Title
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Journal
QUARTERLY JOURNAL OF THE ROYAL ASTRONOMICAL SOCIETY, 34(3)

ISSN
0035-8738

Author
TRIMBLE, V

Publication Date
1993-09-01

Q. J. R. astr. Soc. (1993) **34**, 301–314

Patterns in Citations to Papers by British Astronomers

Virginia Trimble
Physics Department, University of California, Irvine CA 92717-4575, USA;
and Astronomy Department, University of Maryland, College Park MD 20742, USA

(Received 1993 February 11)

SUMMARY

Numbers for annual citation rates to papers by Royal Astronomical Society prize-winners, officers, and randomly-selected members are compiled and compared with corresponding data for American astronomers. The range is large (from 1 to 556 citations per year). Correlations exist with authors' ages, subdisciplines, and places of employment. The sizes and directions of these correlations are rather similar to the American ones: it pays to be a mature, prize-winning theorist, working on cosmology or high-energy astrophysics at a prestigious institution. The average citation rate for all astronomers and many subsets is somewhat smaller than the American one, in much the same ratio as, generically, papers in the *Monthly Notices of the Royal Astronomical Society* are less often cited than papers in the *Astrophysical Journal.*

A table presents citation rates as a function of career length, subdiscipline, and type of employment for the prize-winners, officers, and randomly selected members separately, and for most possible totals. Some demographic attributes of the sample are noted. For instance, stellar astronomers outnumber those studying any other single sort of object, and optical astronomers outnumber those associated with any other single wavelength range. In comparison with the American sample, there are many more people in the youngest group (1982–91) and many fewer in the next-youngest (1975–81).

The similarities of patterns in British citation rates to those in American ones suggest that meaningful comparisons can be made among departments and other groups. For individuals, the caveat remains that citations are associated only with senior or sole authors of multi-authored papers, and comparisons should be made cautiously.

1 INTRODUCTION

Patterns in Citations of Papers by American Astronomers (Trimble 1993) presented average citation rates as a function of chronological cohort, subdiscipline, institution of employment, and gender for prize-winners, officers, and random members selected from the 1992 membership directory of the American Astronomical Society. The referee of that paper (resident in the UK) suggested that a corresponding study of British astronomers might be of interest to the readers of this journal.

The purpose of the present paper is to present the corresponding British numbers and patterns and to compare them with the American ones. The data come from the 1992 membership directory of the Royal Astronomical Society and the *Science Citation Index* for 1990. The 1991 index is, of course, now available, but comparability struck me as more important than timeliness. Readers are welcome to make use of these numbers for their own amusement or to answer questions about whether the work of particular people or institutions is 'recognized as influential'. Quantitative comparisons of this sort are not universally welcomed in the US. The situation in the British Isles is unlikely to be different.

2 SAMPLE SELECTION AND DATABASE

2.1 *The study population: Who is a 'British astronomer'?*

The three groups of astronomers studied are meant to be as similar to the American sample as can be managed, apart from the geographical difference. This presented several difficulties. First, the community is smaller, and statistical errors will be unavoidably larger. In addition, the RAS membership includes (1) a large number of geoscientists, (2) a much larger fraction of overseas members than the AAS, many of whom have lived and worked all their lives somewhere else other than England, Scotland, Ireland or Wales, some of whom are on temporary overseas assignments (e.g. at the UKIRT or ST-ECF), and some of whom have lived abroad (most often in the US) for many years, but still think of themselves as British, and (3) a much larger fraction of people who are interested in astronomy but are not professionally engaged in doing or teaching it. I was unable to think of a simple way of dealing simultaneously with all these for all three groups. It seemed most important to avoid the prejudice in favour of highly-cited astronomers that would come from emphasizing my own knowledge of the people involved. The next three paragraphs define the samples.

The Prize-winners (P in Table I and Fig. 2) are all living or recently deceased medallists and lecturers (pp. 105–108 of the RAS directory) who (a) are astronomers rather than geoscientists as defined by their institutional affiliations and most-cited papers and (b) are either currently resident in the UK or who began their careers there (as evidenced by early publication in UK journals and from UK addresses) and have maintained strong connections with the home country in the form of continued RAS membership, publication in UK journals and/or with UK collaborators, UK passports, frequent returns to UK institutions, and so forth. There are 35 such prize-winners.

The Officers (O in Table I and Fig. 2) are all officers and members of standing committees listed on pp. ii–iii of the directory (slightly augmented from the September and December RAS newsletters). There are 34 officers, including 4 overlaps with the prize-winners.

The Randomly-selected members (R in Table I and Fig. 2) come from pp. 1–3, 9–11, 17–19, etc. (i.e. three on and five off). The goal was an alphabetically uniform distribution that would have roughly the same ratio P:O:R as the American sample. Four categories of members were eliminated immediately (1) junior members, (2) those with addresses at distinctly geological or geophysical institutions, (3) those who listed neither a professional address nor a professional title (Prof., Dr, FRS, MBE, etc.), and (4) 'obvious' foreigners (e.g. Spanish name plus Spanish address, known fellow Americans).

Publication and citation records were examined for the resulting nearly 400 people. Those with publications exclusively or nearly exclusively in the geosciences and/or in non-UK journals were eliminated at this stage, leaving an R sample of 291.

