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UNIVERSITY STUDENT UNDERSTANDING OF EVOLUTIONARY BIOLOGY'S PLACE IN THE CREATION/EVOLUTION CONTROVERSY¹

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ABSTRACT. A questionnaire was used to survey 2,387 students in 10 different science courses at The Ohio State University, Columbus, Ohio. Students were questioned about their views on the creation/evolution controversy, especially their acceptance of the concept of Darwinian evolution and on the concept of equal time for "creation science." Biology students in Ohio showed a surprisingly low level of acceptance for the theory of evolution, and by an 80%-to-20% rate favored the concept of equal time for competing theories of origins. Students with increased education in biology were significantly less likely to accept co-instruction of alternative theories of origins in high school. Only eight percent of students could correctly identify the concept of differential reproduction as being most consistent with Darwinian evolution, among a set of five choices. Twenty-five percent believe that scientists doubt the validity of evolution as a science, while 22% feel that teaching naturalistic theories of science may lead to a decay in American society. Age and college rank had no effect on students' answers when the amount of science education in biology was taken into account. Students who had been exposed to evolution during high school biology courses were more likely to accept the concept of Darwinian evolution. Those students who have experienced more education in biology tend to answer questions in a manner which is more favorable to evolutionary biology and less favorable to creationist ideas. Taken as a whole, the results suggest that current mass biological education is not very successful in conveying the scientific basis of evolutionary biology.

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INTRODUCTION

Public opinion concerning equal educational time for creationist "science" plays an important role in the current evolution/creation controversy. Politically, even a vocal minority of American society can effect educational policy changes which are neither wise, nor supported by verifiable data. This can happen in any educational area, but can be most detrimental if forced upon instruction in a subject which is based upon the methods of hypothesis testing.

Several public opinion surveys have indicated that the non-scientific community strongly supports the teaching of creationist doctrines on an equal footing with evolutionary explanations of origins.

Surveys from the 1970s and before were reviewed by Edwards (1981). The proportion of individuals favoring the teaching of creation, either alone or together with evolutionary biology, ranged from 83% to 89% in three separate studies conducted between 1973 and 1976. Several recent surveys indicated that the earlier sentiments of the general public remain basically unchanged, but others indicated a potential shift in opinion. Among those which were concordant with earlier reports was a poll reported in the August 1982 issue of *Glamour* magazine which showed that 74% of approximately 1,000 respondents favored teaching "other views (including the divine origin of life)" if evolution was taught in public schools. An Associated Press-NBC poll taken in October 1981 found that 86% of the 1,598

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persons polled favored teaching either only the biblical view (10%) or both biblical and scientific theories of evolution. Finally, a Gallup poll taken during the summer of 1982 found that 44% of respondents agreed with the statement that "God created man pretty much in his present form at one time within the last 10,000 years," while only 9% of respondents felt that purely naturalistic processes, operating over millions of years, could account for the human species.

Some polls, however, have indicated other results. A phone-in poll by the *San Francisco Chronicle* in March 1981 showed that 73% of 13,512 callers did not want "the biblical version of creation [to] be taught in science class." *The Detroit Free Press* polled readers in 1981 and found that only 29% favored the compulsory teaching of two models of origins. A different poll, also in 1981, conducted by the *California Poll* found only 50% of respondents in favor of a two-model approach to origins.

The opinions of university students were determined in a poll at Bowling Green State University, Bowling Green, Ohio (Bergman 1979). Student opinion was similar to much of the findings on the general public. Ninety-one percent of the 442 undergraduates and 72% of the 74 graduate students polled felt that both ideas should be taught. However, only five of the 516 students polled were majoring in biology.

Taken as a whole, these results, although methodologically different, indicate a general public sentiment which favors the teaching of origins in a two-model setting, giving equal time to both creationist and evolutionist viewpoints. The results do not indicate whether the public understands the scientific validity of either viewpoint on origins, nor whether changes in opinion might result from increased education in the biological sciences. A survey of students at The Ohio State University was conducted during the fall of 1981 to examine further the opin-

ions of university students and to determine the effects of increased education in biology.

METHODS AND MATERIALS

Students were polled using a questionnaire of nine questions. Four questions dealt with balanced treatment of "creation science" and evolution and were taken from the *Glamour* survey to allow a direct comparison of results. The remaining five questions, specific to this survey, investigated opinions on the validity of evolution as a science. The entire questionnaire is presented in Appendix 1.

