Yellowstone caldera, (ii) a major gravity low with steep bounding gradients and an amplitude regionally atypical for the elevation of the plateau, (iii) an aeromagnetic low reflecting extensive hydrothermal alteration and possibly indicating the presence of shallow material above its Curie temperature, (iv) only minor shallow seismicity within the caldera (in contrast to a high level of activity in some areas immediately outside), (v) attenuation and change of character of seismic waves crossing the caldera area, and (vi) a strong azimuthal pattern of teleseismic P-wave delays, strongly suggest that a body composed at least partly of magma underlies the region of the rhyolite plateau, including the Tertiary volcanics immediately to its northeast.

The Yellowstone field represents the active end of a system of similar volcanic foci that has migrated progressively northeastward for 15 million years along the trace of the eastern Snake River Plain (*8*). Regional aeromagnetic patterns suggest that this course was guided by the structure of the Precambrian basement. If, as suggested by several investigators (*24*), the Yellowstone magma body marks a contemporary deep mantle plume, this plume, in its motion relative to the North American plate, would appear to be "navigating" along a fundamental structure in the relatively shallow and brittle lithosphere overhead. The concept that a northeastward-propagating major crustal fracture controls the migration path of the major foci of volcanisim is at least equally favored by existing data, as Smith *et al.* (*19*) noted.

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Sex Differentials in the Academic Reward System

What changes have there been since the implementation of federal antibias regulations?

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In the last half decade several major laws and regulations concerning sex discrimination in college and university faculties have become effective (*1*). The first is Executive Order 11246, as amended by 11375, which prohibits discrimination in employment (including hiring, upgrading, salaries, fringe benefits, training, and other conditions of employment) on the basis of sex and certain other factors and requires an affirmative action plan (including numerical goals and timetables) of all federal contractors. A second is Title VII of the Civil Rights Act of 1964 as amended by the Equal Employment Opportunity Act of 1972, which likewise prohibits discrimination in academic employment. A third, the Equal Pay Act of 1963 as amended by the Education Amendments of 1972 (Higher Education Act), specifically prohibits discrimination in salaries and covers nonacademic as well as academic employees. Title IX of the Education Amendments of 1972 reaffirms the compliance regulations of the earlier orders, extends coverage to part-time employees, and requires that equal pensions for men and women employees shall be determined.

In this article we present estimates on a national scale of current sex differentials in academic employment and of the extent to which equity has been approached since antibias regulations have been in effect. Many studies of sex discrimination in aca-

demia have been on individual institutions (*2*) or single disciplines (*3*) and cannot be generalized to larger settings. Some have consisted merely of counts of chairmanships and professorships held by women or proportional distributions of the sexes at various salaries or in given positions. Because male and female academics differ in the variables that are traditional criteria for advancement in careers in higher education—attainment of higher degrees, field of specialization, research productivity, length of employment, and others—failure to take such factors into account limits the conclusions that may be drawn about sex discrimination per se from simple distributions or counts (*4*). In addition, the proportion of women faculty varies with type of institution and so does the reward system; women are more frequent on the faculties of 2-year institutions, private colleges, and other small institutions than they are on university faculties, and in general the smaller places pay smaller salaries.

Two studies of national scope and broad disciplinary representation, based on a large-scale survey of faculty members during the academic year 1968–69, have taken into account a number of these factors and have shown substantial independent residual effects of sex on the rewards received in academia (*5, 6*). The present study is a replication of one of these earlier studies (*5*) with data collected during 1972–73. This new analysis is specifically designed to ascertain the extent to which sex differentials in the academic reward system have persisted since 1968–69 or been reduced or eradicated.

Sample and Research Design

In the academic year 1972–73, the American Council on Education (ACE) undertook a general-purpose survey of more than 100,000 college and university faculty members in a nationally representative sample consisting of 301 institutions—80 universities, 179 4-year colleges, and 42 junior or community colleges. This survey closely paralleled the earlier 1968–69 survey of faculty in sample size, design, and content. In the 1972–73 survey 53,034 college and university faculty and staff members responded, of whom 42,345 were identified as currently active teaching faculty (that is, each was teaching at least one course that year at one of the 301 institutions). The descriptive normative findings and the survey procedures are reported in an ACE monograph (*7*) and are also presented elsewhere in summary form (*8*).

All respondents who held regular full-time appointments, with or without tenure, and who had indicated their sex, salary, and rank on the survey questionnaire comprised the sample from which a random subsample was to be drawn of approximately 5000 cases equally split between women and men. The final subsample consisted of 2544 women and 2454 men.

Three criterion variables were used in the studies:

1) Academic rank (continuous variable: professor = 4, associate professor = 3, assistant professor = 2, instructor or lecturer = 1).

