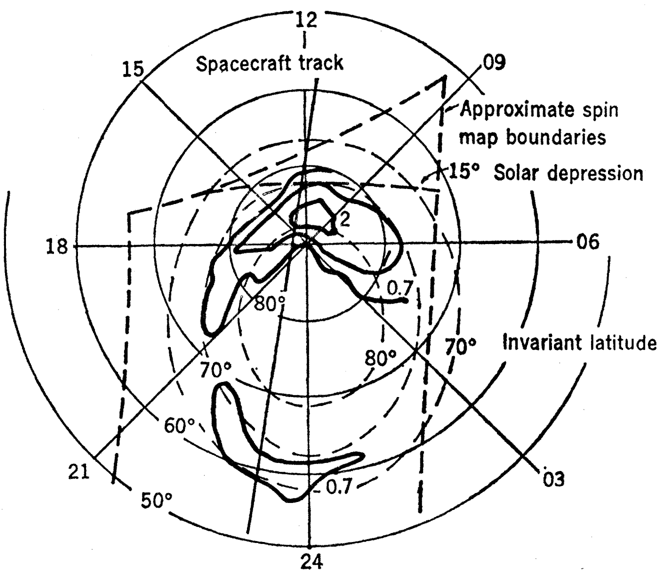

Fig. 2. Intensity contours for 6300-Å emission plotted on coordinates of geographic latitude and local time. The intensities shown are in kilorayleighs. Also shown (dashed) are some invariant latitude contours, the spin map boundaries, the 15° solar depression angle line, and the spacecraft track. Data from orbit 3257, 14 December 1971; 05:18 to 05:40 U.T.

cusp-associated emission has come down to nearly 75° invariant and thus does appear to define an oval consistent with the nightside aurora, which is very weak but is defined by a 0.7-kilorayleigh contour reaching down to 60° invariant latitude.

The excitation mechanism of the 6300-Å emission is an interesting problem in itself. The incoming 100-ev electrons (*5*) excite ^1D atomic oxygen with considerable efficiency, but secondary processes will also be important. High electron temperatures exist in the dayside cusp, at least at spacecraft altitudes (*14*), and hot ambient electrons may produce a significant fraction of the emission. Dissociative recombination of O_2^+ would also be important. Comparisons with other data from the spacecraft will permit a detailed interpretation.

The relationship of the data presented here with the optical data previously collected is not altogether clear. The satellite observation suggests a rather smoothly varying intensity distribution extending over roughly 10° of latitude. In black-and-white all-sky camera photographs (*5–7, 15*) the auroras are seen as very narrow, discrete, rayed, and rapidly varying (*6*). They must also be rather bright, and it is possible that such structured forms were absent when the spin map was obtained, since Anger (*16*) detected fairly low levels of 3914-Å emission with an auroral scanning photometer (*17*). Korosheva (*18*) observed a more homogeneous arc extending around the dayside, at about 75° invariant latitude. But other evidence indicates that these discrete auroras are enriched in the 6300-Å emission. Akasofu photographed them in color, and they appear red (*9*). Starkov (*19*) measured their most probable height as 150 km, which would make them somewhat enriched in 6300 Å. Whalen *et al.* (*7*) used a combination of all-sky camera photographs and scanning photometers to show that there was a continuous 6300-Å background surrounding the discrete auroras, having a sharply peaked latitude distribution, much as described here, except that their reported intensity was only 100 rayleighs (with 30 and 8 rayleighs of 5577-Å and 4278-Å emission, respectively). Strömman *et al.* (*20*) made photometric ground-based measurements at Ny-Alesund, Spitzbergen, which clearly show the cusp emission as a 6300-Å phenomenon. Feldstein and Starkov (*21*) may have provided the clue to this mystery. They maintain that the dayside aurora consists of rays and bands in quiet times, which are distinctly different in form from the morning and evening arcs that move in from both sides toward the noon sector, never quite reaching it, as the activity level increases. Whether these rayed structures are superimposed on a continuous background, or whether they are so uniformly distributed as to appear as a continuous distribution, remains to be resolved.

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Early Hominid Humerus from East Rudolf, Kenya

Abstract. *A fossil hominid humerus discovered in 1970 by the expedition to East Rudolf, Kenya, led by R. E. F. Leakey is examined in comparison with a large series of extant hominoids. This comparison as well as a multiple discriminant analysis shows the uniqueness of the fossil among the hominoids.*

During the 1970 season the expedition led by R. E. F. Leakey to the fossil beds east of Lake Rudolf discovered a well-preserved hominid humerus (*1*). The fossil is missing the proximal end but is otherwise in remarkably good condition considering its age of between 1 and 2 million years (*2*). It derives from the upper half of the "Lower Unit" of locality B, Ileret. A description has already been published (*3*).

This fossil humerus is very important to the reconstruction of the locomotor,

Table 1. Means of the measurements used in the multiple discriminant analysis. The sample size is given in parentheses. For a full description of each measurement see (5).