The questionnaire was distributed by instructors in 10 courses. Answer sheets were anonymous; no attempt was made to ensure that all students returned answers. The exact response rate was not determined but was very high and appeared to be similar for different courses. A total of 2,387 students returned the questionnaire. These students and courses represent a spectrum of exposure to education in biology at The Ohio State University. The Ohio State University is a large (enrollment over 54,000) Midwestern university which exists in an urban setting. Its undergraduate students are drawn mostly from Ohio, both urban and rural backgrounds. Undergraduate admission is open to any Ohio high school graduate meeting minimum high school course requirements. Students tend to have predominantly white, middle to lower class socioeconomic backgrounds. As listed in table 1, the courses included three introductory biology courses, Biology 106 (B106, aimed at non-science students), Biology 110 (B110, agriculture, science and some non-science students), and Biology 113 (B113, science and biology majors). There is an ordering of beginning students with respect to scientific interest and, presumably, ability. The courses would ordinarily be the first college-level biology courses that a student would complete. Two introductory courses

TABLE 1

Number of students responding for each course.

| Course | Respondents |
|--------|-------------|
| L201* | 58 |
| B106 | 680 |
| B110 | 824 |
| B113 | 326 |
| A200 | 157 |
| G140 | 113 |
| G500 | 139 |
| G678 | 90 |
| Total | 2387 |

*L = Linguistics, B = Biology, A = Anthropology, G = Genetics

in social sciences were also surveyed. Linguistics 201 (L201) caters predominantly to a non-physical-science and non-life-science audience but is a subject with evolutionary implications. No science prerequisites exist for this course. Its students have probably had less formal education in biology than those in other surveyed courses. Anthropology 200 (A200, physical anthropology) has a stronger evolutionary orientation than the other undergraduate courses examined in the survey. It also has no science prerequisites. Like the biology courses, it is likely to be the first life-science course taken by its students. Students enrolled in this course are presumably interested in human evolution, are likely to represent a preselected group favorable to evolutionary theory, and are less open to creationist arguments.

More advanced students were surveyed in several courses in the Department of Genetics. The courses included two introductory genetics courses which service different student groups, Genetics 140 (G140, agriculture and non-genetics biology majors) and Genetics 500 (G500, predominantly zoology, microbiology and genetics majors). Finally, three graduate level courses in genetics were surveyed (molecular genetics, evolutionary genetics and biostatistics), with results combined into a group labeled G678. These students have had more exposure to biology than undergraduate students and are expected to have a greater scientific maturity when weighing scientific data and theories. The numbers of students in each course who returned the questionnaire are also shown in table 1. The courses are listed in order of the expected biological knowledge and interest of their students with the exception of A200 which, as mentioned above, represents a preselected group and is placed arbitrarily at the more advanced end of the introductory courses. In table 1 note that the sample is heavily weighted towards the general biology courses, so that averages for the total survey will be more reflective of introductory students than of the students in the higher level courses.

The relative ranking of students by course, and therefore with respect to biological background, permits us to see whether interest in the biological sciences per se may alter an individual's opinion concerning the creation/evolution debate. This is because students with greater interest in biology will be enrolled in the higher level courses. However, the rank of a course (with respect to its level of biological knowledge) will be related to a student's age, and possibly to effects such as separation from family environment. Opinions might change simply because students grow older, or have been "away at college" for a longer time. This effect can be studied by accounting for the academic rank of different students in the three general biology courses, which are taken by students with minimal exposure to university-level biology. The confounding effects of age and college experience can be examined by comparing groups of students with different academic ranks (freshmen vs. sophomores, etc.). Differences

among groups were compared by using the likelihood ratio G-test for independence (Sokal and Rohlf 1969).

RESULTS

Question #1 asked students if they believed in Darwin's theory of evolution. Results are given in the first row of table 2, which presents YES answers for several questions. Of all students, only 62% replied affirmatively, while 30% did not believe in Darwin's theory. Seven percent of the students did not answer the question or circled both yes and no; either response was interpreted as a "not sure" answer to the question. This category was an addition to the YES or NO options of the *Glamour* survey, and represents the only change which we have made in the interpretation of that questionnaire. The rate of YES responses in the student group represents a significant increase over the 47% reported by the *Glamour* survey. Very significant differences were found between students in the various courses, as seen in table 2. Less biologically sophisticated students (L201 and B106) did not differ significantly from the *Glamour* survey results. In contrast, students who had completed several biology courses at the university level (G500 or G678) were much more likely to answer affirmatively. Examining the effects of age/college experience on answers from the three general biology courses (B106, B110 and B113) revealed no significant difference between freshmen, sophomores or juniors/seniors. Thus, the significant increase in affirmative answers which accompanies increased biological education is likely due to the increased education and selection of these courses by students with a bias towards science and not to any confounding factors.