2) Tenure status (dichotomous variable: tenured = 2, otherwise = 1).

3) Base institutional salary for the academic year before taxes and deductions (continuous variable: coded to the nearest $1000).

Four sets of predictor variables were used:

1) Demographic characteristics: sex, age, race, father's education, mother's education, citizenship, religious commitment, political orientation, marital status, and whether a parent.

2) Educational characteristics: highest degree held; field of specialization of highest degree; length of time since receipt of highest degree; receipt of a teaching assistantship, research assistantship, fellowship, or scholarship in graduate school; and rating of the graduate school on a dichotomous measure of quality (*9*).

3) Professional/work variables: teaching department; years of continuous service at present institution; amount of time spent in administrative duties, in teaching, and in research activities; extent of professed interest in research; whether there had been an interruption in the professional career of more than one year for military or family reasons; number of published articles; number of published books; involvement in any paid consulting outside the institution; and basis for the reported salary (included only in analyses where the criterion was salary: 11- to 12-month basis = 2, 9- to 10-month basis = 1).

4) Characteristics of the employing institution: type (2-year, 4-year, or university), control (public or private), racial composition (predominantly black or predominantly white), sex composition (coeducational or single-sex), and geographic (regional) location (*10*).

The analysis follows a stepwise multiple regression model (*11*) similar to that employed in the 1968–69 study (*5*). As in the earlier analyses, we first assessed the relationship of demographic factors (other than sex), educational background, professional/work activities, and institutional variables to the three primary measures of the academic reward system: rank, tenure, and salary. The extent to which sex per se explained the residual variance in the criterion was determined after all other statistically significant correlates of these three criterion measures were statistically controlled. Salary and tenure differentials were then examined within each academic rank.

In addition to the model for all faculty, a separate model was applied to each sex. Such a procedure accommodates the significant interactions between sex and several other variables and is parallel to methods recently employed in single-institution studies (*12*). While other interactions are suppressed for the present study (*11*), the separate analyses by sex allow the predictors that account for differences among men and among women to be ascertained. This procedure also provides suggestive information on the differences and similarities between the criteria used in rewarding women and those used for men. Furthermore, the regression equations obtained from the analyses for one sex are applied to the data for the other in order to demonstrate in concrete terms what adjustments would have been necessary in 1972–73 for equity within the existing reward structure. All results from the present analyses are compared throughout to those obtained in the 1968–69 study so that the degree of change in the status of women during the interval can be observed.

Academic Rank

In the 1972–73 survey 30 percent of male but only 11 percent of female faculty members were full professors; 24 percent of the women and 10 percent of the men were instructors. In part this difference reflects the fact that only 16 percent of the women but 34 percent of the men held a Ph.D. and that the degree has traditionally been an important criterion in achieving high academic rank. Differences in rank (and salary) have been explained to some extent on the basis of field of specialization, research performance, and other differences in background and work activities (*2, 5, 6, 12–14*). The present analysis examines sex differentials in rank, controlling for virtually all major demographic, educational, work experience, and institutional variables that might affect rank attainment.

For this analysis tenure, salary, salary base, and sex were deleted. All other predictor variables were allowed to enter the stepwise regression freely until no addi-

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Table 1. Predictors of academic rank, 1972–73. $R = .790$. All variables are listed in order of entry in a stepwise regression equation. Partial r of sex: female is −.130 ($F = 85.92$) after allowance for all the variables listed. $F > 6.64 = p < .01$; $F > 10.83 = p < .001$.

Variable	Zero order r	Final multiple regression equation	
		Beta (path coefficient)	F ratio
Number of articles published	+.559	+.231	363.47
Age	+.531	+.233	329.22
Highest degree: doctorate	+.443	+.222	151.22
Years of continuous service at institution	+.459	+.150	188.62
Time spent in administration	+.257	+.111	152.53
Years since highest degree	+.495	+.168	151.60
Field: biological science	+.071	−.060	42.01
Institution: 4-year college	−.032	+.083	83.52
Political orientation: conservative	+.008	+.037	16.48
Department: humanities	−.088	−.050	26.28
Number of books published	+.373	+.066	43.11
Highest degree: baccalaureate	−.144	−.078	54.21
Highest degree: master's	−.419	−.115	41.74
Department: fine arts	−.038	+.036	15.47
Field: engineering	+.096	+.037	17.14
Race: white	+.070	+.031	12.51
Department: business	+.003	+.024	7.01
Career interruption	+.085	−.027	8.73
Department: education	−.034	−.025	6.72

Table 2. Predictors of academic tenure, 1972–73. $R = .671$. All variables are listed in order of entry in a stepwise regression equation. Partial r of sex: female is +.014 ($F = 0.98$, not significant) after allowance for all the variables listed. $F > 6.64 = p < .01$; $F > 10.83 = p < .001$.

