Science and Religion: Evolutionism and Creationism in Education.
A survey of teachers conceptions in 14 countries

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Abstract

The renewed creationist movements are currently seen as a threat for science teaching in the world What is their impact on teachers' conceptions? We present here the results of a first large survey on this question, analysing teachers' conceptions in 14 countries (5 in Africa, 1 in Middle East and 9 in Europe). The total sample is composed of 5700 teachers (partly in-service, partly pre-service) of primary and secondary schools; 1846 of these teachers have biological training, 1787 have language training and 2077 have training to teach in primary school. We used a questionnaire including personal information and 15 questions on Evolution. The results show high significant differences between countries, religions, ageing, gender and level of instruction. This latter effect suggests the need for increasing the level of teachers' training in order to overcome the current increasing creationist movements.

Acknowledgements

Introduction and the goals of this research

A good relation between science and religion in the educational systems is a great challenge for the Peace in the world. The situation is very contrasted from one country to an other, religion being or not officially part of the national curricula and taught or not in the public schools. The growing offensive of fundamentalist religious groups is trying to disturb science teaching, proposing to introduce creationist ideas in the curricula or, at least, to avoid to teach evolutionism in schools. This offensive is particularly covered by media in USA (Lecourt 1998, Arnould 2007), but is also present in other countries (Picq 2007). To counter-attack, the scientists mainly develop the facts of the Evolution (National Academy of Science, 2008) to help media and teachers.

Nevertheless, we need to know better the present impact of creationist ideas on teachers, particularly the biology teachers, and on the systems of education around the world. To know

the conceptions of teachers on evolutionism and creationism is a first step to try to improve the teachers' training related to this fundamental topic.

In fact, the links between science and religion could be peaceful. The historians of science analysed that the modern science born in a religious context where the laws of the nature, considered as created by God, were possible to analyse and describe, and had to be respected. After some conflicts as the Galileo affair, the three main monotheist religions (Jewish, Christian and Muslim) have accepted the autonomy and respect of science. The pope Jean-Paul 2 clearly recognized in 1996[1] that the theory of evolution is no more to be considered as a hypothesis after the amount of new knowledge in this field. Today, it is quite possible to believe in God (being Jewish, Christian or Muslim) and at the same time to be evolutionist. Nevertheless, inside these three monotheist religions, some fundamentalist groups, as the "*born-again Christians*"[2] are claiming that evolutionism is not compatible with religion and that the educational systems would have to respect their creationism, at least through its new look: the intelligent design.

What is the impact of this renewed creationism movement on the educational system, and mainly on teachers' conceptions? We tried to answer to this question by carrying out a large enquiry in 19 contrasted countries (table 1) where until now no enquiry has been applied to teachers' conceptions on evolution. We present here some of our results, showing that the creationist convictions are much more present that it was expected and are linked to several parameters.

Methodology

The methodology has been developed in the context of the European FP6 research project Biohead-Citizen (CIT2-CT2004-506015; 2004-2008). The choice of 19 countries has been determined before the beginning of the project. Nevertheless, one African country failed, and an other African country has been recently involved (Burkina Faso). The 15 questions about evolution have been filled only in 14 countries (table 1). In each country, six samples of approximately 50 persons each, were interviewed: primary school teachers (one sample of pre-service, and one of in-service), secondary school teachers in biology (pre-service and in-service) and secondary school teachers in national language (pre-service and in-service). For the 14 countries, the total sample comprises 5700 teachers (about half pre-service and half in-service). The biologists represent about 1/3 of the total sample (1836 : table 1); 1787 have language training and 2077 have training to teach in primary school. The declared religion of each teacher is at the origin of the table 2; only few teachers (about 8%) marked they did not want to answer to this question (one of the alternatives to be chosen); the very few represented religions have been also included in this category "other". Each country can be characterized by a dominant position (sometimes by two : table 2).

Table 1 -
Number of teachers (pre-service + in-service) per country, in the 14 countries

Country (sigla)	Country	Total sample	including biologists
BF	Burkina Faso	296	92
CY	Cyprus	322	63

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[1] http://www.hominides.com/html/theories/jean_paul_evolution.html

[2] George S., 2007 - *La pensée enchaînée.* Paris : Fayard (translation from English: *Culture in chains. How the Secular and Religious Right Captured America*).

DZ	Algeria	217	57
EE	Estonia	182	60
FI	Finland	306	121
FR	France	732	249
HU	Hungary	334	108
IT	Italy	559	119
LB	Lebanon	722	212
MA	Morocco	330	128
PT	Portugal	350	102
RO	Romania	273	93
SN	Senegal	324	114
TN	Tunisia	753	318
Total		*5 700*	*1 846*

Table 2 - *The repartition by religion of teachers (pre-service + in-service) of the total sample, for the 14 countries*

	14 countries	Main countries where > 50% (in brackets where about 30%)
Agnostic	713 (12,5%)	France, