78 (0.83)</td>
<td>0.69 (0.90)</td>
<td>90.0</td>
<td>91.1</td>
<td>0.79</td>
</tr>
<tr>
<td>Nasalis</td>
<td>13.8¹</td>
<td>57%³</td>
<td>86.7</td>
<td>0.75 (0.86)</td>
<td>0.36 (0.52)</td>
<td>91.4</td>
<td>99.2</td>
<td>0.87</td>
</tr>
<tr>
<td>Colobus</td>
<td>9.3¹</td>
<td>79%1</td>
<td>101.8</td>
<td>1.07 (0.74)</td>
<td>1.08 (0.66)</td>
<td>107.5</td>
<td>109.0</td>
<td>0.87</td>
</tr>
<tr>
<td>Cercocetus</td>
<td>8.1¹</td>
<td>76%¹</td>
<td>92.4</td>
<td>0.38 (0.36)</td>
<td>0.19 (0.22)</td>
<td>102.8</td>
<td>103.0</td>
<td>0.87</td>
</tr>
<tr>
<td>Macaca</td>
<td>6.7¹</td>
<td>68%¹</td>
<td>89.9</td>
<td>0.79 (0.86)</td>
<td>0.73 (0.86)</td>
<td>97.6</td>
<td>100.0</td>
<td>0.87</td>
</tr>
<tr>
<td>Presbytis</td>
<td>7.0¹; 1.3</td>
<td>93%¹; 1.3</td>
<td>104.6</td>
<td>1.77 (0.82)</td>
<td>1.67 (0.77)</td>
<td>118.0</td>
<td>118.9</td>
<td>0.87</td>
</tr>
<tr>
<td>C. mitis</td>
<td>6.3¹</td>
<td>70%¹</td>
<td>90.7</td>
<td>0.39 (0.45)</td>
<td>0.63 (0.51)</td>
<td>101.8</td>
<td>100.4</td>
<td>0.87</td>
</tr>
<tr>
<td>C. aethiops</td>
<td>4.0¹</td>
<td>80%¹</td>
<td>97.3</td>
<td>0.63 (0.65)</td>
<td>1.09 (0.71)</td>
<td>110.0</td>
<td>108.5</td>
<td>0.87</td>
</tr>
<tr>
<td>Alouatta</td>
<td>6.6¹</td>
<td>77%¹; 1.3</td>
<td>92.0</td>
<td>1.08 (0.92)</td>
<td>1.06 (0.92)</td>
<td>92.0</td>
<td>93.3</td>
<td>0.87</td>
</tr>
<tr>
<td>Cebus</td>
<td>3.7²</td>
<td>78%¹</td>
<td>99.3</td>
<td>1.33* (0.76)</td>
<td>1.21* (0.81)</td>
<td>108.3</td>
<td>105.2</td>
<td>0.87</td>
</tr>
<tr>
<td>Saimiri</td>
<td>0.7¹</td>
<td>85%¹</td>
<td>103.9</td>
<td>1.60 (0.74)</td>
<td>2.22 (0.80)</td>
<td>117.5</td>
<td>118.0</td>
<td>0.87</td>
</tr>
<tr>
<td>H. sapiens</td>
<td>94.9</td>
<td></td>
<td></td>
<td>1.03 (0.82)</td>
<td>0.74 (0.71)</td>
<td>101.7</td>
<td>100.2</td>
<td>0.87</td>
</tr>
</tbody>
</table>

1 Post (1980).
2 Sacher and Staffeldt (1974).
3 Napier and Napier (1967).
4 Schultz (1956).
* Since \( \delta \) and \( \varphi \) values for this coefficient differ at 95% confidence, these combined values oversimplify.

particularly true for those taxa in which their correlation values were \( \pm 0.3 \) or less. In those cases (five of their eight species), the low correlations make their coefficients of allometry highly questionable. It is on these spurious values that these authors base their two growth patterns. It is not therefore surprising that my results do not confirm theirs.

