the moon moves in its orbit (the sun also, if an eclipse is considered) and as the earth rotates on its axis. For a given place an eclipse begins or ends at the instant of (Greenwich) time when the exact edge of the shadow reaches the place. For a given place this (Greenwich) instant time will be determined by the *position* of the place with reference to the body of the earth, that is, by its ideal geodetic latitude and longitude—also by its radial distance from the earth's center—and not at all by the direction that the plumb line at that place may happen to take. The direction of the plumb line might vary widely and wildly from the normal without affecting the times of the various phases of the eclipse or occultation. The direction of the plumb line would, of course, affect the local time and hence the inferred longitude, but the equations for determining the longitude from an eclipse assume that the ideal geodetic longitude and the actual longitude affected by a deflection are identical.

The geodesist may be able on the basis of extensive and careful surveys to obtain approximations to these ideal geodetic latitudes and longitudes. But his results are based on studies of limited regions, of a continent at most, not on surveys of all the continents and of all the oceans, such as would be necessary to get really accurate values of ideal geodetic latitudes and longitudes.

How large are the differences between the astronomer's ordinary latitudes and longitudes, which depend on the direction of the plumb line, and the geodesist's latitudes and longitudes, from which the effects of the irregular deflections of the plumb line have been at least partially eliminated and which are thus approximations to ideal geodetic latitudes and longitudes? These differences are commonly known as deflections of the plumb line. Deflections of 5″ are commonplace, of 10″ are common enough; deflections of 20″ are not rare and even larger deflections are sometimes found in mountainous country and on oceanic islands. One second of arc corresponds to about 100 feet in meridional distance on the surface of the earth; one second of deflection in longitude corresponds in latitude 45° to 72 feet measured perpendicular to the meridian. By confounding the two kinds of latitude and longitude we may thus make errors in location of many hundreds of feet.

An argument in favor of the Wegener theory based on a comparison of differences of ideal geodetic longitude derived from lunar occultations—and supposed accurate—with differences of ordinary astronomical longitude derived from exchanges of time signals would therefore be fallacious. The two kinds of longitude are different and a fictitious continental drift of hundreds of feet may be apparently "proved," if the two kinds are confounded.

This discussion has, of course, no bearing on a comparison of earlier differences of longitude with later determinations, both determinations being based on time signals.

WALTER D. LAMBERT
U. S. COAST AND GEODETIC SURVEY

FOSSIL DISCOVERY NEAR SAN FRANCISCO

A FOSSIL deposit recently discovered near San Francisco Bay in California has been found to contain, all in close relationship, elephant bones, the tooth of a prehistoric horse, insect remains and a wide variety of botanical specimens.

The location of the discovery is in the unincorporated village of Millbrae, south of San Francisco, on the peninsula that separates the bay from the ocean. The bay at this point is skirted by a wide strip of former salt marsh which has been drained and used for farming and pasture. The fossil deposit was found under one of a series of low hills that protrude into the edge of the former salt marsh, about three fourths of a mile from the shore of the bay on one side, and about the same distance from the foot of larger hills on the other.

To the west, forming the backbone of the peninsula, is a range of hills that reach an altitude of 1,200 feet. The hill at the edge of the salt marsh, which at the point of the discovery attained an elevation of about 20 feet above sea level, was being cut down and leveled off for a housing project when, about 12 feet under the former hill top, the grading machinery cut through the stump of a tree and an elephant's tusk. A careful investigation of the area was immediately undertaken, and excavation of the fossils has now been completed.

Ten elephant tusks were found, but the bones, teeth and tusks, while generally grouped in positions according to size, thus seeming to indicate where the bodies had originally lain, were not articulated in the form of skeletons, nor were all the parts of any one skeleton found.

The largest tusk was approximately ten feet in length and eight inches in maximum diameter, while the smallest was only about four feet long. The largest tusks were sharply curved in two dimensions, while the smaller ones tended to be more nearly straight.

Because of the advanced state of decay in which the fossils were found, it was only with great care and the use of plaster casts that any of the tusks or bones were preserved. Tusks that appeared to be sound shattered into small bits at the first attempt to move them, and the bones were usually more fragile than the matrix that surrounded them. Portions of bones were partially mineralized, while other portions, sometimes of the same bone, had completely disap-

peared—apparently through decay, but possibly in some cases from having been eaten by carnivors. Decay was too far advanced, however, to be sure of any evidence of the latter, such as teeth marks.

