

be nearly equal to that of the entire retina. This demonstrates for each component that there is full summation over the receptive field. Similar results were obtained with monophasic units (Fig. 2a), as well as with triphasic ones.

To restrict the stimulus light to separate portions of the receptive field we examined the area-intensity relationship for each component of the triphasic unit with different size annuli (Fig. 2c). We found no significant differences from the results just described. To adapt out the contribution of one component from another we then combined background adapting lights of 430, 500, and 650 nm, respectively, with the annular stimulus fields. Again, the data confirmed the previous observations.

Our results support the conclusion that the S-potentials studied all have full summation over their entire receptive fields. This type of organization is in distinction to that described for ganglion cells in the closely related goldfish retina where the components have distinguishable field sizes (3). These results apply only to the types of S-potentials described in this study. Other types of S-potentials such as the reciprocals of those described, that is, triphasic units consisting of depolarizing blue and red and hyperpolarizing green processes, have been infrequently recorded in our laboratory, but there has been no opportunity to study them further and to ascertain their organization.

ALAN L. NORTON

*National Institute of Neurological  
Diseases and Blindness,  
Bethesda, Maryland*

HENK SPEKREIJSE

MYRON L. WOLBARSHT  
*Naval Medical Research Institute,  
Bethesda, Maryland*

HENRY G. WAGNER

*National Institutes of Health,  
Bethesda, Maryland*

#### References and Notes

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## Archaeological Excavations in the Calico Mountains, California: Preliminary Report

Since 1964, excavations have been conducted at a site in the Calico Mountains near Yermo, in the Mojave Desert of southern California, under grants from the Research and Exploration Committee of the National Geographic Society, whose generous help is most gratefully acknowledged.

The site was selected by Dr. L. S. B. Leakey after he had undertaken preliminary investigations of the area in company with Miss Ruth Simpson. It is situated in an old alluvial fan which exhibits considerable erosion. The particular point of the fan where the excavations have been carried out was selected because specimens considered by Dr. Leakey to be human artifacts had been obtained nearby in a cut which had been made by a mechanical excavator.

Miss Simpson has been field director of the excavations ever since the inception of the work. She is assisted by a first-class crew, and we are deeply grateful to all members for the hard work and loyal support which they have given us throughout. Dr. Thomas Clements has been the geological adviser from the outset. Administration of the project has been under the general supervision of Dr. Gerald Smith, director of the San Bernardino County Museum.

The principal excavation [25 by 25 feet (7.5 m) and extending downward to an average depth of 13 feet into the undisturbed fan] has yielded more than 170 specimens in these undisturbed deposits. We consider them to be unquestionably the result of human activity. In addition, there are several hundred other specimens which, in view of their association with the first group, must also be regarded as possibly of human workmanship. The matrix of the fan itself, of course, contains a still larger number of pieces of stone which do not exhibit any suggestion of human activity.

Our view that the site has yielded very early humanly made artifacts is shared by a number of our colleagues who have visited the site and examined the material upon which we base our conclusions. Others, however, have found themselves unable to accept these specimens as being the result of human activity and regard them instead as having been produced naturally. The assemblage upon which we

rely includes many examples of large flakes; some of them are very large, and all of them have well-defined bulbs of percussion. In a few cases the flakes also exhibit faceted striking platforms, while in some 30 specimens there is a well-defined *erailleur* across the bulbar face. In a few cases the bulb of percussion of a large flake has been subsequently trimmed away. In our view this trimming has been done carefully and by man.

The collection also includes more than 20 excellent concavo-convex flakes and some large hinge fracture flakes. There are a few specimens which we definitely regard as side and end scrapers and simple bifacially worked tools.

The whole assemblage has a very primitive appearance, but this is only to be expected in view of the probable age of the deposit from which it has been excavated. Geologists and geomorphologists who have examined the site are of the opinion that the age of the fan is over 40,000 years but probably less than 120,000 years, with a probable age of between 50,000 and 80,000 years.

In order to test the validity of a suggestion which had been made by some of those who disagree with us that what we call artifacts are no more than objects made by the natural action of movement of soil and rock within the fan, we excavated a large second pit, as well as a number of smaller test pits, at random points on the fan. The second large pit, situated somewhat higher on the fan than the first at a point indicated by those who disagreed with us, yielded no specimens which we would regard unquestionably as artifacts. Only a few artifacts were found in the smaller pits, especially those close to the main excavation.

Another factor which we consider to be of undoubted significance is that at our original site there appears to have been a very definite selectivity in respect of materials from which the flakes and other artifacts have been made. There is abundant chalcidonic material of less good quality in the fan, but the vast majority of the specimens which carry evidence of being artifacts were made from the better quality material. It seems improbable that nature would, or could, be thus selective.

In view of the great significance of the discovery, if our claims are valid, we cordially invite geologists and archaeologists who are interested to visit the site and also to make arrange-

ments to view the assemblage of artifacts. Arrangements should be made with Miss Simpson, Box 535, Yermo, California.

