THE BODILY STRENGTH OF CHIMPANZEES

By Glen Finch

Some time ago, Bauman (1923, 1926) reported a few observations on the bodily strength of chimpanzees. His conclusions, based on dynamometer measurements, indicate that the adult chimpanzee is several times as strong as man. The present investigation was undertaken as an attempt to clarify and to supplement Bauman's data.

Eight chimpanzees from the Yale Laboratories of Primate Biology colony were used as subjects (all four of the adult males in the colony and four adult females). Of these, five are among the healthiest and most vigorous animals in the colony; the other three (Jack, Cuba, and Pati) cannot be characterized as especially vigorous and healthy, although all were in good condition at the time of the present experimentation.

The technique utilized consisted of the subjects' pulling in an incentive placed on a small carriage which was attached to a 1-inch Manila rope, resistance being furnished by a variable weighting of the rope. Figure 1 is a profile diagram of the apparatus. It will be noted that, from the weights, a rope is led over a pulley system so arranged that the animal is required to pull with a power twice as great as the weights (*i.e.*, a unit movement of the rope results in 2 units of movement of the weights). It will also be noted that a ratchet (attached to the first pulley above the weights) was provided, which prevented backward movement; the ratchet engaged with every 3 inches of forward movement of the incentive. The weights used were discs of cast iron, each weighing 10 pounds.

With such a system as that diagrammed (fig. 1), it is obvious that the force a subject must apply to move the incentive is determined by (1) the gravitational resistance of the load, (2) the inertia of the system, (3) the power of the pulley system, and (4) the frictional resistance of the system. In order to translate the subjects' pulls into absolute terms, the force necessary to move the system at each of the 10 pound weight increments was determined by attaching a spring-scale to the rope in the subject's position and pulling it with a windlass. Scale-readings were taken at the instant the system was put in motion. Figure 2 presents the calibration data. Each of the points represents the mean of 5 scale readings. The straight-line, fitted to the data graphically, was drawn so that the force of pulls beyond the scale's calibration (*viz.*, beyond 300 pounds) might be estimated.

Each subject was tested with a modified "method of limits" technique. Preliminarily, the subjects were accustomed to the apparatus through several days with increasingly greater resistances to their pulls, each subject being allowed to recover the incentive (a small piece of fruit) with each completed pull (a completed pull consisted of pulling in the rope a distance of 9 to 12 inches). Test trials were given in two days' sessions, the first day with normal prior food-deprivation (each subject was tested in the morning before a major feeding), the second day with 24 hours prior food-deprivation.

Tests were conducted as follows: With one small piece of banana as incentive, the subject was given the rope and allowed to pull against the maximal resistance that he had previously overcome. When the incentive was recovered, the rope was withdrawn, one 10 pound weight was added to the load, another piece of banana was provided as incentive, the subject was given the rope and allowed to pull. If the subject failed to move the system in one minute, an additional piece of fruit (apple, orange, or banana) was added to the incentive, and so on with further additions of fruit each minute until ten minutes had elapsed, at which time the test was terminated and the subject's maximal pull was recorded as the resistance which he had overcome (as judged by a movement of the incentive of at least 3 inches). It might be noted that the size of the incentive became comparatively very great before a trial was recorded as failure. Addi-