Variable	Zero order r	Final multiple regression equation	
		Beta (path coefficient)	F ratio
Academic rank	+.601	+.497	11,114.68
Age	+.485	+.154	126.37
Institution: 2-year college	+.038	+.100	73.33
Years of continuous service at institution	+.437	+.141	119.24
Institution: private control	−.101	−.083	49.04
Time spent in teaching	−.048	+.051	20.93
Institution: Great Lakes and Plains region	+.079	+.052	23.82
Children	+.064	+.063	23.69
Institution: university	+.011	−.052	16.45
Highest degree: master's	−.152	+.037	8.87
Institution: coeducational	+.054	+.034	7.90
Field: humanities	−.031	+.034	9.61
Political orientation: conservative	+.067	+.030	7.50
Status: married	+.034	−.034	6.96

Table 3. Predictors of academic salary, 1972–73. $R = .467$. Salary base is forced into regression first; all other variables are listed in order of entry in a stepwise equation. Partial r of sex: female is −.043 ($F = 9.20$) after allowance for all the variables listed. $F > 6.64 = p < .01$; $F > 10.83 = p < .001$.

Variable	Zero order r	Final multiple regression equation	
		Beta (path coefficient)	F ratio
Salary base	+.182	+.119	83.01
Academic rank	+.373	+.205	144.50
Number of articles published	+.339	+.154	94.33
Years since highest degree	+.289	+.104	50.50
Highest degree: professional	+.125	+.084	43.67
Time spent in administration	+.195	+.067	24.60
Institution: 2-year college	−.020	+.075	33.06
Mother's education	−.073	−.039	9.40
Political orientation: conservative	−.004	+.039	9.26
Time spent in teaching	−.176	−.041	8.60

tional variable could significantly ($p < .01$) predict the remaining differences in rank. Of the 60 potential predictors 19 entered the regression equation with a statistically significant weight, producing a multiple correlation coefficient (R) of .79, explaining 62 percent of the variance in rank. Precisely the same R was obtained in the 1968–69 analyses, and most of the primary predictors were the same then as for 1972–73.

The five most significant predictors of rank (Table 1) are productivity as measured by articles published, age, degree level, years of continuous service at the present institution, and time spent in administration. These were all among the primary predictors in 1968–69 also, and all are generally acknowledged to be important considerations in promotion decisions in academia. Several of the remaining variables among the 19 shown in Table 1 are less generally acknowledged but nevertheless are significant independent predictors of academic rank.

After all 19 variables had entered, the partial correlation between being a woman and holding a high rank was −.13 ($F = 85.92$). That is, even after we allow for a sizable number of other variables much of the differential in rank is still attributable to sex per se. A statistically definitive comparison of these results with those obtained in 1968–69 cannot be made, but the differences are possibly suggestive of some improvement in the status of women with respect to the attainment of rank; in the 1968–69 analyses the partial correlation between being a woman and holding a high rank was −.17 ($F = 197.02$). Estimates of the actual change in the relative rank position of women are given below.

Academic Tenure

Across all types of institutions and among all teaching faculty, 67 percent of men and 54 percent of women in 1972–73 reported that they were tenured. The second regression analysis dealt with the predictors of tenure and the influence of sex per se on achieving tenure.

Rank was the most significant predictor (Table 2). Independently of rank, attainment of tenure was largely determined by age, type of institution, and length of employment at the current institution. In total there were 14 significant predictor variables, with $R = .67$ (compared with .72 in 1968–69).

As was the case in 1968–69, the effect of sex on tenure, independent of all significant predictor variables, was not statistically significant.

Academic Salary

In 1972–73 the average salary of academic men exceeded that of academic women by more than $3000. Much of this differential is attributable to differences in rank, years of employment, field of specialization, research productivity, work setting, and related background and work activities. In the third multiple regression analysis, controls were introduced also for differences in salary base (whether 9 to 10 months or 11 to 12 months). Table 3 shows the results of the examination to determine whether or not sex had an independent effect on salary differentials.

The obtained R of .47 indicates that 22 percent of the variance in salary can be explained on the basis of other variables, of which the three most important were rank, productivity, and number of years in professional life. But even after control for rank, which carried the heaviest weight in the regression equation, and for the remaining nine statistically significant predictors of salary, the partial correlation (–.04) between sex (female) and salary was statistically significant ($F = 9.29$). It was lower, however, than in the 1968–69 survey, when the partial correlation between sex (female) and salary was –.16 ($F = 191.52$).