Measurement	*Homo* (63)	*Pan troglodytes* (42)	*Pan paniscus* (16)	*Gorilla* Male (25)	*Gorilla* Female (41)	*Pongo* Female (13)	*Pongo* Male (21)	East Rudolf
Trochlear width	21.9	21.6	19.5	34.1	28.6	24.9	21.0	24.7
Trochlear anterior-posterior diameter	15.0	16.1	14.4	25.9	19.9	17.4	13.9	14.6
Lateral trochlear ridge, anterior-posterior diameter	22.3	26.8	24.0	38.9	29.4	31.4	24.3	24.4
Capitular width	15.7	18.2	16.0	24.1	20.0	19.7	16.3	17.3
Capitular height	19.0	21.4	19.1	32.9	25.3	27.6	21.5	25.6
Articular surface width	38.8	44.6	39.5	69.6	53.8	51.5	41.8	43.6
Biepicondylar width	55.7	62.1	56.1	103.9	79.0	72.6	58.9	71.2
Trochlear to medial epicondyle	38.6	43.7	41.6	75.9	57.2	55.0	43.7	49.7
Trochlear to supracondylar ridge	36.6	40.4	39.8	70.8	54.2	53.7	43.1	47.1
Capitate to lateral epicondyle	26.5	30.8	29.4	50.2	39.7	39.3	31.7	34.3
Olecranon fossa width	25.0	25.2	23.5	42.1	31.9	29.2	23.0	29.9
Olecranon fossa depth	6.7	9.3	8.2	14.9	11.4	9.2	7.4	8.1
Olecranon fossa, width of medial wall	9.3	11.9	11.8	17.8	13.6	16.5	14.0	13.3
Olecranon fossa, width of lateral wall	14.8	19.3	17.1	30.6	23.7	21.9	18.0	18.6
Shaft anterior-posterior diameter	14.7	17.4	15.2	25.1	20.6	18.5	14.4	17.3
Medial epicondyle width	12.0	12.6	11.5	19.2	14.9	16.6	12.2	13.3
Total length	291.2	300.0	279.9	454.0	379.0	371.2	326.2	328.0
Shaft circumference	57.4	70.7	60.4	108.0	86.0	77.5	61.0	84.0

postural, and manipulative behavior of the early hominids. As Leakey and others have pointed out, it is a very robust and rugose bone (*1*, *3*). These and other features, as well as the morphology of other fossils, present the possibility that at least one kind of early hominid was something other than a habitual bipedal strider. Suggested alternatives range from knuckle-walker (*1*) to tree-climber (*4*).

Leakey generously provided me with the opportunity to study the original specimen in the fall of 1970. I made extensive comparative analyses which have been reported in detail elsewhere (*5*).

The study reported here is based on 18 measurements of the humerus taken on a series of hominoids (Table 1). The means of the individual measurements shown in Table 1 are difficult to interpret, but a few points deserve mention. The fossil has a very thick shaft as indicated by the circumference at midpoint, which is comparable to that of a female gorilla humerus. The estimated total length of the fossil [based on a regression analysis (*5*)] compared to this circumference gives an indication of the robusticity. Dividing the circumference by the length results in an index for the fossil which surpasses the means for all the great apes and man and is almost outside of the observed range of variation among the gorillas.

The significance of the shape of the distal end is more difficult to assess. Straus (*6*) and others (*7*, *8*) have noted the remarkable similarity of hominoid distal humeri. Two features are worth noting, however. The olecranon fossa of this fossil is relatively more shallow than is true for most great apes, and in this respect resembles the human bone. This feature probably has something to do with the fact that man is the only hominoid who does not use his forelimbs as supportive structures in locomotion. Related to this is a second feature of the fossil which is distinctly hominid: the rounded lateral border of the olecranon fossa. All of the great apes examined have a ridge of bone extending proximally from the trochlea back to form a steep wall on the lateral side of the olecranon fossa.

Combining the 18 measurements into one multivariate analysis is instructive in that it gives an impression of overall affinities of the fossil. The method employed here is that of multiple discriminant analysis, which has proved useful in previous studies of fossils (*7*, *8*). The technique has serious drawbacks, as several recent publications have shown (*9*), but in a limited sense it is still valuable, especially in testing negative hypotheses.

One of the most serious problems in the application of multiple discriminant analysis is its assumption that the unknown specimen which it attempts to classify into known groups is, in fact, a member of one of those groups.

