A Stable Dimorphism in the Common Paper Clip (Clipus Papyrus Comm.)

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INTRODUCTION

The life history of the common paper clip (Fig. 1) *(Clipus papyrus comm.)* is still enigmatic. While it is widely accepted that it occurs predominantly in close contact with bureaucratic action of modern man, the occasional appearance of varients of *C. papyrus* in prehistorical excavations and in the context of cave paintings (Fig. 2) suggests a much longer history. In fact, extremist positions (Döniken, 1976) claim an extraterrestrial origin of *C. papyrus* (Fig. 3). We have recently observed that the modern paper clip occures in two distinct phenotypes, namely a clockwise and an anti-clockwise configuration (Fig. 4). However, rare variants have been observed (Fig. 5). Such variants have been found predominantly on desk tops of some of our more neurotic colleagues.

FIGURE 1. An isolated individual randomly chosen from one of the ten *C. papyrus* populations (This individual is from strain ψ IV)

We have performed a number of experiments designed to investigate the quantitative relationship of the two more frequent forms, to test the stability of this relationship, and to get a deeper insight into an eventual mechanism maintaining this dimorphism.

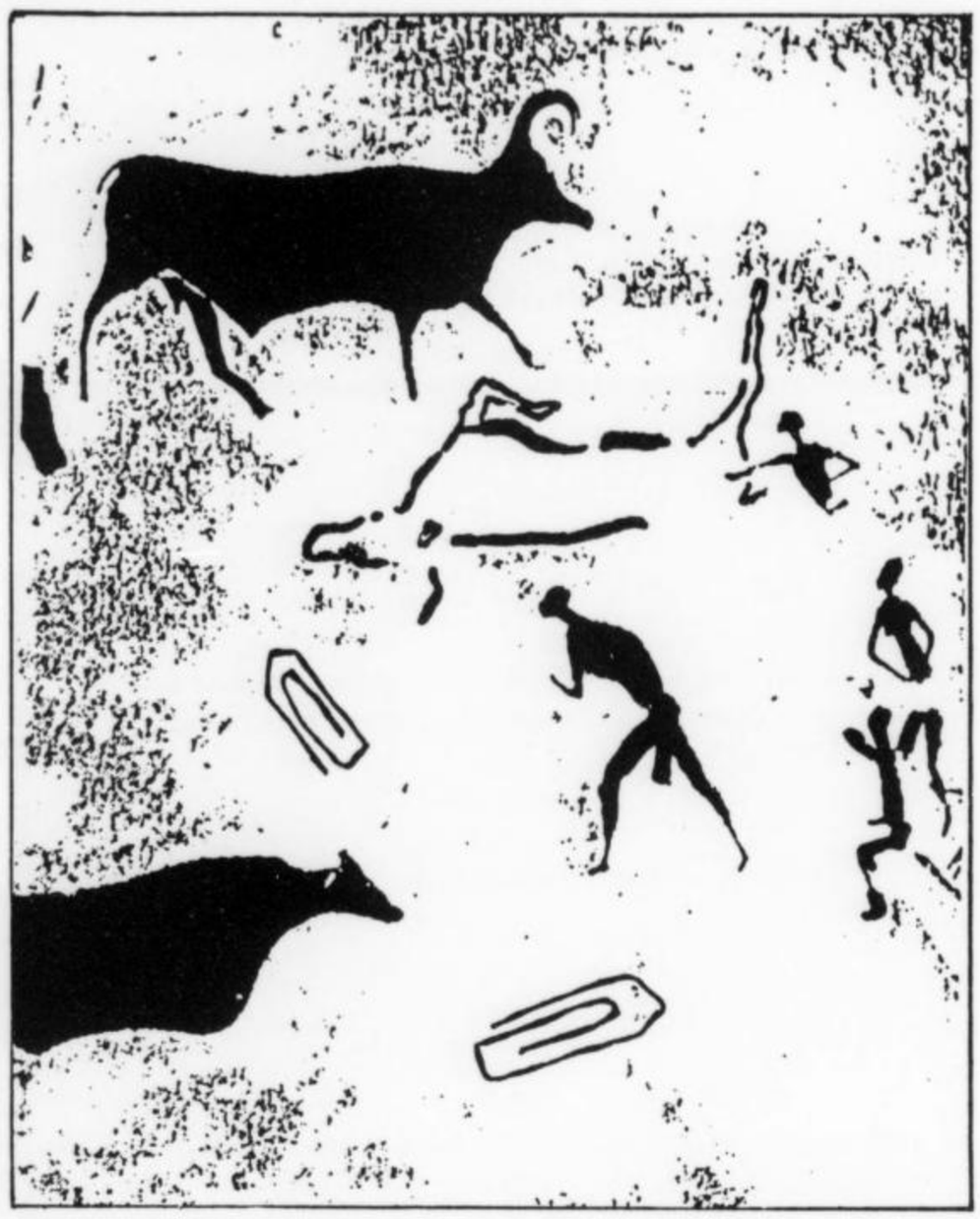

FIGURE 2. Cave painting found in the South-East of Lower Saxony (FRG). (Reprinted with kind permission of Dr. C.P. (Institute of Historical Research in Prehistorical Research History, Prehistorical Unit)).

MATERIALS AND METHODS

Ten boxes (''strains'') containing 1000 specimens each of *C. papyrus* were purchased from five randomly chosen stationeries at Göttingen, Lower Saxony, FRG between 1978 and 1986. All experiments were carried out according to the following scheme: 1. Preincubation followed by thorough mixing on a laboratory shaker at controlled temperature, time, and at a fixed rate of 300 rpm; 2. Plating out samples on Whatman Nr. 5 filter paper; 3. Repeated counting both manually and by the use of an on-line digitizing equipment (Lower Saxony Electronics. Ltd.)

RESULTS

1. Frequency of clock-wise and anti-clockwise wound paper clips among the ten different strains.

This series of experiments was carried out after mixing the original strains for 60 min. at 15°C (standard ambient temperature in Southern Lower Saxony). χ^2-analysis was applied to the data to exclude inhomogeneity between the different strains. As no inhomogeneity was found, the overall maximum likelihood estimate of the frequencies could be calculated as number of observations divided by the total number of trials. The results of this analysis showed that the two morphs appeared at equal frequencies, not significantly different from 0.5 each.