From their positions, the bones would seem to have been scattered and maltreated for some time before being covered, but they were also distorted afterward by movements of the earth. These distortions varied from a slight fracture or curvature to an indistinguishable mass of bones pressed together as if by a landslide.

Twenty-one more or less complete teeth were obtained, five of which are still *in situ* in the jaw bones. There are, besides, many fragments and portions of teeth. No cranium was found, scarcely even a recognizable portion, and almost no vertebrae. On the other hand, the mandibles of two animals are nearly complete, and one other pair, the largest, was found complete but grotesquely distorted and badly decayed. Other readily recognizable bones were a femur and various other leg bones, scapulae, pelvic bones and ribs.

A superficial study of the teeth tentatively identifies the animals as belonging to the Columbian species (*Parelephas Columbi* Osborn).

The geological structure of the region suggests that the fossils were deposited in the marginal area of an alluvial fan. The most careful geological study of the area was made by Professor Eliot Blackwelder, of Stanford University, whose findings are herewith quoted. No dissenting opinions have been advanced by any of several other geologists who visited the excavations.

There are strata that show "the usual varieties of sedimentary material," says Blackwelder, "characteristic of alluvial fans in this part of California. They comprise fairly clean gravel and various grades of sand, all distinctly although complexly stratified. There are also beds of very poorly sorted pebbly material which is probably the result of successive mudflows. All these are stream channel deposits, indicating many temporary channels spaced only a few feet apart."

The deposit in which the elephant bones were found was a uniform bed of "smoke-gray" sand mixed with clay, which was probably an overflow out beyond the stream channels. Blackwelder's analysis of this bed is as follows: "course gray sand about 58 per cent., fine sand about 17 per cent., dark gray silt with a minor amount of coarse clay about 25 per cent." It owes its dark color to "much finely comminuted woody material."

The horse tooth (equus) mentioned at the beginning of this article was found in gravel at the edge of a stream bed. It was within a few feet of some of the elephant bones but not in the same sedimentary deposit. The elephant bones, on the other hand, were almost without exception in the bed of gray sand-clay described above, all within an area about 15 by 40 feet, and with not over 8 feet variation in depth.

As to the age of this deposit, consensus of opinion places it in middle or late Pleistocene time. Blackwelder has summarized the data as follows:

> From the undisturbed character of the beds and the unmineralized condition of both wood and bones, I infer that they are not older than Middle Pleistocene. On the other hand, the extent to which the original fan has been eroded, the altered condition of the wood, and the progress of decay in the more susceptible pebbles in the gravel indicate that they are not of Recent age and probably do not belong to the latest part of the Pleistocene. . . . I am inclined to venture the guess that the alluvial fan at Millbrae dates from about the time of the third or Tahoe glacial epoch or else the immediately preceding or succeeding interglacial age.

Summing up the data, the forming of this deposit of elephant bones may well have occurred in the following manner. During the process of formation of this alluvial fan, much of its surface was probably covered with vegetation on which elephants might feed. Furthermore, during rainy seasons this bed of sand-clay could well be soft enough so that animals as heavy as elephants would sink in it and not be able to escape. After they had been entrapped and died, their carcasses would be eaten by carnivors and their bones exposed, scattered and trampled probably for some time before being covered by the expanding alluvium.

When once they were covered, the fineness of the mudflow around them, together with the never-failing supply of ground water at this low level, created an anaerobic condition which preserved them from complete decay. The distortion of the bones could well be caused by slumps or crawling of the soil, or possibly by earthquake action. It should be added that in all the excavation there was no evidence of marine life.

The botanical and insect specimens were found both in conjunction with the elephant bones and also over a wider area. Some were in immediate juxtaposition with the bones, and all were in the same surrounding alluvial deposit. They ranged from small seeds and finely comminuted wood particles up to stumps and sizable logs, and from a lone blue iridescent beetle wing to whole insects. None of the trees were *in situ*, evidently having been washed down from the hills, but many of the smaller plants may well have grown on the surface of the expanding alluvial fan.

