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IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF CALIFORNIA

JEANNE E. CALDWELL,

Plaintiff,

v.

ROY L. CALDWELL, PH.D., in his
official capacity as Director of the
University Of California Museum Of
Paleontology; DAVID LINDBERG, in
his official capacity as Chair of the
Integrative Biology Department of the
University of California-Berkeley; and
MICHAEL D. PIBURN, in his official
capacity as Program Director for the
National Science Foundation,

Defendants.

ORIGINAL
FILED
OCT 14 2005
RICHARD W. WIEKING
CLERK, U.S. DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA
OAKLAND

ADM
PJE

C05-04166

CASE NO. _____

COMPLAINT: CLAIM FOR
DECLARATORY AND INJUNCTIVE
RELIEF AND NOMINAL DAMAGES
FOR VIOLATION OF THE
ESTABLISHMENT CLAUSE OF THE
FIRST AMENDMENT TO THE UNITED
STATES CONSTITUTION

[42 U.S.C. §1983]

[Demand for Jury Trial]

COMPLAINT

1 Plaintiff, JEANNE E. CALDWELL, alleges:

2 CLAIM FOR RELIEF
3 FOR VIOLATION OF THE ESTABLISHMENT CLAUSE OF
4 THE FIRST AMENDMENT AND THE FOURTEENTH AMENDMENT
5 OF THE UNITED STATES CONSTITUTION
6 (42 U.S.C. SECTION 1983)

7 1. This is a civil action whereby Plaintiff seeks Declaratory Judgment, Preliminary
8 and Permanent Injunctive Relief enjoining Defendants ROY L. CALDWELL, PH.D., in his
9 official capacity as Director of the University Of California Museum Of Paleontology; DAVID
10 LINDBERG, in his official capacity as Chair of the Integrative Biology Department of the
11 University of California-Berkeley; and MICHAEL D. PIBURN, in his official capacity as
12 Program Director for the National Science Foundation, their agents, servants and employees and
13 those acting in active concert and with actual notice thereof, from acting in such a manner as to
14 violate the Establishment Clause of the United States Constitution by creating, posting, and
15 maintaining an evolution website in which the government endorses certain religious beliefs and
16 denominational statements and expresses hostility towards other religious beliefs and
17 denominational statements.

18 2. This action arises under the United States Constitution, particularly the First and
19 Fourteenth Amendments; and under federal law, particularly 28 U.S.C. §§ 2201, 2202 and 42
20 U.S.C. §§ 1983 and 1988.

21 3. This Court has original jurisdiction over these federal claims by operation of 28
22 U.S.C. §§ 1331 and 1343.

23 4. This Court has authority to issue the requested declaratory relief under 28 U.S.C. §
24 2201.

25 5. This Court has authority to issue the requested injunctive relief under 28 U.S.C. §
26 1343(a)(3).

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28 COMPLAINT

1 6. This Court is authorized to award the requested damages under 28 U.S.C. §
2 1343(a)(3).

3 7. This Court is authorized to award attorneys' fees under 42 U.S.C. § 1988.

4 8. Venue is proper under 28 U.S.C. § 1391 in the Northern District of California
5 because this claim arose there, in that the "Understanding Evolution Website" described in
6 paragraph 12 below was created and is published at the University of California Museum of
7 Paleontology in Berkeley, and because plaintiffs are informed and believe that two of the three
8 defendants reside in the Northern District.
9

10 9. Plaintiff JEANNE E. CALDWELL is a resident of Placer County, California.
11 Plaintiff has two children who attend public school in Placer County, and a third child who is
12 likely to attend public school in Placer County when she reaches school age. Plaintiff pays taxes
13 to the State of California and the United States government.
14

15 10. Defendant ROY L. CALDWELL, PH.D., is the Director of the University Of
16 California Museum Of Paleontology, and a professor at the University of California-Berkeley.

17 11. Defendant DAVID LINDBERG is the Chair of the Integrative Biology Department
18 of the University of California-Berkeley.

19 12. Defendant MICHAEL D. PIBURN is the Program Director for the National
20 Science Foundation.
21

22 13. The University of California Museum of Paleontology publishes an evolution web-
23 site entitled "Understanding Evolution" that is located at <http://evolution.berkeley.edu> ("the
24 Understanding Evolution Website").

25 14. The Understanding Evolution Website was produced, and is maintained, pursuant
26 to a federal grant from the National Science Foundation ("NSF"), which is an agency of the
27 United States. *See* NSF Award Abstract #0096613, attached to the Complaint as "Exhibit 1."
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COMPLAINT

- 1 15. To date, \$523,261 has been awarded under the grant.
- 2 16. The grant runs through October 31, 2006
- 3 17. The Understanding Evolution Website states that it "is a collaborative project of the
4 University of California Museum of Paleontology and the National Center for Science Education."
5
- 6 18. The Understanding Evolution Website was funded, at least in part, by a \$523,261
7 grant from The National Science Foundation, grant no. 0096613.
- 8 19. The grant started on April 1, 2001, and expires on October 31, 2006.
- 9 20. The "sponsor" for the grant is the University of California-Berkeley.
- 10 21. The Understanding Evolution Website was most recently copyrighted in 2005 by
11 The University of California Museum of Paleontology, Berkeley, and the Regents of the
12 University of California.
13
- 14 22. The Understanding Evolution Website is intended to be relied upon and
15 implemented in classrooms by public school teachers in California and elsewhere.
- 16 23. The Understanding Evolution Website is intended, *inter alia*, to provide training
17 and advice to teachers on how to teach religious doctrine and issues relating to the interplay
18 between religion belief and evolutionary theory in K-12 public school science classes. One intent
19 of the Understanding Evolution Website is to use classroom instruction in science classes to
20 modify the religious beliefs of public school science students so that they will be more willing to
21 accept evolutionary theory as being true. And, as alleged below, an important tool for achieving
22 this goal is to convince students that "most" other people affiliated with their religious faiths
23 purportedly find no conflict between their religious beliefs, when properly understood, and
24 evolutionary theory. The centerpiece of the Understanding Evolution Website is a web page
25 entitled "Misconceptions: 'Evolution and religion are incompatible.'" A true and correct copy of
26 this web page is attached as "Exhibit 2" to this complaint and incorporated by this reference.
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1 24. The Understanding Evolution Website endorses the following religious beliefs,
2 doctrinal statements, and religious viewpoints:
3 a. The religious doctrine that religion and religious beliefs are limited to the
4 spiritual and supernatural world, and that they do not involve the material world and do not
5 provide “real knowledge” about the material world. A corollary is the religious doctrine that
6 religion and religious beliefs are “human constructs” that consist of “personal beliefs and
7 preferences” of individuals that aren’t real and aren’t rational. For example the “Misconceptions”
8 web page of the Understanding Evolution Website attached as “Exhibit 2” provides in this regard
9 that “Religion and science (evolution) are very different things. In science (as in science class),
10 only natural causes are used to explain natural phenomena, while religion deals with beliefs that
11 are beyond the natural world.” As another example, an article entitled “The Domains of Science
12 and Human Preferences,” by John Moore, a biologist, endorsed by and linked to the
13 Understanding Evolution Website, in which the religious belief is expressed that “Science and
14 religion are both human constructs, and our responses to them can be no more than human
15 choices,” as well as the religious belief that “the purely human aspects of ourselves such as . . .
16 personal beliefs, ethics, and religion demand neither evidence nor proof.” Moore goes on to
17 define scientific thought and knowledge as “rational” thoughts that are supported by real
18 “evidence,” and religious thoughts and knowledge as “emotional” (i.e., “irrational”) thoughts that
19 “demand neither evidence nor proof.” Then, the article states Moore’s religious viewpoint that
20 defines the role of religion in the evolution debate as follows: “The two modes come into conflict
21 in the debate between evolution and creationism. Teachers struggle to clarify one concept based
22 on confirmable evidence and the other based on personal preferences and beliefs. . . . A devout
23 creationist truly believes and requires no confirming data. This belief demands the acceptance of
24 supernatural phenomena, that is, things and processes that do not occur in nature and are above
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COMPLAINT

1 and beyond natural explanations and laws.” A true and correct copy of said article is attached as
2 “Exhibit 3” to this complaint and incorporated by this reference.

