of the fore-reef deposits is entirely depositional, the original water depth is equal to the present difference in elevation between the point and the equivalent reef crest, provided that the reef crest grew at sea level. In practice, however, only the approximate water depth can be determined in this way, because of outcrop limitations and the impracticability of demonstrating exact correlation between a particular bedding plane and its equivalent reef crest. Moreover, the reef crest may have stood significantly below sea level in some areas.

The best locality to deduce approximate water depths for algal stromatolites in fore-reef facies is in the Virgin Hills Formation adjoining McWhae Ridge, a ridge of reef 1.75 km east-southeast of Cave Spring in Bugle Gap. Columnar and longitudinal stromatolites in their growth positions are well developed at this locality, and they grew on depositional slopes as high as 40° to 45°. Detailed study of geopetal structures indicates that post-depositional steepening of the fore-reef dip is slight, amounting to no more than 6°. The stromatolites cut out passing down the fore-reef slopes 45 m to 50 m below the crest of the reef ridge. At the present level of erosion, the top of the reef on McWhae Ridge is believed to be equivalent to fore-reef strata several meters stratigraphically lower than the stromatolite-bearing beds. It is accordingly concluded that in this area the deepest of the stromatolites must have grown in water at least 45 m deep.

Our study has thus shown that abundant and varied algal stromatolites grew to considerable depths below sea level in the Canning Basin reef complexes, and that they were formed by both sediment-binding and carbonate-precipitating algae. Accordingly, the presence of algal stromatolites in ancient sedimentary rocks cannot be accepted as diagnostic evidence that those sediments were deposited within the tidal range or in very shallow subtidal environments.

PHILLIP E. PLAYFORD
ANTHONY E. COCKBAIN
Geological Survey of Western Australia, Perth, Western Australia

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6. This study is part of a biostratigraphic research project on the Devonian of the Canning Basin being carried out by the Geological Survey of Western Australia and the Australian Bureau of Mineral Resources. We thank E. C. Druce, J. S. Jell, and M. S. Petersen for assistance in the field, and B. E. Balme, D. C. Lowry, and J. L. Wray for reading the manuscript.

22 April 1969

Autosomal Trisomy in a Chimpanzee: Resemblance to Down's Syndrome

Abstract. *An infant chimpanzee* (Pan troglodytes) *with clinical, behavioral, and cytogenetic features similar to those in Down's syndrome is described. The infant shows retarded growth rate, congenital abnormalities, retarded neurologic and postural development, epicanthus, hyperflexibility of the joints, muscle hypotonia, and trisomy of a small acrocentric chromosome.*

The most frequent form of Down's syndrome (Mongolism) (*1*), trisomy of a G-group chromosome (*2*), is reported to occur in the human population with a frequency of approximately 1 in 600 births (*3*). Other types, such as translocation or mosaicism, are much less frequent. Comparable conditions have not previously been reported in any species of nonhuman primate.

The subject of this report is a female chimpanzee (*Pan troglodytes*), born 6 July 1968. This infant (Jama) was delivered after an apparently normal and uncomplicated pregnancy. The mother (Wenka) had one previous pregnancy which resulted in a premature stillbirth 28 months before Jama was born. Wenka is now 15 years old and the father (Frans) is 22. Since the reproductive period for laboratory chimpanzees is usually between 10 and 30 years of age, Wenka is classified as a relatively young breeder. No other relevant medical history has been recorded for either the mother or father.

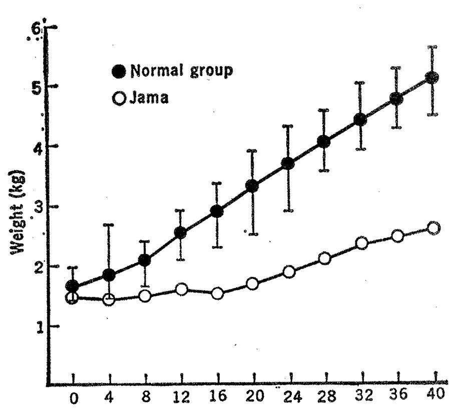

Fig. 1. Comparison of weights from birth to 40 weeks for Jama and a group of chimpanzees raised under similar nursery conditions. Both males and females are included in the group average and range (vertical line). The number of subjects included in the group curve varies between five and seven over the 40-week period, because two of the animals are younger than Jama.

