

# On the Systematic Bias in Skeletal Sexing

KENNETH M. WEISS

*Department of Human Genetics, University of Michigan,  
Ann Arbor, Michigan*

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**ABSTRACT** Comparison of a large series of sexed adult skeletal populations and a similar series of adult pre-industrial peoples shows that there is a regular and systematic bias in the sexing of adult skeletons. This bias, which is about 12% in favor of males, is due to the nature of secondary sex characteristics in bone. It should be corrected in skeletal series before demographic analysis is made of them. Application of this knowledge and the same data to problems of age-specific male and female mortality rates is inconclusive, but points to an area for important future investigation. Application to the fossil record confirms some ecological ideas about human evolution.

For many purposes, the analysis of a series of excavated skeletons requires that the adult specimens be sexed. On the accuracy of the sexing procedures hinge the results of, for example, analysis of mortality patterns or metric analysis of sexual dimorphism. This paper will look at the sexing procedures as they have been used and will demonstrate that they have resulted in a significant bias which must be considered when sex-specific analysis of skeletal material is attempted.

There are many works which discuss the morphological features of the bones of the skeleton by which sexing can in theory be performed (Hrdlička, '52; Krogman, '62; Bass, '71). The pelvis seems to be the most reliable single bone for this, and it receives the greatest treatment in the literature. Pelvises are often not well preserved, however, and in such cases sexing must be performed on the other, less reliable, bones.

Several studies have stressed the increased accuracy in sexing skeletal material which results from the combination of many measurements from a single bone or a series of measurements from different bones; these studies are multivariate in nature (Hanna and Washburn, '53; Pons, '55; Thieme and Schull, '57; Giles, '63). They recognize that as secondary sex characteristics on bone vary from individual to individual and from

group to group, one must sex a new-found individual only in comparison to a well analyzed *population*. These studies derive methods for determining population-specific cutoff points between males and females for the particular array of traits they include.

The multivariate methods which consider populational variation are clearly superior to subjective morphological criteria in that they provide rigorously-defined, objective methods for determining sex and their results seem to be such that fewer specimens are "doubtful" than is the case with the morphological criteria. Unfortunately, however, the more sophisticated methods require better data on which to work; usually, one needs to have the same bones from each individual in the population, and often the measurements to be taken demand a good state of preservation as well. In practice, the data are usually somewhat fragmentary, and the rule seems to be that subjective anatomical criteria are used which differ with each specimen sexed, depending on the bones represented. The vast majority of sexed skeletal populations in the literature have been sexed in this way.

Stewart ('54) and Hrdlička ('52) in fact support subjective methods when performed by experienced professionals. In today's computer parlance they could argue that the trained human brain can

handle larger arrays of variables than can machines. While this may be the case, there is still good reason to suspect the results of the sexing which has been done in this way. The reason for this suspicion is the general nature of sex characteristics on bone, which produces an irresistible temptation in many cases to call doubtful specimens male. A great many of these characteristics are of what could be called a "larger-smaller" nature: the larger, or more marked trait is called male. Examples of this are muscle markings on the skull, size of the skull, femoral head size, rugosity of bone, and so forth. While there are many other traits in which presence indicates a female (for example, the pre-auricular sulcus on the pelvis), it seems that the "larger-smaller" traits are often, if not most often, the ones used. In particular, the sexing of specimens by characteristics of the skull is widespread, and many sex reflections in the skull are of the larger-smaller type. This being the case, when a specimen is found in which the traits are of intermediate size, rugosity, or development there seems to be a tendency to call it a male. Thus, a skull with a moderately marked temporal line is likely to be called male: it would be the absence of a marked temporal line which would indicate a female.

There are other reasons to suspect that too many skeletons might be called male. One is expressed by E. A. Hooton, who believed that typological characteristics of various "racial" groups were best found on the males (Hooton, '30), a reflection of the general tradition of basing comparisons on males; with small samples of material, it would be quite tempting to put all doubtful specimens into the male category (S. L. Washburn, personal communication).

Skeletal series themselves might be biased. This could occur as the result of differential burial customs, unrepresentative sites, or poorer preservation of female material. In some cases, other information might lead us to suspect that the site was an unusual one (for example, a monastery graveyard); some of these problems have been discussed by Brothwell ('71). Differential preservation does not seem to be the answer, for were this the case one would expect female remains

in general to be more deteriorated than males; in the author's experience this is not so: the clearly-female skulls seem as well preserved as the clearly-males. Vallois ('60) argues that even fossil hominid *infants* preserve as well as adults; if it is true that, historically, anthropometrists sought well-preserved males for comparative studies, still one suspects that even complete series would show an excess of males, because of the nature of the sexing criteria themselves.