The only pattern seen in the allometric coefficients of the present data is the moderate correlation with sexual dimorphism noted above. This also contradicts the findings of Mobb and Wood (1977), who concluded that body size dimorphism was not significant as a cause of pelvic growth differences. The results obtained here suggest that while size dimorphism does contribute, another factor or factors must be significant. I again attribute the difference between my conclusions and those of Mobb and Wood to the low correlations associated in many cases with their coefficients of allometry. These data therefore support the view of Leutenegger (1970) that sexual dimorphism in body size is a critical factor influencing pelvic dimorphism.

The fact that these \( \alpha \) values do not show extremely close relationships to body size or sexual dimorphism and that they do not fall
into discrete groupings suggests that these coefficients are being influenced by a factor or factors not included in this study. Very likely the overall size and especially the head size of newborns are significant, a point also suggested by Leutenegger (1970). While some data on these variables are available (Doyle, 1979; Leutenegger, 1974, 1979; Sacher and Staffeldt, 1974), they are too limited for use in the present context. While Leutenegger (1973a) has shown that smaller primates have relatively larger newborns, he points out that the data on newborn cranial dimensions, the critical information in the present context, are scanty. There are no data at all on fetal head size for many of the species in this study, and in other cases the sample size is only one or two specimens, so reliability is poor. No doubt these data on a wider range of taxa and individuals will be necessary to reach some further understanding of pelvic sex differences. Another factor that obfuscates the interpretation of these sex differences is differences in locomotor habit among the species involved. Many of the dimensions that influence the size of the birth canal also influence locomotor characteristics, for example, the distance between the sacroiliac joint and the hip joint, discussed by Steudel (in press), or the leverage of the adductor muscles. An example of the latter is described by Leutenegger (1973b). Thus species differing in their locomotor constraints may also differ in the average size of the pelvic outlet. Females of a species in which locomotor adaptations favored a relatively small outlet might show greater enlargement of these dimensions relative to the males of the species than would be found in a species in which the outlet was larger. However, fetal head and body size at birth may increase or diminish in response to pelvic outlet size as determined by locomotor constraints.

Whereas the significance of sex differences in primate pelves may not be fully understood until locomotor influences on the pelvis are clearer and we have more data on newborns, the results described here have indicated certain generalizations. Average female values for dimensions relating to the size of the birth canal taken in percent of corresponding male values were correlated with percent sexual dimorphism of body size (r = 0.5). Thus it seems contrary to Mobb and Wood (1977), that sexual dimorphism in body size is an important factor influencing pelvic dimorphism, though not the exclusive determinant.

ACKNOWLEDGMENTS

I am grateful to the curators of the primate skeletal collections listed in the text for the opportunity to examine their material. Professors Walter Leutenegger and John Robinson provided helpful reviews of the manuscript. This study was supported in part by NSF grant GS-34039. Computer time was granted by the University of Wisconsin Graduate School. I would also like to thank Dr. H. J. Steudel for assistance with the computing.

### Table 4: Means and standard deviations (in brackets) calculated separately for males and females of each taxon on untransformed data