Examination of the 1990 *Science Citation Index* then yielded the numbers of citations (excluding self-citations) to papers of which each sample astronomer was the sole or senior author. The range is 0–556 citations in the year (vs. 0–908 for the Americans). At this point, we lost two prize-winners and six officers because their work was not cited at all. From the random sample, we lost 13 whose records could not be disentangled from those of other scientists with similar names and interests, and 86 people whose work was not cited, although 18 list a professional address in the directory, 43 have titles of Dr, Prof., etc., and 25 have both. Undoubtedly some of these people are uncited geoscientists and others are amateur astronomers who happen also to be MDs (etc.). Others are surely analogous to the Associate members of AAS – people who began or completed astronomy PhDs, but whose later work has gone in other directions. I do not see any reliable way to distinguish these possibilities, and comparisons of fraction of uncited astronomers between the UK and US samples are not, therefore, meaningful.

We are left with 33 Ps and 28 Os (still with four overlaps) and 188 cited Rs (16 overlaps with P or O or both), or a total of 229 distinct people. These constitute the sample discussed in the following sections.

2.2 *The subsamples*

The 229 cited astronomers were assigned to subsamples by institution of employment, chronological cohort, and subdiscipline. Because the RAS directory does not list first names, gender determination was not, in general, possible. The P sample includes one (and I am quite sure only one) woman, or 3 per cent, and the O sample at least four, or at least 12 per cent. Among R members at the postdoctoral level, about 10 per cent are women (Wilkinson 1990), and the fraction is undoubtedly smaller in the older cohorts.

The institution is that listed in the RAS directory, supplemented by information from IAU directories (for more senior astronomers) and recent papers (for some junior ones). Retired members are associated with the institutions from which they retired. For one officer and 24 random members, no institutional affiliation could be established.

The employment classification scheme is that of Trimble (1993). The categories are U (universities that grant PhDs in astronomy and/or physics), O/I/L (observatories, research institutes, and laboratories), C/M (colleges and mission-oriented organizations) and H (home address only). Cs include the former polytechnic universities and other teaching-oriented places, and Ms include industrial organizations, the BBC, and *Nature*. Several universities have closely-associated laboratories and institutes (and so present the same classification difficulties as the organizations that share 60 Garden Street, Cambridge, MA). An astronomer whose address line says 'Department of Psychoceramics' was classified as university; one whose address line says 'Institute of Astrology, Camford' was included in O/I/L. This cannot be a very clean distinction, though the difference in average citation rates between the two categories indicates that there is something to it. The H sample was eventually merged with C/M, partly because both are small and partly because they both seem to consist primarily of people who now spend most of their time on something other than astronomical research and graduate teaching.

No subsample of 'prestigious' institutions was defined, owing both to small numbers and to my cowardice. But, yes, Oxbridge people are cited more often than most others, and all of the 15 or so most-cited astronomers are at places even ignorant Americans have heard of.

The chronological cohorts are defined by publication date of the earliest cited paper (even if it happened to be a self-citation, and typically the PhD dissertation) and are meant to reflect the time at which each individual became an active member of the astronomical community. The cohorts, as in the American study, are 1928–45, 1946–56, 1957–67, 1968–74, 1975–81, and 1982–91. The largest number of prize-winners fall in 1946–56 (vs. 1957–67 for Americans), officers in 1968–74 (same as for Americans), and random members in 1982–91 (vs. 1975–81 for Americans). The oldest cohort is very poorly represented, with only 7 cited members (5 P, 2 R). There are no prize-winners in the youngest group and only two in the next-youngest (very different from the American sample, because the RAS currently does not offer any distinctions analogous to the Pierce and Warner prizes for astronomers under 35). There are no officers in either of the two oldest cohorts.

Subdiscipline assignments were also done, as nearly as possible, in the same way as for the American sample. The categories were

Theory	Sun	Optical
Observation	Solar System	Radio
Instrument development, experiments, laboratory data, etc.	Stars	X- and gamma-rays
	Milky Way and ISM	Infrared & ultraviolet
	Dynamics	
	Galaxies, extragalactic	
	High-energy astrophysics	
	Cosmology	

Each individual was placed in every subclass where he belonged, on the basis of most-frequently cited papers and my own knowledge. The abstract compilations by Burkhard *et al.* (1991) were enormously helpful in this process, further details of which are described in Trimble (1993).

In the process of subdiscipline assignment, it became clear that RAS members do somewhat different things from AAS members, probably including a wider range of activities. 'Dynamics', which in the AAS sample had meant dynamics of clusters of point masses, had to be expanded to include a number of fluid dynamicists. A handful of people whose disciplines might best be described as atomic, molecular, or chemical physics ended up in 'theory' or 'experiment' as appropriate, plus 'stars', 'ISM', or 'galaxies', depending on what sorts of papers cited theirs.

Once the subsamples had been established using the above criteria, mean citation rates were calculated for the P, O, and R classes and totals thereof. Section 3 presents and discusses the results.

2.3 *Normalization procedure*

In the American sample, the single most obvious correlation was a nearly-linear increase in citation rate with cohort age. Data were therefore presented both raw and as normalized for the age distribution of the people in each subsample (universities, women, Solar System, etc.). The UK pattern is not monotonic, but the three oldest cohorts are, at any rate, cited a good deal more often than the three youngest ones (Table I and Fig. 1).

