ment analyst, Department of Science and Agriculture, British Guiana; and Brig.-Gen. D. J. McGavin, director-general of Medical Services in New Zealand. *C.B.:* Mr. Ll. S. Lloyd, assistant secretary to the Department of Scientific and Industrial Research. *K.C.I.E.:* Col. W. H. Willcox, late medical adviser to the Civil Administration in Mesopotamia. *C.I.E.:* Dr. M. N. Banerjee, principal of Carmichael Medical College, Belgatchia, Bengal. *Companion Imperial Service Order:* Mr. G. J. Williams, senior inspector of mines, Mines Department.

PROFESSOR G. F. FERRIS, of Leland Stanford University, California, is spending the summer collecting and studying scale insects in Texas, in cooperation with the Division of Entomology of the Texas Agricultural Experiment Station.

THE British government will devote the sum of 1,000,000*l.* to fostering cotton-growing in the Empire. The money will be placed at the disposal of the British Empire Cotton Growing Corporation, and will be in place of the government's former promise of 50,000*l.* a year for five years to the corporation.

UNIVERSITY AND EDUCATIONAL NEWS

DR. LIVINGSTON FARRAND, chairman of the executive committee of the Red Cross, formerly adjunct professor of psychology and professor of anthropology at Columbia University and president of the University of Colorado, has been elected president of Cornell University.

DR. FRANK PIERREPONT GRAVES, dean of the school of education of the University of Pennsylvania, has been appointed commissioner of education of the state of New York and president of the University of the State of New York.

DR. P. J. HANZLIK, of the medical school of Western Reserve University, has been appointed professor of pharmacology in the Stanford University Medical School to succeed Professor A. C. Crawford, who died recently.

DR. W. H. RODEBUSH, who has been for the past year a research fellow of the National Research Council at the University of California, has been appointed associate professor of physical chemistry at the University of Illinois.

GEORGE M. WHEELER, PH.D. (1921), Bussey Institution, has been appointed instructor in entomology, and William E. Greenleaf, instructor in zoology, in the zoology department of Syracuse University.

DR. R. R. GATES has been appointed to the university chair of botany tenable at King's College, University of London, in succession to Professor W. B. Bottomley. He was appointed university reader in botany at that college in 1919, and has since that date been in charge of the department in the absence of Professor Bottomley.

DISCUSSION AND CORRESPONDENCE

THE CANNONBALL LANCE FORMATION

TO THE EDITOR OF SCIENCE: In reviewing Stanton's memoir on the Cannonball Lance formation, Dr. Schuchert has advocated drawing the line between Cretaceous and Tertiary at the base of the Wasatch. He has referred to the vertebrate evidence as supporting this view, and as recent researches have considerably clarified and extended this evidence, a brief summary of its present status may be of some aid toward harmonizing the existing conflict of opinion.

The position of these border-line formations has been in dispute not merely for a number of years, as Dr. Knowlton remarks, but ever since they were first discovered. A Cretaceous vertebrate fauna was found associated with a Tertiary flora. Vertebrate palæontologists and palæobotanists took opposite sides; the stratigraphic geologists were divided, and the relations with the marine succession, European standard, theories of diastrophism, etc., have been invoked by both sides for a decision. This discrepancy has been maintained and confirmed by all subsequent work. It should be recognized as the fundamental difficulty. It does not help matters to misrepresent or ignore any part of the evidence, and if Dr. Cross's references to the vertebrate evidence fairly reflect the way in which the U.

S. Geological Survey "considered all available evidence" it is clear that its weight and tenor was not correctly understood.

When the subject was discussed by the Palæontological Society in 1913 I presented a paper outlining the vertebrate evidence, especially with regard to the Paleocene faunas.[1] Subsequent researches by Brown, Lambe, Osborn and Parks on the Alberta dinosaurs, by Gilmore on the New Mexican reptiles, by Granger and myself on Paleocene and Eocene mammals, by Stehlin, Teilhard and Schlosser on the Eocene and Paleocene mammals of Europe, by Smith Woodward and myself on the Cretaceous mammals of Alberta, confirm the correlations and conclusions presented in that paper, but strengthen certain views which were then rather suggested than advocated.

1. The Lance fauna is wholly Cretaceous in character. It is entirely a continuation and specialization of the Judith (late Cretaceous) without any new elements, but the amount of evolutionary change in the many phyla that have now been traced through Judith, Edmonton and Lance shows that it is considerably later in time.

2. The earliest placental mammals appear in the Puerco "Lower Paleocene" which may be as old as the Lance or older, although usually regarded as later. The Torrejon and Fort Union faunas, Upper Paleocene, are not much later than the Lance, and the phyletic evolution indicates that they are considerably later than the Puerco. The Tiffany and Cernaysian faunas show a still later stage of the Paleocene faunas.

3. The Paleocene placentals are of primitive and archaic aspect. Although some of their phyla survive into the Eocene, they are as a whole not nearly related to the characteristic and dominant Tertiary Mammalia, and much more primitive. The metatherian mammals (multituberculates and marsupials), a minor but considerable element in the Paleocene faunas, are of distinctly Mesozoic aspect and closely related to those of the Judith and Lance. The reptiles are all Cretaceous families continued from the Judith.