3 b. The religious doctrine that the theory of evolution is not in conflict with
4 properly understood Christian religious beliefs and theology or with properly understood Jewish
5 religious beliefs and theology. As one example, the “Misconceptions” web page, “Exhibit 2” is
6 subtitled “Evolution and religion are incompatible,” which is a religious statement. As another
7 example, the “Misconceptions” web page, “Exhibit 2”, references the “misconception that one has
8 to choose between [evolution] and religion,” and the statement that “Most Christian and Jewish
9 religious groups have no conflict with the theory of evolution” As another example, the
10 “Misconceptions” web page includes a cartoon depicting a scientist shaking hands with a religious
11 pastor holding a Bible with a cross on it, intended to convey the message that there is no conflict
12 between religious beliefs and the theory of evolution.
13

14 c. The “Misconceptions” web page also includes a link to an NCSE web page
15 entitled “Voices for Evolution” on the NCSE website that includes seventeen purported religious
16 doctrinal statements on the theory of evolution by a number of religious organizations, including
17 the Roman Catholic Church, the Presbyterian Church, and the United Church of Christ, all of
18 which are offered in support of the government’s endorsed religious position that “most Christian
19 and Jewish religious groups have no conflict with the theory of evolution.” The blatantly religious
20 content of these doctrinal statements are exemplified by a United Church of Christ doctrinal
21 statement on evolution entitled ““UNITED CHURCH BOARD FOR HOMELAND
22 **MINISTRIES: *Creationism, the Church, and the Public School*”, which states in part:
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1 "Purpose of the document:

2 "[F]or the United Church Board to work with members of the United Church of Christ and
3 others to understand this issue from the perspective of our religious and educational
4 traditions."

5 ...
6

7 **"II. Affirmations**

8 1) We testify to our belief that the historic Christian doctrine of the Creator God does not
9 depend upon any particular account of the origins of life for its truth and validity. The
10 effort of the creationists to change the book of Genesis into a scientific treatise dangerously
11 obscures what we believe to be the theological purpose of Genesis, viz., to witness to the
12 creation, meaning, and significance of the universe and of human existence under the
13 governance of God. The assumption that the Bible contains scientific data about origins
14 misreads a literature which emerged in a pre-scientific age.

15
16 2) We acknowledge modern evolutionary theory as the best present-day scientific
17 explanation of the existence of life on earth; such a conviction is in no way at odds with
18 our belief in a Creator God, or in the revelation and presence of that God in Jesus Christ
19 and the Holy Spirit."
20

21 A true and correct copy of the doctrinal statement is attached as "Exhibit 4" to this
22 complaint and incorporated by this reference.

23 c. The religious beliefs and religious viewpoint advocated by the
24 National Center for Science Education, an organization with a long history of religious advocacy
25 on the evolution issue, on it website, including the seventeen religious doctrinal statements
26 described above, as well as such religious writings as a study guide on evolution published by the
27 Congregational Church, and a publication of the Episcopal Church entitled "A Catechism of
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1 Creation,” as well as in articles by Eugenie C. Scott, the Executive Director of NCSE, who is
2 credited on the Understanding Evolution Website as one of the authors of its content. Proof of
3 NCSE’s active involvement in religious advocacy is provided by its endorsement of these
4 numerous religious doctrinal statements, by a number of articles on religious issues relating to
5 evolution on the NCSE website, by the presence on the NCSE staff of an employee described as
6 an “ordained deacon in the Episcopalian church” whose job title is “Faith Network Project
7 Director” and whose duties, according to the NCSE website, include preparing study guides on
8 evolution for churches, as well as providing “preaching” and religious education presentations on
9 evolution to “faith groups,” and by public statements by the Executive Director of NCSE, Scott, a
10 self-described “evolution evangelist” who has said that the debate over how evolution should be
11 taught in public schools is “all about God.” Also, as discussed below, Eugenie C. Scott has
12 written an article also linked on the Understanding Evolution Website urging teachers to use
13 exercises in science classes designed to convince students that most Christians and Jews find no
14 conflict between evolution and their religious beliefs, but warning teachers not to use the exercises
15 in homogenous conservative religious communities, since the exercise may not produce the
16 desired impact on the students’ religious beliefs. A true and correct copy of the article is attached
17 as “Exhibit 5” to this complaint and incorporated by this reference.
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21 25. In addition to endorsing and propagating the religious beliefs, doctrinal statements
22 and viewpoints described in paragraph 24, defendants seek to proselytize public school students
23 and the general public to adopt these religious beliefs, doctrinal statements and viewpoints through
24 the following aspects of the Understanding Evolution Website:

25 a. By advocating that teachers use public school science classrooms to
26 proselytize minor students to adopt the government’s preferred religious beliefs and doctrines
27 regarding evolutionary theory. In this regard, the Understanding Evolution Website includes a
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COMPLAINT

1 link to an article authored by Eugenie C. Scott, Executive Director of NCSE, in which she
2 recommends classroom exercises that teachers are encouraged to use in science classrooms to
3 proselytize minor students to subscribe to adopt the government's preferred religious beliefs and
4 doctrines regarding evolutionary theory. As an example of a recommended strategy, the article
5 relates the experience of teachers who "have had good results when they begin the year by asking
6 students to brainstorm what they think the words "evolution" and "creationism" mean. . . . Don't
7 be surprised to find some variant of, "You can't believe in God" or some similar statement of
8 supposed incompatibility between religion and evolution. Under "creationism" expect to find more
9 consistency: "God"; "Adam and Eve," "Genesis," etc. The next step in constructing student
10 understanding of concepts is to guide them towards a more accurate view. . . . After one such
11 initial brainstorming session, one teacher presented students with a short quiz wherein they were
12 asked, "Which statement was made by the Pope?" or "which statement was made by an Episcopal
13 Bishop?" and given an "a, b, c" multiple choice selection. All the statements from theologians, of
14 course, stressed the compatibility of theology with the science of evolution. This generated
15 discussion about what evolution was versus what students thought it was. By making the students
16 aware of the diversity of opinion towards evolution extant in Christian theology, the teacher
17 helped them understand that they didn't have to make a choice between evolution and religious
18 faith. A teacher in Minnesota . . . had good luck sending his students out at the beginning of the
19 semester to interview their pastors and priests about evolution. They came back somewhat
20 astonished, "Hey! Evolution is OK!" Even when there was diversity in opinion, with some
21 religious leaders accepting evolution as compatible with their theology and others rejecting it, it
22 was educational for the students to find out for themselves that there was no single Christian
23 perspective on evolution. *The survey-of-ministers approach may not work if the community is*
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COMPLAINT

1 *religiously homogeneous, especially if that homogeneity is conservative Christian*, but it is
2 something that some teachers might consider. . . ." (Emphasis added.)

3 b. By publishing the purported denominational religious belief on evolutionary
4 theory of various Christian denominations and Jewish religious groups as examples of the correct
5 religious belief and viewpoint on evolutionary theory with the goal of proselytizing citizens to
6 adopt that religious belief and viewpoint. This publication has the purpose and effect of advancing
7 the religious beliefs contained in these doctrinal statements. By purporting to state the "official"
8 doctrinal beliefs of Christian denominations, the government is also improperly entangling itself in
9 religion, and in intra-denominational religious debates and disputes. For example, the
10 Understanding Evolution Website includes a statement on evolution by the late Pope John Paul II
11 that is offered as an official statement by the Roman Catholic Church that evolutionary theory is
12 not in conflict with Catholic theology, but does not include the recent statement by Cardinal
13 Christoph Schönborn, the archbishop of Vienna who was the lead editor of the official 1992
14 Catechism of the Catholic Church, in which Cardinal Schönborn states the religious position that
15 the theory of evolution *is* in conflict with Catholic theology. As another example, the
16 Understanding Evolution Website includes a Presbyterian doctrinal statement holding that
17 evolution is not in conflict with Christian beliefs, while omitting any statement by prominent
18 Presbyterian leaders such as Dr. D. James Kennedy, who subscribe to the religious doctrine that
19 the theory of evolution is diametrically in conflict with Christian religious beliefs.

20 c. By telling citizens that "thousands of scientists" are "devoutly religious"
21 and find no conflict between their religious belief and evolutionary theory, and by stating the
22 corollary that almost no "professional scientists" hold the religious belief and viewpoint that
23 religion is in conflict with evolutionary theory, as a further effort to proselytize citizens to adopt
24 the government's preferred religious belief and viewpoint on evolutionary theory.

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1 d. By including the following hypothetical student question and recommended
2 response: **Quick Quiz:** "If I accept evolution, do I have to quit going to church?" ""Science and
3 religion deal with different things. Science tries to figure out how things work and religion teaches
4 about morality and spirituality. There doesn't need to be a conflict.""