Normalization for age distribution in the subsamples therefore still seems appropriate (it is the one category we cannot change for ourselves!). It was done in the same way, by calculating what the citation rate would be for the entire sample of 229 astronomers if it had the age-mix of a given subsample. Then the ratio of the actual citation rate to the 'predicted' one is a measure of whether that particular subsample is doing better or worse than average. Such ratios were calculated for the total of each subsample and for the whole P, O, and R classes. Ratios greater than one indicate above-average citation rates.

2.4 *Sources of error*

About 12 per cent of all astronomical citations are wrong (Abt 1992). Most of the errors (volume and page numbers, year of publication) are unimportant for our purposes. The one kind of error that matters, a completely wrong name for the first author, afflicts less than 1% of the literature, and so also does not matter here. John Bahcall (personal communication, 1992) has, however, reminded the author of the well-known Bethe–Salpeter formula (for which the correct reference is a paper by Salpeter and Bethe).

Because there are fewer UK astronomers than American ones (229 vs. 614), random statistical errors are inevitably larger. The table shows the numbers of astronomers in each subsample, and entries with fewer than 10 people are clearly suspect. Tossing the two or three most or least cited people out of various subsamples shows, however, that a good many of the differences (e.g. theorists vs. observers, universities vs. other institutions, radio vs. optical wavelengths, prize-winners vs. the others) are quite robust. The random sample could be slightly more than doubled to about 400 (eliminating overlaps) by using all directory pages. The penalty would be complete domination of the total sample by Rs in comparison with Ps and Os.

A potential source of systematic error is the association of citations to multi-authored papers with the name of only the first-named ('senior') author. Alphabetization of authors should average out over subdisciplines and most institutions (though there was a time at the University of Maryland when the median astronomical surname was Smith). The situation is different for individuals. Only the most highly cited are mentioned by name in Section 3, and alpha-centrism is not obviously important for them. The middle of the alphabetical RAS membership list is roughly David Latham, and the median highly-cited astronomer is D.Lynden-Bell.

What could introduce systematic errors is differing customs among subdisciplines and institutions for the ordering of names of collaborating students and professors, postdoctoral students and advisors, etc. If professors generally come first, then older cohorts and the more traditional institutions where they work will be favoured. Putting students and postdoctoral fellows first will favour the younger cohorts and the kinds of institutions where they work. There is no internal evidence for this sort of problem (nor was there in the American sample) in the form of statistically robust high or low rates for the youngest or oldest cohorts in one subsample compared to another. But I also cannot prove that it does not occur. Again, individual citation rates can be strongly affected for people who are very generous (or the opposite) about putting their colleagues' names first.

If you wish to compare yourself (or someone else) with the averages, one strategy might be to count up all the citations to all your papers, but divide each number by the number of authors on each paper before summing. But since some authors do more than $1/n$ of the work (I have never heard anyone claim to have done less), this is not entirely fair either.

3 RESULTS AND DISCUSSION

3.1 *Basic data*

Table I shows the mean citation rates for all of the assorted subsamples, separated into prize-winners, officers, and randomly-selected members and into chronological cohorts, plus most of the possible summations. The last few lines of each column are means for the entire subsample, the age-adjusted expected citation rate for that subsample, and the ratio of the actual rate to the expected one. Subsamples with ratios, r, greater than one are doing better than average. Individuals who happen to be both prize-winners and officers, or one of these and also in the random group, appear in each data set where they belong, but only once in each relevant total.

Average rates for the major categories are all rather smaller than the American values: P = 103·3 vs. 114·9, O = 28·4 vs. 63·4, R = 21·2 vs. 27·5, and T = 30·5 vs. 48·7. The difference is insignificant for the prize-winners, large and real for the officers, and small but real for the random members. Some, but not all, of the difference for the total sample is the larger fraction of R (vs. P) members in the British data. The 'American' mix of British P+O+R numbers would yield a total rate of about 40·3, smaller than the American average, but not by much. The difference is of much the same magnitude as the differences in average citation rate per year per paper for papers published in the *Monthly Notices of the Royal Astronomical Society* vs. papers published in a combination of the *Astrophysical Journal* and the *Astronomical Journal*. My impression is that most UK astronomers believe the journal differences are a result of Americans reading and citing only their own papers (or maybe only *Astrophysical Journal* papers), while the British are less parochial. It is not quite this simple (see Appendix).

Many of the patterns in average rates have the same sign in the UK as in the US sample, but the UK amplitude is often larger. Prize-winners are well above average (r = 2·14 UK vs. 1·60 US). Universities outscore observatories and research laboratories, which, in turn, outscore the C+M+H group (UK r = 1·42, 0·87, 0·25; US r = 1·28, 0·80, 0·36). Theorists beat observers who beat instrumentalists (UK r = 1·57, 0·83, 0·42; US r 1·30, 0·90, 0·71). People who collect and think about optical data do better than those who collect and think about radio data (UK r = 0·84, 0·53; US r = 0·91, 0·69). In