Inasmuch as this method of determining the extent to which salary differentials are attributable to sex per se is conservative, in that it allows control for rank, the analysis was repeated with rank deleted as a predictor, an estimate being thus provided of the cumulative effects of rank differentials on the salaries of academic women (Table 4). Several of the same independent variables continue to predict academic salary, but some additional variables enter the equation; $R = .45$. The partial r between sex (female) and salary irrespective of rank is –.05 ($F = 12.35$).

These results suggest that the sex differential in salary is due in part to differences in rates of promotion in rank, and that the change since 1968–69 may have occurred primarily in the lower ranks for the new recruits to the profession. Analysis of salary differentials within rank supports this inference. The summary results, showing the residual effects of sex in the separate stepwise regression analyses undertaken for each rank, are reported in Table 5. There are no statistically significant sex differentials among or within academic ranks with respect to tenure. As to salary, in the junior ranks (instructor/lecturer, assistant professor) women received remuneration about on a par with men's; senior-level women (full professor, associate professor) had lower salaries than their male counter-

Table 4. Predictors of academic salary with academic rank excluded. $R = .455$. Salary base is forced into regression first; all other variables are listed in order of entry in a stepwise equation. Partial r of sex: female is –.050 ($F = 12.35$) after allowance for all the variables listed. $F > 6.64 = p < .01$; $F > 10.83 = p < .001$.

Variable	Zero order r	Final multiple regression equation	
		Beta (path coefficient)	F ratio
Salary base	+.182	+.122	84.57
Number of articles published	+.339	+.192	125.23
Years since highest degree	+.289	+.154	104.12
Time spent in administration	+.195	+.089	43.02
Highest degree: professional	+.125	+.073	31.48
Tenure	+.230	+.059	16.45
Department: business	+.024	+.040	10.06
Highest degree: master's	–.181	–.052	12.00
Institution: 2-year college	–.020	+.062	20.99
Engage in paid consulting	+.126	+.039	8.75
Mother's education	–.073	–.042	10.84
Number of books published	+.210	+.047	10.77
Department: engineering	+.064	+.038	8.86
Time spent in teaching	–.176	–.041	8.23
Institution: 4-year college	–.067	+.035	6.98

Table 5. Relation of sex to salary and tenure, by rank and independent of all other statistically significant ($p < .01$) predictors. Salary base (9 to 10 months or 11 to 12 months) is forced into the regression first. $F > 3.84 = p < .05$; $F > 6.64 = p < .01$; $F > 10.83 = p < .001$.

Rank	Partial r of sex on:		F ratio in final multiple regression equation	
	Salary	Tenure	Salary	Tenure
Professor	–.117	–.029	20.03	1.28
Associate professor	–.060	+.025	4.94	0.82
Assistant professor	+.018	–.001	0.52	0.01
Instructor/lecturer	–.046	–.053	1.32	1.70

Table 6. Predictors of rank of academic men and academic women, 1972–73. R for men = .787. R for women = .772. All predictor variables entered freely. $F > 6.64 = p < .01$; $F > 10.83 = p < .001$.

Variable	Step at entry		Zero order r		F ratio in final multiple regression equation	
	Men	Women	Men	Women	Men	Women
Age	1	1	+.619	+.510	212.59	179.40
Number of articles published	2	3	+.517	+.502	190.28	121.42
Highest degree: doctorate	3	2	+.268	+.489	68.57	96.90
Years of continuous service at institution	4	4	+.493	+.420	76.96	80.64
Time spent in administration	5	5	+.221	+.254	51.40	87.76
Years since highest degree	6	7	+.590	+.400	81.28	62.18
Children	7	6	+.057	–.164	54.02	40.41
Field: biological science	8	10	+.049	+.078	26.88	24.99
Institution: 4-year college	9	8	–.060	+.044	22.93	39.90
Highest degree: baccalaureate		9		–.171		45.34
Engaging in paid consulting	10		+.156		17.02	
Department: fine arts	11		–.039		10.44	
Institution: 2-year college	12		–.183		11.33	
Number of books published	13	12	+.368	+.335	14.29	19.81
Department: education	14		–.002		10.05	
Career interruption		14		–.011		8.94
Race: white	15		+.051		6.75	
Time spent in teaching		15		–.195		7.30
Department: humanities	16	11	–.060	–.059	7.29	26.69
Department: health fields	17		–.011		10.03	
Highest degree: master's	18	13	–.280	–.424	7.02	16.10

parts. For full professors the residual effect (partial r) of sex (female) on salary was −.12 ($F = 20.03$).

Sex-Specific Equations

In this section we present separate stepwise multiple regression analyses for men and for women on the predictors of rank and salary. (Tenure is excluded because we have found it not to be independently related to sex.) These analyses take into account the interaction effects between sex and several of the predictor variables; consequently they provide some rudimentary indication of similarities and differences in the characteristics that determine rewards of academic men and academic women and of possible differences in the weights given to the same characteristics in men and women (*15*).

