

DEREK ROFF AND THE EVOLUTION OF BODY SIZE: A REJOINDER

Søren Løvtrup

Department of Zoophysiology

S-901 8F Umeå, Sweden

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Macromutations or micromutations (i.e. sports or individual differences), which are the source of evolutionary modification? Darwin vacillated for a long time, but finally settled for the latter. (The reasons for his choice have been ably discussed by Provine (1971) and Vorzimmer (1970).

The first to reproach Darwin for this option was T.H. Huxley, who wrote to him (23rd November 1859): "You have loaded yourself with an unnecessary difficulty in adopting Natura non facit saltum so unreservedly". Huxley was a morphologist, and it is typical that among those who in the past century have rejected Darwin's theory, many have been morphologists. For those who know how animals are constructed it is often difficult to accept that intraspecific variation is the exclusive source of evolutionary innovation. Some of the arguments used to support this view have been discussed elsewhere (Løvtrup, 1974; 1976; 1977).

But argument is one thing and experimental evidence something else. It is not easy to observe macromutations, and since their existence is alien to the neo-Darwinian theory of population genetics, this phenomenon has generally been rejected in present-day evolutionary theory.

But the latter stand has not been vindicated experimentally either, I believe it is fair to say that all attempts to accomplish even moderate changes through accumulation of micromutations have been failures.

If this issue is unsettled more than one hundred years after the publication of Darwin's theory, it would seem that to all thinking biologists it should be of immediate importance to devise means for testing the alternative: macromutations - micromutations. Since all references to qualitative properties have been rejected so far, however convincing they may seem to a macromutationalist, I came upon the idea some years ago that it might be possible to use a quantitative parameter, body size, for this testing.

There are a number of observations suggesting that the body size in the higher animals varies in a geometrical series with base 2. Some of this material was presented in Løvtrup *et al.* (1974), as well as a simple epigenetic mechanism to account for this regularity. In order to test this theory my colleagues began by collecting data on the body size of birds and mammals in some standard works. We realized that on the background of the individual variation in body size within most species it would not be easy to get reliable body size data. However, when the data thus obtained were subjected to cluster analysis the grouping obtained corresponded quite nicely with the theory.

In some cases the significance of the clustering was evidently unsatisfactory, but in other cases values of $0.95 < P < 0.99$ made us believe that we had obtained significantly separate subgroups - and our statistical advisers did not attempt to dissuade us on this point.

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We therefore thought that we had reached our goal, to arouse the suspicion that something might be rotten in the state of evolutionary theory. In that case one might expect that some members of the biological community would be alerted and search for more and better data, in the defense either of the ruling orthodoxy or of the equally old alternative theory.

Rallying to the defence of micromutationism, Derek Roff (1977) has made life easy for himself by simply showing that in cluster analysis significance values have a different implication than elsewhere, and that our clusters are not significant. We, the authors of Løvtrup *et al.* (1974), stand corrected and unmasked as mediocre statisticians. Herein lies Roff's contribution to science and not, as the title of his article seems to suggest, in the falsification of the macromutation theory.

The reason for starting the work on animal body size was my very deep conviction, which I happen to share with a number of outstanding biologist and others who have voiced their opinion during the last one hundred years, namely, that evolution is unexplainable without recourse to macromutation. And therefore, had our statistical council told us that the collected data were insignificant, I would surely have asked my collaborators to look for other data.

As it is, we have in fact been looking for further corroboration of our theory. We have collected a comprehensive material, but as before we are still missing competent assistance in cluster analysis. I shall therefore on this occasion present only one set of data, distinguished by the fact that Nature herself has performed the clustering.

This material has been published by Stahl and Gummerson (1967) and concerns the body weight of members of five species of monkeys. In Figure 1 it is shown how neatly and distinctly the species are clustered. In Table 1 it is seen that the ratios of the body weights of the five species are close to 1 : 2 : 8 : 32 : 64. The only serious deviation from prediction concerns the smallest species, *Tamarinus nigricollis*. One reason for this may be that this was the most heterogenous sample, representing a mixture of the two sexes while in the other species only one sex is represented.

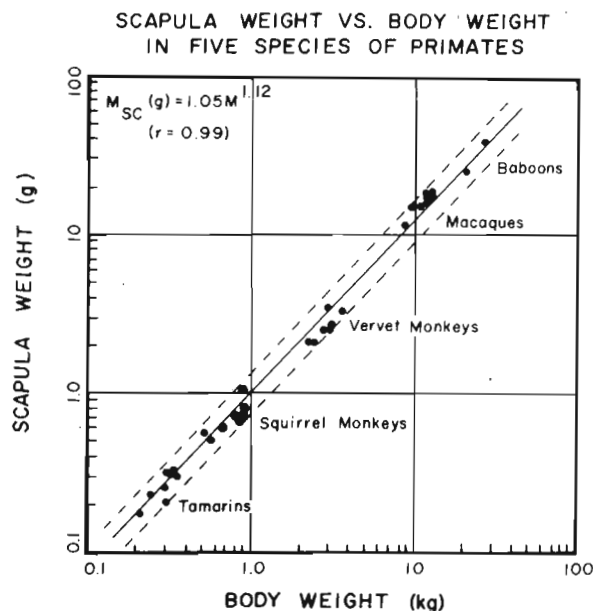


Table 1

Body weight in five primate species

	n	Observed mean body weight M (kg)	Assumed relative body weight	Expected body weight (kg)	Expected/ observed
<u>Tamarinus</u> <u>nigricollis</u>	8	0.27	1	0.34	1.25
<u>Saimiri</u> <u>sciurea</u>	9	0.71	2	0.68	0.96
<u>Cercopithecus</u> <u>aethiops</u>	8	2.83	8	2.72	0.96
<u>Macaca</u> <u>mulatta</u>	8	10.6	32	10.88	1.03
<u>Papio</u> <u>cynocephalum</u>	2	22.0	64	21.76	0.99

The unit body weight \bar{m} (0.34) kg was calculated from $n_1 \cdot 1 \cdot m + n_2 + 2 \cdot m + n_3 \cdot 8 \cdot m + n_4 \cdot 32 \cdot m + n_5 \cdot 64 \cdot m = n_1 \cdot M_1 + n_2 \cdot M_2 + n_3 \cdot M_3 + n_4 \cdot M_4 + n_5 \cdot M_5$. Based on data published by Stahl and Gummerson (1967).

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I do not expect this set of data to convince sworn micromutation-ists. But I hope they will convince Derek Roff and others that the issue at stake is not settled by a few calculations, but by painstaking search for empirical data like those presented here. And since the problem about the mechanism of evolution (macromutation-micromutation) is one of the most decisive questions facing biologists today, it would be gratifying if the specialists would assist in this work.

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