#### *Testing for bias*

To determine if the suspected excess of males in fact occurs, a compilation has been made of some 43 populations of adult skeletons from various time periods, cultures, and geographic areas. Table 1 shows these data; for each population the total number of adults is listed as well as the percent which were called male and a source reference.

Of the 43 populations shown, 33 had more males than females and only ten had an excess of females. This is significantly different from what would be expected assuming random sampling from populations with male-female equality ( $Z > 3.0$ ;  $P < 0.01$ ). The range in percent-male is 39 to 80. This clearly indicates the bias suspected. There are other ways of looking at the results which also show the degree and significance of the bias.

Weighting the populations equally even though they consist of different numbers of skeletons, one can compute the simple average of the populations' percent males. This is 56.8, and is significantly different from 50 for 43 populations ( $t = 3.7$ ;  $P < 0.001$ ). Alternatively, if we weight the population by the number of specimens, we merely sum all of the data together. There were 12,064 specimens with an overall percent male of 54.4, which is significantly different from 50 to many decimal places. No matter how we partition the data, the excess of males is systematic, obvious, and statistically significant when compared to a hypothetical expectation of 50% male.

However, it has not been proved that the problem is in the sexing, for it is possible that 50% males is not to be expected. In order to establish some control on the sex ratio to be expected, data from 31

TABLE 1

*Adult sex ratios from skeletal populations*

Population	Number of specimens	Percent male	Reference
<b>Amerindians</b>			
Pecos Pueblo	614	60	Hooton, '30
Texas Aborigines	507	53	Goldstein, '53
Eva	69	54	Lewis and Lewis, '61
Californians	206	48	Brabender, '65
Occaneechi	84	57	Hoyme and Bass, '62
Modoc	27	48	Neumann, '67
Hiwassee Island	133	61	Hoyme and Bass, '62
Indian Knoll	511	55	Johnston and Snow, '61
Knight	98	53	Wilkinson, '71
Norton Mound	15	80	Wilkinson, '71
Peruvians	242	57	MacCurdy, '23
East Greenlanders	51	61	Pedersen, '49
Eskimos	224	58	Hanna and Washburn, '53
<b>Africans</b>			
"Negroes"	187	58	Todd, '27
Northwest Mesolithics	42	62	Briggs, '55
Taforalt	86	55	Angel, '69
Nubians	36	53	Anderson, '68
Nubians	151	70	Smith and Jones, '08
Protohistoric Saharans	44	46	Chamla, '68
Neolithic Saharans	41	71	Chamla, '68
Egyptian mummies	110	57	Pearson, '02
<b>Japan</b>			
Jomon period	235	57	Kobayashi, '67
Edo period	166	70	Kobayashi, '67
<b>Europeans</b>			
France Eneolithic	242	46	Riquet, '53
Westerhus Sweden	154	46	Gejvall, '60
English medieval	59	85	Dingwall, '31
Yugoslavia	189	55	Ivaniček, '51
Hungary —Avar period	31	68	Wenger, '68
Hungary —Xth Century	600	52	Acsadi and Nemeskeri, '57
Hungary — Xth Century	47	49	Ery, '70
Hungary — XIIIth Century	34	56	Ery, '68
Other Hungarians	639	57	Ery, '68
Rome	4632	53	MacDonell, '13
Austria Bronze Age	228	53	Vallois, '37
Turkey Copper Age	159	63	Senyürek, '51
Nea Nikomedea	44	48	Angel, '69
Szekesfehervar	103	46	Angel, '69
Catal Huyuk	216	39	Angel, '69
Karatas	230	43	Angel, '69
Lerna	105	52	Angel, '69
Athens Classic	79	57	Angel, '69
Continental Greece	362	58	Angel, '47
Tasmanians	32	62	Todd, '27

Total number of populations: 43. Number at least 50% male: 33. Average of population sex ratios: 0.568 male. Total number of skeletons: 12,064. Overall percent male: 54.4.

populations of pre-industrial peoples have been compiled in table 2. Here, an actual census of the living was taken. These populations represent, as well as can be done, the kinds of living conditions which we would have expected for our skeletal populations.