Students were next asked whether both evolutionary theory and views such as special creation should be taught in public schools. Results are presented in table 2, for question #2. The overall student response in favor of equal time (80%) represents a significant increase over the responses of the *Glamour* poll (74%), and is

TABLE 2
 Percentage "YES" answers to question 1-3, 5, 8, 9.

| | Course | | | | | | | | Total sample |
|--|--------|------|------|------|------|------|------|------|--------------|
| | L201 | B106 | B110 | B113 | G140 | A200 | G500 | G678 | |
| Question #1 Believe in Theory of Evolution (n = 2387) | 50 | 50 | 60 | 69 | 69 | 82 | 86 | 84 | 63 |
| Question #2 Should other views be taught (n = 2351) | 83 | 85 | 83 | 80 | 78 | 75 | 62 | 55 | 80 |
| Question #3 Is creationism religion in public schools (n = 2337) | 33 | 42 | 39 | 45 | 48 | 44 | 52 | 45 | 42 |
| Question #5 Was evolution taught in high school (n = 2341) | 67 | 65 | 74 | 79 | 84 | 54 | 88 | 92 | 73 |
| Question #8 Scientists think evolution is invalid (n = 2265) | 27 | 36 | 23 | 25 | 16 | 15 | 12 | 13 | 25 |
| Question #9 Teaching naturalistic theories can degrade society (n = 2276) | 27 | 26 | 23 | 22 | 19 | 12 | 9 | 11 | 22 |

consistent with results obtained for similar questions on the NBC/Associated Press poll of 1981, the poll of Bowling Green students (Bergman 1979), and two separate telephone polls conducted by the Institute of Creation Research in the "Midwest" (Bergman 1979).

The results show a significant change in attitude as biological education increases. The two upper level groups (G500 and G678) have significantly lower percentages opting for co-instruction of theories of origins, opinions different both from other course groups and from the results of the *Glamour* poll. Nevertheless, despite the decline there is still strong support among all student groups for the inclusion of special creation somewhere in the public school curriculum. Since this question used the wording of the *Glamour* questionnaire, no specifications were made concerning the location of instruction in

origins. The students were not given the option of deciding whether a course such as sociology or comparative religions would be more appropriate than a biology course for the presentation of alternative theories of first origins. There were no differences between the various academic groups within the general biology courses, again indicating that biological education is the principal factor affecting the responses. There were very significant differences in responses, however, depending on a student's response to question #1, as shown in table 3. Ninety-one percent of students who answered NO or UNSURE for question #1 wanted both theories to be taught, compared with 74% of those who said they believed in Darwin's theory of evolution. This last figure is obviously still quite high.

The third *Glamour* question investigated a respondent's feelings concerning

TABLE 3
Relationship between student answers to question #1 and their responses to other questions. Percentage answering YES to other questions.

| Percentage which answered yes to: | Among those who gave following answer to question #1 | | |
|-----------------------------------|--|----|--------|
| | YES | NO | UNSURE |
| Question #2 | 74 | 91 | 92 |
| Question #3 | 47 | 39 | 32 |
| Question #5 | 75 | 70 | 66 |
| Question #8 | 19 | 40 | 17 |
| Question #9 | 12 | 40 | 24 |

creationism as religion in the public schools. Results are given in table 2. Among the entire student group, 58% did not agree that giving creationism equal time would be allowing religion into public schools. Although there was some heterogeneity in responses among the different courses, in only a single course (G500) did a majority (52%) of students agree that teaching creationism would be allowing religion into the schools. There was no effect of class rank within the general biology courses upon the student responses, nor were the total student responses different from the responses received by *Glamour* magazine to the same question. However, if students answered YES to question #1, they were very significantly more likely to feel that creationism would be religion in the public schools (47% vs. 34% for students who answer NO or UNSURE to question #1). See table 3.

