is another service of inestimable value. What has been accomplished in increasing the productivity of agriculture, in preserving its products from one harvest to the next, and in the development of new species and varieties to suit particular locations and limitations of climate are but other reminders of the debt which civilization owes to those who work quietly and persistently in research laboratories and who for the most part are rewarded principally by the knowledge of a task well performed, by the plaudits of their fellow scientists and by a salary which too often is too meager to relieve them of financial worry.

There is always danger that a scientific man will claim too much for his efforts and while it is true that darkness has been banished, isolation broken, drudgery reduced, climate altered, the prospect of famines decreased, life extended and protected, and real poverty reduced almost to the vanishing point, it must be admitted that quite frequently the contribution of the original discoverer is but a few per cent. of the total effort involved in making the results available to people at large. There can be no development without the discovery, and yet the discovery must be followed by a great investment of time and money, in pilot plants, in semi-commercial-scale production, and ultimately in the provision of those facilities representing capital and labor which are the essential steps between the brilliant discovery of the scientist and the article which can be sold at a price to make it available to a great consuming public. The contributions of research to wealth, therefore, are so fundamental that it is difficult to claim too much, and yet with proper modesty the scientist may recognize how essential is the support of capital, labor, the public in general, if his research is to become useful. It is always well to recall the words of Millikan, that research to be justified must ultimately be useful.

All of what I have said and much more that could be said may be summed up very clearly, I think, by reference to the inscription on the beautiful dome of the building of the National Academy of Sciences and National Research Council in Washington. The logical development of the thoughts expressed in this quotation cannot fail to impress upon the minds of all, whether scientists or laymen, the key position which research occupies in the creation of wealth by whatever standard you care to measure it—"To science, pilot of industry, conqueror of disease, multiplier of the harvest, explorer of the universe, revealer of Nature's law, eternal guide to truth."

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## FAMILY BUDGETS OF UNIVERSITY FACULTY MEMBERS[1]

FOR a long time the low salary of the professor has been matter of discussion. Those who deplore the relative smallness are sometimes in the profession, but more often are men and women in other professions. Of late, however, expressions of unrest have become very audible in academic circles, perhaps because of the rise in the cost of living and of the changes in the standards of living in all classes which now include even the conservative college professor. The younger generation of this profession is, I think, unanimous in believing that the salary now offered in the academic world, especially to its higher ranks, is not one that can fairly be expected to meet the needs of the professional family.

This assumption that, given the accepted professional standard of living, salaries usually paid university teachers will not meet family living expenses and that to maintain the standard, supplementary earnings or vested income, one or both, become necessary, seemed to invite verification by the test of expenditures. In 1923, a keen interest in the real facts behind such statements led the writer to ask a number of faculty members at the University of California to give help in testing the truth of the assertion that salaries did not pay for needs.

Requests were sent to the two hundred forty-seven persons who represented the married members of the faculty. One hundred twenty-one of these refused to participate. Of the one hundred twenty-six who accepted the invitation, thirty could not, for one reason or another, be included in the study.

By the beginning of February, 1923, ninety-six complete family schedules were available, a number which represented 50 per cent. of the married members of the University of California faculty.

Characteristically this group of ninety-six families was made up of men and women in the prime of life and of their descendants under sixteen. Sixty-two per cent. of the men of the families were somewhere between thirty-five and fifty years of age; their wives, slightly younger. The families were typically American, born in the north and west of the United States. On the whole, the households were of the modern "small-family" type. The size of family showed an average of 3.5 persons.

When the facts of income and expenditure obtained by the interviewers were tabulated and interpreted, the assumption that salaries do not meet the scale of

[1] Read before the general session of the association devoted to the work of the Committee of One Hundred on Scientific Research at the Nashville meeting.

wants seemed entirely verified. These ninety-six families showed an average family expenditure of $5,000 per annum and this total was required in despite of budgets which evidence the utmost diligence and care in the use of the family income.