5 e. By permitting a private religious advocacy organization, NCSE, to use
6 public funding from the National Science Foundation and public resources of the University of
7 California Museum of Paleontology, presented under the auspices of the University of California,
8 to propagate NCSE's religious beliefs and religious viewpoints regarding evolutionary theory to
9 citizens, with the goal of proselytizing public school students and the general public to adopt the
10 NCSEs religious beliefs and religious viewpoints regarding evolutionary theory. Defendants have
11 facilitated and continue to facilitate this propagation by, *inter alia*, permitting NCSE to be deeply
12 involved in the planning and programming of the Understanding Evolution Website, providing
13 numerous references and links to the NCSE Website on the Understanding Evolution Website, as
14 well as to articles authored by NCSE Executive Director, Eugenie C. Scott, who, along with Alan
15 D. Gishlick and Eric Meikle of NCSE, are credited as some of the authors of the content of the
16 Understanding Evolution Website.
17

18 f. By using the Understanding Evolution Website to proselytize the general
19 public to adopt the government's preferred religious beliefs and viewpoints on evolutionary theory
20 by directing them to religious doctrinal statements on the NCSE's website in an effort to
21 proselytize citizens into adopting the government's preferred Christian religious belief and
22 viewpoint on evolutionary theory or the government's preferred Jewish religious belief and
23 viewpoint on evolutionary theory.
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25 26. As the parent of children in public schools, plaintiff is actively involved in school
26 board elections, school board meetings, and other public debates and processes regarding the
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1 selection of instructional materials and course contents for science classes in the public schools.
2 In particular, she is interested in how teachers teach the theory of evolution in biology classes in
3 the public schools. Plaintiff desires to participate as an informed citizen in these elections, public
4 debates and processes, so she makes use of the "Understanding Evolution" website described in
5 paragraph 13 below as a resource, to learn how the University of California recommends that
6 public science teachers teach evolution to K-12 students in California. However, when plaintiff
7 utilizes the "Understanding Evolution," she is offended by the government's endorsement in the
8 website of religions and religious denominations that subscribe to the religious doctrine that their
9 religious belief is compatible with evolutionary theory, and the government's attempt to
10 proselytize citizens such as herself to adopt the government's preferred religious beliefs about
11 evolution, and plaintiff is offended by the government's express and implicit disapproval in the
12 website of any irreligious or religion or religious denominations that subscribe to the religious
13 doctrine that their religious belief is incompatible with evolutionary theory. As a result of such
14 endorsement of some religious beliefs and disapproval of other religious beliefs, persons such as
15 plaintiff, who subscribe to the religious doctrine that their religious belief is incompatible with
16 evolutionary theory, are made to feel like outsiders by the State of California and the United
17 States. Defendants have opened the site to the general public for information and review. As
18 such, Plaintiff has been exposed to the government endorsed religious messages to her harm.

22 27. Each and all of the acts alleged herein were done by Defendants under the color
23 and pretense of state law, statutes, ordinances, regulations, customs, usages, and policies of the
24 University of California-Berkeley and the NSF.

25 28. Unless and until the enforcement of the Defendants' religiously discriminatory
26 policy is enjoined, the Plaintiff will suffer and continue to suffer irreparable harm to her federal
27 constitutional rights.

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COMPLAINT

1 29. The Establishment Clause prohibits preference of one set of religious beliefs or
2 religious denominations over another. In the Understanding Evolution Website, defendants,
3 acting in their official capacities on behalf of the State of California and the United States,
4 communicate a preference fore the religious beliefs, doctrinal statements, and viewpoints alleged
5 in paragraph 25 above.

6 30. The Defendants have narrowly selected only those faith traditions whose views
7 align perfectly with those of the NCSE and to the exclusion of other faith traditions. In sum, the
8 Defendants have selected from a voluminous body of religious traditions and theological
9 positions, a particular interpretation of religious doctrine with that of the government. By so
10 doing, Defendants exclude other religious and theological views which they deem adverse to the
11 state.

12 31. The Establishment Clause prohibits endorsement of particular religious beliefs. In
13 the Understanding Evolution Website, defendants, acting in their official capacities on behalf of
14 the State of California and the United States, communicate and endorse the religious beliefs,
15 doctrinal statements and viewpoints described in paragraph 25 through the means described in
16 paragraph 26 and actually seek to utilize the Understanding Evolution Website to proselytize
17 public school students and the general public to adopt those government endorsed religious
18 beliefs, doctrinal statements and viewpoints.

19 32. The Establishment Clause prohibits the government from showing hostility toward
20 religion, or toward a particular religious belief or denomination.

21 33. In the Understanding Evolution website, defendants express endorsement of
22 religious beliefs and denominations that embrace the religious doctrine that there is no conflict
23 between religion and evolutionary theory and express disapproval of any religious beliefs and
24 denominations that embrace the religious doctrine that there *is* a conflict between religion and
25 evolutionary theory.

26 34. Defendants' actions have no secular purpose.

27 35. The Defendants' policy demonstrates impermissible hostility towards religion.
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COMPLAINT

1 36. The Defendants' policy and practice requires an excessive entanglement of
2 religion.

3 37. There is thus an identifiable measurable sum of public funds being used to further
4 the actions of the Defendants and each of them. Specific tax dollars are spent solely for the above-
5 described activities by Defendants and each of them. Moreover, the unlawful acts of Defendants,
6 as described above, adds costs to the operation of the website. As a result, Plaintiff has sustained
7 an injury resulting from the above-described government expenditure of tax revenues.
8

9 38. Defendants have no compelling interest that would justify their hostility towards
10 religion, nor for their endorsement of some religious beliefs and denominations.

11 39. The Defendants' policy therefore violates the Establishment Clause of the First
12 Amendment to the United States Constitution as incorporated and applied to the states under the
13 Fourteenth Amendment.

14 WHEREFORE, Plaintiff respectfully prays that the Court grant the relief set forth
15 hereinafter in the prayer for relief.

16 **PRAYER FOR RELIEF**

17 WHEREFORE, Plaintiff requests the following relief:

18 A. That this Court preliminarily and permanently enjoin the Defendants from continuing
19 to publish the Understanding Evolution Website with the religious and anti-religious materials and
20 statements alleged in this complaint, and that Defendants be enjoined from spending any
21 additional money from the State of California and or the National Science Foundation in relation
22 to such religious and anti-religious materials and references on the Understanding Evolution
23 Website;

24 B. That this Court enter declaratory judgment stating that the Defendants' inclusion and
25 publication of such religious and anti-religious materials and statements in the Understanding
26 Evolution Website is unconstitutional and violates the Plaintiff's rights as guaranteed under the
27 First and Fourteenth Amendments to the United States Constitution;

28 **COMPLAINT**

1 C. That this Court award Plaintiff nominal damages in the sum of \$100 arising from the
2 acts of the Defendants as an important vindication of the constitutional rights at stake;
3 D. That this Court award Plaintiff her costs and expenses of this action, including
4 reasonable attorneys' fees, in accordance with 42 U.S.C. § 1988 and other applicable law;
5 E. That this Court grant such other and further relief as the Court deems equitable, just,
6 and proper;
7 F. That this Court adjudge, decree and declare the rights and other legal relations of the
8 parties to the subject matter here in controversy, in order that such declarations shall have the
9 force and effect of final judgment; and
10 G. That this Court retain jurisdiction of this matter as necessary to enforce the Court's
11 orders.

12 Dated: October 13, 2005

13 PACIFIC JUSTICE INSTITUTE

14
15 By: 


16 Kevin T. Snider,
17 Attorney for Plaintiff
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COMPLAINT

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REQUEST FOR JURY TRIAL


Plaintiff requests trial by jury of each of her claims, to the extent available under law.

By: 
Kevin T. Snider,
Attorney for Plaintiff

Certification of Interested Entities [Civil L.R. 3-16]

Pursuant to Civil L.R. 3-16, the undersigned certifies that as of this date, other than the named parties, there is no such interest to report.

Dated: October 13, 2005

By: 
Kevin T. Snider,
Attorney for Plaintiff

COMPLAINT



NSF Award Abstract - #0096613

WWW.Evolution

NSF Org ESI

Initial Amendment Date May 10, 2001

Latest Amendment Date May 3, 2005

Award Number 0096613

Award Instrument Standard Grant

Program Manager Michael D. Piburn

ESI Division of Elementary, Secondary & Informal Education
EHR Directorate for Education & Human Resources

Start Date April 1, 2001

Expires October 31, 2006 (Estimated)

Awarded Amount to Date \$523261

Investigator(s) Roy Caldwell rcroy@socrates.berkeley.edu (Principal Investigator)

Kevin Padian (Former Principal Investigator)

David Lindberg (Co-Principal Investigator)

Sponsor University of California-Berkeley

Sponsored Projects Office

Berkeley, CA 94720 510/642-6000

NSF Program(s) TEACHER ENHANCEMENT PROGRAM

Field Application(s) 0000099 Other Applications NEC

Program Reference Code(s) SMET,9177

Program Element Code(s) 7300

Abstract

The National Center for Science Education proposes to develop a website on evolution and the nature of science for K-12 teachers. This project, "WWW.Evolution," aims to improve teacher understanding of the nature of science, the patterns and processes of evolution, and the history of evolutionary thought and to increase their ability to teach these subjects effectively. The Site will also provide teachers with classroom resources, including a selection of effective approaches and teaching strategies and a searchable database of curricula, teacher-tested activities, and lesson plans, which are consistent with those modeled in the National Science Education Standards. The evaluation of the project will include multiple aspects of the proposed website and its constituent elements, ranging from its appeal and utility to its ability to help users understand new concepts and acquire strategies for -- and confidence in -- teaching evolution.

Home > Misconceptions

Search Site Index Glossary Home

Evolution & How it Works Evidence Regarding Evo Implications of Evo Evo & Religion Teaching Evo Quick Quiz

Compatibility with Religion?

Misconception: "Evolution and religion are incompatible."