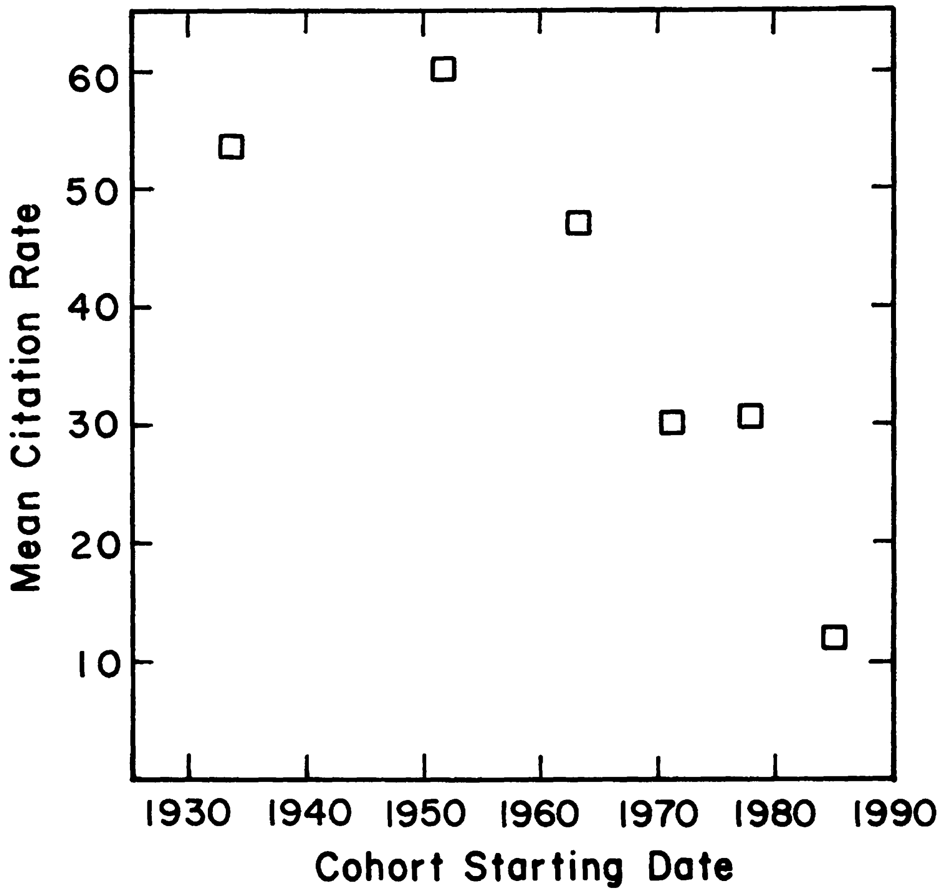

FIG. 1. Mean number of citations to members of each chronological cohort as a function of the year the average member of that cohort entered the community. The corresponding American data show the same near-equality of cohorts 4 and 5, but the approximately linear rise with cohort age continues back to the oldest cohort, which shows much the highest average citation rate.

the American sample, UV and IR astronomers do rather better than X- and gamma-ray astronomers. This pattern is reversed in the UK sample (but the numbers of people involved are relatively small).

Solar System and solar astronomers have lower than average citation rates (UK $r = 0{\cdot}64, 0{\cdot}85$; US $r = 0{\cdot}94, 0{\cdot}84$). Workers in extra-galactic astronomy, high-energy astrophysics, and cosmology are all above average (UK $r = 1{\cdot}67, 1{\cdot}47, 2{\cdot}34$; US $r = 1{\cdot}60, 1{\cdot}56, 1{\cdot}96$). Stellar astronomers are inevitably close to average, since there are so many of them ($r = 0{\cdot}92$, UK, and $1{\cdot}04$, US). UK dynamicists seem to do less well than American ones ($r = 0{\cdot}80, 1{\cdot}04$). but both groups are small, and they are dominated by different kinds of dynamics.

Citation rate vs. chronological cohort is somewhat different in the two samples. Fig. 1 shows the British data and looks a bit like a supernova light curve. The corresponding American rates (Trimble 1993) continue to rise for the oldest cohort, just about linearly with cohort scientific age. The near equality of cohorts 4 and 5 (1968–74, 1975–81) is present in both samples. The former is 'my' cohort, and I am just a bit worried that we are, somehow, not doing our job.

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TABLE I

Mean 1990 citation rates of British astronomers, classified by chronological cohort, employer, and scientific subdiscipline (number of astronomers per subsample in parentheses)