Salaries did not supply the $5,000 necessary for this scale of wants. Indeed, in three fourths of the cases salaries did not pay for the goods and services regarded as necessary. Seventy-five per cent. of these ninety-six faculty families supplemented salaries by other earnings. In 47 per cent. of the cases, salary was more than three fourths of the income; 40 per cent. reported salary as less than two thirds of their total income. For all ranks of the faculty members in the group studied, the mean salary was 65 per cent. of the total income. Vested income played relatively little part in the income of most of the group. Of the ninety-six families studied, only five cases reported property income that exceeded the income from work. An exceptional case showed salary as only 13 per cent. of the total income, returns from property and additional earnings making up the rest. But in the major part of this group of ninety-six families, salary was added to by forms of work other than regular university work which yielded an average return in sums that range from $1,000 to $2,000. The salary range of this group was $6,000, that is, from $1,400 to $8,000. The income range was $13,200, from $1,800 to $16,000. Massing is, of course, in the lower income groups. Only one family was trying to live on less than $2,000, only two commanded more than $12,000. The average mean income from all sources proved to be $5,300; the median, $4,800. This is to say that 60 per cent. of these ninety-six families had total incomes of less than $5,000.

Can a professional standard be maintained on less than this $5,000? Does not this sum represent the minimum cost of health and decency? In certain circles this question challenges ironical reference to the bald fact that statisticians tell us that 86 per cent. of the nation does live on less than $2,000; that only 600,000 of this prosperous nation are supposed to be enjoying $5,000 a year or over. It may be that the professor has no justification for his desire to be included in this two per cent. of the nation's income-earning population. The fact is he does so desire, because, as consumer, he has a scale of wants that with the current price level requires $5,000 or more to satisfy it. Also, and this is the gist of the findings here presented, the budgets secured seem on inspection to show a scale of wants and a habit of spending endorsed by the most conservative teachers of thrift.

In general, when statistically examined, the expenditures all showed spending ways it would be difficult to call careless or extravagant, all obviously followed the plan advocated vigorously by all schemes for "wise spending." In these expense histories, the emphasis fell most heavily on what used to be called "the higher life," those items of an important class of expenditures which as yet have no well-established name. For lack of a better term, these items, such as investment, insurance, savings, automobiles, recreation, health, dependents, gifts, education, professional expense, association, church, charity, tobacco, were grouped in this study under the heading "miscellaneous." The thirteen items in this subdivision and the items of house operation are those which give special character to the spending reported by these university families. The mean cost of living for the whole group of ninety-six families whose average size was 3.5 persons proved to be $5,511.77. For the professors the average expenditure proved to be $7,014.88. The instructors reported an average expenditure of $4,016. On an average, seventeen per cent. of the income was allotted to food; nine per cent. to clothing; shelter absorbed an average of seventeen per cent.; house operation, a caption that covers twelve rather important items, took thirteen per cent.; miscellaneous, with its thirteen sub-items, averaged forty-three per cent.

These percentages contrast notably with the percentage distributions of expenditure being sent out for popular consumption. Banks and other publishers of budget forms tell us that, with an income of $4,800, the expenditure for food should be eighteen per cent. to twenty-five per cent.; for clothing, eleven per cent. to eighteen per cent.; for shelter, fifteen per cent. to twenty-five per cent.; for house operation, from thirteen per cent. to twenty per cent.; for miscellaneous, including investments and savings, is ordinarily assigned from twenty-six per cent. to forty per cent. In the study whose findings I am presenting, the professors of this faculty, as a rule, spent for miscellaneous, forty-eight per cent. of their income. For miscellaneous the associate professor spends forty-six per cent. and the assistant professor, thirty-eight and two tenths per cent. The instructors and associates gave fifty and four tenths per cent. and forty-two per cent. respectively to these two items. Engel's law is once more verified. As the total amounts expended annually increase, the percentage these families assign to food and clothing regularly decreases in favor of expenditures for some one of the thirteen items of miscellaneous.