Teachers:
[Help us improve this site.](#)

Response: Religion and science (evolution) are very different things. In science (as in science class), only natural causes are used to explain natural phenomena, while religion deals with beliefs that are beyond the natural world.

The misconception that one has to choose between science and religion is divisive. Most Christian and Jewish religious groups have no conflict with the theory of evolution or other scientific findings. In fact, many religious people, including theologians, feel that a deeper understanding of nature actually enriches their faith. Moreover, in the scientific community there are thousands of scientists who are devoutly religious and also accept evolution.

For concise statements from many religious organizations regarding evolution, see [Voices for Evolution](#) on the NCSE Web site.



[NEXT TOPIC](#)
[Misconceptions: Teaching Evolution](#)

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The Domains of Science and Human Preferences

by John A. Moore



No one has ever seen one species evolve into another, yet scientists who study the history of the earth and the nature of living organisms are convinced that they do, and creationists, who are almost never professional scientists, are equally convinced that they do not. This is more than an esoteric problem that befuddles philosophers because it has become an unacceptably disruptive matter in many public schools. When our civilization is so totally dependent on science and technology, it is important that the citizens who make the nation's decisions have a deep understanding of the nature of science and the strengths and limitations of scientific evidence. The basic intellectual demands for so doing are not overwhelming.

Two worlds of the mind

Science deals with the things and processes of the natural world that are generally codified as biology, chemistry, physics, geology, and astronomy. Strictly speaking, it seeks not truth per se but concepts that can explain those natural things and processes by using what is already known of natural things and processes. These understandings must be based on data derived from observations and experiments and they must be confirmable by others. Alternatively, the purely human aspects of ourselves such as love, friendship, hate, pleasure, personal preferences, personal beliefs, ethics, and religion demand neither evidence nor proof.

Thus, we live in two worlds of the mind. One is the world of science and rational thought that was so dominant among intellectuals in the 18th century that it was called "The Age of Reason," or "The Enlightenment." Those intellectuals were deeply impressed with the ability of Newton and many others to provide explanations for the properties of light, mechanics, and the movements of the heavenly bodies. For many human beings, this was unsatisfactory due to the lack of attention paid to human hopes and desires. The pendulum swung, and more emphasis was devoted to the humanities. This emphasis on personal preferences gave us the romanticism of the 19th century—a swing from the rational end of the spectrum to the emotional.

No choice is necessary, because a full human life requires that the rational and the emotional coexist. The rational must dominate when one asks for reliable explanations of nature, the identification of and cure of diseases, superior agriculture, and the technology required for our civilization. Alternatively, the emotional or romantic mode is more personal, reflected in our wants and dreams.

The two modes come into conflict in the debate between evolution and creationism. Teachers struggle to clarify one concept based on confirmable evidence and the other based on personal preferences and beliefs. Why does this serious condition exist? It exists because different segments of society accept different criteria for evidence.

A devout creationist truly believes and requires no confirming data. This belief demands the acceptance of supernatural phenomena, that is, things

and processes that do not occur in nature and are above and beyond natural explanations and laws.

The dominant trend in the patterns of thought in Western Civilization since the Middle Ages has been to abandon supernatural explanations and to seek rational ones for natural phenomena. The enormous advances in our understanding of how the human body works, treating diseases, building trains, aircraft, and automobiles, producing more bountiful and useful crops, and communicating more rapidly and efficiently with others throughout the world are based on rational thought and the use of scientific procedures that form the basis of invention. They provide human beings with enormous power, but we must remember that this power can be used for good or for evil. The glorious news is that this grand ability is totally controlled by human beings. We determine whether science and rational thought will be used to augment or decrease human welfare and happiness.

Best explanation available

Scientists accept evolution because, after a century and a half, it continues to explain the existing data and has yet to be replaced by a better theory. The fact that the evidence for biological evolution is overwhelming does not mean that a creationist cannot believe in a divine creation as described in Genesis. In the United States, everyone has a protected right to believe anything natural, supernatural, or based on human preference. A major problem ensues, however, when creationists try to prevent the teaching of evolution in the public schools. Students should hear an honest evaluation of what scientists who have spent their lives studying living and fossil organisms have concluded about the history of life over time. This means surveying the data and understanding the interpretation of the data, which has left the concept of evolution the best explanation so far available to explain the history of life over the eons of geological time.

The goal of all science is to formulate a statement, a concept, or a theory that accounts for all the existing data on a major topic and that can be expanded, modified, or negated on the basis of additional information. There are many cases where a concept has been validated so adequately that one can say it is "true beyond all reasonable doubt." One of these is the concept of evolution, which has been greatly expanded beyond its mid-19th-century formulation. New fields such as genetics and molecular biology have provided valuable new insights, along with new data from the classical fields of paleontology, comparative anatomy, and embryology. For example, the observation that all living creatures have bodies composed of cells and that many of the same chemical reactions occur within the cells of different species can be understood as a consequence of the fact that the ancestor of all living species was a cell and that the basic cellular structure and its chemistry has been conserved to this day.

There are no observations that invalidate evolution as being the only useful scientific explanation available. Nevertheless, for individuals lacking a broad background in biology and geology, it is not easy to relate these observations to the conclusion that evolution is a useful theory and the only scientific explanation. Unfortunately, this is true for many conclusions in science. For example, few individuals today will maintain that night and day are the result of the sun rotating around the earth, as common sense seems to tell us and as was believed for so many centuries. Instead, the rotation of the earth on its axis gives us night and day. This is now accepted, yet very few well-educated persons will be able to provide the evidential basis that this is so. The same goes for the Big Bang and other new theories in modern cosmology. It means little to most of us if told that one of the critical bits of evidence for the Big Bang is that the spectral lines in light from distant stars show a shift toward red or that the temperature in deep space is little more than one degree on the Absolute Scale. When a well-educated nonscientist accepts that the Big Bang is highly probable, it will almost certainly be because he accepts not the evidence but what the cosmologist says about its significance.

Conflict here to stay

Now back to the question of science and creationism. Does it really matter

if individuals believe in divine creation? People are free to believe anything they wish. As is the case with science, however, religion can be used for good or evil, and the choice depends on human will.

It is probable that the evolution/creationism conflict will be with us as long as the current K-12 curriculum characterizes our schools. A solution will require an understanding of the basis of the disagreements between scientists and creationists. We must realize what scientists mean by confirmable scientific evidence and how it differs from other sorts of evidence. "Scientific" means that it relates to the things and processes of the natural world. "Confirmable" means that the scientific observations must be repeatable by others and the same results obtained. This excludes all supernatural statements that lack the key requirement of repeatability.

The majority of adults lack this understanding of the total incompatibility between what the scientists and creationists have to say. A final answer may come when the educational system changes to provide much better science education in the K-12 curriculum and especially in K-5. To the extent that ignorance is the problem, education is the solution.

The world today has become so complex and uncertain that plans for the present, and especially for the future, must be made on the best available evidence, not on supernatural dreams. For example, the world cannot support an infinite number of human beings, and even today we are exceeding the carrying capacity of nature to supply some of the necessities for life. There can be no *ex deus machina* to save our skins. It is essential for us to use the rational procedures of science to shape our future. Yet science alone will not ensure an acceptable continuation of the human experiment. Science and religion are both human constructs, and our responses to them can be no more than human choices. The future we choose will be an ethical decision, but the voyage toward it must be based on scientific procedures. Both a scientific head and a warm heart are needed—the heart to define the goal and the head to manage the journey.

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UNITED CHURCH BOARD FOR HOMELAND MINISTRIES:
Creationism, the Church, and the Public School

I. Background On The Creationism Issue

Creationism is a relatively recent development in an older and on-going controversy concerning the relationship between science and religion. In the 1920's the teaching about evolution in public schools (specifically the work of Charles Darwin) was challenged on the basis of perceived conflict with biblical teaching. In Tennessee John Scopes was convicted of violating a law which made it "illegal ... to teach any theory that denies the story of the divine creation of man as taught in the Bible, and to teach instead that man has descended from a lower order of animals." Although the conviction was overturned on a technicality, the Tennessee Supreme Court upheld the constitutionality of the law which was not repealed until 1967.

The central issue in challenges such as this is the apparent conflict between scientific explanations about the origins of life, even the cosmos itself, and biblical accounts of creation. Science and religion often are perceived as being in basic conflict concerning creation.

In more recent decades, the debate has taken a new twist. While still opposing the scientific theories of evolution concerning the origins of life, a number of persons began to suggest that certain scientific data and/or approaches could 'prove' the validity of biblical accounts concerning creation. In the 1960's and early 1970's, several organizations were formed to promote the idea that the creation accounts recorded in the book of Genesis were supported by scientific data. The terms "creation-science," "scientific creationism," and "creationism" are used to describe this interpretation of scripture.

This movement took on more focused activity in 1977 when over twenty state legislatures recorded bills requiring teaching of "creation-science" when evolution was taught. This "balanced treatment" proposition was passed as model legislation by the Arkansas Legislature in 1981.