Cohort	Class	University		O/I/L		C+M+H		Total		Theory		Obs.		Inst/Exp		Sun		Solar Syst	
1928–45	P	73·0	(5)	—	—	—	—	73·0	(5)	73·0	(5)	—	—	—	—	37·0	(1)	99·7	(3)
	O	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	16·5	(2)	5·0	(1)	—	—	12·5	(3)	29·0	(1)	4·5	(2)	4·0	(1)	—	—	—	—
	T	61·5	(6)	5·0	(1)	—	—	53·4	(7)	73·0	(5)	4·5	(2)	4·0	(1)	37·0	(1)	99·7	(3)
1946–56	P	112·9	(7)	22·7	(4)	—	—	80·1	(11)	187·5	(4)	75·2	(5)	17·4	(5)	—	—	65·0	(1)
	O	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	R	54·9	(8)	25·5	(4)	2·0	(1)	41·8	(13)	60·0	(7)	28·0	(3)	18·8	(5)	—	—	—	—
	T	80·9	(13)	21·4	(7)	2·0	(1)	60·1	(21)	100·4	(10)	59·6	(7)	12·1	(8)	—	—	65·0	(1)
1957–67	P	240·4	(5)	84·1	(3)	16·0	(1)	163·4	(9)	229·0	(5)	81·5	(4)	64·0	(1)	—	—	29·0	(1)
	O	83·3	(3)	11·2	(4)	—	—	42·1	(7)	93·3	(3)	4·3	(3)	2·0	(1)	31·1	(1)	10·1	(1)
	R	36·3	(14)	31·5	(11)	4·5	(4)	30·2	(29)	35·5	(15)	30·2	(11)	14·8	(6)	25·0	(2)	14·6	(5)
	T	85·0	(18)	33·8	(16)	7·6	(5)	47·3	(39)	84·4	(20)	26·6	(15)	19·4	(8)	25·0	(2)	13·8	(6)
1968–74	P	114·7	(3)	153·0	(1)	2·0	(2)	83·5	(6)	278·0	(1)	55·0	(4)	49·0	(1)	17·0	(1)	3·0	(1)
	O	33·5	(6)	40·5	(4)	1·0	(1)	33·1	(11)	46·2	(5)	20·3	(6)	49·0	(1)	61·0	(1)	61·0	(1)
	R	26·0	(17)	22·0	(15)	5·1	(8)	20·4	(40)	21·7	(17)	22·5	(19)	28·3	(6)	14·6	(7)	17·8	(4)
	T	38·5	(22)	30·3	(19)	4·5	(10)	30·0	(51)	39·2	(21)	24·0	(25)	31·3	(7)	14·6	(7)	22·5	(6)
1975–81	P	191·0	(1)	1·0	(1)	—	—	96·0	(2)	191·0	(1)	1·0	(1)	1·0	(1)	—	—	—	—
	O	1·0	(1)	15·0	(2)	26·7	(3)	15·9	(6)	32·0	(2)	13·7	(4)	1·0	(1)	—	—	53·0	(1)
	R	28·6	(14)	37·9	(12)	3·1	(7)	25·1	(33)	49·8	(10)	24·6	(19)	10·4	(5)	40·0	(2)	19·5	(2)
	T	39·5	(15)	36·7	(13)	10·2	(10)	30·8	(38)	57·5	(13)	22·4	(21)	8·8	(6)	40·0	(2)	30·7	(3)
1982–91	P	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	O	7·7	(3)	3·0	(1)	—	—	6·5	(4)	13·0	(1)	3·0	(2)	3·0	(1)	3·0	(1)	—	—
	R	16·1	(23)	13·2	(27)	4·9	(21)	11·9	(71)	11·3	(20)	14·2	(44)	7·3	(11)	7·8	(4)	—	—
	T	15·5	(26)	13·2	(27)	4·9	(21)	11·7	(74)	11·3	(21)	14·0	(45)	7·3	(11)	7·8	(4)	—	—
Total	P	137·7	(21)	55·3	(9)	6·7	(3)	103·3	(33)	170·6	(16)	65·9	(14)	25·1	(8)	27·0	(2)	66·0	(6)
	O	36·5	(13)	21·8	(11)	20·2	(4)	28·1	(28)	54·4	(11)	12·6	(15)	13·8	(4)	31·7	(3)	41·3	(3)
	R	28·3	(78)	22·8	(70)	4·8	(40)	21·2	(188)	29·6	(70)	19·9	(98)	14·4	(34)	11·7	(15)	16·6	(11)
	T	47·9	(100)	26·2	(83)	6·3	(46)	30·5	(229)	54·0	(90)	22·8	(115)	14·8	(41)	18·8	(16)	35·5	(19)
Expected	T	33·8		30·1		24·5		30·5		34·3		27·5		35·0		29·1		41·8	
Ratio	T	1·42		0·86		0·26		1·00		1·57		0·83		0·42		0·64		0·85	