Of the 31 populations listed, only 13 have more males. The unweighted average sex ratio is 48.8 percent male, and weighting by aggregating all individuals shows almost exactly half of the 39,843 people (adults) to be male. It seems reasonable to argue from this that, in the

TABLE 2

*Adult sex ratios from live pre-industrial populations*

Population	Number of adults	Percent male	Reference
<b>Australians</b>			
North Territories	10806	51	Jones, '63
Pitjandjara	438	50	Yengoyan, '71
Groote Eylandt	145	55	Rose, '60
North Queensland	280	49	Sharp, '40
Central Australia	1193	47	Meggitt, '68
<b>Eskimos</b>			
East Greenland	312	45	Mikkelsen and Sveistrup, '44
Greenland	321	45	Hansen, '11
Greenland	456	45	Pedersen, '49
Baker Lake	218	50	Vallee, '67
Angmagssalik	475	48	Skeller, '54
Labrador	194	49	Stewart, '39
<b>Other Amerindians</b>			
Nootka	213	55	Colson, '53
San Luis Obispo	471	44	Cook, '40
Cayapo Brazil	366	47	Salzano, '71
Caingang	1854	51	Salzano, '64
Guarani	64	41	Salzano, '64
Xavante	380	49	Neel and Chagnon, '68
Yanomama	272	51	Neel and Chagnon, '68
Siriono	91	46	Holmberg, '69
Hutterites 1880	230	49	Eaton and Mayer, '53
Birhor (India)	64	55	Williams, '65
Abor (India)	421	52	Sarkar, '60
Andaman Islands	196	60	Sarkar, '60
Pygmies	411	49	Turnbull, '65
Bushmen	289	45	Lee, '69
Bushmen	105	33	Lebzelter, '34
Cocos Keeling	887	53	Smith, '60
Tiwi	491	47	Jones, '63
Tikopia	736	50	Borrie et al., '57
Tsembaga	127	54	Rappaport, '68
"Kuru-free" New Guinea	17337	49	Gadjusek et al., '61

Total number of populations: 31. Number at least 50% male: 13. Average of population sex ratios: 0.488 male. Total number of individuals: 39,843. Overall percent male: 49.6.

main and in the absence of clear cultural information indicating otherwise, one should expect about an equal number of adult males and females.

This sample of known peoples highlights the significance of the excess of males in the worldwide skeletal sample, and indicates the seriousness of the problem of sexing inaccuracy for either demographic or sexual-dimorphism investigations. For example, if we know that the sex ratio at birth is about 53% male (Cavalli-Sforza and Bodmer, '71; Van den Berghe, '70; Stern, '60), the adult sex ratio says much about age-specific mortality patterns, especially those for children. We must have confidence that the sex ratio observed among adults is accurate. A 56.8% male sex ratio for adults

implies that there is higher juvenile mortality among females; if that sex ratio is accurate, it would indicate a population very much different from those in our ordinary experience in which male children suffer higher mortality rates than females. Accepting a biased sexing would result in a misunderstanding of the population under study.

Other studies show similar biases toward male skeletons. Brothwell ('71) analyzes 27 populations of skeletons and concludes that the data show "encouraging" nearness to female-male equality. His data, however, show 18 of the 27 populations to have more males than females, and a visual fit to his chart (p. 120) yields an unweighted average figure of about 54% male per population.

A complex sexing analysis was performed on the material from Jebel Moya by Mukherjee, Rao and Trevor ('55) who determine sex in three ways: original field assessment, laboratory anatomical study, and discriminant function. For most of their data the methods differed widely in the sex attributions they produced, and differences between different scholars working at the site and even between digging seasons were significant. However, the material judged most reliable consisted of at least 54% males and perhaps more depending on the method used.

Another detailed populational study shows an excess of adult males among the specimens used. This is Hanna and Washburn's ('53) analysis of Eskimo pelvises. Their material seems to be 58% male, while most living Eskimo populations counted show more adult females than males (table 2; Hansen, '11; Skeller, '54). Here, as in the Jebel Moya material, even sophisticated sexing resulted in about the same excess of males which was just observed in the data in table 1. It cannot simply be assumed that the sexing procedures are in error here also, for in these works special care was taken to be as accurate as possible. There may be slight errors favoring males, as in the sexing of the few intermediate specimens, but one is probably safer in assuming that the data *were* more male than female. This highlights the fact that it is difficult to determine the source of a given observed sex ratio.