2. Stability of clockwise and anti-clockwise morph frequencies under different external conditions.

In a series of independent experiments, both mixing time and temperature were varied systematically. No deviations from the 1:1 ratio described above were found in a temperature range of 4°-56°C and mixing times between 1 sec. and up to two weeks.

3. Morph frequencies after invasive procedures.

From each strain clockwise and anti-clockwise specimens were separated. These substrains were subjected to the standard mixing protocol and recounted. Surprisingly, all substrains were found to have split up again into clockwise and anti-clockwise sub-substrains, with the two morphs not significantly different from the 1:1 ratio. Next, clockwise and anti-clockwise specimens from either one and the same strain or from all possible combinations of the ten original strains were mixed at a ratio of 1:10, 1:5, 1:2.5 and 1:1 at absolute specimen numbers of 100, 500 and 1000. The result of these 600 independent experiments was surprising again: In all cases the 1:1 relationships between the two morphs was restored.

FIGURE 3. Part of an ancient Egyptian papyrus (1). (From the King George Collection of Ancient Fish and Chips Wrappings, London).

DISCUSSION

The results of our experiments lead us to assume a mechanism inherent in the life cycle of *C. papyrus comm.* populations always to attain a 1:1 ratio of clockwise and anti-clockwise morphs. This effect seems to be independent of external variables such as temperature and incubation periods, and of internal factors such as the starting ratios of the two morphs and strain origin. Of special interest is the fact that restoring mechanism is a time-independent (instantaneous) process. Since this observation may be understood as a counter-example of the "Spezielle Relativitätstheorie" (Einstein, 1905) it could have a more general implication for our understanding of nature. Unfortunately our experiments do not yield any direct clue as the underlying mechanism of the ratio restoration. Under the experimental conditions employed we were unable to observe directly in which way the paper clips were interacting during the preincubation and mixing processes. The occasional occurrence of entangled doublets (Fig. 6), was reminiscent of a