Cohort	Class	Stars	MW/ISM	Dynam.	Extragal.	HEAP	Cosmology	Optical	Radio	X & Gamma	UV+IR
1928–45	P	60·5 (2)	— —	25·3 (3)	— —	— —	43·7 (3)	— —	— —	— —	— —
	O	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —
	R	12·7 (3)	— —	29·0 (1)	— —	— —	29·0 (1)	5·0 (1)	— —	— —	— —
	T	32·5 (4)	— —	25·3 (3)	— —	— —	43·7 (3)	5·0 (1)	— —	— —	— —
1946–56	P	102·0 (3)	221·5 (2)	10·5 (2)	— —	38·0 (2)	113·3 (3)	13·0 (3)	24·7 (4)	— —	— —
	O	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —
	R	56·0 (3)	86·0 (5)	27·0 (1)	— —	59·5 (2)	37·3 (3)	11·5 (2)	30·0 (3)	— —	— —
	T	79·0 (6)	117·8 (6)	16·0 (3)	— —	50·7 (3)	75·3 (6)	12·8 (4)	24·3 (6)	— —	— —
1957–67	P	86·0 (5)	— —	138·0 (2)	132·5 (2)	205·7 (3)	289·7 (3)	91·5 (4)	— —	— —	— —
	O	2·0 (1)	— —	31·1 (1)	— —	105·0 (2)	125·5 (2)	4·3 (3)	2·0 (1)	— —	10·0 (1)
	R	51·9 (9)	36·0 (6)	27·8 (5)	73·8 (5)	55·8 (5)	51·7 (3)	38·6 (8)	28·0 (2)	4·0 (1)	— —
	T	48·8 (13)	36·0 (6)	64·3 (6)	73·8 (5)	105·0 (7)	160·0 (6)	35·7 (12)	19·3 (3)	4·0 (1)	10·0 (1)
1968–74	P	17·0 (1)	— —	— —	278·0 (1)	99·6 (5)	278·0 (1)	17·0 (1)	77·0 (2)	25·0 (2)	— —
	O	10·5 (2)	18·0 (2)	61·0 (1)	16·5 (2)	37·0 (5)	4·0 (1)	16·0 (3)	13·0 (2)	53·7 (4)	25·0 (1)
	R	17·3 (13)	6·0 (3)	15·8 (5)	24·8 (8)	19·2 (10)	40·3 (3)	29·6 (8)	14·1 (7)	31·2 (6)	— —
	T	17·1 (14)	10·8 (5)	23·3 (6)	50·3 (10)	47·5 (17)	99·8 (4)	28·4 (10)	30·9 (9)	31·6 (11)	25·0 (1)
1975–81	P	— —	1·0 (1)	— —	— —	— —	191·0 (1)	— —	1·0 (1)	— —	— —
	O	24·0 (1)	1·0 (1)	53·0 (1)	13·0 (1)	7·0 (2)	19·0 (1)	21·5 (2)	7·7 (3)	— —	— —
	R	36·0 (7)	15·9 (7)	3·0 (2)	40·5 (5)	27·9 (10)	92·0 (3)	21·3 (7)	11·2 (6)	46·9 (7)	15·5 (6)
	T	24·5 (8)	12·4 (7)	19·7 (3)	40·5 (5)	24·7 (12)	116·8 (4)	21·6 (8)	6·6 (7)	46·9 (7)	15·5 (6)
1982–91	P	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —
	O	3·0 (1)	— —	— —	— —	— —	— —	13·0 (1)	— —	3·0 (1)	3·0 (1)
	R	11·1 (20)	6·1 (12)	11·2 (6)	25·6 (13)	21·5 (12)	22·5 (10)	20·7 (22)	6·3 (12)	15·8 (8)	7·1 (9)
	T	11·1 (20)	6·1 (12)	11·2 (6)	25·6 (13)	21·5 (12)	22·2 (10)	20·4 (23)	6·3 (12)	14·3 (9)	6·5 (10)
Total	P	79·4 (11)	148·0 (3)	53·3 (7)	181·0 (3)	119·1 (10)	164·6 (11)	52·7 (8)	36·3 (7)	25·0 (2)	— —
	O	10·0 (5)	12·3 (3)	48·3 (3)	15·3 (3)	45·4 (9)	68·0 (4)	13·0 (9)	8·5 (6)	43·6 (5)	12·7 (3)
	R	24·0 (55)	25·7 (33)	17·4 (20)	35·5 (31)	27·3 (39)	39·8 (23)	24·6 (48)	12·9 (30)	26·9 (24)	10·5 (15)
	T	29·6 (65)	31·4 (36)	28·6 (27)	42·6 (33)	44·1 (51)	82·7 (33)	24·3 (58)	16·3 (37)	28·6 (28)	10·7 (18)
Expected	T	32·1	23·0	35·8	25·5	30·0	35·3	28·9	30·5	24·9	21·1
Ratio	T	0·92	1·36	0·80	1·67	1·47	2·34	0·84	0·53	1·15	0·51