For attainment of academic rank the same five variables were the primary predictors for women as for men—age, number of articles published, the doctorate, years of continuous service, and time spent in administration (Table 6). For the male sample a total of 18 variables entered the regression equation with statistically significant weights, and R was .79. For the female sample 15 variables carried statistically significant weights and R was .77. Almost identical final results were obtained from the 1968–69 study.

In contrast to the predictors of rank, the predictors of salary differed substantially between men and women (Table 7). After control for salary base and rank, only four of the predictors entered the regression equation for women (highest degree professional, number of published articles, 2-year college as the institution of employment, and amount of time spent in administration). For men those four and 13 additional predictor variables entered. For men R was .70, for women .29. This discrepancy indicates substantially greater difficulty in predicting 1972–73 salaries of women than of men. The 1968–69 study showed higher multiple correlations and substantially greater similarity in the degree of predictability of men's and women's salaries (men, $R = .81$; women, $R = .76$). These shifts in results between 1968–69 and 1972–73 suggest that the traditional criteria used in the awarding of salaries may be in the process of being abandoned or reformulated, or at least are not being uniformly applied to women and men throughout the various sectors of academe.

If the same predictors of rank, with the same weights, that applied to men in 1972–73 (Table 6) are used to predict rank of women, the average expected rank is about one-tenth of a step above the observed, rising from somewhat below to slightly above midway between the assistant and associate professor levels (Table 8). The parallel analysis in the 1968–69 data indicated a differential of one-fifth step. Thus some gains in the academic rank of women relative to men have been made over the past half decade, though substantial differences persist.

The case with respect to salary is somewhat more complicated. In 1968–69 an average raise for women of more than $1000 across all ranks would have been required for equity in accordance with the predictors of men's salaries. The comparable figure in 1972–73 was $600. Both these figures are conservative, inasmuch as they are based on accepting all preceding differentials, including rank, as being not related to sex. If we exclude rank as a predictor of salary, as in Table 4, application of the men's regression equation to the women's data yields an average gross salary differential in 1972–73 in excess of $1000 between the actual and the predicted salaries of academic women.

This is an average differential for all ranks. We have previously shown (Table 5) that equity in salary between men and women has been virtually achieved in the junior ranks while differentials persist in the senior ranks, particularly at the level of full professor. The last line of Table 8 shows the calculated difference between actual salaries of women full professors and salaries predicated on the basis of the regression equation obtained for men full professors; the difference, $1680, is the amount of underpayment in 1972–73 to women in high rank with characteristics statistically identical to men's in educational attainment, specialization, productivy, and so forth.

Table 7: Predictors of salary of academic men and academic women. R for men = .700. R for women = .287. Salary base forced into regression first; all other predictor variables entered freely. $F > 6.64 = p < .01$; $F > 10.83 = p < .001$.

Variable	Step at entry		Zero order r		F ratio in final multiple regression equation	
	Men	Women	Men	Women	Men	Women
Salary base	1	1	+.299	+.108	154.01	16.52
Academic rank	2	2	+.539	+.226	146.17	54.72
Years since highest degree	3		+.492		63.50	
Number of articles published	4	4	+.462	+.193	65.77	20.99
Time spent in administration	5	6	+.272	+.125	40.91	8.64
Department: health fields	6		+.195		31.91	
Institution: 2-year college	7	5	−.032	+.009	38.57	11.22
Time spent in teaching	8		−.250		15.85	
Field: biological science	9		+.048		12.26	
Highest degree: master's	10		−.208		7.62	
Institution: Northeast and North Atlantic region	11		+.032		18.15	
Institution: private control	12		−.076		17.42	
Degree from top 12 institutions (*9*)	13		+.134		10.32	
Highest degree: professional	14	3	+.164	+.096	9.20	19.06
Department: engineering	15		+.042		8.53	
Years of continuous service at institution	16		+.289		10.26	
Political orientation: conservative	17		−.009		9.59	
Age	18		+.442		8.40	
Department: humanities	19		−.107		7.39	

Table 8. Average actual salary and rank of men and of women, and women's averages predicted by the multiple regression equation for men's. Scale for rank: professor = 4, associate professor = 3, assistant professor = 2, instructor or lecturer = 1.