The final *Glamour* question posed a choice of the methods to implement teaching both evolution and creationism. Results are presented in table 4. Of the students, 62% felt that textbooks or school curricula should be changed to present both theories. This compared to 60% of respondents to the original *Glamour* poll. There was no difference between students of different academic rank within the general biology courses, but very marked

differences were seen between courses. Although choice (c) was always chosen most often, there was a tendency for it to be less acceptable to the more advanced students (G678 students chose this option 41% of the time). Interestingly, L201 students ranked second lowest for this answer and also ranked second highest to G768 in the proportion of students opting to teach creationism at home (19% for L201, 20% for G678, overall response 10%). This compares with 17% of the respondents to the *Glamour* poll. Only eight percent of the students opted to require students to take courses in both biology and religion, while 20% of the students favored "other," compared to nine percent and 13% of the *Glamour* respondents. Option (c) was less acceptable (by 56% vs. 71%) to the students who answered YES to question #1, compared to those answering NO/UNSURE, as given in table 5. The question was worded to reflect the *Glamour* survey, and results might have been different if worded to permit a choice of requiring only one subject but not the other.

The second part of the questionnaire, which was not part of the *Glamour* magazine survey, attempted to ascertain student opinion concerning the validity of evolution as a scientific theory. Question #5 asked whether the students had been introduced to the biological theory of evolution in their high school studies. It should be remembered that such answers will depend upon the student's recall and cannot ascertain in any way the extent or quality of high school instruction of evolutionary biology. Results are given in table 2. Among the total group of students, 73% had been introduced to evolutionary biology at some time during their high school education. There were significant differences between courses. The two non-biology courses were among the lowest in positive responses to this question (54% for A200 and 67% for L201), being joined at the low end of the scale by the non-major general biology courses (65%, B106). Among the biology and genetics courses catering to more bio-

TABLE 4

Opinions in favor of various methods to implement teaching of creationism. (Total sample size = 2259.)

| | Course | | | | | | | | Total sample |
|--------------------------------------|--------|------|------|------|------|------|------|------|--------------|
| | L201 | B106 | B110 | B113 | G140 | A200 | G500 | G678 | |
| Require biology and religion courses | 11 | 8 | 5 | 10 | 9 | 7 | 9 | 12 | 8% |
| Teach creationism at home | 19 | 8 | 9 | 13 | 12 | 13 | 17 | 20 | 10% |
| Change texts | 52 | 64 | 66 | 62 | 63 | 55 | 52 | 41 | 62% |
| Other | 19 | 20 | 20 | 15 | 16 | 25 | 22 | 27 | 20% |

TABLE 5

Relationship between answers to question #1 and opinions on methods to implement teaching of creationism.

| Percentage which answered question #4: | YES | | | NO | | | UNSURE | | |
|--|-----|----|--------|-----|----|--------|--------|----|--------|
| | YES | NO | UNSURE | YES | NO | UNSURE | YES | NO | UNSURE |
| Require biology and religion courses | 8 | 8 | 5 | | | | | | |
| Teach creationism at home | 13 | 6 | 6 | | | | | | |
| Change texts | 57 | 70 | 73 | | | | | | |
| Other | 22 | 16 | 16 | | | | | | |

logically oriented students there was an increase in positive responses from 74% for B110 to 92% for G678. We interpret this increase as an indication that students who eventually decide on biologically oriented careers are more likely to have had a more thorough high school education in biology than non-science students in the same university. There were no significant differences between the various academic ranks in the percentage of students having high school instruction in biology.

There was a significant tendency for those with high school education in evolution to answer YES to the question #1, as shown in table 3 although the absolute difference between those with high school evolution (64% answered YES to question #1) and those without high school evolution (58%) was not great.

The students were next asked to identify a statement which best agreed with their idea of the modern theory of evolution.

The potential answers can be ranked by their accord with modern evolutionary teachings. Thus, answer (b) (differential offspring production) was the best answer, with answers (a) and (e), which are related to general survival, being the next most acceptable, and neither of the answers (c) or (d) being in accord with modern evolutionary theory. Answer (d) represents a vitalistic viewpoint of evolution, while answer (c) is a popular misrepresentation of evolutionary interpretations.