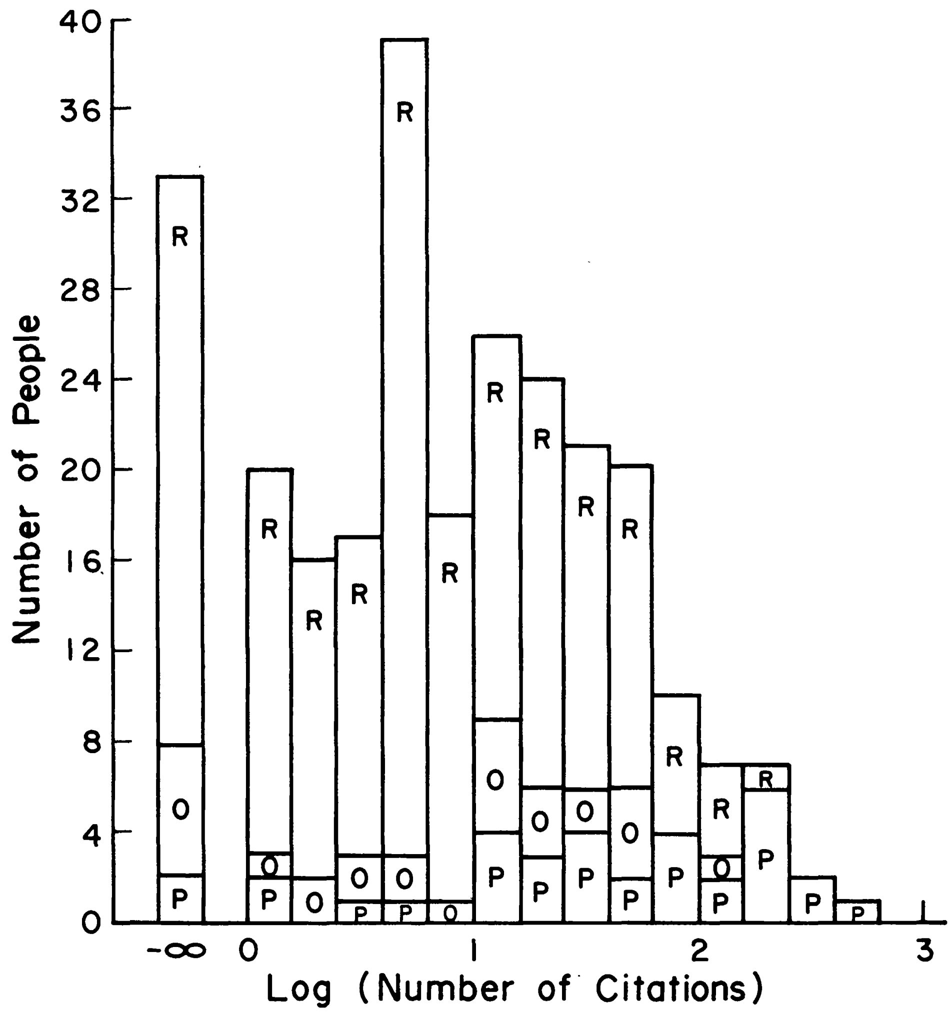

FIG. 2. Histogram of numbers of P, O, and R astronomers as a function of number of citations to their work in 1990. The bins are logarithmic. Astronomers shown as having no citations are the P and O sample members for whom this is the case and the subset of R members whose directory listings include both an address at an astronomical (vs. geosciences) institution and a title like Dr or Prof. This is a lower limit to the real number of uncited R astronomers in the sample. People who appear in more than one sample are shown only once in the histogram.

The ten most cited RAS astronomers and numbers of citations in 1990 are: Stephen Hawking (556), Roger Blandford (278), Michael Seaton (277), Donald Lynden-Bell (247), Roger Penrose (242), Martin Rees (209), Sidney Chapman (197), Simon White (196), John Barrow (191) and Alexander Dalgarno (166). Only Hawking would better any of the US top ten. All but White are from the prize-winner sample. Others with more than 100 citations include Wallace Sargent, Bernard Pagel, P.G.Burke, Andrew Fabian, Ian Axford, Michael Rowan-Robinson and Nicholas White. Some readers may feel that several of these people do not belong in a properly-defined sample of *British* astronomers. If that is your view, drop the ineligibles from the sequence and advance the people you feel do belong. This will, of course, also somewhat reduce the averages for their cohorts and subdisciplines.

Figure 2 is a histogram of numbers of people with various citation rates in the P, O and R groups. The horizontal scale is logarithmic, in accordance with an old theorem (attributed to Lev Landau) that scientists should be judged on a logarithmic scale. People in more than one group appear only once in the histogram (as P if P and O; as P or O if also in R). The shape is a bit more gaussian than the corresponding American histogram, which has a large peak at 1–2 citations per year and a second maximum near 45.

3.2 *Demographics and other sidelights*

In addition to the average citation rates described in Section 3.1, the data reveal an assortment of statistical items about the survey populations.

(1) The prize-winner and officer groups are about the same size (UK, P = 35, O = 36; US, P = 143, O = 132). They are not drawn at random from the entire group of astronomers in the countries. In the UK case, four overlaps between samples of 35 and 36 imply a parent population of 315, compared to about 800 people employed in the UK in astronomical jobs at or above the postdoctoral level (Wilkinson 1990).

(2) The prize-winner, officer and random samples differ noticeably in their distributions by chronological cohort (Ps are oldest; Rs youngest) and by institutional affiliation. For instance, the college, mission-oriented, and home group includes 9% of the cited Ps, 14% of the cited Os, and 21% of the cited Rs. Differences among subdisciplines in the three groups are generally not statistically significant because of the small sample sizes, though a disproportionate fraction of prize-winners are theorists in general and cosmologists in particular.

(3) The subdiscipline distributions of the total sample are rather similar to the American ones. Observers outnumber theorists by 30% (60% in the US, presumably owing to clearer skies). Instrument builders, laboratory experimenters, etc. are a fairly small group (18%), but not so small as in the US (11%). They are also somewhat better represented among prize-winners in the UK than in the US. Optical astronomers are the single largest wavelength group, though they do not outnumber the sum of all the other bands as in the American data. And stellar astronomers are the largest subject-oriented group, making up 28% of the UK sample and 25% of the American one.

(4) Relative to the total memberships of the societies, women are under-represented among prize-winners (1 of 35 or 3% in UK; 13% in US) and slightly over-represented among officers (at least 4 of 36 or 12% in UK; 21% in US). Nothing useful can be said about representation in the random group or about cited vs. uncited women.

(5) Members of the older cohorts are more likely to hold, or to have retired from, university jobs than are members of the younger cohorts (70% of cohorts 1 and 2 vs. 37% of cohort 6), and less likely to fall in the C+M+H group (4% of cohorts 1 and 2, vs. 30% of cohort 6). Since young astronomers are more likely to move out of the community than old ones to move back in, and people with postdoctoral positions at prestigious institutions often end up with permanent positions at less prestigious places, these differences can only grow with time.