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Variable 1</th>
<th></th>
<th></th>
<th>Variable 2</th>
<th></th>
<th></th>
<th>Variable 3</th>
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<th></th>
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<tr>
<td></td>
<td>?</td>
<td>c</td>
<td>?</td>
<td>c</td>
<td>?</td>
<td>c</td>
<td>?</td>
<td>c</td>
<td>?</td>
</tr>
<tr>
<td>Homo sapiens</td>
<td>11.8 (0.56)</td>
<td>13.1 (0.63)</td>
<td>7.5 (0.35)</td>
<td>8.5 (0.25)</td>
<td>8.6 (0.59)</td>
<td>8.4 (0.42)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gorilla gorilla</td>
<td>20.7 (1.42)</td>
<td>24.5 (1.44)</td>
<td>9.7 (0.59)</td>
<td>12.1 (0.89)</td>
<td>9.7 (0.68)</td>
<td>11.2 (0.95)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pan troglodytes</td>
<td>17.7 (1.01)</td>
<td>18.0 (0.60)</td>
<td>7.9 (0.44)</td>
<td>8.2 (0.51)</td>
<td>7.3 (0.53)</td>
<td>7.2 (0.45)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pongo pygmaeus</td>
<td>15.7 (1.54)</td>
<td>17.0 (1.38)</td>
<td>8.0 (0.68)</td>
<td>9.1 (0.89)</td>
<td>7.9 (0.61)</td>
<td>8.4 (0.64)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hylobates lar</td>
<td>9.3 (0.34)</td>
<td>9.3 (0.50)</td>
<td>3.9 (0.23)</td>
<td>3.8 (0.22)</td>
<td>3.5 (0.16)</td>
<td>3.4 (0.17)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cebus</td>
<td>5.9 (0.34)</td>
<td>6.0 (0.48)</td>
<td>2.6 (0.16)</td>
<td>2.8 (0.23)</td>
<td>2.5 (0.26)</td>
<td>2.3 (0.16)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saimiri sciureus</td>
<td>3.8 (0.13)</td>
<td>3.7 (0.16)</td>
<td>1.8 (0.05)</td>
<td>2.0 (0.07)</td>
<td>1.8 (0.16)</td>
<td>1.5 (0.08)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alouatta</td>
<td>8.0 (0.65)</td>
<td>8.6 (0.71)</td>
<td>3.1 (0.25)</td>
<td>3.5 (0.31)</td>
<td>3.7 (0.36)</td>
<td>4.1 (0.37)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Papi anubis</td>
<td>11.1 (0.27)</td>
<td>12.7 (0.66)</td>
<td>5.4 (0.34)</td>
<td>7.2 (0.67)</td>
<td>4.7 (0.44)</td>
<td>5.2 (0.31)</td>
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<td>Nasalis larvatus</td>
<td>10.1 (0.54)</td>
<td>11.4 (0.56)</td>
<td>4.6 (0.23)</td>
<td>6.1 (0.14)</td>
<td>4.2 (0.28)</td>
<td>4.6 (0.19)</td>
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<td>Colobus</td>
<td>9.8 (0.62)</td>
<td>9.8 (0.56)</td>
<td>4.5 (0.31)</td>
<td>4.7 (0.44)</td>
<td>4.0 (0.31)</td>
<td>3.7 (0.26)</td>
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<td>Cercocebus albigena</td>
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<td>9.2 (0.30)</td>
<td>3.9 (0.16)</td>
<td>4.7 (0.23)</td>
<td>3.5 (0.21)</td>
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<td>Macaca mulatta</td>
<td>8.1 (0.99)</td>
<td>9.2 (1.20)</td>
<td>3.8 (0.68)</td>
<td>4.9 (0.70)</td>
<td>3.6 (0.46)</td>
<td>3.7 (0.46)</td>
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<td>9.3 (0.40)</td>
<td>3.8 (0.22)</td>
<td>4.7 (0.18)</td>
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<td>Cercopithecus aethiops</td>
<td>7.1 (0.70)</td>
<td>7.6 (0.59)</td>
<td>3.6 (0.34)</td>
<td>4.2 (0.35)</td>
<td>3.4 (0.31)</td>
<td>3.1 (0.19)</td>
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<td>Presbytis cristatus</td>
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<td>8.4 (0.35)</td>
<td>3.9 (0.17)</td>
<td>4.1 (0.21)</td>
<td>3.5 (0.21)</td>
<td>3.0 (0.15)</td>
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### LITERATURE CITED


Pearson, K (1897) On a form of spurious correlation which may arise when indices are used in the measurement of organs. Proc. R. Soc. Lond. 60:489–502.