Item	Men (Actual)	Women		
		Actual	Predicted	Difference (predicted minus actual)
Rank	3.05	2.43	2.54	+0.11
Salary (all faculty)	$17,850	$14,730	$15,330	$600
Salary (all faculty, academic rank excluded as a predictor)	$17,850	$14,730	$15,770	$1,040
Salary (full professors only)	$22,080	$19,170	$20,850	$1,680

Discussion

Academic men and academic women differ in educational backgrounds, professional activities, work setting, and related characteristics which affect rewards in academia. In the ACE's 1972–73 survey, 39.7 percent of the men but only 19.9 percent of the women reported that they held a doctorate. Larger proportions of women than of men listed their fields of specialization as education (23 percent versus 13 percent), humanities (21 percent versus 17 percent), and health sciences (10 percent versus 3 percent); larger proportions of the men than of the women were in the physical sciences or engineering (21 percent versus 5 percent) or in the social sciences (13 percent versus 9 percent). Of the women 39 percent reported spending more than 12 hours a week in scheduled classroom teaching, of the men only 29 percent. Only 14 percent of the women but 33 percent of the men reported that they spent more than 8 hours in an average week in research and scholarly writing. These differences are also reflected in publication productivity: of the men 35 percent had published at least five articles and 12 percent at least one book; in contrast, 12 percent of the women had published at least five articles and 7 percent at least one book.

These and certain other differences between academic men and women which are primary criteria for rewards in the current academic system have been controlled in the present study. Of course there may be some additional determinants of academic rewards that we have not taken into account. Lester, for example, indicates that some of the additional variance we attribute to sex per se may actually be a function of "career motivation, ability to perform demanding teaching assignments, standing in the discipline and the profession," and other factors which he labels "unmeasurable quality aspects" (*14*, p. 55). However, several of the variables included in the present analyses are proxies for some of these "unmeasurables," some have not been shown to be distinctively possessed by men more than by women, and others may merely reflect the cumulative effects of sex discrimination before a woman enters academia as a trained professional. Indeed, if there is cumulative discrimination one would expect the women entering academia and surviving in it to be particularly well qualified. The differences between expected and actual rewards which we discover when the weights derived from the men's analysis are applied to the women's data demonstrate powerfully the presence of sex bias, especially since the variables used are those that can be measured and that are widely accepted as the basic factors in promotion decisions.

The focus of this study is on women who are already established in academic positions. We have not directly addressed the question of current recruitment patterns in academia as they relate to hiring more women, nor of changes in the relative credentials of men and women entering the profession. But the study does show that the sex differential in salary is largest for women who have been in the system longest and achieved high rank when sex discrimination was presumably greater, and that women of junior rank who represent the pool of relatively new recruits are rewarded on a par with male colleagues of comparable credentials.

Women are, however, at some present disadvantage with respect to rate of promotion. Whether the newer recruits, when it comes time for promotion, will be as successful as comparable men remains to be seen (*16*). There are some other indications that sex discrimination in academic recruitment may persist to the present. In 1968–69, 19.1 percent of college and university faculties were women; by 1972–73 the proportion had increased only to 20 percent (*17*). The distribution of this growth is of interest: the proportion of women on university faculties increased from 14.8 percent in 1968–69 to 16.5 percent in 1972–73, but the proportion in 2-year colleges and in 4-year colleges actually declined over the period (*7, 8*). The universities have been under more scrutiny with respect to affirmative action than the colleges and junior colleges. However, it must also be noted that faculty recruitment in general was lower in 1972–73 than in 1968–69. In 1969 there were 23,800 new openings for junior faculty; in 1972 there were only 10,900 such openings (*18*). In part, the smallness of the growth in the proportion of women could be explained on the basis of this general decline in growth.

Finally, it should be observed that the present reward system, with its stress on the accrual of large numbers of publications and attendant phenomena, is more consistent with the present professional roles and opportunities of male faculty members than of female. In that sense, estimates of sex bias predicated on the existing reward system are almost inevitably underestimates. Nevertheless, it is fair to say that substantial progress toward equity has been made since the antibias regulations have been in effect. It is equally clear, on the other hand, that neither the spirit nor the objectives inherent in the antibias regulations and laws have yet been fully achieved.

References and Notes

1. B. Sandler, *J. Law Educ.* **2**, 613 (1973); A. P. Buck and J. H. Orleans, *Conn. Law Rev.* **6**, 1 (1973); Project on the Status and Education of Women, "Summary of Title IX: What the proposed regulations require" (Association of American Colleges, Washington, D.C., 1974).
2. See, for example, M. F. Fox, "Sex related income differentials among academic employees at the University of Michigan", mimeograph (University of Michigan, Ann Arbor, 1973).
3. The field of sociology is illustrative. See, for example, M. A. LaSorte, *Am. Sociol.* **6**, 304 (1971); J. C. Wolfe, M. L. DeFleur, W. L. Slocum, *ibid.* **8**, 159 (1973); Ad Hoc Committee on the Status of Women in the Profession, *The Status of Women in Sociology: 1968–1972* (American Sociological Association, Washington, D.C., 1973).
4. These differentials in themselves may reflect forms of discrimination which are not dealt with in this paper. Some may reflect the cumulative effects of earlier sex differentiation processes and discrimination: early childhood socialization for "appropriate" sex roles; different treatment and expectations accorded to boys and girls by their parents, teachers, and peers throughout adolescence and early adulthood; differential opportunities for access and admission to undergraduate and graduate school; and differential recruitment of academic women by various types of institutions.
5. H. S. Astin and A. E. Bayer, *Educ. Rec.* **53**, 101 (1972).
6. M. G. Darland, S. M. Dawkins, J. L. Lovasich, E. L. Scott, M. E. Sherman, J. L. Whipple, paper presented at the Allied Social Sciences meeting, New York, December 1973.
7. A. E. Bayer, *Teaching Faculty in Academe: 1972–73*, ACE Research Report 8:2 (American Council on Education, Washington, D.C., 1973).
8. ———, *Change* **6**, No. 2, 49 (1974).
9. This dichotomous variable indicates whether the highest degree was obtained from a graduate school in the top 12 of such institutions as listed in A. M. Cartter, *An Assessment of Quality in Graduate Education* (American Council on Education, Washington, D.C., 1966), p. 107.
10. Tables show the zero *r*'s and the normalized regression coefficient betas (path coefficients) for readers who wish to ascertain the direction and magnitude of the simple relationship and of the relative effects of each variable on the criterion. Only variables with significant *F*-ratios at the .01 level in the final solution are reported; other variables, statistically significant at the .05 level, have little practical significance and contribute little to increasing the R^2. Because of the large *N*, the statistical significance of all *F*-ratios is reported for infinite sample sizes and hence is only a close approximation of the actual significance level.

    All analyses are reported for unweighted data. Weights designed to adjust for sampling and response biases are also available and have been incorporated in a series of weighted multiple regression runs, with results parallel to those reported here. The unweighted runs employ as predictors the primary variables which were also criteria for statistical weighting, including degree level and selected institutional characteristics, thereby introducing control for sampling and response bias in the analytical model rather than through use of weighted regression routines.
11. A description of the stepwise multiple regression routine is presented in N. H. Nie, D. H. Bent, C. H. Hull, *Statistical Package for the Social Sciences* (McGraw-Hill, New York, 1970). Although widely employed in educational and social science research, stepwise multiple regression as a method has been criticized by some writers because it does not indicate an order of priority of entry into the equation of each predictor variable. See, for example, P. M. Blau, *The Organization of Academic Work* (Wiley, New York, 1973), p. 47. However, for our purposes the order of entry is not of primary concern because we are interested in determining the proportion of variance that can be attributed uniquely to sex. That is, we focus on the residual effects of sex after all other significant predictors, regardless of their order of entry, have entered the equation.

    Linear multiple regression is a very powerful technique for partitioning the total variance that can be attributed to a large number of possible sources, but in the present instance the concern is rather with eliminating the variance that may be attributed to sex (once the contribution of other sources is taken into account). Our estimate of the sex bias is thus a conservative one, since our preliminary analyses (Tables 1 to 5) in effect assign the predictive variance resulting from collinearity between sex and other variables to nonsex sources. Moreover, this statistical method permits us to

ascertain the relative importance of a number of variables simultaneously.

Theoretically, the present analyses might be extended further and one might examine these same relationships separately within an extensive number of subpopulations in order to take into account any interaction effects, most notably those variables which are shown in the tables to have sign reversals between the zero-order relationship and the beta in the final multiple regression equation. Such interactions, when present in the additive model that we have employed, will cause us to underestimate the relationships between predictor variables and outcome measures. Again, such "errors" will result in a more conservative estimate of sex bias. For example, in the present case, since differences in the type and magnitude of sex differentials between different types of institutions and different fields may be expected, the analyses might be performed separately by type of institution and by field or department. However, the present analyses, which combine fields and types of institutions, tend to underestimate the true magnitude of obtained differences. See, for example, *Opportunities for Women in Higher Education*, a report and recommendations by the Carnegie Commission on Higher Education (McGraw-Hill, New York, 1973), sec. 7 and append. C. See also (*6*). Furthermore, this is a replication study of an earlier one based on the status of academic women and men in 1968–69 (*5*) and we follow the same model in order to get an actual comparison over time. Future analyses will involve an examination by field and by type of institution, and will incorporate further study of other interaction effects shown in the present tables.