4. The true Tertiary mammal fauna appears suddenly at or near the base of the Wasatch, and in the Sparnacian of Europe (London Clay, etc.). It is a new fauna, identical in these two far distant regions, and consists in the main of the modern orders of mammals, which now appear for the first time and evolve through the course of the Tertiary into their present diversity and specialization. The two most important families of Tertiary and modern chelonians (terrapins and tortoises) appear at the same time.

5. The great faunal break lies at the end of the Paleocene, with the incoming of the Cenozoic vertebrates at or near the base of the Wasatch. The European standard has drawn the line above the great chalk formations and below the Thanetian (Cernaysian). The Judith corresponds to the Upper Senonian of Europe, but is older than the Maestrichtian and Danian divisions of the chalk, unquestionably Cretaceous, aside from certain formations of disputed age grouped as Montien. The end of the unquestioned Cretaceous in Western Europe is then considerably later than the Judith, perhaps as late as the Lance or later. Its precise correlation can best be made through comparisons of the marine Cannonball phase of the Lance formation with the Danian, etc. On the other hand the Tertiary as generally recognized in Western Europe begins at least with the Thanetian, containing the Cernaysian fauna, uppermost Paleocene, equivalent to the Tiffany zone at the base of the Wasatch in the San Juan basin. It is therefore a little below the great migrational break indicated by the vertebrate faunas.

There are two criteria generally used in faunal classifications, the extinction of ancient types and the first appearance of new groups. The latter appears to me the more logical and practical. By this standard the Wasatch Sparnacian fauna of the London Clay, etc., is the introduction of the distinctively modern or Cenozoic life, the preceding faunas, even including the Paleocene placentals, being essentially the last stages of Mesozoic life.

This division is not supported by the palæobotanists. Their Cenophytic era, it is well recognized, begins with the upper Cretaceous

[1] *Bull. Geol. Soc. Am.*, XXV., pp. 381–402 Sept. 15, 1914.

(Dakota, etc.); they find a sharp floral break between Judith and Lance at a point where no break occurs in the vertebrate fauna; and so far as I understand no serious break between Paleocene and Eocene. I can hardly venture an opinion as to where the majority of invertebrate palæontologists would draw the line, if based wholly on invertebrate data; in practise most of them draw it at the summit of the chalk succession of western Europe.

The great stratigraphic break asserted by some stratigraphers to exist everywhere at the base of the Tertiary is denied by others of no less ability and experience, and its universality and importance seem to have been much exaggerated.

Is it not possible, where the evidence is thus conflicting, to adopt a compromise by mutual concession? It appears to me that the compromise indicated by Schuchert has the best elements for universal acceptance. It is in accord with the historic and universal European usage, including the Thanetian in the Tertiary, but none of the chalk succession. It conforms to the insistence of the palæobotanists that the Lance and Fort Union should be kept together. It gives a satisfactory practical base for the stratigrapher in the widespread and characteristic Wasatch formations. It places all the dinosaur formations and the bulk of the "Paleocene" faunas in the Cretaceous where the former certainly and the latter in my opinion properly belong; but the uppermost Paleocene faunas are placed in the Tertiary. The replacement of the Cretaceous by the Tertiary vertebrate fauna would thus be a little later, of the Upper Cretaceous by the Tertiary flora a little earlier than the line agreed upon.

W. D. MATTHEW

NEWCOMB ON EXTRA-MUNDANE LIFE

TO THE EDITOR OF SCIENCE: As one long interested in the subject matter covered by the inquiry of Professor Clark, published in SCIENCE of May 13, I have read with some care Newcomb's essay to which Professor Campbell refers, in the same issue of SCIENCE. While this essay may be presumed to represent an opinion at some time entertained by its distinguished author, an opinion that merits respect, it seems wholly unresponsive to the request for evidence upon which such an opinion may be based. The author expressly admits that "scientifically we have no light upon the question and therefore no positive grounds for reaching a conclusion." In another place, *Popular Astronomy,* ed. 1890, p. 528, he amplifies as follows:

> The spirit of modern science is wholly adverse to speculation on questions for the solution of which no scientific evidence is attainable, and the common answer of astronomers to all questions respecting life in other worlds would be that they knew no more on the subject than any one else and having no data to reason from, had not even an opinion to express.

It is probable that few astronomers will dissent from either of these statements. Most of them, Newcomb included, will concur in the statement that of the hundred or more millions of celestial bodies known to exist it may be shown with a high degree of probability that, barring our two neighbors, Mars and Venus, no one of them is suited to be the abode of animate beings. As to the numerous worlds alleged to be the abode of life, Newcomb in his essay raises the question: "But where are we to look for these worlds?" and replies to it: "This no man can tell." Nevertheless, as quoted by Professor Campbell, he goes on to say:

> It is perfectly reasonable to suppose that beings not only animated but endowed with reason inhabit countless worlds in space.

A major premise upon which this conclusion might rest would seem to be: We may reasonably suppose anything that does not admit of disproof. In the bald form here stated this premise would doubtless be rejected by those who believe in the plurality of abodes for animate intelligence, but without some appropriate equivalent for it there seems to be a hiatus between the conclusion above set forth and the facts that constitute its minor premise. Possibly Newcomb's own words anent this subject matter, *loc. cit.,* p. 531, may be a less objectionable formula: