tabu, animal descent, etc.), although "they exist separately and independently from one another," are also found associated in totemic complexes. If they were "nowhere found united" and were "not correlated to one another," there would be no totemic problem.

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February 23, 1911

EVIDENCE OF THE ZEBRA IN THE PLEISTOCENE FAUNA OF FRANCE

FROM certain drawings by paleolithic artists, reproduced by Édouard Piette in his work on "The Art Relating to the Reindeer Age,"[1] it would appear that a species of zebra had wandered northward, with other members of the African fauna, during the Pleistocene, at least as far as central France. On plate XXX. of Piette's work are reproduced two engraved figures of an animal that seem undoubtedly intended to represent a zebra. In one of these (Fig. 6) only the head and neck appear, while in the other (Fig. 7) almost the entire animal is drawn. The reference to these figures in the accompanying text is as follows:

FIG. 6. Engraving representing the head and neck of a horse-like animal with erect mane, delicately striped like the zebra. The stripes are formed by rows of points almost contiguous. One notices in the front of the head a series of marks like chevrons and under the neck, two short parallel stripes. Grotte des Espélungues, A'Arudy.

FIG. 7. Engraving representing an animal like a horse, delicately striped like a zebra, with erect mane, small head having small ears. The stripes are indicated by series of parallel lines or of points. The tail is incompletely drawn. Grotte de Tayngen.

The striping of the hind quarters in Fig. 7, suggests the "gridiron" pattern on the rump of the rock or berg zebra (*Equus zebra*), an existing species, now on the verge of extinction, but formerly abundant in the mountainous districts of Cape Colony. Here, however, the likeness ends, for the absence in the engraving of stripe marks on the limbs, the presence of which, clear down to the hoofs, is a character of the above species, would suggest Burchell's zebra (*Equus Burchelli*) as would also the small size of the ears.

A careful study of these drawings forces one to the conclusion, it seems to me, that a species of zebra was present in western Europe when paleolithic men were engraving the lineaments of reindeer, bison, horse, mammoth, cave bear, woolly rhinoceros and other animals of that strange and interesting time. Surely this ancient artist did not stretch his imagination to so accurately delineate the stripe pattern of a zebra, without having seen it. All of these paleolithic engravings depict an animal most faithfully, even, at times, to minute details. The familiar sight of some beast begat an impulse that found its expression in virile representations of form, remarkably accurate considering the rude and primitive implements for engraving, that were in the hands of these artists of the remote past.

I am not aware of any previous reference to the zebra's former existence in Europe, and I present the above facts simply as evidence coming from the hand of one who without doubt knew and drew some form of zebra that later, like so many other great mammals, vanished from the northern lands.

SPENCER TROTTER

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February 14, 1911

[1] "L'Art Pendant L'Age Du Renne," Paris, 1907.

SCIENTIFIC BOOKS

Termitenleben auf Ceylon; Neue Studien zur Soziologie der Tiere, zugleich ein Kapitel Kolonialer Forstentomologie. Von KARL ESCHERICH. Jena, Gustav Fischer. 1911. Pp. xvii + 262. 68 text-figures; 3 pls.

This important contribution to our rapidly increasing knowledge of the termites, or "white ants," had its origin in a journey made by Professor Escherich during 1910 to Ceylon, and contains a very interesting account of the behavior of several of the species of that island. Four fungus-growing species (*Termes obscuriceps, redemanni* and *ceylonicus* and *Microtermes globicola*) are considered at length in the opening chapter of the work, their architecture and fungus-gardens being

described in detail and with a number of striking illustrations. The fungus (*Volvaria eurhiza*) which is cultivated and eaten by *T. redemanni* is described and figured in accordance with Petch's investigations published in 1906 in the *Annals* of the Royal Botanical Gardens of Peradenyia.

One of the most interesting portions of this chapter deals with social symbiosis, or the tendency of two species of termites or of termites and ants to inhabit the same nest. Thus Escherich often found *Termes ceylonicus* and *obscuriceps* in the same termitarium, but each species inhabited galleries of its own, and although these were mingled they did not inosculate and the two species, when the nests were undisturbed, were always separated from one another by masonry walls. If the insects of the two colonies, however, were made to meet through a breaking down of the walls, their behavior towards each other was decidedly hostile and bitter conflicts ensued.