12. N. M. Gordon, T. E. Morton, I. C. Braden, *Am. Econ. Rev.* **64**, 419 (1974).
13. H. S. Astin, *The Woman Doctorate in America* (Russell Sage Foundation, New York, 1969); A. E. Bayer, *College and University Faculty: A Statistical Description*, ACE Research Report 5:5 (American Council on Education, Washington, D.C., 1971); D. Chubin, *Am. Sociol.* **9**, 83 (1974); A. S. Rossi and A. Calderwood, Eds., *Academic Women on the Move* (Russell Sage Foundation, New York, 1973).
14. R. A. Lester, *Antibias Regulation of Universities: Faculty Problems and Their Solution* (McGraw-Hill, New York, 1974).
15. The analytical method is limited in its capacity to ascertain relative weights and the differential impact of a large set of independent variables. In stepwise regression, minor differences in correlations can produce different orders of entry. Some of the independent variables are also somewhat redundant with others, so that which enters in precedence to another may be due in part to chance. Finally, some variables may have greater variance for one sex than the other and so be more likely to enter the equation. However, between-sex comparison of multiple correlations, and the application of the full equation to the opposite sex, are the primary objectives of the present analyses and are appropriate to the present method. See L. G. Humphreys, *Am. Educ. Res. J.*, in press.
16. Others have recently reported findings similar to ours with respect to increasing sex differentials with increasing experience. See, for example, G. E. Johnson and F. P. Stafford, *Am. Econ. Rev.* **64**, 888 (1974), and J. A. Centra, *Women, Men and the Doctorate* (Educational Testing Service, Princeton, N.J., 1974). Inasmuch as adequate longitudinal data are not employed in these studies, however, it cannot be ascertained whether this increasing disparity is inherent in the career progressions of academic personnel, as these researchers suggest, or whether equity is just now being achieved for newer recruits and will be sustained during their careers.
17. This slight change in proportion represents the following estimated numerical change: In 1968–69 there were approximately 517,000 faculty members in higher education, of whom 99,000 were women. In 1972–73 the total was approximately 620,000, of whom 124,000 were women. Therefore the average annual rate of increase of women on faculties was 6.3 percent during the period; for men it was 4.7 percent, the latter percentage being derived, however, from a substantially larger base-year figure.
18. A. M. Cartter, "The supply and demand for new college and university faculties," in preparation.
19. Supported by a subcontract from the American Council on Education to Florida State University, under grant SSH72-03432 A02 (formerly GI-34394) from the Research Applied to National Needs (RANN) Program of the National Science Foundation. The results and interpretations herein do not necessarily reflect the position of these agencies and are solely the responsibility of the authors.

RNA Processing and RNA Tumor Virus Origin and Evolution

RNA tumor virus genomes may originate from cell DNA via an alternative mode of RNA processing called paraprocessing.

David Gillespie and Robert C. Gallo

Viruses are generally considered to have evolved from cell nucleic acids, but many viruses bear no genetic relationship to the cells they infect. This appears to be true for virulent bacteriophages (*1*), and is assumed to be the case with most plant and animal viruses. Viruses of this type probably could not form a persistent association with host cell DNA. Some bacteriophages have the capacity of interacting with host cell DNA and possess some genetic information similar to sequences in host DNA (*1*). Recombination between the phage genome and host cell DNA results in the physical insertion of phage genes into the host genome (*2*). In this lysogenic state (*3*), genes are expressed at low levels and duplicated indefinitely along with the host cell DNA. Occasionally the inserted bacteriophage information is excised from the host genome (*2*). Fragments of adjacent host cell information can be excised along with the phage genome, and if this occurs the resulting phage genome contains both viral and cellular components (*2–4*).

The cell-like components found in the genomes of most temperate bacterial phages appear to arise from an interaction of the established viral genome with host cell information. If bacteriophages did originate from cellular genetic information, the genetic elements of the phage itself and those of its host have since diverged to the extent that they no longer share most nucleotide sequences. The situation with the RNA-containing animal tumor viruses is different. Evidence from molecular hybridization experiments suggests that the RNA genomes of these viruses have nucleotide sequences that are similar to sequences found in DNA of normal cells. This indicates that RNA tumor viruses (*5*) were relatively recently generated from host cell information. The point of origin of most RNA tumor viruses can probably be measured as having occurred within the last tens of millions of years (*6, 7*). Biological experiments indicate that the viruses are still being generated from cells.

Results from molecular hybridization, from physical analyses of RNA from RNA tumor viruses, and from biochemical analyses of infected animal cells has suggested to us that events in RNA processing determine whether a particular cellular RNA transcript can acquire the potential to become the genome of an RNA tumor virus or whether it will become a messenger RNA (mRNA) molecule. In this article we propose that the type of RNA processing ("paraprocessing") that leads to the formation of an RNA tumor virus genome involves relatively little RNA cleavage in the nucleus. We further suggest that paraprocessing is a form of RNA processing used normally for the expression of particular genes during early stages of differentiation but not normally in mature adult cells.

The results leading to these ideas rely in part on an estimation of the genetic rela-

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