Only eight percent of all students chose answer (b) as their most appropriate answer. Among various courses, only the graduate students in genetics (G678) chose answer (b) more than 11% of the time, but even here just 21% recognized differential reproduction as the most appropriate choice. Answers (a) and (e) were chosen by 31% and eight percent of the total student group, respectively. If we consider the aggregate of student answers for either choice (a), (b) or (e), under a heading of "natural selection," there was a significant increase in student response according to course, as shown in table 6. All of the general biology courses, as well as L201, chose natural selection oriented answers less than 50% of the time. The graduate students (G678) chose either of the three most appropriate answers 77% of the time. Turning to the two "wrong answers," six percent of all students said that answer (c) (man evolved from the chimpanzee or gorilla) was most appropriate. Only 1% of the students in G500 and G678 chose this option. More

TABLE 6
Percentage of answers to question #6 concerning possible statements of evolution (n = 2146).

| | Course | | | | | | | | Total sample |
|---|--------|------|------|------|------|------|------|------|--------------|
| | L201 | B106 | B110 | B113 | G140 | A200 | G500 | G678 | |
| "Survival of fittest" (answer a) | 23 | 26 | 30 | 27 | 38 | 35 | 47 | 52 | 31 |
| "Different # of offspring" (answer b) | 7 | 7 | 8 | 4 | 9 | 11 | 11 | 21 | 8 |
| "Strong eliminate weak" (answer e) | 14 | 9 | 10 | 6 | 8 | 6 | 8 | 3 | 8 |
| "Natural selection" (either a, b, or e) | 44 | 44 | 48 | 37 | 55 | 51 | 66 | 77 | 48 |
| "Purposeful striving" (answer d) | 52 | 46 | 48 | 55 | 43 | 42 | 32 | 22 | 46 |
| "Evolution from gorilla" (answer c) | 4 | 11 | 4 | 8 | 2 | 6 | 2 | 1 | 6 |

interesting, however, was the dramatic response to answer (d). This answer, which explicitly calls for purposeful striving to "higher" forms, was chosen by 46% of all students, easily garnering a plurality among any of the choices, and only barely lower than the combined total for answers (a), (b) and (e) (48%). In two courses (L201 and B113) over 50% of the students felt that answer (d) was most representative of the modern theory of evolution. There was a significant decrease in the proportion of students choosing answer (d) as course level increased, but even in G500 and G678, 32% and 22%, respectively, of students felt that this answer represented their impression of the modern theory of evolution.

From the answers to question #6, it seems that many students do not have a clear understanding of the underlying mechanisms causing evolutionary changes in populations, as postulated by evolutionary biologists. There was a barely significant difference, within the general biology courses, in the answers given by students having different academic rank. Upper level students (juniors or seniors) were more likely to choose answer (b) (by 13% to six percent) than were freshmen or sophomores. However, if we consider answers (a), (b) and (e) as one group, there was no heterogeneity among the various

TABLE 7
Relationship between answers to question #1 and choice of best statement of modern theory of evolution.

| Percentage which gave answer to question #6 | Among those who gave following answer to question # | | |
|--|---|----|--------|
| | YES | NO | UNSURE |
| a) | 32 | 29 | 31 |
| b) | 8 | 9 | 6 |
| c) | 5 | 11 | 3 |
| d) | 47 | 41 | 53 |
| e) | 8 | 10 | 7 |

academic ranks. There was no heterogeneity among the groups which answered YES, NO or UNSURE to question #1, as shown in table 7, suggesting that simple belief in evolution did not imply better understanding of the scientific theory. If we examine the pattern of answers to question #1, in the reverse way to that given in table 7 as a dependent variable of the answers to question #6, significant differences were seen for one group, those who gave answer (c) as the most appropriate response to question #6. This group answered YES to question #1 only 47% of the time (equivalent to the *Glamour* results) while other answers to question #6 were associated with 65% YES responses

for question #1. We interpret this difference to indicate that students who have only the most superficial knowledge of the theory of evolution (i.e. would choose (c) for question #6) are least likely to accept that evolution has occurred. There was no heterogeneity in the percentage of "correct" answers (a, b, or e) among groups who did or did not have exposure to evolutionary biology in high school. It would appear that high school biology courses are not very successful in conveying a correct understanding of modern evolutionary ideas.

Two questions were concerned with determining the students' opinions of the validity of evolutionary biology as a scientific discipline. One question dealt with the students' opinions directly, while a second dealt with the students' understandings of the scientific community's opinion of evolutionary theory.