Singularly enough, each of these species had its own fungus-gardens, the chambers containing which were seen to be intermingled when the termitarium was sectioned. Escherich believes that *T. obscuriceps* is the original architect of the nest, whereas *T. ceylonicus* is merely a "Raumparasit." Another case of similar symbiosis is furnished by *Capritermes ceylonicus* and *incola,* each of which may inhabit the nest of *T. redemanni* or *obscuriceps.* In this case, also, the *Capritermes* inhabits small burrows of its own in hills built by the *Termes* and violently attacks the latter whenever it is encountered. The *Capritermes* soldier has extraordinary asymmetrical mandibles by means of which it can jump into the air or hurl its enemies away from the battlefield. Other species, which Escherich found nesting in the mounds of *T. obscuriceps,* are *Leucotermes ceylonicus, Eutermes escherichi, Eurytermes assmuthi* and *Hamitermes quadriceps.* In all cases these lived shut off from but in very close proximity to their hosts and were always inimical to the latter when the two species were brought together. *Hamitermes, Leucotermes* and *Eurytermes* may, however, live in independent nests. Speaking in myrmecological terms, the author concludes that "all the phenomena which we ascertained regarding the living together of different termites belong without exception in the category of 'compound nests,' as opposed to 'mixed colonies.'" Concerning the relations of ants and termites he says that in Ceylon there is scarcely a termitarium which does not harbor ants. The commonest species are *Camponotus rufoglaucus* and its subspecies *paria* and *C. sericeus opaciventris.* These usually inhabit the outer walls or "Mantel-region" of the nest. Escherich was quite unable to observe any such relations as Wasmann has described as existing between South American termites and *Camponotus termitarius* and has called "phylacobiosis" on the supposition that the ant stations itself at the nest-entrance and defends its termite hosts from their enemies. Another common ant in the Ceylonese termitaria is the tropicopolitan *Plagiolepis longipes,* "which lives in nearly every mound, or at least in its immediate neighborhood, flitting like a shadow over the opened portions of the nest and rushing into the galleries and chambers to seize their occupants." In agreement with Wroughton, Escherich describes the habits of a ponerine ant, *Lobopelta ocellifera,* which he calls "die Termitenräuberin par excellence." A whole army of this ant may proceed in a file to a termitarium, break into its galleries and carry away the workers and larvæ in great numbers. An interesting new genus and species of ant, *Pœdalgus escherichi* Forel was discovered nesting in the termitaria in small chambers which evidently communicated by means of very slender galleries with the galleries or chambers of the termites. From the great disparity between the size of the queen and that of the worker—the former measuring 5.5 mm., the later 1.1–1.2 mm.—it is inferred that this species must be a thief-ant like the species of *Carebara, Oligomyrmex, Aëromyrma* and *Solenopsis,* which are also known to live as thief-ants in termitaria or the nests of other ants.

Escherich discusses, in this connection, the habits of a few guests or termitophiles, espe-

cially the carabid beetle *Orthogonius acutangulus,* the swollen or "physogastric" larvæ of which feed on the termites. Wasmann had supposed that these larvæ were adopted and fed by the termites in the place of their own huge queens, but Escherich shows that there is nothing to support this view. The first chapter of the book concludes with an account of the growth of termitaria and the architectural instincts of the worker and soldier termites.

The second chapter is devoted to the habits of the species of *Eutermes,* which have peculiar nasute soldiers, and especially to a charming account of *E. monoceros,* a black termite which goes forth in long processions fully exposed to the tropical sun to browse on the lichens on tree-trunks and the roofs and walls of houses. These processions are indeed "erstaunlich," since they may be several hundred meters long and make the most unaccountable détours, "often three and four times the shortest distance to the feeding grounds." Escherich estimates the number of individuals in a colony of this species at about 200,000. It reminds one of a common European ant, *Lasius fuliginosus,* not only in its dark color and its tendency to form these long processions, but also in its nesting habits. Its termitarium is a carton structure and, like that of *L. fuliginosus,* situated in a hollow tree-trunk. Escherich finds that it also forms on the outside of the trunk an "Abtritt," or latrine near its nest, a black stalactite-like mass which grows gradually as the workers add their feces to it and eventually drops from the tree or dissolves away in the tropical rains. It is, however, constantly renewed and is guarded by a cordon of soldiers called by Escherich guards of the latrine ("Abtrittswächter"). Since the workers and soldiers of *E. monoceros* are blind, Escherich was naturally led to investigate their "homing" instincts. Bugnion, who had previously studied this same termite in the same locality, showed that its sense of smell is very acute, and Escherich finds that the workers while they move along discharge from time to time small, black fecal masses which adhere firmly to the substratum like so many fly-specks and serve as guide-posts for the workers and soldiers that follow. He concludes, therefore, that the "spoors of the black termites not only have a more intense odor than those laid down by the ants, but are much more stable and persistent." A brief account is added of the habits of some other species of *Eutermes* and especially of the "gallery" termite (*E. ceylonicus*), which, like most species of the genus, constructs a gallery or arcade under cover of which it moves from place to place.

