PUBLICATION-RATE AND SIZE OF TWO PROLIFIC RESEARCH GROUPS IN DEPARTMENTS OF INORGANIC CHEMISTRY AT DACCA UNIVERSITY (1944-1965) AND ZOOLOGY AT KARACHI UNIVERSITY (1966-84)*

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There has been considerable interest in studying how the research output of a group of N researchers depends on the group-size, N. Several workers have studied this, but with conflicting conclusions, ranging from finding constant per-capita output to per-capita output varying linearly as N, and even exponentially with N. The present communication states afresh the author's earlier theory of productive interactions and gives analyses of the outputs of two prolific research groups: one from Dhaka University, Bangladesh, and one from Karachi University, Pakistan, each over nearly two decades. The data, obtained from published bibliographies, are sub-divided into small successive ranges of lab. group size, 1-2, 3-4, 5-6, etc., and analyzed by calculating the relevant publication-rate per person (R) for each range. Plots of the data from each group show evidence of an initial approx. linear rise of per-capita publication rate, R, up to about N=5, followed by a maximum at group-size of 6 to 8 persons. This group size would correspond to the optimum efficiency, as a balance between the benefits of increasing interaction (α.N^2) and Parkinsonian loss of efficiency. This is in agreement with the first peak in the author's earlier analysis (of recent U.K. and U.S.A. data) published five years ago in *Scientometrics*, as well as his previous work published elsewhere. Possible reasons for the failure of statistical criteria to show up this phenomenon of increasing per-capita output are indicated and further indepth studies on two University research groups are planned.

Introduction

In a series of papers1-3 published nearly twenty years ago to study the optimum size of research groups, it was noted that (i) the per-capita research output of two typical applied-research laboratories showed a marked peak at group-size of N=22 ± 2, with a (probable) second maximum at N ~ 80, and (ii) the size-distribution of the groups also had maximum probability at these sizes [c.f.Fig. 1a-c]. In a later study of university and other specialized research groups sizes,4 peaks were found at group sizes of N=5 ± 1 and 14 ± 3 persons, respectively (cf. Fig. 2). These small, apparently highly-productive groups seem to be typical of certain types of monofunctional research work and corresponded to high per-capita outputs, of the order

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* Dedicated to the memory of Michael J. Moravesik

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of 1 to 2 research papers/annum, often with 2 to 3 co-authors/paper,\textsuperscript{3,5} compare Fig. 1c and Fig. 2, reproduced from earlier papers dealing with two different sets of data from Institutes and Universities. The basic theory was as follows.

One can expect that, if there is no wasteful effort, the output of a group of \( N \) scientific research workers should be represented by \( \Phi(N) \), a monotonously increasing function of \( N \), which gives the integrated numerical affect of the \( N \) workers. To this might be multiplied an efficiency factor, corresponding to a state of "diminishing returns" elaborated by Parkinson\textsuperscript{6}. 

\begin{figure}
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\includegraphics[width=0.8\textwidth]{figure1.png}
\caption{Mean plots for distribution of density of scientific effort among institutes of various sizes for agriculture research in U.K. and Canada, showing the peak at \( N = 28 \) scientists per institute. Fig. 1b. Corresponding mean distribution for industrial scientific research showing a main peak at \( N = 69 \) and a subsidiary maximum at \( N = 28 \). The broken line shows the two component distributions. Fig. 1c. Annual research output of Karachi labs. of P.C.S.I.R. plotted against the number \( N \) of scientists, while the inset shows per-capita output or publication rate against \( N \), which clearly brings out the two maxima at \( N = 20 \) and \( N = 80 \), respectively.}
\end{figure}