Question #7 gave several options concerning the scientific foundation of evolutionary theory. Results are given in table 8. Of the total student group, only 59% felt that the modern theory of evolution has a valid scientific foundation, with over half of these (35% of the total) feeling that it was both valid and testable. Of the 41% of students who felt that evolutionary theory does not have a valid scientific foundation, almost half (19% of the total) said that this was because the theory was principally based on speculation. There was a significant increase in the proportion of

students saying that evolutionary theory has a valid foundation (answers #1 or #2) as the course level increased (table 8), but no difference was found within the general biology courses between students having different academic ranks. One interesting point emerges if we examine only students who felt that evolutionary theory was not scientifically valid. Among only those students in the upper level courses (G140-G678) with such negative responses to question #7 (answers c-e), there was a significantly increased proportion (55% to 44%, compared to introductory level students) of those who felt that evolutionary theory was invalid because it was based on speculation.

Seventy-eight percent of students who said they believed in Darwinian evolution (YES to question #1) felt that evolution has a valid scientific base. This was significantly different from students who answered NO to question #1 (22% valid) or UNSURE (46% valid). Thirty-six percent of those who did not believe in evolution said that evolutionary theory was based on speculation, compared to 25% of those who were UNSURE on question #1, and only 10% of those who believe in evolution. Details on the relationship between answers to question #1 and student opinions on the validity of evolutionary theory are given in table 9.

Having given their own opinions on the validity of evolutionary theory, the students were asked about their under-

TABLE 8
Percentage of answers to question #7, does evolution have a valid scientific foundation.

| | Course | | | | | | | | Total sample |
|-----------------------------|--------|------|------|------|------|------|------|------|--------------|
| | L201 | B106 | B110 | B113 | G140 | A200 | G500 | G678 | |
| a. yes, because testable | 27 | 36 | 34 | 37 | 41 | 41 | 55 | 55 | 35 |
| b. yes, but not testable | 22 | 21 | 22 | 29 | 27 | 33 | 33 | 31 | 25 |
| c. no, because not testable | 14 | 15 | 12 | 4 | 5 | 6 | 2 | 2 | 10 |
| d. no, based on speculation | 20 | 23 | 19 | 21 | 18 | 14 | 6 | 8 | 19 |
| e. no, other reasons | 18 | 15 | 14 | 9 | 8 | 5 | 4 | 3 | 12 |

TABLE 9
*Relationship between student answers to question #1
 and their opinion of validity of evolutionary theory
 (question 7).*

| Percentage who gave answer to question #7 | Among those who gave following answer to question #1 | | |
|--|--|----|--------|
| | YES | NO | UNSURE |
| a) | 47 | 10 | 27 |
| b) | 31 | 13 | 19 |
| c) | 7 | 15 | 18 |
| d) | 10 | 35 | 25 |
| e) | 5 | 28 | 11 |

standing of the scientific community's opinion on the validity of the theory. The results are given in table 2. Twenty-five percent of the students said that scientists do not consider evolutionary theory to be a valid scientific theory. As course level increased there was a significant decrease in the proportion of students who said that scientists considered evolutionary theory invalid. There was no effect of academic rank. As with question #7, there was a strong correspondence between the answers students gave on question #8 and their answers to question #1, given in table 3. Students who said they did not believe in evolution were twice as likely as students who did believe in evolution, or who were UNSURE, to say that scientists considered evolution invalid (40% versus 19%).

An interesting contradiction arises when the answers of a particular student to questions #7 and #8 are compared. Thirty-six percent of students who answered that scientists consider evolutionary theory invalid, nevertheless personally felt that evolutionary theory had a valid scientific foundation. Only 67% of students who believe that scientists consider evolution to be a valid science will themselves accept that evolution has a valid scientific base.

The final question of the survey asked the students to consider the effect on the future of our society of teaching subjects such as evolutionary biology. Results are

given in table 2. Twenty-two percent of students felt that teaching naturalistic theories of science could lead to a "decay" in American society. Once again, we see a decline in the anti-evolutionary answer as biological education increases, from 27% in the L201 students to a low of nine percent in the G500 students. There was no effect of academic standing on the answers of students in general biology courses. High school education in evolutionary biology had no effect on this answer. The question showed one of the strongest associations with answers to question #1, given in table 3. Students who answered YES, UNSURE or NO felt that naturalistic theories could lead to a decline in American society by 12%, 24% and 40% proportions respectively.