The third chapter is full of interesting miscellaneous observations and accounts of laboratory experiments. It opens with some remarkable notes on the queen termite and contains confirmation of Holmgren's recently published theory according to which the queen termite sweats out on to the surface of her body a substance ("exudate") which is eagerly devoured by the workers and not only keeps the helpless queen supplied with attendants, but, so to speak, binds the whole colony together. Not only are the attendant workers continually licking the body of the queen, but Escherich actually saw a worker tear a strap-like piece out of its mother's hide and lap up the liquid exuding from the wound. He noticed also that the unwieldy bodies of the queens are often scarred in such a manner as to suggest that this treatment is not unusual. The exudate thus obtained by licking or even wounding the queen is often distributed to other workers by regurgitation. From these and many other observations Escherich infers "that the eager licking of the queen has its origin not only in the cleansing instinct of the workers, but quite as much in their feeding instincts, or, as Holmgren says, in their 'exudate-hunger.'" The queen termite is therefore fed and cherished by her offspring as if she were herself a termitophile, or termite guest, and for the same reasons, and since the other castes—*i. e.,* the males, workers and soldiers and their larvæ—also have exudate organs of peculiar structure, Holmgren assumes that the whole problem of caste differentiation in these insects is to be solved with the aid of the exudate theory. In

other words, "the amount of exudate determines the amount of food and the latter determines the development of one or the other caste." It is certainly noteworthy, in this connection, that the queen termite, in the egg-laying stage, is clearly afflicted with physogastry, a condition which, as Wasmann has shown, is as characteristic of the guests of termites as the possession of trichodes is characteristic of myrmecophiles.

In the same chapter Escherich gives an account of a number of experiments on the behavior of termites brought together from different colonies. He found that alien larvæ are much less hostile to one another than are strange imagines (workers or soldiers). As would be expected, the soldiers of different species differ markedly in their methods of attacking and killing their enemies: the *Termes* soldier uses its sharp mandibles as a poniard or pair of scissors, the *Capritermes* soldier as a catapult with which to toss its enemies into the air; the *Eutermes* soldier, however, pounds its enemies with its cephalic horn and simultaneously smears their bodies with a sticky secretion from its cephalic gland; the *Coptotermes* soldier reduces its enemy to impotence by throwing over it a milky secretion. When termite colonies are invaded by small enemies, the workers often do all the fighting and the soldiers slink away; but larger and more powerful enemies are attacked by the soldiers while the workers behave rather indifferently. The main function of the soldiers is to defend the nest entrances.

Escherich is of the opinion that the negative phototaxis of termites has been greatly overestimated, but while this may be true of *T. redemanni* and *obscuriceps* which were seen building, and of *E. monoceros* which was seen foraging "am hellen Tage im grellsten Sonnenschein," the other observations cited do not prove the indifference of termites in general to light. Ants, too, are in the main negatively phototactic, though they often forage and build in the bright sunlight.

The fourth chapter is devoted to the methods of exterminating termites, a matter of great importance in tropical countries where these insects are often a serious menace to all wooden structures, books, papers, cloth and even to the stems of growing plants (tea, cacao, etc.). The following measures are recommended: first, stopping some of the main openings of the nest with tow or "waste" soaked with carbon bisulphide and closing all the remaining openings with clay or earth; second (and this is recommended as the most effective treatment), the use of the "universal ant-exterminator," an appliance manufactured by C. Henwood & Son, of Durban. This consists of a small charcoal stove connected on one side with a hand-pump (resembling that used for inflating bicycle tires) and on the other with a rubber hose provided with a nozzle. On glowing charcoal in the bottom of the stove a small quantity of a powder consisting of 85 parts of arsenic and 15 parts of sulphur is placed, the nozzle of the hose is inserted in the entrance of the termitarium and the poisonous fumes which fill the stove are forced into its galleries and chambers by working the pump. The hose is then removed, the openings are at once plugged with clay and the nest is left undisturbed for several days. If at the end of a week's time some of the termites are found to have survived, the fumigation has to be repeated. Escherich describes an interesting apparatus for locating termites, a "Termitensucher" manufactured by Friedrich Suck, of Hamburg, for use in the German colonies. This consists of a microphone inserted in a funnel at the end of a steel tube and connected with a telephone receiver. When the tube is stuck into the earth the noise made by the crawling termites can be distinctly heard through the receiver even when they are working at a considerable depth in the soil. By means of this apparatus termites may be readily located in the tree-trunks of orchards or estates or in the walls of houses and marked for treatment with the arsenic-sulphur fumes.