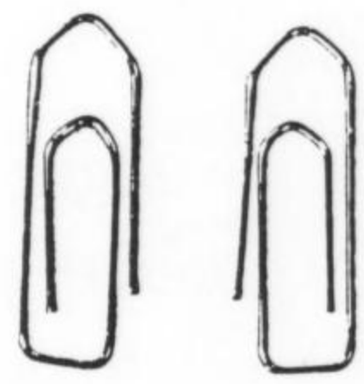

FIGURE 4. Two individuals showing the clockwise (left) and anti-clockwise (right) phenotype.

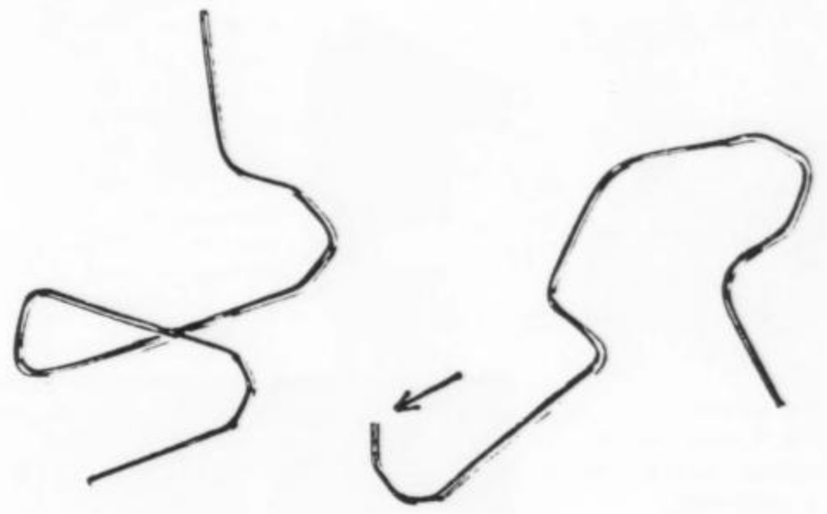

FIGURE 5. Rare variants of *C. papyrus*. The arrow points towards an apparent terminal deletion.

rudimentary form of sexual behaviour, during which the assignment of each partner to one of the two morphs was ambivalent. However, it must be emphasized that the ratio restoring mechanisms may also be completely independent of any specimen interaction and is not dependent on reproduction since no overall increase in the number of clips was observed in any of these experiments. This assumption is attractive, because we have demonstrated the independance of the process from the absolute number of specimens, which could be extrapolated to one (or even zero?).

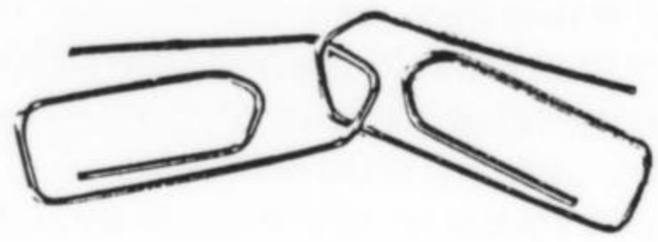

FIGURE 6. A couple of *C. papyrus* exhibiting the entangled doublet configuration (potential copulation activity).

An alternative explanation of these observations has been suggested to us. Rather than a structural dimorphism we might be observing a behavioural effect in which any individual clip spends one half its time in attitude 1 (which we call "up") and half its time in an alternative attitude 2 ("down"). We do not favour this explanation for two reasons; firstly the absence of nervous or motor mechanisms in these organisms makes any behaviour unlikely, and secondly extended observations of isolated individuals for periods up to 10^4 sec. revealed no spontaneous change of morph or attitude.

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This paper is dedicated to Professor Ulrich Langenbeck, to whom we owe thanks for many years of intellectual stimulation.

Is it currently the vogue,
For an over-worked erg,
To offer resistance to dyne,
At his joule's ohm,
By partaking of a few calories
on her log table?

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