DISCUSSION

At the politically sensitized interface between lay society and science, it seems that few topics have generated as much conflict as the creation/evolution controversy. Advocates who oppose "dogmatic" science attempt to influence the public against a scientific establishment that is portrayed as engaging in a conspiracy to suppress those seeking the equal consideration of equal hypotheses. Equal time or balanced treatment arguments provide seemingly plausible bases for legislative actions or school board mandates on scientific education policy. That the American public has a right, through their elected school boards, to determine the overall content of public school education is undeniable. That the content of science education should be determined by the outcome of popularity contests is, in contrast, a very deniable contention. Public opinion is of interest to the educator who can use it to gauge how educational methods have succeeded or failed in their purpose of conveying objective knowledge. In this second area, evolutionary biologists can be concerned with evaluating whether public perception of their science is accurate.

The present survey suggests that accurate perceptions of evolutionary science are

not being communicated effectively, even to those with more opportunities for exposure to science education. That only about two-thirds of students taking university level biology courses are willing to accept Darwinian evolution should be troubling to any biologist. Some may quibble with the wording of particular questions in this survey, but the results seem to give a clear picture. Biology students, like the public in general, feel that the equal teaching of "creation science" is fair when evolutionary science is being taught. Yet, the results also suggest that the current teaching of that evolutionary science is not successfully conveying a correct impression of the Darwinian theory of evolution. Ideas, such as those conveyed by question #6's option (d) may well be those which are being presented to many students when they get a single lecture or two on evolution in their high school biology classes. This can lead us to wonder about the level of understanding of evolutionary biology which exists among high school teachers of biology.

The results suggest that increased interest in science, and the accompanying increase in education in the biological sciences does lead to greater acceptance of evolution as a scientifically valid discipline. The fact that as many as 36% of some student groups in the sciences still should perceive scientists as doubting this validity has to be especially troubling. Can this be the result of a complete misunderstanding of the methods of scientific inquiry on the part of these students? Alternatively (or additionally), there appears to be great misunderstanding of the creation/evolution controversy, itself, and of the more scientifically meaningful controversies within evolutionary biology. Such disagreement within evolutionary biology includes the concepts of selective neutrality in molecular evolution, and punctuated equilibria in paleontology. If this is so, how much more misunderstanding exists in the general public which will have less exposure to biological education? The current wave of anti-evolutionary rhetoric cannot help but result in

the reduction of the time spent on evolution in biology courses at the high school level (Nelkin 1976). The low level of acceptance of evolution indicated by the present results must, therefore, cause biologists to rethink ways to better communicate to the general public the actual theory and results which underly this major fundamental viewpoint of life.

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APPENDIX 1

THE QUESTIONNAIRE

1. Do you believe in Darwin's theory of evolution? a. yes; b. no. (Students who answered neither or both were classified as "unsure.")
2. If Darwin's theory of evolution is taught in public schools, should other views (including the divine origin of life through special creation) be taught too? a. yes; b. no.
3. Do you think that scientists are right in their argument that by giving creationism equal time they are allowing religion into the public schools? a. yes; b. no.
4. If you think Darwinism and creationism are both valid theories, what is the best way to teach them? a. require all students to take courses in biology and religion; b. teach creationism at home; c. change textbooks or school curricula to present both theories; d. other.
5. Were you taught about evolution in your high school biology course? a. yes; b. no.
6. Which of the following best agrees with your impression of the Modern Theory of Evolution? a. The phrase "Survival of the Fittest"; b. evolution occurred because different individuals left different numbers of offspring; c. man evolved from either the gorilla or chimpanzee in Africa; d. evolution involved a purposeful striving towards "higher" forms, (that is a steady progress from microbes to

man); e. evolution occurred because the strong eventually eliminated the weak.

7. Do you think the modern theory of evolution has a valid scientific foundation? a. yes, because it is possible to test many "predictions" of evolutionary science; b. yes, even though we can never test "predictions" about events in the past; c. no, because we can never be sure about the past; d. no, because evolutionary science is principally based on

speculation, and not on "hard" scientific facts; e. no (for other reasons).

8. Is it your impression that most scientists now believe that the modern theory of evolution is not a valid scientific theory? a. yes; b. no.

9. Do you believe that the teaching of concepts which rely on a purely naturalistic explanation of the world, such as that used in the modern theory of evolution, might eventually lead to a "decay" of American society? a. yes; b. no.