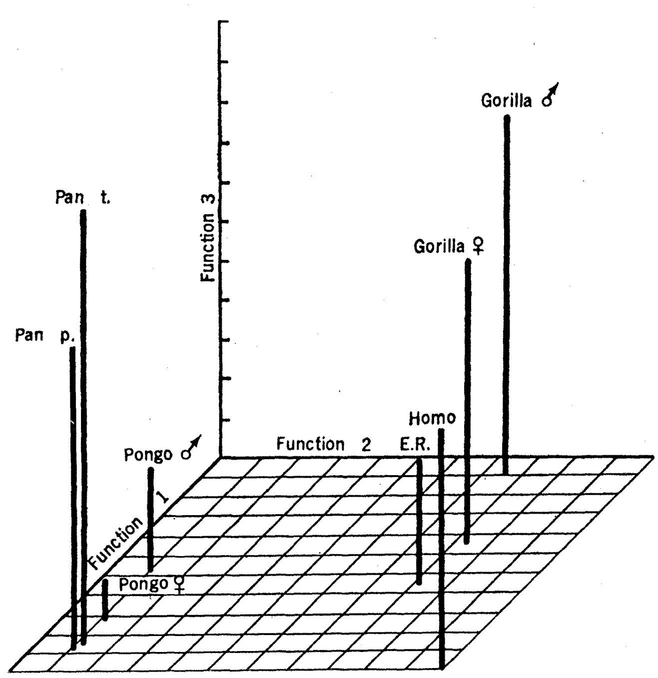

Fig. 1. Distribution of group centroids and fossils on the first three discriminant functions, which account for 94.4 percent of the total discrimination. *Pan t.* and *Pan p.* stand for *Pan troglodytes* and *Pan paniscus*, ♂ and ♀ for male and female, and *E.R.* for the East Rudolf fossil.

What so often happens in the treatment of fossils is that the specimen is unique in shape and does not resemble any extant species. This problem was noted in one of the first reports on the application of discriminant functions to early hominid fossils (*10*).

The most important results of the discriminant analysis are represented in Fig. 1 (*11*). Discriminant function 1, which accounts for 69.0 percent of the total discrimination, acts to separate the humeri primarily on the basis of size (*12*), with male gorilla humeri at one extreme and human humeri at the other. All measurements are highly correlated with the discriminant scores of the first function. The fossil humerus projects between the male and female *Pongo* humeri.

The second function accounts for 14.1 percent of the discrimination. Since each function is uncorrelated (and hence orthogonal) with each other function, the effects of overall size are probably minimized here, having played the dominant role in function 1. This is not to say that the function is not influenced by the effects of size; there is no reason why size could not influence shape in more than one way. But the distribution of the species on this axis is not at all according to size. Again, the discriminant scores for the human humeri are maximized. All of the great ape scores are minimized except those for the gorilla. The traits which are most highly correlated with the function concern the shape of the olecranon fossa and the size of the proximal extension on the lateral trochlear ridge. The human humerus is unique in having a wide olecranon fossa compared with the width of the shaft as measured at the position just proximal to the fossa, and in having practically no lateral ridge extending proximally to form a sharp wall on the lateral surface of the olecranon fossa. In both of these traits the gorilla humerus is somewhat more similar to the human one than are those of the other great apes. The fossil discriminant score is almost equal to the mean score for the female gorilla.

On the third function the fossil projects most closely to the orangutan humeri. This function accounts for 11.3 percent of the total discrimination. It maximizes the chimpanzee discriminant scores and minimizes the orangutan ones. The traits most closely associated with the function are the depth of the olecranon fossa and the anterior-posterior diameter of the shaft just proximal to the olecranon fossa. Both of these dimensions are relatively large in *Pan*, especially compared with the total length, which is the third most highly correlated measurement with this function.

The last three functions account for little over 5 percent of the total discrimination. Function 4 maximizes the male orangutan scores and minimizes the female gorilla values. An important trait which affects this separation is the shape of the capitulum, which is much wider from its distal edge to its proximal edge in *Pongo* than in the other hominoids. Function 5 separates the pygmy chimpanzee humeri from the rest. The last function accounts for only 0.5 percent of the total discrimination. It separates the male and female humeri of both *Pongo* and *Gorilla*.

Figure 1 is a plot of the relative positions of the centroids for functions 1, 2, and 3. These three functions account for about 95 percent of the total discrimination. The significance of Fig. 1 is in the placement of the fossil: it does not approach any of the centroids very closely, but the nearest groups are female gorilla and man. If all six discriminant functions are considered, a similar result is obtained by determining the geometric distances between the centroids in the six-dimensional discriminant space. The fossil is placed well away from all the hominoid humeri, but approximates the female gorilla and, in this case, the male orangutan, most closely.

The morphological uniqueness of the East Rudolf humerus may imply a functional uniqueness as well. This would be compatible with the conclusions of Napier (*13*), Rightmire (*8*), and others on the hand: at least one kind of early hominid was equipped with forelimbs somewhat unlike those of extant hominoids. The question is still open whether or not this early hominid was a habitual biped equipped with forelimbs used solely for manipulation.

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Anticoagulant-Resistant Rats: Possible Control by the Use of the Chloro Analog of Vitamin K_1

Abstract. *Strains of wild rats that are resistant to the anticoagulant action of coumarins and derivatives of indandione have been discovered in a number of geographic areas. These rats have now been shown to be more susceptible than normal rats are to the anticoagulant action of the vitamin K antagonist, 2-chloro-3-phytyl-1,4-naphthoquinone. This compound, either alone or in combination with warfarin, would appear to be an effective rodenticide in areas where resistance to the indirect anticoagulants is a problem.*

Strains of wild rats that are resistant to the action of the widely used anticoagulants were first discovered in a number of areas in northern Europe where warfarin was being fed as a rodenticide (*1*, *2*). More recently a similar resistance to these anticoagulants, which act by suppressing the synthesis of the