(6) The distribution among cohorts is rather different from the American

one. Within the two randomly-chosen samples, the US ratio of cohort 5 to 6 is 1·06. The UK ratio is 0·46. There are other differences, but I find this the most striking. The production rates of PhDs in the two countries have been fairly steady for some time at about 85 per year in the UK (Wilkinson 1990) and 125 per year in the US (Boyce *et al.* 1991). The difference seems, therefore, to imply a larger 'drop out rate' (from the subject, the country, or the Society) among UK astronomers than among American ones.

(7) British astronomers as defined here have citation rates that fall between the European ones studied by Jaschek (1992) and the American ones reported by Trimble (1993). Jaschek examined 1988 citations to papers by the 1072 IAU members resident in France, GFR, Spain, Sweden, and Switzerland. About one-quarter were not cited at all, and the mean rate for the others was 15·9. The 117 randomly-selected RAS members who also belong to the IAU have a mean 1990 rate of 23·6. The corresponding US number (for 282 random astronomers old enough to be IAU members) is 32·5. The process of identifying British IAU members revealed several demographic oddities, most notably that a large fraction of highly-cited X-ray observers are not IAU members.

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APPENDIX

Patterns in citations by and to astronomical journals

Papers published in some journals get more citations than papers published in others. Part of the reason is that there are more papers published in, for instance, *MNRAS* than in *QJRAS* (for journal abbreviations used throughout the Appendix see page 314). However, there are also differences in the numbers of citations *per paper* to papers published in different journals. A quantitative measure of this, called the impact factor, is a suitably-averaged number of citations per paper per year to a given journal (Garfield 1988). It is very high for *Nature* (about 15) and probably very low for the *Corn Huskers' Monthly*. Among standard astronomical journals, impact factors are: *ApJ* = 3·54, *MNRAS* = 2·50, *AJ* = 2·00, *A&A* = 1·96, *PASP* = 1·4, *PASJ* = 1·3, *AZh* (plus its translation as *Soviet Astronomy*) = 0·28, and so forth. These are fairly stable from year to year.

Someone who publishes exclusively in *MNRAS* can, therefore, expect to find his citation rate to be only about 70 per cent of that of someone who publishes exclusively in *ApJ*, other things being equal; and *A&A* authors will do still less well. The differences among national averages noted in Section

TABLE AI

Patterns in citations by journals

		Citing journal			
		MNRAS	*ApJ*	*A&A*	*AJ*
	Total no....	13132	43439	25117	10914
Cited journal	*MNRAS*	18·5%	6·4%	6·9%	6·0%
	ApJ	30·2%	39·8%	26·3%	28·7%
	A&A	8·0%	6·5%	17·8%	6·9%
	AJ	3·7%	3·3%	4·3%	13·4%
	AZh	0·6%	0·5%	0·5%	0·5%
	PASJ	0·5%	0·5%	0·5%	0·3%

3.2, point 7 are about the same size as these differences among journal averages.

The cause is not quite so simple as the fact that there are an awful lot of American astronomers who cite only each other. In order to explain the actual pattern, it is convenient to treat the journals as active entities that can cite themselves or each other (meaning really that the authors of a paper in e.g. *MNRAS* have chosen to cite another paper that appeared in *MNRAS* vs. another journal). All journals over-cite themselves, compared to their average rate of citation by others.

Table AI presents data (from Garfield 1988) on self-citation vs. other-citation rates for several journals. For our purposes, *MNRAS*, *ApJ*, *A&A*, and *AJ* are the most relevant. Data on *AZh* (plus translation) and *PASJ* are included for comparison. The numbers given are the total number of citations *by* each journal in the 1988 compilation and the percent of that number that are citations *to* itself and to each of the other journals.

Let us define the amount of excess self-citation for a particular journal as the difference between its percentage of self-citations and the average of the percentage of citations it receives in the other three journals. For instance, for *MNRAS*, the self-citation fraction is 18·5%, while in the other three it receives 6·4, 6·9 and 6·0% of the citations. Thus, on average, *MNRAS* over-cites itself by 12·1%. The corresponding excess of self-citations is 10·7% for *A&A*, 9·6% for *AJ*, and 11·4% for *ApJ*. In other words, the average of the two American journals is indistinguishable from the average of *MNRAS* and *A&A*. All over-cite themselves by about 10%.

Notice that *PASJ* and *AZh* make up nearly the same fraction of citations in all four of the western journals. We are all equally parochial in this respect as well. Because *PASJ* and *AZh* publish relatively few papers per year, their rates of excess self-citation are somewhat poorly determined, but both seem to be a little larger than 10%.

In summary, while the sheer numbers of American astronomers and publications mean that they dominate many kinds of statistics, the British and European journals display essentially the same patterns, citing themselves more often than average, but *ApJ* most often of all.

Key to journal abbreviations

A&A	*Astronomy & Astrophysics*
AJ	*Astronomical Journal*
ApJ	*Astrophysical Journal*
AZh	*Astronomicheskii Zhurnal*
MNRAS	*Monthly Notices of the Royal Astronomical Society*
PASJ	*Publications of the Astronomical Society of Japan*
PASP	*Publications of the Astronomical Society of the Pacific*
QJRAS	*Quarterly Journal of the Royal Astronomical Society*

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