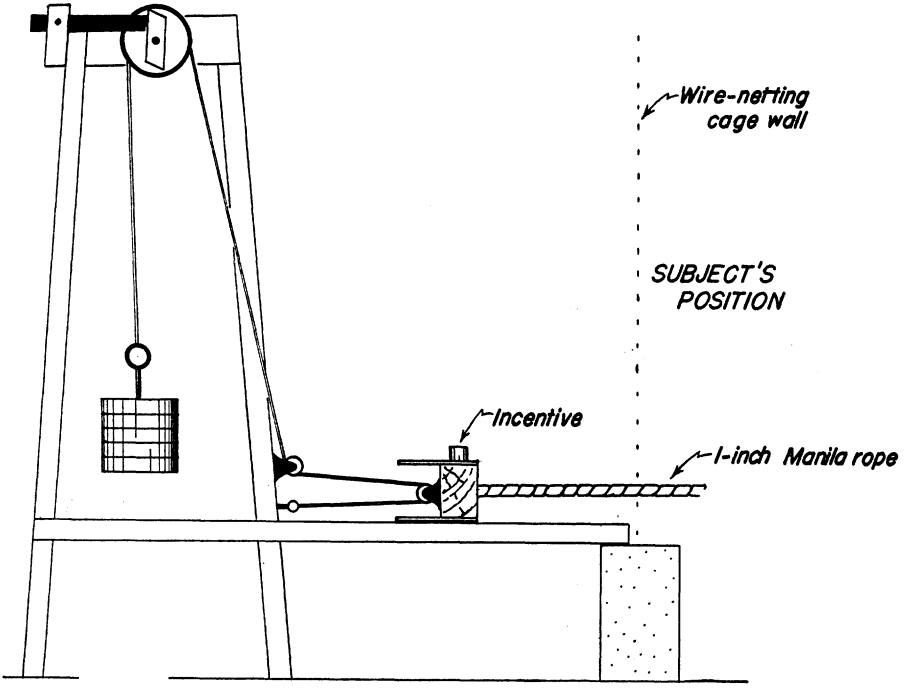

FIG. 1. Diagram of strength-measuring apparatus

tional 10 pound weights were added, one at a time, until the subject failed to move the system in ten minutes.

In order to provide comparative human data, four members (adult males) of the staff of the Yale Laboratories consented to serve as subjects. They were tested in the same way as the chimpanzees (except that social incentives were substituted for food motivation and the subjects were tested in only one day's session).

Table 1 presents the bodily weight, maximal pulls, and ratio of maximal pulls/ bodily weight for all subjects. From this table, it will be seen that the heaviest

chimpanzee (Jack) was considerably (13 pounds) lighter than the lightest human subject. Under normal hunger conditions, the male chimpanzees greatly outpulled the females (males' pulls range from 375 to 487 pounds, females' from 227 to 300). Comparison of the pulls after the 24-hour food-deprivation is difficult because of the failure of two animals (Bokar and Cuba) to pull. Only three animals (Pan, Lita, and Cuba) bettered their pulls with increased hunger. The human pulls range from 338 to 525 pounds. One of the human subjects (number 1) outpulled all the chimpanzees, and all the human subjects outpulled all the female chimpanzees.

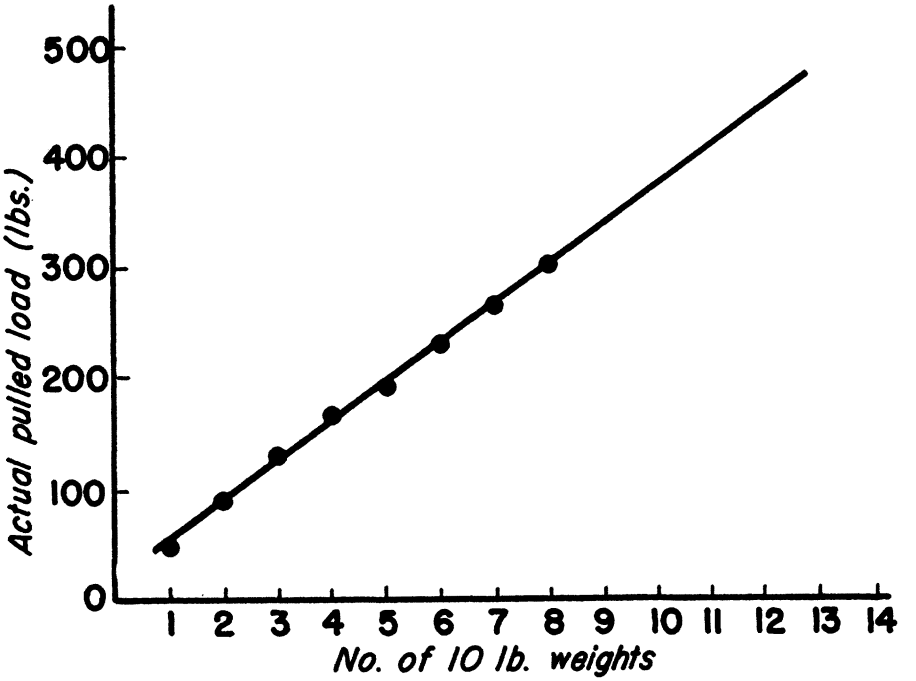

FIG. 2. Apparatus calibration curve

Statistical comparison of the records, especially the computing of bodily weight-strength correlations, is difficult or impossible because of the small number of subjects. It seems reasonable to conclude, however, that there is no great *absolute* strength discrepancy between the human and chimpanzee males and that the males of both species are absolutely stronger than the female chimpanzees. It seems strongly indicated that the male chimpanzees, pound for pound of bodily weight, are relatively stronger than either the human males or the chimpanzee females.