Opponents of the Act, including religious leaders, educators, and scientists, challenged the constitutionality of the Act in the federal courts (*McLean v Arkansas Board of Education*) and in 1982 the law was declared unconstitutional. A similar law was passed in Louisiana and litigation went all the way to the U.S. Supreme Court. The court in *Edwards v Aguillard* declared the law unconstitutional in 1987. the Supreme Court decision has been applied in subsequent cases involving individual teachers who chose to teach "creation-science" outside the curriculum. Federal courts declared that teaching "creation-science" was a religious advocacy and, therefore, unconstitutional. Courts have taken special care to protect the religious independence of students in the public schools.

Since the Supreme Court decision in *Edwards*, creationists have concentrated their efforts at the level of the local school board, where they pressure educators to teach "creation-

science," omit or qualify the teaching of evolution, and/or adopt textbooks that exclude evolution. Additional terms for "creation-science," such as "abrupt appearance theory" or "intelligent design theory" are attempts to avoid the constitutional issue of religious advocacy. However, beyond the notion of "equal time" other issues are emerging. The attempts to use scientific data and methods to prove certain biblical claims are raising concerns among many educators and scientists about the integrity of scientific inquiry itself and what students may be learning about the nature and role of science. Science and scientific methods can be abused by setting out to prove certain assumptions rather than allowing even those assumptions to be open to inquiry and discussion.

The concerns over current activities by creationists touch basic affirmations about the public school made by the United Church Board for Homeland Ministries. The effort to make creationism part of the science curriculum in the public schools tests our commitments to the public school, excellence in education, the integrity of science, and academic freedom. It also tests our interpretation of the Bible and our belief in God's unlimited creative powers.

It is therefore appropriate amidst this controversy for the United Church Board to work with members of the United Church of Christ and others to understand this issue from the perspective of our religious and educational traditions. We mean to assist persons to participate fearlessly in open inquiry, debate, and action concerning the goals of education; to understand the role of science, including an appropriate relationship between science and faith; to help develop consensus in public policy issues affecting the public school; and to support academic freedom at all levels of the educational experience.

II. Affirmations

1) We testify to our belief that the historic Christian doctrine of the Creator God does not depend upon any particular account of the origins of life for its truth and validity. The effort of the creationists to change the book of Genesis into a scientific treatise dangerously obscures what we believe to be the theological purpose of Genesis, viz., to witness to the creation, meaning, and significance of the universe and of human existence under the governance of God. The assumption that the Bible contains scientific data about origins misreads a literature which emerged in a pre-scientific age.

2) We acknowledge modern evolutionary theory as the best present-day scientific explanation of the existence of life on earth; such a conviction is in no way at odds with our belief in a Creator God, or in the revelation and presence of that God in Jesus Christ and the Holy Spirit.

3) We affirm the freedom of conscience and freedom of religion set forth and protected in the U.S. Constitution, including the right of the creationists to their religious beliefs.

4) We believe that the nurturing of faith and religious commitment is the responsibility of the church and home, not of the public school. No person or group should use the school

to compel the teaching or acceptance of any creed or to impose conformity to any specific religious belief or practice. Requiring the teaching of the religious beliefs of creationists in the public school violates this basic principle of American democracy. We concur with judicial rulings that the teaching of the religious beliefs of the creationists in the public school science curriculum is unconstitutional.

5) We assert that the public school science curriculum is not the proper arena for the expression of religious doctrine. However, we believe that the public school does have the responsibility to teach about religion, in order to help individuals formulate an intelligent understanding and appreciation of the role of religion in the life and culture of all people and nations. In this context, it is fully appropriate for the public school to include in its non-science curriculum consideration of the variety of religious literature about the creation and origins of human life.

6) We reaffirm our historic commitment to the public school, and declare that each student has the right to an education which rests firmly on the best understandings of the academic community.

7) We affirm our historic commitment to academic freedom in the public school; in that context, the open and full search for truth about all issues in science including creation must proceed in the light of responsible scholarship and research, subject always to the process of peer review, and of factual and logical verification, and of scientific replication.

8) We reject any modification of science textbooks to include the point of view of the creationists or that weakens scientific teachings, and we support publishers who resist this effort. To do otherwise would abridge both academic freedom and the customary practices of careful scholarship.

9) We affirm the responsibility of professional educators to make final decisions about the public school curriculum. These decisions should be based on sound scholarship, competent teaching practices, and policies of local and state school boards which are accountable to the public and in keeping with judicial decisions upholding Constitutional values.

III. Recommendations

1) That through study and discussion we, as church people, become informed about issues of creation raised by both science and religion, including the "creation-science" controversy.

2) That we urge pastors and teachers to preach and teach about issues of creation, particularly the ways of understanding the first eleven chapters of Genesis, the first chapter of the Gospel of John, and other relevant Scripture passages. We further urge pastors and teachers to teach about the problems of biblical literalism in blocking creative dialogue between the faith community and contemporary educational, scientific, and

political communities.

3) That we support the determination of schools, school boards, and textbook publishers to retain their professional integrity in treating the creationism issue, carefully recognizing the distinction between promoting religion and teaching about religion.

4) That we make all efforts to resist any viewpoint which would maintain that belief in both a Creator God and in evolutionary theory are in any way incompatible. Confident in our conviction that God is the ultimate source of all wisdom and truth, we encourage the free development of science and all other forms of intellectual inquiry.

5) That clergy and laity exercise their civic responsibility to monitor the work of state legislatures, taking care that any discussion of proposed "creation-science" legislation include educational and constitutional questions, and affirming that such legislation is a violation of the First and Fourteenth Amendments of the U.S. Constitution.

6) That informed persons, including clergy and laity, in each community monitor the work of local school boards and state departments of education, so that issues of "creation-science" may be discussed fully and openly if and when they come to their agendas. In communities being divided by the creationism controversy, we ask our people to be both a source of reconciliation and a community of support for those who oppose efforts to present creationism as a science.

7) That concerned educators and citizens work with teachers to support their efforts to teach their disciplines with integrity, rather than omit subjects such as evolution as a way of avoiding controversy.

9) That the church renew efforts to understand and relate to science and technology, not only to comprehend and respond to issues of controversy, but also to discover new ways of appreciating and expressing God's creative and redeeming activity.

IV. For Further Reading

Ronald S. Cole Turner, *An Unavoidable Challenge: Our Church in an Age of Science and Technology*, a Foundation Paper on science and technology as a lifelong issue for education, available from the Division of Education and Publication, UCBHM, Cleveland.

Langdon Gilkey, *Creationism on Trial: Evolution & God at Little Rock*, Harper & Row, 1985.

Betty McCollister, ed., *Voices for Evolution*, the National Center for Science Education, Inc. (P.O. Box 9477, Berkeley, CA 94709)

October 1992 (*This statement supercedes the 1983 statement printed in the first edition of Voices for Evolution*)

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DEALING WITH ANTIEVOLUTIONISM

EUGENIE C. SCOTT

INTRODUCTION

IN NOVEMBER of 1995, the Alabama Department of Education required all biology textbooks used in the state to display a disclaimer informing the young reader that this textbook discusses evolution, a controversial theory some scientists present as a scientific explanation for the origin of living things, such as plants, animals and humans. No one was present when life first appeared on earth, therefore, any statement about life's origins should be considered as theory, not fact.

The governor of Alabama in March of 1996 sent all biology teachers a copy of an antievolution book, *Darwin on Trial*, using his discretionary funds.

Shortly thereafter, another "evolution as theory rather than fact" law was considered in a nearby state. In March of 1996, the Tennessee legislature debated and ultimately rejected a requirement that no teacher or administrator in a local education agency shall teach the theory of evolution except as a scientific theory. Any teacher or administrator teaching such theory as fact commits insubordination.... (Tennessee HB 2972/SB 3229, 1996)

Also during the spring of 1996, Georgia voted down an amendment to an education bill that would "provide that local boards of education may establish optional courses in creationism;" and as part of any science curriculum wherein students are taught concerning the origins of life and living things, including the origins of humankind, teachers shall have the right to present and critique any and all scientific theories about such origins and all facets thereof, including without limitation scientific theories other than evolutionism.

"Critiques of evolution", or "arguments against evolution" are code-phrases for creation science, stimulated by Supreme Court Justice Antonin Scalia's dissent to *Edwards v. Aguillard*, the 1987 case that struck down "equal time for creationism and evolution" laws. Another "arguments against evolution" law was debated by the Senate Education Committee of the Ohio state legislature in May of 1996. It was ultimately rejected (by a vote of 12 - 8). The wording directed that whenever a theory of the origin of humans or other living things that might commonly be referred to as "evolution" is included in the instructional program provided by any school district or educational service center, both scientific evidence and related arguments supporting or consistent with the theory and scientific evidence and related arguments problematic for, inconsistent with, or not supporting the theory shall be included.

And, as this essay was being written, news arrived to the office of National Center for Science Education (NCSE) that the Cobb County, Georgia school district had requested MacMillan-McGraw Hill to delete a chapter on the Big Bang and earth's origin in an earth science booklet for fourth graders, after parents complained. Newspaper accounts reported that MacMillan would comply.