Jama was of low-normal birth weight and has exhibited a slow rate of growth, compared to other laboratory-reared chimpanzees (Fig. 1). In contrast to other chimpanzees in our colony, she has bilateral, partial syndactyly of the toes with clinodactyly, prominent epicanthus, hyperflexibility of the joints, and a short neck with excess skin folds. An undetermined type of cardiac defect was radiographically observed shortly after birth (*4*). Further diagnostic radiography has been postponed because of possible risk to her survival. She continues to show poor clinical progress, as judged by retarded growth and delayed neurologic development. The Moro reflex is absent, there are marked hypotonia, abnormal traction and suspension responses, and general inactivity. At 40 weeks of age, Jama is still unable to sit up or move about in her cage. She has had recurrent bouts of enteric and upper respiratory disorders; however, such infections are not uncommon in laboratory-reared chimpanzees.

Systematic behavioral observations support the conclusion that her postural development is markedly retarded, especially when compared with other Yerkes nursery animals and the critical-age norms reported for chimpanzees

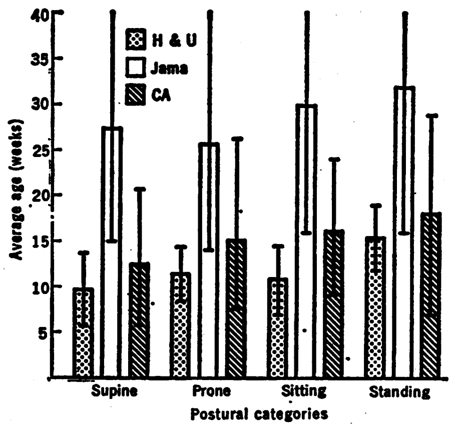

Fig. 2. A summary of the critical-age norms (*CA*) compared with the development of Hook and Ubar (*H&U*) and Jama. A total of 34 behavioral items are included in the four postural categories—seven supine, nine prone, eight sitting, and ten standing. Each bar in the graph represents the average age at which the items in that category were completed. The lower limit of the range (vertical line) for each bar was calculated by averaging the earliest age at which each of the behavioral items in that category was observed. The upper limit was obtained in the same way by averaging the latest age at which the items were completed. Since Jama has not completed all the items in each category, the upper limits of those ranges are presently indeterminate. Averages were calculated for Jama by assigning a maximum score of 40 weeks to all uncompleted items. The CA norms derived from the data of Riesen and Kinder (*5*) represent the average age at which 50 percent of the 14 chimpanzees in their sample completed the behavioral items included in each of the four categories.