All the chimpanzee subjects impressed human observers as exerting maximal or near-maximal effort on their maximal pulls. The human subjects testified that their pulls were maximal.

Reconciliation of the present data with that presented by Bauman is difficult.

Differences in technique hardly seem adequate to account for the great differences in results. Examining Bauman's data critically, we find that his conclusions are based largely upon a trial of three, or possibly of four, pulls registered by two animals. The adult female chimpanzee, Suzette (estimated weight, 135 pounds), *in a rage*, registered one pull of 1260 pounds; she also registered, *deliberately*, a pull of 905 pounds. The adult male, Boma (estimated weight 165 pounds), registered one-hand pulls of 847 and 640 pounds. The only other animal that Bauman could induce to pull (the adult female chimpanzee, Johanna) registered a pull of 378 pounds. Suzette's phenomenal pull might be attributed to the fact that she was enraged when pulling, whereas none of the present

TABLE 1

SUBJECTS	BODILY WEIGHT	MAXIMAL PULL		RATIO OF MAXIMAL PULL/BODILY WEIGHT	
		Normal	24-hour hunger	Normal	24-hour hunger
	lbs.	*lbs.*	*lbs.*		
Male chimpanzees					
Bokar	107	487	*	4.6	—
Jack	122	450	450	3.7	3.7
Frank	108	450	413	4.2	3.8
Pan	106	375	413	3.5	3.9
Female chimpanzees					
Lita	103	300	375	2.9	3.6
Cuba	82	300	*	3.7	—
Mimi	109	227	264	2.1	2.4
Pati	103	227	194	2.2	1.9
Human males					
1	190	525		2.8	
2	145	487		3.4	
3	145	450		3.1	
4	135	338		2.5	

* Refused to pull any weight.

subjects were greatly emotionally disturbed, although usually obviously highly motivated; but still, her deliberate pull of 905 pounds, made when *not* enraged, greatly exceeds the highest pull recorded in the present experiment. The results of Bauman's tests of seven college football players are closely comparable to the present human tests (Bauman's range—327 to 460 pounds; present human pulls range from 338 to 525 pounds). Inasmuch as Bauman states that the same apparatus was used in testing his chimpanzee and human subjects, the discrepancies can hardly be attributed either to apparatus differences (unless Bauman's apparatus-calibration changed during the interval between chimpanzee and human tests), nor to the bodily weight superiority of Bauman's chimpanzee subjects.

CONCLUSIONS

1. Chimpanzees were taught to pull in a rope against resistance to procure a food incentive. Four male chimpanzees, tested under normal hunger conditions, registered maximal pulls of 375, 450, 450, and 487 pounds; under the same conditions, four female chimpanzees' pulls were 227, 227, 300, and 300 pounds.

2. Prior food-deprivation of 24 hours resulted in two animals' refusing to pull; three bettered their "normal" records; one pulled the same under both conditions; two pulled less.

3. Four adult male human subjects, tested under comparable conditions (with social incentives), pulled 338, 450, 487, and 525 pounds.

4. These results seem to indicate: (a) Adult human males and adult chimpanzee males are roughly equal in absolute pulling strength, (b) chimpanzee females are inferior in pulling strength to human and chimpanzee males, and (c) pound for pound of bodily weight, chimpanzee males are superior in pulling strength to human males and to chimpanzee females.

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TWO NEW RACES OF THE PUMA

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The pumas of the northern part of the Rocky Mountain region have hitherto been assigned to *Felis concolor hippolestes* of Wyoming. Distinctive cranial details, however, seem to warrant the recognition of a separate race. In marked contrast, toward the southern end of the range of the species, are specimens from Descalvados and Corumbá, Brazil, and from Puerto Suarez, extreme eastern Bolivia, referred by Nelson and Goldman (Jour. Mamm., vol. 10, no. 4, p. 345, 1929) to *Felis concolor osgoodi*, and which have also been subjected to revision. A few additional specimens have been examined, and more familiarity with the group has convinced me that the pumas of the lowlands of Matto Grosso, characterized by very light rufescent coloration and slender skull, can not satisfactorily be identified with any of the neighboring geographic or ecologic races. For two of the specimens from Descalvados, Brazil, one of which is here designated as the type of a new subspecies, I am indebted to Alfred M. Bailey, Colorado Museum of Natural History, who has generously donated them to the National Museum collection. My thanks are also due to C. C. Sanborn, Field Museum of Natural History, and H. E. Anthony, American Museum of Natural