The persistence of the sexing bias is found in a wide range of data. As a general figure, between 10 and 15% or an average of about 12% too many males seems a reasonable estimate of the crude error rate in the sexing of adult material, *for whatever reason*. About 56% of a population will, on average, be called male when only 50% ought to. This of course is a statistical fact applying to the net results of many independent studies. It may be due to the general nature of the sex criteria themselves, but the problem is raised as to what to do in order to compensate for this bias now that it is known. Certainly, it would not be reasonable to apply a 12% correction to *all* series, for this would assume more than has been shown; we have demonstrated

an *average* error only. For some populations, such as Jebel Moya or the Eskimos, one should be guided by the strength of the evidence indicating the reliability of the data sample or of the sexing procedures. When confidence can be placed in the sexing, the problem is narrowed down to a question of sampling error or the possibility that the particular population actually had the observed sex ratio.

There is no simple way to decide which studies are reliably sexed and which are not. It might be best to avoid using sex information whenever possible. When a site yields no information which can aid morphological evidence in determining an expected sex ratio, it would be a candidate for the application of a correction factor. This would be especially true in the case of many studies in the literature in which populational sexing methods were not used.

#### *Age-specific tests*

For more detailed demographic analysis, the application of a single correction for material at all ages might mask information which could be useful. In particular, there might be differing biases for specimens of differing ages, and one would want to apply an age-specific correction. This is important in that much of interest to demographers lies in age-specific mortality rates by sex.

It is known that among most modern populations males experience higher adult mortality and morbidity rates than females at nearly all ages. The data on this are extensive, but material in Stern ('60) and the life tables in Keyfitz and Flieger ('68) will suffice to support these facts. The fact that males are born in greater numbers than females has itself been explained as the *result of selection* in populations whose males are less hardy than in females, which is an idea going back at least to R. A. Fisher (Crow and Kimura, '70).

In the face of the above, it is surprising that Vallois ('37), Senyürek ('51), and Angel ('69) among many others argue that before very recent times adult females died at an *earlier* age than did males. The data they use support this idea, in showing the percent-males in-

TABLE 3  
*Age-specific sex ratios for live pre-industrial populations*

Population	Age 15-30 (approx.)		Over age 30 (approx.)	
	Number	% Male	Number	% Male
Australians				
North Territories	4078	51	6728	52
Pitjandjara	178	45	260	53
Groote Eylandt	74	44	71	65
North Queensland	86	57	194	45
Eskimos				
East Greenland	146	46	166	45
Greenland	340	45	116	45
Baker Lake	106	50	112	49
Angmagssalik	293	50	182	44
Labrador	69	54	125	46
Other Amerindians				
Nootka	67	43	146	60
San Luis Obispo	237	49	234	40
Caingang	1069	49	785	53
Guarani	38	42	26	38
Xavante	257	51	123	47
Yanomama	185	51	87	51
Hutterites 1880	112	47	118	50
Birhor (India)	33	58	31	52
Cocos Keeling	712	53	175	53
Tiwi	173	47	318	46
Tikopia	354	52	382	49
Tsembaga	55	60	72	49
"Kuru-free" New Guinea	13251	50	4086	48

Number of populations: 22.

Age 15-30: Number of individuals: 21,913. Percent of individuals male: 50.1. Average population sex ratio: 0.497 male. Populations at least 50% male: 12.

Ages over 30: Number of individuals: 14,537. Percent of individuals male: 50.2. Average population sex ratio: 0.491 male. Populations at least 50% male: 9.

creasing with age among adult skeletons. This is directly contrary to modern experience, and another glance at the data used here may aid in determining if there has in fact been a recent and fundamental change in adult human mortality patterns.

Choosing roughly 30 years as the breaking point between young and "old" adults, since the data are more likely to be broken down there, it is possible to examine age-class changes in sex-specific mortality. Table 3 lists the results from the analysis of 22 living populations. If the notion that pre-industrial societies experienced higher female mortality is to be true, then the data must show the percent males in the over-30 group to be greater than the percent males in the under-30 group. That is, whatever the sex ratio for adults under 30, if the females die faster there must be relatively more males left in the ages

over 30. If childbirth mortality is the primary cause for the higher female mortality, then most of its effects will be shown across age 30, since most reproduction occurs before that age (see Barclay, '58).