These families spend an average amount of $900 for food, a sum that passes everywhere just now as

the cost of minimum food requirements for those living at a subsistence plus level. The same extreme simplicity plainly dictates clothing expenditures. Two thirds of the husbands and one half of the wives spent annually between $100 and $200 each for their personal wardrobes. Thirteen women and eight men reported spending less than $100 each. The maximum spent by either sex, in families with the highest income, was about $500. One of the surprising facts which developed was this: although the simplicity in clothing of the average professor is traditional, in 40 per cent. of the families the housewives spent less than their husbands. The reason for this low expenditure of the adult members of the families does not seem to lie in the cost of the clothing of their children. Here also the least amount was spent. Plain clothing was evidently standard.

With regard to shelter, as might have been expected by those knowing the ways of academic people, a different standard appeared. The mode of desire is expressed in "a dwelling of seven or eight rooms," which requires a relatively high proportion of expenditure for shelter. Seventeen per cent. as an allotment to housing costs is not high in relation to a total income of $5,000, but the amount is disproportionate in comparison with the percentage these families allotted to food and clothing.

House operation, as analyzed in the schedule of inquiry that was used, contained items that ordinarily scatter under the headings such as rent and sundries. In this study, the term "house operation" covered a group of expenditures, such as light, fuel, heat, water, ice, telephone, telegraph, garbage removal, personal and house-cleaning supplies, house laundry, all types of domestic service, furniture and furnishings. These items took as an average 13 per cent. of the income with a range from 4 per cent. to 30 per cent. Fuel and heat represented an average cost of $100. Fuel, heat and light averaged $140. One among the outstanding facts which the study developed was the way these ninety-six families consistently aimed to dispense with domestic service or at least to use a minimum of it. Ten per cent. of these wives of professional men spent nothing for help in their housework. Fifteen per cent. paid $25 or less during the year under discussion. No family with a total expenditure below $6,000 had a full-time resident help. Even in families with incomes about $6,000, two thirds paid only $200 or more annually for help. The desire to save the costs of domestic service appeared in every family. Indeed twenty-one of the wives, most of them college-bred women, did all their own laundry work, from desire to save or to spend on other things.

As has been said, the allotment to miscellaneous took from one third to one half of the income. One third of the families paid for the support of one dependent or more outside the home, a cost that runs from three per cent. to ten per cent. of the total expenditures.

Fifty-five of the ninety-six families reported owning automobiles. For these fifty-five families, this item took 6 per cent. of the total expenditure, 17 per cent. of the miscellaneous expenditures. As might be expected, the tendency to own automobiles appears more regularly when incomes are over $4,000. Between $2,000 and $4,000 a trifle over one third of the families owned cars. At the level of $4,000 to $6,000, 50 per cent. had their own cars. Between $6,000 and $10,000, three fourths had automobiles. With incomes over $10,000 nearly 90 per cent. had automobiles. Apparently $6,000 to $7,000 was the income level where professional families felt free to buy automobiles. In nearly two thirds of the cases it was reported that they were spending less than $500 annually on their cars, but one third spent more than $1,000. In the group of fifty-five who own cars, 11 per cent. reported no expenditures for domestic service, apparently preferring to spend for the combined service and recreation which an automobile represents.

For forms of recreation other than automobiles, the average expenditure proved to be about $200. The amount spent for commercial amusements was notably small. Social entertainment seemed to be the preferred form and the tendency is toward a fixed allotment for this item.

A careful examination of the costs of ill health seemed worth while. Consequently, totals were obtained for the amounts paid for doctors, dentists, drugs, hospitals and opticians. Of the ninety-six families only two reported no expenditure for sickness. On the other hand, a few families quoted amounts very high indeed. Five families, two of whom had incomes under $5,000, reported health costs between $1,000 and $2,000. One instructor's family of four persons living on $3,400 was constrained during the year 1921–1922 to spend 25 per cent. of the total income on this item. However, for two thirds of the ninety-six families, expenditures for health absorbed less than 6 per cent. For 16 per cent. the item took $500 or more. The average physician's bill was $75. Forty families paid specialists amounts that averaged $35. Ninety reported dentist bills whose average was $50. The costs of the services of optometrists averaged $30, paid for by fifty-five families. The thirty-six who reported hospital bills, quoted sums that averaged $62. The twenty-three families who set down a nursing charge showed an average of $45. It was interesting to note that the higher expenditures for dentistry appear in the higher ex-

penditure levels only. It seems fair to argue that the lower cost of dentistry in the lower income groups is in part due either to inability to pay or at least to a relative unreadiness to allot money to dental prophylaxis.