What's going on here? Clearly, pressure against the teaching of evolution has not abated, and (judged from the increasing number of calls for help that NCSE receives) even appears to be on the rise (Gillis, 1994; Scott, 1994; 1996.) What is it about evolution, more than any other scientific theory, that elicits this response? The Alabama disclaimer "no one was present" argument is especially puzzling, as many phenomena studied in modern science are not observed directly. In fact, no one has stood in space and observed the earth making its circuit around the sun through the course of a year, but we do not hear protestations that heliocentrism should be considered just a guess or hunch (the street definition of "theory.")

Heliocentrism, as Galileo discovered, was once considered a challenge to religion, because it was thought to conflict with the Bible. The Bible, read literally, assumes the ancient view of the cosmos that the earth is the center of the solar system and the sun revolves around it. Few Americans these days interpret the Bible as a geocentric document, but a healthy percentage still accept a literal reading of Genesis regarding the separate creation of plants and animals as independent "kinds". This belief contrasts starkly with the scientific concept that living species are descended with modification from ancestors that differed from them. Thus evolution, and not theologically-acceptable heliocentrism, is vigorously opposed by an active segment of modern American society.

Antievolutionism extends beyond mere Biblical literalism, however, as shown by comparing survey data on American religious opinions with survey data on attitudes towards evolution. Polls of adult Americans have consistently shown over the last fifteen years or so that a substantial proportion of us do not think humans evolved (whether other creatures evolved is usually not part of the standard query.) In May of 1996, the National Science Foundation released results from a telephone survey of 2,006 individuals who were asked questions about basic science literacy (Petit, 1996.) One question was, "Human beings as we know them today, developed from earlier species of animals." Only 44% of Americans answered "True". In 1994, the American Museum of Natural History asked "Human beings evolved from earlier species of animals, true or false" and only 45% agreed — results virtually identical to the NSF study.

Defining religious conservatism is tricky, as there is no uniform agreement on terms. One term for conservative Christians is "evangelical." Evangelicals are Christians who believe the Bible is inerrant, and that salvation is achieved only through Christ (Hunter, 1983.) According to Marsden (1987), about 20% of Americans are evangelicals, far fewer than the 44% of Americans who reject evolution.

In a nutshell, there is more antievolutionism than there are religious conservatives: antievolutionism appeals both to evangelicals as well as Americans who adhere to religiously-moderate faiths. There is an irony here: the "official" theologies of Catholic and mainstream Protestant Christianity are not literalist, and have accommodated evolution as the way God created (Scott, 1995.) NCSE's book, *Voices for Evolution* (Matsumura, 1995), includes a collection of statements from the Roman Catholic Pope, the Episcopalians, Methodists, United Church of Christ, Presbyterians, and the Lutheran World Federation (and several Jewish groups) all expressing respect for science and for evolution as part of science. Nonetheless, even if the ministers, priests and rabbis accept evolution, many people on the other side of the pulpit appear largely ignorant of their own theology!

It is important for those of us trying to teach evolution to recognize that many of our fellow citizens find evolution profoundly disturbing. They have been told or have somehow acquired the belief (sometimes from scientists, unfortunately) that evolution "proves" that there is no purpose to life, that life has no meaning, that they must give up their sense of the divine. According to a respected City College of New York poll, 90% of Americans describe themselves as religious (Goldman, 1991.) If evolution is presented as antithetical to religion (which is precisely how organizations such as the Institute for Creation Research present it), it is no wonder that a high percentage of Americans reject it. Actually, as suggested by the selections in *Voices for Evolution*, mainline Christianity can accommodate evolution, though it is doubtful that Biblical literalism can. As teachers and scientists, we need to leave an opportunity for the religious individual to work out the accommodation according to his or her beliefs, and not slam the door by inserting extra-scientific philosophical statements about purpose and meaning into our discussions of evolution. I will discuss this in greater detail below.

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THE IMPORTANCE OF EVOLUTION IN THE CURRICULUM

Evolution is a necessary part of the science curriculum. A biology or earth science course taught without the inclusion of evolution is an inferior course. Students who take these courses without being told that evolution unifies the data and concepts of the field are being cruelly short-changed. They will leave the course having being misled that science largely consists of the tedious memorization of lists of facts, rather than a tool we can use to help us understand the world of nature. This episodic, atomistic view of science is particularly regrettable: it turns students away from studying science, and perhaps worse yet, defeats our efforts to produce a scientifically literate society.

Evolution needs to be taught, but some teachers will be doing so in a hostile environment. How can teachers present this topic and avoid the potential minefields? Or, since some of the land mines are unavoidable, how can a teacher defuse them?

Evolution Happened — First, teachers need to be confident that evolution is state of the art science. A common claim made by antievolutionists is that evolution is a "theory in crisis," in the words from the title of a popular antievolution book (Denton, 1985.) Many teachers have not studied evolution, feel unconfident about teaching it, and are susceptible to being swayed by "new" information that "evolution is not as well accepted as it used to be". Evolution is presented matter-of-factly at every decent college or university in this country, including Brigham Young, Notre Dame, and Baylor. It is simply untrue that evolution is being widely challenged by scientists themselves. Help your colleagues to understand that scientists do not debate whether evolution (change through time, descent with modification) took place, though they vigorously argue how it took place — the processes, mechanisms and details of evolution. The previously-mentioned *Voices for Evolution* contains 33 statements from scientific organizations, all of which reassure teachers that evolution is indeed the reigning paradigm explaining how the universe came to be in its present state. Some statements, such as that from the National Academy of Sciences' booklet *Science and Creationism*, clearly distinguish between evolution as something which should be taught in the science classroom, and creation science which should not:

...the Academy states unequivocally that the tenets of "creation science" are not supported by scientific evidence, that creationism has no place in a science curriculum at any level, that its proposed teaching would be impossible in any constructive sense for well-informed and conscientious science teachers, and that its teaching would be contrary to the nation's need for a scientifically literate citizenry and for a large well-informed pool of scientific and technical personnel. (Committee on Science and Creationism, 1984, p. 7-8.)

As scientists agree that evolution is a crucial part of science, so also do educators. The National Science Education Standards, released in February of 1996, present evolution as one of the "Unifying Concepts and Processes," as well as listing it prominently in the Content Standards for grades 9-12. Anticipating a tendency for states and districts to pick and choose among the standards rather than truly revise their curricula, the publication states firmly that, "No standards should be eliminated from a category." Perhaps presciently, the Standards chose evolution as a negative example. "For instance, 'biological evolution' cannot be eliminated from the life science standards." (National Research Council, 1996, p. 112.)

"Benchmarks for Science Literacy," the 1993 publication by the American Association for the Advancement of Science's Project 2061: Science for All Americans, cites evolution as an integral part of the science curriculum. Similarly, the California Science Framework and the curricula of most other states require evolution to be presented. (Some disguise it as "change through time," and confuse ontogeny with phylogeny by referring to evolution as "development.") Voices for Evolution includes statements from 30 science education organizations including the National Science Teachers Association, the National Association of Biology Teachers, and the National Science Supervisors Association — all exhorting science educators to teach evolution and not present creation science. If evolution is a "theory in crisis," somehow the entire science and education establishments are unaware of it.

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KNOW WHAT YOU ARE TALKING ABOUT!

Now, appealing to authority may often be effective with students, but it is hardly something we wish to encourage! Opponents of evolution rely exceedingly heavily upon (out of context) quotations from authorities like Stephen Jay Gould in their attacks upon evolution. Because "famous scientist X" said something, it supposedly should be accepted. As it happens, when it comes to appeals to authority, the pro-evolution side wins hands down! We have the National Academy of Science, the Nobel laureates, and all the other heavy hitters of big science — but what is more important, we have the science itself. Teachers need to be familiar with the data and theory of evolution, and why this theory has such strong explanatory power. Evolution is accepted by scientists today because it explains more observations than any alternative. Any of a number of basic college level biology and especially evolution textbooks will provide teachers with plenty of evidence for evolution being the unifying theory explaining observations from biogeography, comparative anatomy, comparative biochemistry, the fossil record, developmental biology, and many other fields.

Define Evolution — A colleague in physical anthropology teaching a small college in the Southeast told me she was teaching a class of freshmen college students and found

that none of them had ever studied evolution or even knew what evolution was. When they found out, they found the concept exciting and intellectually challenging, and they clamored for a special course on the topic. Their response, in her words, was "Of course species change through time! You mean that's evolution?!"

Sometimes finding out what evolution actually is (or more precisely, replacing erroneous ideas about evolution) in itself reduces students' reluctance to learn about it. A proper definition of evolution is important to helping students understand the concept.

It's been my experience (and perhaps yours too) that most non-scientists think evolution means "man evolved from monkeys," which is an exceedingly narrow definition. It is both scientifically accurate as well as strategically wise to embed evolution within the broadest scientific context possible. Evolution isn't just about humans, or even about living things. Astronomers do, after all, study cosmic evolution. Geologists and geophysicists study the evolution of the planet earth, and evolution is the organizing concept of earth science just as it is for the life sciences. Biologists and biochemists study the change through time of living things. Rejection of evolution doesn't mean merely rejection of "man evolved from monkeys," but rejection of principles relevant (and in some cases crucial) to modern science.