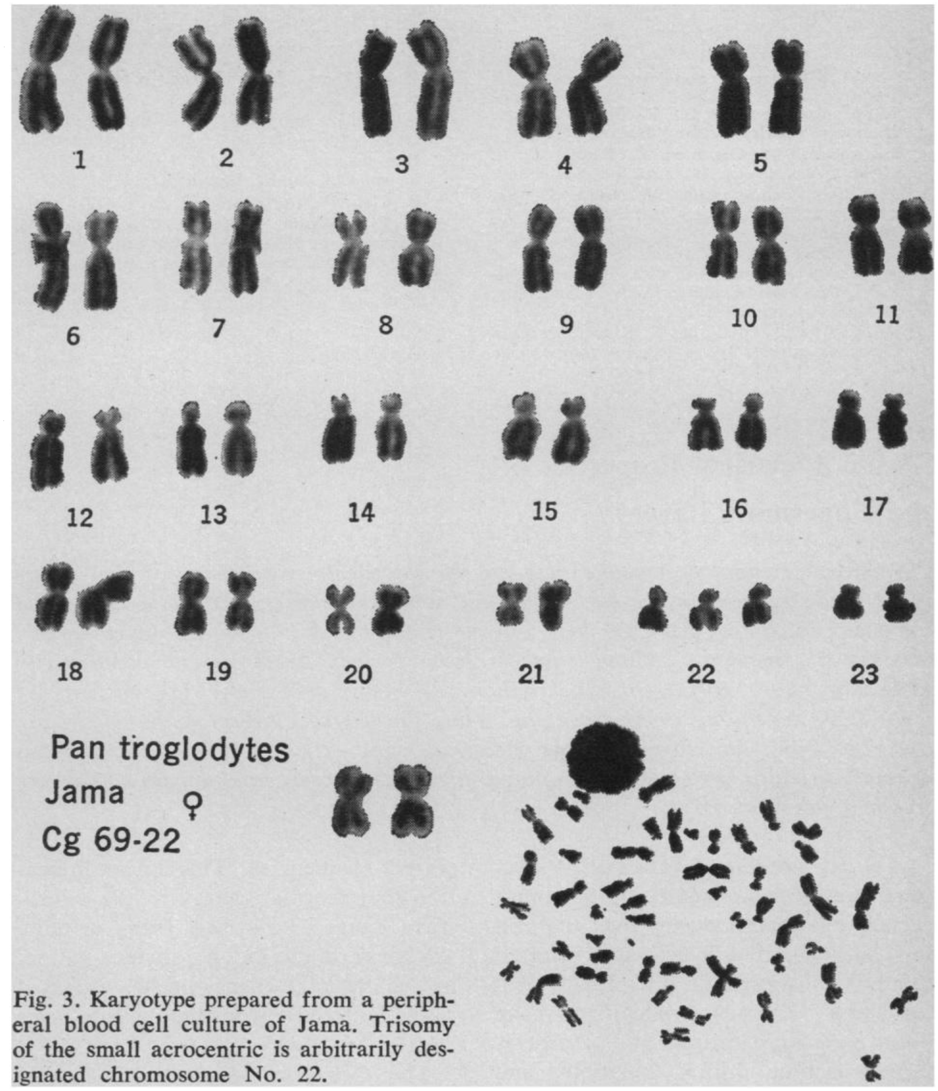

Fig. 3. Karyotype prepared from a peripheral blood cell culture of Jama. Trisomy of the small acrocentric is arbitrarily designated chromosome No. 22.

(*5*). Figure 2 summarizes the behavioral results. These data consist of observations recorded at weekly intervals with 34 items selected from the postural development schedule for chimpanzees by Riesen and Kinder (*5*). To simplify presentation, specific items have been grouped into the four postural categories of supine, prone, sitting, and standing. In every category, Jama's development has been slow. When individual items of postural maturation are examined, she exceeds the critical-age norms in 31 of 34 measures. In comparison with the average of the two nursery animals now being tested (Hook and Ubar) she is slower in all 34 tasks. These observations are especially convincing since the presence of the syndrome resembling Down's was not known to the psychometric technicians (*6*) until the animal was 36 weeks old.

Cytogenetic studies were conducted on cell cultures of the peripheral blood (*7*) when the animal was 6 months of age. Twenty-five metaphase spreads were analyzed by routine techniques. A modal number of 49 chromosomes was found, in contrast to the normal diploid number of 48 chromosomes in chimpanzees (*8*). Of the 25 cells examined, 20 had 49 chromosomes. Three cells had 48 chromosomes, one cell had 47, and the other contained 46 chromosomes. Karyotypes prepared from the aneuploid cells revealed an additional small acrocentric chromosome (Fig. 3). The 25 cells examined contained this extra acrocentric, regardless of the total chromosome number. Cells containing fewer than 49 chromosomes probably resulted from excess spreading during hypotonic treatment, since all cells showed apparent trisomy of a small acrocentric. This autosomal trisomy has been confirmed in immediate bone marrow aspirates and in fibroblast cultures obtained from skin biopsy (*9*). Cytogenetic studies on both parents revealed normal chromosome complements.

In our opinion the presence of autosomal trisomy in conjunction with the anatomic, neurologic, and behavioral abnormalities described justifies the classification of this case as one resembling Down's syndrome; a comparable condition has not been reported in nonhuman primates. The occurrence of this condition in a lower primate again emphasizes the close phylogenetic relation between man and the great apes and may provide a model for studying this relatively frequent human syndrome.

Harold M. McClure
Kathy H. Belden
W. A. Pieper
Departments of Veterinary Pathology and Psychobiology, Yerkes Regional Primate Research Center, Emory University, Atlanta, Georgia 30322
Cecil B. Jacobson
Reproductive Genetics Unit, Department of Obstetrics and Gynecology, George Washington University School of Medicine, Washington, D.C. 20037

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Moon: Electrical Properties of the Uppermost Layers

Abstract. *Presently available data on the electrical conductivity of the uppermost lunar surface layers are in accord with the presence of dry, powdered rocks in which the dielectric loss tangent is frequency-independent over several decades of frequency. These powders have typical direct-current conductivity values of about 10^{-13} to 10^{-16} mhos per meter and dielectric constants of about 3.0, depending on the packing. Thus the surface layers of the moon are likely to have an extremely low electrical conductivity. At high frequencies normal dielectric losses lead to much higher apparent conductivities that are frequency-dependent.*

A great amount of data on the electrical and thermal nature of the lunar surface has been collected over the past few decades; microwave and infrared thermal emission data and direct measurements of radar reflectivity have been used to determine the temperature variation during lunations and eclipses. Some of these results have been interpreted by Piddington and Minnett (*1*) and others (*2, 3*). The apparent temperature variation during lunations and eclipses is small at microwave frequencies but quite large at infrared frequencies. This is an indication that thermal energy in the microwave range is derived from a finite thickness of the moon's surface whereas the thermal energy in the infrared range is derived from the surface layer itself.