As might be expected, expenditure to provide against the future takes first place in the general spending plan of these families. As a whole, investments absorb 26 per cent. of miscellaneous and 13 per cent. of the total expenditure, more than clothing and very little less than food or shelter. Only four families made no report of expenditure for this item. Of these, two families were buying homes, an item classified as an investment. Life insurance was the most recurrent type of "investment." Sixty families reported savings other than insurance. These appear as bank savings in thirty-six cases and as stocks and bonds and other forms of securities in thirty-eight cases.

The reports concerning gifts suggest that a fixed standard controlled expenditure for this item. The expenditure for all levels of income averages about $100 annually, 2 per cent. of the total expenditure, 5 per cent. of miscellaneous. As the proportion allotted to miscellaneous increases the relative cost of gifts decreases.

The amount which the academic man himself spent on professional expenses appears amazingly small, although it has a wide range and varies according to the amount paid out for technical books and magazines, for secretarial service, for professional organizations and travel for professional purpose. The amounts reported range from one per cent. to 38 per cent. of the total income. Of ninety-six men, twenty-two spent less than one half of one per cent. The average expenditure is $60, or 1.3 per cent.

The schedule used aimed to reduce the item of incidentals to the lowest terms. The number of subitems included expenditures difficult to classify otherwise, such as carfare other than that spent for going to and from work, lawyers' fees, barber service, moving expense, funeral expense and the like. Nearly 80 per cent. of the families investigated spent less than $100 on incidentals. Study of this item included the discovery that the average cost of all tonsorial service for man, wife and children was $13, a fact that raised the question whether economy, a preference or preoccupation dictated this infrequent patronage of the barber.

The costs of association dues, that is, affiliations with social clubs, vary slightly from one per cent. Expenditure for church and charity proved to be comparatively small. It is interesting to report, though difficult to explain, the fact that the fifty-two members of the group who recorded church contributions were those with small expenditures and that it was generally true that the percentage supporting churches decreases as total expenditure rises. For the fifty-two families out of ninety-six who supported churches the contribution varied from one tenth of one per cent. of the total expenditure to 7.5 per cent. In only two cases was more than 5 per cent. of income dedicated to this purpose. One family gave 7 per cent. of total expenditure, or $350. For charitable purposes, there was a wide range from one tenth of one per cent. to four per cent.

Only sixty-three of the ninety-six families reported any expenditure for tobacco. For these sixty-three families apparently tobacco is regarded as a fixed charge rather than a luxury permitted only when income rises. The highest and exceptional amount spent constituted one per cent. of the annual income. The median amount spent was less than one twentieth of one per cent., or about $25 per annum.

To summarize, these ninety-six families, at every income level, spent for the items of investments, automobiles, health, recreation and dependents outside the home an average of one fourth to one third of the total expenditure. Every family met charges for recreation, health and investment. Fifty-seven per cent. had automobiles, one-third had dependents outside the home to care for. An average of 2 per cent. of the total expenditure went for gifts. Education took 1.5 per cent. Professional expense was always about the same charge upon income, taking a trifle over one per cent. Church, charity and tobacco absorbed less than one per cent. Thus the outstanding facts concerning the expenditures of faculty families seem to be these: As the total expenditure increases, more is spent for investment, especially if the income becomes $5,000 and up. The proportion assigned to recreation and health decreases with increase of income. Expense for gifts, professional expense, church and charity remain a constant proportion of the total for all classes of income. The cost of tobacco is irregular and seems to bear no direct relation to purchasing power.

The table on page 501 shows these facts in detail.

All these facts could be more readily evaluated, if there were any accepted standards by which to test these expenditures. The field of expenditure is as yet the playground of the moralist.