The word "evolution" is defined and used in many different ways, some more useful and accurate than others. Embedding evolution in a wide range of sciences requires a broad definition. What unites astronomical, geological, and biological evolution is the concept of change through time. But "change through time" can also refer to phenomena like the water cycle, or the rotation of the earth around the sun, or the passage of energy through a food chain, or the metamorphosis of insects. Not all change is evolution, so we must distinguish evolution as being cumulative change through time. The evolution of a star from white dwarf to supernova is one such cumulative change.

When we discuss organic evolution, we must be especially precise. Here I part company with many of my colleagues: I do not find the traditional "evolution is changes in gene frequencies through time" to be a useful definition, even if it were modified to be "cumulative changes in gene frequencies through time." Especially at the beginning of a course, who knows what a gene frequency is? The genetically-based definition of evolution is useful in understanding the major constituents of evolution (genetic variation, adaptation, reproductive isolation/speciation), but if a teacher waits until students understand all of the related concepts, it will be the end of the semester. If evolution is to be taught as the organizing principle of biology, we shouldn't wait until the end of the semester to let them in on the secret! I find that even college students lose track of the relationship of evolution to biology using this genetically-based definition, and I am sure high school students will also.

What do we want students to know about organic evolution? The "Big Idea" is that living things (species) are related to one another through common ancestry from earlier forms that differed from them. Darwin called this "descent with modification," and it is still the best definition of evolution we can use, especially with members of the general public and with young learners. Descent with modification makes biology make sense. We can study and understand the workings of evolution using genes, cells, fossils, ecology, taxonomy — you name the biological subfield, and evolution is there.

For example, everyone teaches some taxonomy in high school and junior high. But how

many explicitly teach how the concept of descent with modification makes it possible to group organisms into taxa? Horses and donkeys are similar because they shared a common ancestor quite recently, geologically speaking (in fact, they can still interbreed, though the hybrid is sterile.) The horse/donkey group can be grouped with zebras because it shared a common ancestor with zebras, and so on up through genera, families, orders, classes, and phyla. Most of the time taxonomy is taught backwards: organisms are classed together because they are similar. Wrong. They are classed together and they are similar because they shared a common ancestor.

A good example of a confused understanding of evolution is even found in some textbooks. How many times have you seen the peppered moth or other cases of industrial melanism used as an example of evolution? It is an example of change, but fluctuating change. Remember that the frequencies of melanic genes shifted back to their pre-industrial lows after scrubbers were placed on smokestacks and air pollution was reduced. Industrial melanism is an example of natural selection, not of evolution. A good exercise would be to have the students figure out whether industrial melanism could be an example of evolution (as in our definition of "descent with modification.") (Hint: add reproductive isolation and speciation!)

Define Theory — Not incidentally, teachers also need to be clear in their minds about what a "theory" is, because (as illustrated in the examples with which I opened this essay) evolution is under attack for being "just" a theory. The problem is that "theory" is used outside of science in a deprecating way as a synonym for guess or hunch. What is a "fact" and what is a "theory?"

A fact is a confirmed observation. For example, it is a confirmed observation that every tetrapod known has at some stage of its life, a humerus, a radius and ulna, and a distal cluster of bones corresponding to carpals, metacarpals and phalanges. The general public (and even some scientists) use the word "fact" to imply capitul T "Truth": unchanging agreement. In science, facts, like theories, may change: it was once a fact (for about 10 years) that Homo sapiens had 48 chromosomes. But other observations were confirmed and explanations found for the erroneous observations, and now we know that there are 46. In general, though, in science we treat facts as statements we don't need to test and question anymore, but rather can use as givens to build more complex understandings.

A theory, in science, is a logical construct of facts and hypotheses that attemptsto explain a natural phenomenon. It is an explanation, not a guess or hunch that one can casually disregard. Theory formation — explanation — is the goal of science, and nothing we do is more important. A scientist joked that we should applaud the Tennessee law punishing teachers for teaching evolution as a "fact rather than a theory" because "everyone knows that theories are more important than facts!" Theories explain facts, but the general public doesn't know that.

Concerning evolution, then, what's a fact and what's a theory? One hears from many scientists, "Evolution is FACT!!!" The meaning here is that evolution, the "what happened," is so well supported that we don't argue about it, anymore than we argue about heliocentrism versus geocentrism. We accept that change through time happened, and go on to try to explain how. What we mean and what is heard is often different, however. What the public often hears when scientists say "Evolution is FACT!" is that we treat evolution as unchallengeable dogma, which it isn't.

We must learn to present evolution not as "a fact" in this dogmatic sense, but "matter of factly," as we would present heliocentrism and gravitation. Most people consider heliocentrism and gravitation as "facts", but they are not "facts" in my definition of "confirmed observations." Instead, they are powerful inferences from many observations, which are not in themselves questioned, but used to build more detailed understandings.

From the standpoint of philosophy of science, the "facts of evolution" are things like the anatomical structural homologies such as the tetrapod forelimb, or the biochemical homologies of cross species protein and DNA comparisons, or the biogeographical distribution of plants and animals. The "facts of evolution" are observations, confirmed over and over, such as the presence and/or absence of particular fossils in particular strata of the geological column (one never finds mammals in the Devonian, for example.) From these confirmed observations we develop an explanation, an inference, that what explains all of these facts is that species have had histories, and that descent with modification has taken place. Evolution is thus a theory, and one of the most powerful ones in science.

We may also speak of "theories" (plural) of evolution, in the sense of the explanations for how descent with modification has taken place. It is conceptually sound to separate evolution as something that did or did not happen from explanations about how, or how fast, or which species are related to which. I'll return to this idea below.

Indeed, teachers have to be sure that students know what theories are and why they are important. Students also must — this is crucial — learn as part of their science instruction that our explanations change with new data or better ways of looking at things. Antievolutionists make the statement that "evolution isn't science because you guys are always changing your minds about stuff." This is not a criticism. That's the way a vigorous science works.

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DEALING WITH ANTIEVOLUTIONISM

EUGENIE C. SCOTT

DEFUSE THE RELIGION ISSUE

People don't oppose evolution because they disagree with the science but because it offends their religious sensibilities. In most communities, at least some students come into a class wary of the "e-word" because somehow they have acquired the idea that acceptance of evolution is incompatible with religious faith. Antievolutionists, in fact, make a special point of proclaiming that one is either an evolutionist or a creationist, falsely dichotomizing the issue. Although it is not the job of public school science teachers to teach theology, when students come to class with their fingers stuck into their ears and their eyes closed, it is necessary to figure out a way to get the fingers out and the eyes open.

Most Catholic and mainline Protestant denominations have accepted evolution as the way God brought the world about, and this is also true of the theology of all but the most conservative Jews. Although it would be inappropriate for a teacher to encourage students towards or against any religious view, it is appropriate to inform them, in a comparative sense, of the existence of more than one religious perspective on creation and evolution. Because students are not *tabulae rasae* when they come to class, a constructivist approach is a useful way to help them build their understanding of this important fact.

Teachers have told me they have had good results when they begin the year by asking students to brainstorm what they think the words "evolution" and "creationism" mean. As expected, some of the information will be accurate and some will be erroneous. Under "evolution," expect to hear "Man evolved from monkeys" or something similar. Don't be surprised to find some variant of, "You can't believe in God" or some similar statement of supposed incompatibility between religion and evolution. Under "creationism" expect to find more consistency: "God"; "Adam and Eve," "Genesis," etc. The next step in constructing student understanding of concepts is to guide them towards a more accurate view. One goal of this exercise is to help them see the diversity of religious attitudes towards evolution.

After one such initial brainstorming session, one teacher presented students with a short quiz wherein they were asked, "Which statement was made by the Pope?" or "which statement was made by an Episcopal Bishop?" and given an "a, b, c" multiple choice selection. All the statements from theologians, of course, stressed the compatibility of theology with the science of evolution. This generated discussion about what evolution was versus what students thought it was. By making the students aware of the diversity of opinion towards evolution extant in Christian theology, the teacher helped them understand that they didn't have to make a choice between evolution and religious faith.

A teacher in Minnesota told me that he had good luck sending his students out at the beginning of the semester to interview their pastors and priests about evolution. They came back somewhat astonished, "Hey! Evolution is OK!" Even when there was

diversity in opinion, with some religious leaders accepting evolution as compatible with their theology and others rejecting it, it was educational for the students to find out for themselves that there was no single Christian perspective on evolution. The survey-of-ministers approach may not work if the community is religiously homogeneous, especially if that homogeneity is conservative Christian, but it is something that some teachers might consider as a way of getting students' fingers out of their ears.