F. D. Klyver, paleobotanist at San Mateo Junior

College, has identified sixty-eight different varieties of plants, and the study is by no means completed. Not counted in this number are many specimens of wood and bark, some microscopic, others several feet long.

Heading the list of trees so far identified are Douglas fir, Monterey pine, Monterey cypress and alder. Manzanita, snow berry and poison oak are among the shrub species, and yerba buena and wild blackberry are two species of vines present. The list of smaller plants, representing the common wildflowers such as red maids and miner's lettuce, include grasses, sedges and rushes. One fossil bulb has been found. Added to all these items is one equisetum (scouring rush or horsetail), and one or more mosses.

There are also more than twenty-five specimens of insects and closely related animals. The green, scarab-like iridescence of a beetle's wing was the first evidence of prehistoric insects to be discovered. The collection now includes several kinds of beetles, ants, grasshoppers and one or more millipeds. Numerous specimens of what appear to be insect and spider eggs have been found.

It is impossible at present to say of what value this fossil discovery may prove to be, nor which part of it may be of greatest significance. It does at least afford an opportunity for an authentic reproduction of a period of prehistoric life in this area. The specimens are still under study at San Mateo Junior College, San Mateo, California.

FRANK M. STANGER

SCIENTIFIC BOOKS

ARGASIDAE

The Argasidae of North America, Central America and Cuba. By R. A. COOLEY and GLEN M. KOHLS. iii + 152 pp. 57 figures. 14 plates. (The American Midland Naturalist Monograph No. 1.) Notre Dame, Ind.: The University Press. 1944.

THIS monograph is the third in a series of monographs of the ticks of North America. The first, appearing in 1938, monographed the genera *Dermacentor* and *Octocentor;* the second, in February, 1944, treated the genus *Amblyomma;* the present one is more ambitious and treats of the family Argasidae not only of North America but includes Central America and Cuba. This beautiful volume is not only well illustrated but contains a wealth of information about the soft ticks of the region under discussion. Like the preceding numbers it is a model of exactness and clarity. As certain species are important vectors of diseases this work will prove of great value not only to the taxonomists but also to the medical and veterinary profession.

The authors first present a general account of the family, followed by a detailed explanation of the various terms used in the text. A brief account of methods of handling, studying and rearing ticks is also given, and the reviewer wishes this could have been more detailed and illustrated. There is also a brief statement of the medical and veterinary importance of the Argasidae. The authors point out that at least five species of *Ornithodoros* (*hermsi, turicata, parkeri, talaje* and *rudis*) are proved vectors of relapsing fever spirochaetes; one species (*O. parkeri*) has been proved experimentally to be a vector of Rocky Mountain spotted fever and American Q fever. *Argas persicus,* of world-wide distribution in warm climates, is a notorious pest of poultry and is the vector of avian spirochaetosis and is also reported as a probable vector of fowl paralysis. Other species are important pests of various animals, including man.

The main part of the volume is devoted to a detailed account, with numerous illustrations, of the various species. The authors recognize four genera and twenty-four species in the restricted area. These are *Argas,* with two species; *Octobius,* with two species; *Ornithodoros,* with 18 species; and *Antricola,* with two species. In general the following information is given for each species: a list of synonyms; detailed description of the adult; brief descriptions of the larval and nymphal stages when known; line drawings of significant details; photographs of dorsal and ventral views of many of them; host data; biological notes; distribution records with spot maps. Closely related species are treated in great detail and the important differences between them stressed. Keys to genera and species are provided.

The monograph concludes with a classified list of hosts and their ticks; a geographical distribution summary; and an excellent bibliography. This volume will prove of great value to the parasitologists and medical entomologists; the members of the medical and veterinary professions will also find much in it that is of importance to them.

ROBERT MATHESON

THEORY OF FUNCTIONS

The Theory of Functions. By J. E. LITTLEWOOD. 243 pp., Oxford University Press. $5.50.

A BOOK by the noted English mathematician, J. E. Littlewood, is sure to arouse widespread interest. The present volume, two thirds of which was printed in 1931, deals largely with conformal mapping, harmonic and subharmonic functions of two real variables,