The aim of this study was to let exact methods tell a story. Arguments on a speculative basis are less convincing. But even facts call for some criteria by which to evaluate them. Unfortunately such criteria in relation to standards and costs of living are not always formulated scientifically or clearly. There is little knowledge about human needs, real or custom made. Most claims for the amounts required

MEAN AND MEDIAN AMOUNTS AND PERCENTAGES OF TOTAL EXPENDITURES ALLOTTED TO EACH ITEM OF THE BUDGET

| | Number of families reporting expenditure | Amount of expenditure | | | |
|---|---|---|---|---|---|
| | | Mean | Median | Mean | Median |
| Total expenditure | 96 | $5,511.77 | $4,893.22 | 100.0 | 100.0 |
| Food | 96 | $893.73 | $807.50 | 17.3 | 16.8 |
| Clothing | 96 | 487.78 | 440.33 | 9.4 | 8.8 |
| Shelter | 96 | 871.11 | 684.50 | 17.1 | 15.8 |
| House operation | 96 | 746.49 | 568.21 | 13.1 | 12.2 |
| Total miscellaneous | 96 | 2,512.44 | 2,047.19 | 43.1 | 41.2 |
| Investments | 90† | 774.34 | 357.50 | 12.7 | 7.9 |
| Automobile | 55 | 673.35 | 364.00 | 10.3 | 6.2 |
| Recreation | 96 | 286.50 | 197.85 | 5.1 | 4.1 |
| Health | 95 | 316.33 | 203.16 | 5.7 | 3.9 |
| Dependents | 34 | 250.39 | 200.00 | 5.1 | 3.1 |
| Gifts | 94* | 123.41 | 100.00 | 2.3 | 2.0 |
| Education | 96 | 164.06 | 69.30 | 2.6 | 1.5 |
| Professional expenses | 93* | 169.27 | 60.00 | 2.9 | 1.3 |
| Incidentals | 95 | 93.23 | 55.00 | 1.7 | 1.2 |
| Associations | 94 | 75.74 | 49.70 | 1.3 | 1.1 |
| Church | 52 | 64.01 | 30.00 | 1.3 | 0.6 |
| Charity | 90§ | 41.47 | 27.00 | 0.7 | 0.6 |
| Tobacco | 61* | 34.21 | 25.00 | 0.6 | 0.4 |

* In 1 additional case, expenditure was reported but the exact amount was not available.
† In 2 additional cases, expenditure was reported but the exact amount was not available.
§ In 3 additional cases, expenditure was reported but the exact amount was not available.

to meet standards of living rest upon unsettled questions about the nature, the quantities and the costs of the several levels of living. Wise men, democrats and perhaps demagogues, unite in questioning the relation between income, a long scale of wants, and healthful and comfortable modes of existence. Much can be said for the Greek idea of the opportunities that lie in avoiding comfort. The country editor who, when he read my statement about $5,000 being not enough for comfort at a professional standard, waxed eloquently indignant about the lack of economic sense of those who spend $1,000 to $2,000 a year on automobiles, tobacco and recreation, has everything in favor of his position, except matter of fact. Inexorable custom jostles him and all professional men daily. Standard of living is not a question of prerogative but of practical utility. Like the rest of those who earn, the professor is in a specific occupational group. The idealists notwithstanding, occupational relationships react to settle effectively customary notions about modes of living. Given, the test of custom, the standard and cost of living displayed by the facts shown in this paper are minimum for professional men; these show the habitual mode of living that those who have spent long years in training for the profession consider "necessary and proper."

If the salaries of the full professor at least can not yield the average of $5,000 necessary to satisfy "custom" needs such as these budgets display, it is to be feared that men of initiative will leave the classrooms of universities to classroom plodders.

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## THE INDUSTRIAL SIGNIFICANCE OF SOME RECENT DEVELOPMENTS IN ORGANIC CHEMISTRY[1]

WHEN I compare the little I have to say with the length of my title I feel like a microbe with a Latin name.

My appearance on the program anyhow is due far more to my desire to have an opportunity to congratulate the Division of Industrial and Engineering Chemistry on its fine record of accomplishment during

[1] A paper read on September 11, 1928, at the meeting of the American Chemical Society at Swampscott, Massachusetts.