The dielectric constant ε is known from radar reflections, and the thermal parameter $(k\rho c)^{-\frac{1}{2}}$ (where k is the thermal conductivity, ρ is the density, and c is the specific heat) is known from observations of the surface temperature fluctuation. The magnitude of the thermal parameter has been supplemented by direct observations of the lunar surface made by the Surveyor spacecraft (*4*). The value of $(k\rho c)^{-\frac{1}{2}}$ is still somewhat uncertain, but it appears to be about 500 in the lunar mare and perhaps about 240 to 400 in the vicinity of the crater Tycho where Surveyor 7 landed. This is somewhat less than the values near 1100 ususally predicted from earth-based observations. The decrease in amplitude and the phase lag in the temperature in the microwave region provide information about the variation of thermal and electrical energy with depth.

These observations indicate that the temperature variations at the lunar surface do not extend to a significant depth. If we assume that the surface layer is uniform and that the properties are temperature-independent, it is possible to estimate a value for the penetration depth of the thermal energy in the microwave range. This penetration depth can be simply interpreted in terms of a loss tangent or an apparent electrical conductivity (*3*). Radar reflections indicate that the dielectric constant is about 2.8 (*5*).

Values of the electrical conductivity (*6*), the dielectric constant ε, and the dielectric loss tangent have been determined for a series of powdered samples (*6*). Figure 1 shows a typical example of the dielectric properties of a vacuum-dried, powdered basalt as a function of frequency up to 1 Mhz for a range of temperatures. At low frequencies, both the dielectric constant and the loss tangent increase quite consistently. As the temperature increases, values of the dielectric constant and the loss tangent also increase, an indication that a thermal activation process is involved. This is probably related to a relaxation process centered at frequencies of about 10^{-3} hz. In the basalt sample a second relaxation occurs of the classic Debye type (see *7*).

There is a peak in the loss tangent curve which is thermally activated. This shows up as a step in the corresponding curve of dielectric constants. This relaxation is due to the presence of biotite in the basalt (*6*). At room temperatures and at frequencies of 10^3 hz or greater, the dielectric constant and the loss tangent both approach a constant value. Additional relaxation peaks may exist at higher frequencies, but, if none do, the dielectric constant approaches a value of 3.5. The exact

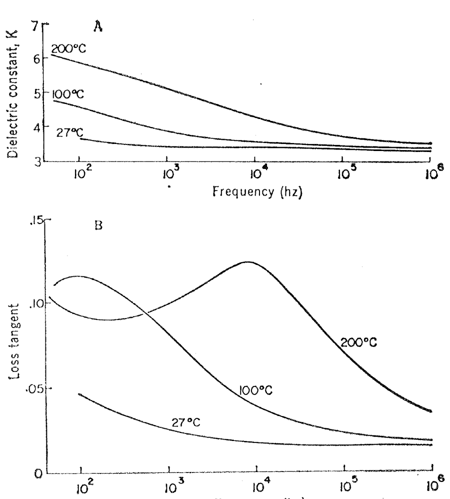

Fig. 1. Data on the dielectric constant (A) and loss tangent (B) of basalt as a function of frequency and temperature.

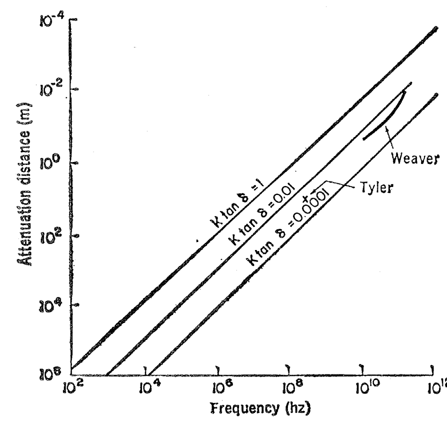

Fig. 2. Theoretical curves for attenuation depth as a function of frequency for constant values of K tan δ. Superimposed values for the lunar surface show that K tan δ is approximately equal to 0.003.