Table 3 shows that both the weighted and unweighted average sex ratios from ages 15-30 are almost exactly 50% male. Twelve of 22 populations show at least 50%. For adults over age 30, the unweighted average is 49.1% male, and the weighted (total) is 50.2%. Here nine of 22 populations have at least 50% males. If anything, the evidence shows the reverse of an excess female mortality; in fact, the sex ratio has *declined* in 13 and held steady in three of the 22 populations.

This has two consequences: first, there seems to be little difference between the sex ratios for younger and older adults,

TABLE 4  
*Age-specific sex ratios for skeletal populations*

Population	Age 15-30 (approx.)		Over age 30 (approx.)	
	Number	% Male	Number	% Male
Amerindians				
Eva	22	77	47	42
Indian Knoll	261	50	250	61
East Greenland Eskimos	32	53	19	74
Africans				
"Negroes"	106	55	81	62
Protohistoric Saharans	20	50	17	47
Canary Islands (Schwidetzky, '58)	564	66	1090	68
Japan				
Jomon period	119	55	116	59
Edo period	46	63	120	72
Europeans				
France Eneolithic	100	45	142	47
Westerhus Sweden	84	48	70	44
Yugoslavia	74	40	115	63
Hungary — Xth Century	141	45	459	54
Other Hungarians	246	54	393	60
Lower Austria (Vallois, '37)	142	40	86	73
Turkey Copper Age	66	52	93	71
Romans	2664	48	1968	59

Number of populations: 16.

Age 15-30: Number of individuals: 4,687. Percent of individuals male: 50.8. Average population sex ratio: 0.526 male. Populations at least 50% male: 10.

Ages over 30: Number of individuals: 5,066. Percent of individuals male: 60.9. Average population sex ratio: 0.597 male. Populations at least 50% male: 12.

and second, the trend does not seem to favor males at later ages. This can be compared with the 16 available skeletal populations which could be broken down at the required ages. Table 4 lists these data. For the younger adults, the unweighted average is 52.6% male and the weighted 50.8%, with 10 of the 16 populations having at least 50% males. The older age group has sex ratios of 59.7 (unweighted) and 60.9 (weighted). All but four of the populations show males in excess, and there does seem to be a trend towards increased sex ratio with age.

Thus the skeletal data do support the relative advantage of males at later ages, but clearly show also the general bias in favor of males. If there is a difference in bias at various ages, there would seem to be about 20% too great a probability that an older skeleton is called male. If true, this could be due either to a tendency to call a bone which shows signs of age male, or to sex-specific differences in age and sex criteria themselves (e.g., different rates of cranial suture closure for each sex).

Even applying a blanket 12% correction factor to all of the skeletal data, there is still an increase in percent males with age, from 47% under age 30 to 52% over 30. This would tend to reinforce the arguments of demographers that earlier cultures experienced higher female mortality rates. Unfortunately, the data from living populations cannot verify this.

There may well be reasons for the failure of living primitives to support a theory observed in skeletal populations. Censused primitive populations may not be representative of all pre-industrial cultures, and in fact may be censused in some way because they are not representative. Contemporary pre-industrial peoples may also have been disrupted enough demographically that the earlier pattern has been changed; one such cause could be a reduced fecundity after contact which might lower childbirth risks enough to change basic male-female mortality differences (on the reduced fertility after contact, see Carr-Saunders, '22). Russell ('58) has noted historical evidence for the high maternal mortality toll which might explain

earlier patterns. In general, it is not necessarily safe to assume that the living groups reported here are valid controls.

It is necessary to conclude that due to small samples and questionable reliability of control data the age-specific mortality for males and females in pre-industrial societies cannot be determined. Whether there has been a significant and quite recent change in basic patterns cannot be told, but the data presented here do suggest the importance of investigating this phenomenon among the few remaining primitive groups, for important genetic, medical, epidemiological, and economic consequences might depend on our correct understanding of the root causes of human mortality.

#### *A note on fossil man*

It is interesting to take a speculative look at the sex ratio among specimens of fossil hominids. For convenience they are divided into four stages: australopithecine, *Homo erectus*, Neanderthal, and "early modern." It cannot be claimed that biological populations are represented by the fossils, but since single, isolated specimens have regularly been sexed, one can examine the pooled results of the sexing procedures.