A less constructivist but not necessarily ineffective approach is to begin by properly separating "evolution" as something that occurred (change through time) from the processes and mechanisms — the causes — of evolution. Define evolution as an issue of the history of the planet: as the way we try to understand change through time. The present is different from the past. Evolution happened, there is no debate within science as to whether it happened, and so on. Then, list (for later discussion) a number of causes or processes which might explain in whole or in part, how this change through time might have taken place. Stress that this is where debating takes place. List both currently-debated and also rejected explanations, such as Lamarckism, saltation, Darwinian natural selection, neodarwinism, non-Darwinian evolution, and so on. At the end of the list (and I recommend using a transparency or writing the list on the blackboard), include "Supernatural Causation". Explain that some people think that change through time is caused directly or indirectly by a supernatural being, including God, the Hero Twins (Navajo), or some other supernatural power. At this point you then state because this is a science class, and science is limited to explaining through natural forces, we cannot discuss supernatural causation here.

I have used this approach at the college level and seen a remarkable development: the fingers start coming out of the ears. Just by mentioning the fact that some people believe God was responsible for change through time, you are recognizing the view of many Christian and Jewish students, even though you are not going to discuss it further (you're not a theology teacher!) Many religious students have never been exposed to a continuum of religious views, and in a very real sense, you are giving them an opportunity to listen to you and not shut you out. Note that you are not to promote theistic evolution: the schools must be religiously neutral. The purpose of this exercise is to give the student some critically important information so that he or she will be more willing to listen to the scientific information you will present.

Similarly, it is useful to separate "creationism" into two parts. Most Americans define "creationism" as "God Created," and when creationism is juxtaposed with evolution, the translation made is that "evolution = God didn't create." This is the perspective promoted by antievolutionists, of course, but it is an unnecessary dichotomy. As discussed above, mainline Christian and Jewish theology accept evolution as the way God created. The other type of "creationism" tries to more specifically answer the question, "what happened?" Special creation, the view of biblical literalists, is that everything in the universe was created all at one time, in its present form. From my experience in dealing with the general public on this issue (radio talk shows are very educational...), most Americans are willing to accept that change through time has taken place, but they very much want to retain God as the creator.

Whether God created is of course, not a scientific question, because science is restricted to explaining natural phenomena using only natural processes. But science can tell us a great deal about "what happened," and the evidence powerfully leads us to conclude that

change has taken place, not that everything appeared in its present form.

Helping students understand that evolution, like all scientific explanations, deals only with proximate, never ultimate cause, allows them to accommodate their religious views to evolution, if they so choose. Much resistance to evolution is overcome by allowing the religious student to retain his or her faith in God the creator, while still accepting the scientific evidence for descent with modification.

"But I don't believe in evolution!" — There will doubtless be students who refuse to accept evolution. That's all right. Remember, the job of you and your colleagues at the K-12 level is to help students understand the consensus view of a discipline, whether it is history, literature, mathematics, or science. No one said a student has to "believe" in a spherical earth, and in fact, a teacher in a small mountain community in Appalachia told me that she had a brother and sister who would walk out of the class when she discussed a heliocentric solar system! It's the job of the teacher to instruct, not to indoctrinate. All you are asking is that the student learn the subject. Whether he agrees with what is being taught is up to him. Although you'd feel silly telling students, "Well, kids, today we're going to discuss the theory of heliocentrism, but you don't have to believe it!" tension is often reduced when you reassure students that all you're expecting of them is to learn the material (they have to pass the test, after all.) Whether they accept the modern scientific consensus that evolution occurred is up to them.

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COUNTER THE "EQUAL TIME"/"FAIRNESS" SENTIMENT

Schoolboards in every state have been pressed by citizens to include creationism in the science curriculum because "you already teach evolution, so it's only fair to teach creationism too." The idea of "balancing" evolution with creationism, giving "equal time," out of "fairness" is an approach that resonates with Americans. It is, in fact, the strongest argument creationists have raised — not because of logical soundness, but because Americans value fairness and equality.

Science is not a democratic process — We decide which explanation (theory) is superior based on its power to explain successfully, not on how popular it is. Heliocentrism was not a popular idea 300 years ago — ask Galileo — but it is now the standard explanation for the relationship of the earth to the sun because it explains so many more observations than any other theory. The theories of kin selection and parental investment derived from sociobiology are not "popular" views, but if they continue to explain social behavior successfully, they will be utilized.

If scientists could vote to choose theories, I'd vote for Lamarckism! It's a lot more humane and useful than natural selection! But the world doesn't work that way. The laws of nature work as they will, irrespective of human wish or will. The explanations scientists accept are the ones that work, and Lamarckism doesn't work. The special creationism explanation that the universe was created all at one time in its present form doesn't explain nature nearly as well as the evolutionary explanation that the universe has had a history and that change has taken place. Thus, special creation has been discarded as a scientific explanation.

"It's only fair!" — It is not "fair" to mislead students by pretending that discarded ideas

are still viable. We do not present geocentrism and heliocentrism as if they are currently contending theories. We only confuse students by presenting special creation and evolution as if both were equally scientific and as if scientists were still trying to decide between them.

There is another question regarding the "fairness" approach: How should educational curricula be determined? Most of the time, we agree that the consensus scholarship of history, literature, art, or science should be presented to Kindergarten-12th grade students. We do not teach astrology with astronomy because professional astronomers (and physics teachers) tell us that astrology is not considered good scholarship. Biologists, geologists, astronomers and other scientists tell us that evolution should be taught, and creation "science" should not. The proponents of creationism in the curriculum are a political pressure group outside of the educational and scientific communities. A good defense against the "fairness" argument is to point out that we do not determine scholarship depending on what a political pressure group wants, otherwise we would teach Holocaust revisionism along with standard World War II history, and give equal time in medical school to the ideas that AIDS is caused by viruses and AIDS is a curse sent from God.

"Teach both creationism and evolution to promote critical thinking" — Often teachers are encouraged by parents or others to present creationism with evolution for pedagogical reasons: supposedly, presenting nonscience with science and "letting the children decide" will improve their reasoning skills. It makes more sense to have students practice critical thinking by evaluating ideas that are truly in contention. Few teachers would have students evaluate the "scientific" evidence for flat-earthism (there is some, with emphasis on the quotation marks!) versus spherical-earthism "and let the children decide." Again, the creationists make an issue of whether evolution occurred, rather than how. The scientific debates concern the latter, not the former.

It is possible to use creationism and evolution as foils in a discussion of the nature of science, but this may well result in a student's taking offense at what may appear to be criticism of his or her religion. It is better to avoid this, for many reasons.

Evaluating the creation science literature requires far more background than students have, or will have — and maybe even than the teacher has. Most teachers would not ask students to evaluate whether balloon angioplasty or by-pass surgery should be used to treat heart failure, and that question deals "only" with medicine, one field in biology. Consider that organic evolution (not to mention astronomical and geological evolution) relies on data from biochemistry, comparative anatomy, the fossil record, biogeography, and many other fields. The vast majority of students are not well enough versed in even one of these areas to critically evaluate it. The amount of time devoted to evolution in most classes is pitifully small as it is, although the consensus of science educators and scientists is that it should be the organizing principle of biology and geology, and be referred to regularly throughout the semester. Few teachers who favor teaching the "two models" would be willing to spend enough time teaching about evolution so that students could see why the creationist arguments are faulty.

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SUMMARY

Teachers should teach evolution, but in many classrooms they encounter much

opposition, mirroring the rejection of evolution by large percentages of the population. There are three approaches discussed here to help teachers deal with antievolutionism.

First, be informed about the nature of science, and the science of evolution.

Second, understand the religiously-based opposition to evolution, and consider ways to defuse it. Before students can learn evolution, they must be willing to learn, and many come into class thinking that evolution is incompatible with their religious views. In some cases, this will indeed be the case, and nothing a teacher can say will change it. In this situation, it is best to remind the student that the job of the teacher is to communicate the consensus view of the field, and the job of the student to learn it. Whether the student accepts what he learns is up to him. For most students, becoming aware of the plurality of religious views towards evolution allows them to accommodate their views to the science you are presenting.

Finally, there is much pressure on teachers to teach creationism along with evolution in the science class because doing so is "fair," or perhaps "good pedagogy". Neither is the case: students should learn state of the art science, not outmoded views which have been rejected as science. Also, we do not determine curricula based on the desires of a pressure group, but based on the consensus of scholars in the field.

But teachers themselves need to take the initiative, because ultimately, the buck stops in the classroom, with the teacher. Many teachers teach science without having had training in the subject, or with only inadequate training. Especially at the elementary level, many teachers have "science phobia". These teachers are especially reluctant to teach evolution, for obvious reasons. They need better knowledge of the content of science, but they also need encouragement to teach a controversial issue. There are many knowledgeable teachers who are teaching evolution, and teaching it well. You have a responsibility to mentor those who are not, and I encourage you to do so.

Evolution is the organizing principle of biology and geology, and it needs to be taught if we are to produce new scientists as well as have a scientifically literate society. There is help for teachers willing to teach this "controversial subject," from organizations like the National Association of Biology Teachers, the National Center for Science Education, and also — most importantly — from colleagues.

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