Toward the end of 1968 it is hoped to hold a symposium at which we will present the whole of our evidence to our colleagues. Those who support us will then be able to do so openly, while those who disagree can put forward their reasons for their opposite view.

L. S. B. LEAKEY

National Museum, Centre for  
Prehistory and Palaeontology,  
Nairobi, Kenya

RUTH DE ETTE SIMPSON

San Bernardino County Museum,  
Bloomington, California

THOMAS CLEMENTS

University of Southern California,  
Los Angeles

1 April 1968

### Cold Flour Beetle: Reminiscence or Change of Bias

Alloway and Routtenberg report (1) that if beetles (*Tenebrio molitor*) are cooled after learning, they perform less well on retest after 2 days during which they have been cooled than after 1, 3, 4, or 5 days of cooling. They interpret this in terms of an alteration in memory and postulate various physiological mechanisms. However, it is not clear that changes in memory are involved. Although the control experiment they report is ingenious, it fails to exclude important possibilities. To exclude the possibility that the decrement in performance they observed after 2 days was due to "nonspecific motivational factors," they required another group of beetles to learn the reverse of an initially learned habit after they had been cooled for various numbers of days. Their finding that reversal learning was faster after 2 days of cooling supports the idea that their original result was not due to some general disorientation or a lack of attractiveness of the reward. However, there are other nonspecific motivational factors which it does not exclude, and which might be responsible for their results. For instance, we may note that, before original training, "subjects were given a test for turning bias, which consisted of five runs through the maze. In original learning, training was against the subject's measured bias." Now if different periods of cooling produced systematic changes in the beetle's bias, then we

should observe that there were changes in performance of a previously learned habit. If the initial bias had been to turn left, then the habit taught the beetle would have been a turn to the right. If a given treatment increased the bias toward left turning, then the beetle would appear to have forgotten the habit of turning right, but would, by the same token, more easily learn a reversal habit—a turn to the left.

At present, such an alternative interpretation in terms of bias remains open. Changes of bias as a result of treatment are a commonplace and cannot be dismissed a priori. Scrutiny of the data of Alloway and Routtenberg reveals discrepancies which need to be explained. The number of trials to learn a reversal when the beetle has allegedly suffered from "apparently total forgetting" is much smaller (something like 2.5 trials) as against 4.62 trials in relearning and 4.78 trials in original learning. This difference looks as large as the differences between difficulty of reversal on different days, reported as highly significant. This might be explained as a manifestation of the original bias. However, as the authors stress, choice of the correct alley on the first trial of retest after 2 days of cooling was precisely at chance, an indication that, if memory was completely lost, the original bias was also lost.

Can these two pieces of evidence be reconciled on the hypothesis that the beetle is suffering from an amnesia? A complete amnesia for the learned habit should lead to a reappearance of the original bias. Then we cannot account for the fact that "the best available index of retention" indicates that on the first trial of the second task 50 percent of the subjects make a response which was correct in original learning. This could only be explained by relinquishing the claim that "apparently total forgetting" took place. But suppose that forgetting was only partial and that the remaining memory compensated for the bias of the beetles. With such cancellation of two opposing tendencies, it is difficult to see why reversal should be so much faster on the 2nd day than original learning and why relearning should only be as fast as original learning when memory sufficient to overcome original turning bias was already there at the beginning of training. If partial memory of the original habit was present, we should expect the opposite of what is actually the case; that is, reversal learning would be expected to take longer than relearning of the orig-

inal habit, as original bias has been counteracted by the remaining memory. Original learning was against the bias of the beetle; reversal was in the same direction. Any lessening of the effective bias by the partial memory should therefore speed up relearning of the original learning and retard reversal turning.

Experiments are needed to determine the biases of the beetle before cooling and then after cooling for various lengths of time. To dispel doubts, there should be an experiment in which beetles would be trained as in the report, but various numbers of uncooled days would be interposed between initial training and later cooling and retesting. If the effect is due to some phase of memory storage, such a procedure should be critically affected by the number of uncooled days between initial training and subsequent cooling and retesting. If the effect is simply one on biases, then a reasonable number of interposed uncooled days should not crucially affect the outcome of the experiment.

J. A. DEUTSCH

Department of Psychology,  
University of California, San Diego

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The preceding interpretation of our results (1) rests on the assumption that "different periods of cooling produced systematic changes in the beetle's bias." Recent results obtained in our laboratory do not support this view. First, one group of ten animals was run for 5 successive days on a bias test consisting of ten trials. Between days, animals were maintained in the cold. Correlations between successive days revealed no significant relation between bias shown on any 2 successive days. Thus, the very concept of bias may be misleading since a preference for one arm of the T-maze shown on any 1 day was not reflected in a similar preference (or aversion) on the subsequent day.

A second experiment was performed to test directly the suggestion made by Deutsch. Thus, five groups each of ten animals were tested for bias on day 1. All animals were placed in the cold, and each group was retested for bias on one of days 2 through 6. According to Deutsch there should be a systematic change in the bias across days, with the highest correlation between original and subsequent bias being demonstrated on