Australopithecines are generally grouped into robust and gracile forms, each commonly considered to represent a separate taxon. Recently Brace ('72) and others have questioned this taxonomy, and have argued that there is only one taxon of early Pleistocene hominid whose variability is largely a function of sexual dimorphism. Sex attributions in the literature are exclusively made according to the former taxonomy, although for most of the more complete specimens the sexing criteria would probably result in the same attribution within the latter taxonomy as well (sexing is based on robustness, cresting of skull, overall size and so on). As sexed in original reports, 48% of sexed adult australopithecines have been called male.

For *H. erectus* and Neanderthals, sex attributions are taken from Coon ('62) and Day ('65). The reported adult sex ratios are 55% male for *H. erectus* and 62.5% male for Neanderthals. For sev-

eral series of Mesolithic, Upper Paleolithic and other groups generally called "early modern" men which have been reported by Vallois ('61) and listed in the Appendix of Coon ('62), the sex ratio is 56.3% male.

The fossil sex ratios have been developed in detail by Weiss ('71) where it was shown that there is a statistically significant excess of males overall. The fact that the modern series has a sex ratio very similar to that observed in table 1 leads to the suspicion that a similar sexing bias may be operating here. The fossil sex ratios have therefore been corrected by a 12% factor, which results in ratios of: australopithecines 43%, *H. erectus* 49%, Neanderthals 56%, and "early modern" 50%. The use of a 12% factor is of course tenuous, especially since sexing criteria must be different for fossils than they are for modern man; however, it is no more tenuous than are the guesses as to sex cutoff points for the fossil specimens, and it serves to discount the number of males enough that the resultant sex ratio is statistically not different from an expected 50% overall.

One can speculate on these results and the meaning they could have in interpreting the population structure of early human populations: In groups of subhuman primates living in East and South African savannahs, there are nearly always more adult females than males. Baboons range from 27-48% male (Aldrich-Blake et al., '71; Kummer, '68), and even including the subadult males will not raise the sex ratio above 50%. For geladas (Crook and Aldrich-Blake, '68) and for the patas monkey (Hall, '68; Struhsaker and Gartlan, '70) conditions are similar. This is a general condition for most primates (Schultz, '61), although it has not been fully explained.

If savannah primate populations have more adult females than males, and if the australopithecine sex ratio is at all reliable, this would suggest that perhaps savannah-primate group structure applies to them. This would fit the baboon analogy which ecological data from the fossil sites has suggested to many people.

In regard to the later fossil series, all but the Neanderthals are indistinguishable from 50% male. Brace ('64) dis-



cusses at length the historical, psychological, and typological reasons why one might expect the Neanderthals to exhibit a great excess of males even after an average bias factor has been applied. If the Neanderthal excess of males is due at least in part to non-ecological reasons, then the fossil sex ratios suggest that by the time *Homo erectus* had evolved, his population structure closely resembled that of modern hunter-gatherers. Since the archeological evidence has suggested this to others for other reasons, the results from adult sex ratio analysis, while clearly speculative, are a pleasing corroboration of theory concerning the evolution of our ancestral populations in the Pleistocene. This has been done by only the most general use of the fossil sex ratios.

#### CONCLUSIONS

Most papers analyzing skeletal demography accept the sexing of the specimens they use and attempt to explain the observed sex ratios in demographic or cultural terms, rather than first questioning the accuracy of the sexing procedures themselves. This questioning was done here, and a systematic, statistically significant bias was found.

It is possible to avoid inaccurate sexing in many cases once one is aware of the bias in the sexing procedures as they have generally been employed. There are a great many large skeletal series which can, and should, be sexed by populational methods. When a new site is excavated, the material should be sexed by comparison with such a well-analyzed series of people closely related to the new site; in most cases today these series exist if they would only be analyzed. The same sex cutoff points could be used on the new site, and this procedure would result in more satisfactory demography for the new data.

For sites which are reported in the literature and whose sexing procedures are unknown or known to be poor, one is safest in assuming that adult males and females should probably be about equal in number. Fluctuations from this would be expected through sampling error, but any deviations above this stochastic level

must be explained in some adequate way before the sexing can be used with confidence. Only in a case in which there is simply no information should a blanket correction factor be used; in such cases it would seem that the application of a correction would at least increase the likelihood that the corrected sex ratios were accurate.

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