The work closes with the following series of valuable appendices by various authors on the material collected by Professor Escherich in Ceylon; a taxonomic account of the Ceylonese

termites by Holmgren; a similar account of the ants by Forel; descriptions of the termitophilous coleoptera by Wasmann; a description of a new cricket (*Myrmecophila escherichi*) which has become termitophilous, by Schimmer; termitophilous thysanura, myriopoda and coleopterous larvæ by Silvestri; a termitophilous earthworm (*Notoscolex termiticola*) by Michaelsen.

W. M. WHEELER

SCIENTIFIC JOURNALS AND ARTICLES

THE contents of *The American Journal of Science* for April are as follows:

"Ionization of Different Gases by the Alpha Particles from Polonium and the Relative Amounts of Energy Required to Produce an Ion," T. S. Taylor.

"Heat Generated by Radio-active Substances," W. Duane.

"Contributions to the Geology of New Hampshire. IV. Geology of Tripyramid Mountain," L. V. Pirsson and Wm. North Rice.

"Note on a Method in Teaching Optical Mineralogy," F. W. McNair.

"New Paleozoic Insects from the Vicinity of Mazon Creek, Illinois," A. Handlirsch.

"Results of a Preliminary Study of the so-called Kenai Flora of Alaska," A. Hollick.

SPECIAL ARTICLES

THE ORIGIN OF FIVE MUTATIONS IN EYE COLOR IN DROSOPHILA AND THEIR MODES OF INHERITANCE

The White Eye

IN cultures of *Drosophila ampelophila,* that had been closely inbred for a year, a male fly, lacking the red pigment of the eye, appeared. The same stock has continued to produce these white-eyed mutants always of the male sex. A white-eyed father transmits the character to about one fourth of his grandsons, but to none of his granddaughters. In this sense the character is sex limited. The white eye can be transmitted, however, to the females, most readily by breeding any white-eyed male to red hybrids (F_1) out of white by red. White-eyed males and females give pure stock. When a white-eyed female is bred to any wild male all of the female offspring have red eyes and all of the male offspring white eyes. The result shows that the male-bearing sperm of the wild flies lacks at least one of the factors essential for the production of red eyes. This statement does not mean that the male-determining sperm lacks all of the factors essential for producing red, but only that it lacks one of the factors necessary for the production of red. In fact, it is conceivable that all of the rest of the cell may be equally essential for the production of red, but in the absence of one condition (factor) the red fails to develop. It is in this sense that I understand the use of the word "factor" in inheritance; and in the same sense one might employ the word "unit character," although the latter word may seem to imply (from usage) that a particular character is represented entirely by some unit in the germ cells. We are not warranted, I believe, in extending to the results of Mendelian inheritance such an interpretation. Since I have discussed elsewhere the mode of transmission of the white eyes,[1] I shall omit further details here.

The Pink Eye

This eye color has appeared at least twice in cultures in no way closely related to the white-eyed stock. It is not due to a cross between red- and white-eyed flies. The color is much lighter and more translucent than red, and appears to contain more yellow. It is seen to best advantage soon after the flies have emerged. Later it becomes darker and casual observation might mistake it for red. As the flies get old the pink changes to a somewhat purplish color, and this change does not take place in the red eyes, so that with experience there is no difficulty in separating the two colors at all stages. No intermediate condition has been seen despite the fact that thousands of the pink-eyed flies have been examined.

Pink-eyed males bred to wild red-eyed females produce all reds in the first generation. These flies, inbred, have produced in the second filial generation 3,063 reds to 169

[1] SCIENCE, July 22, 1910.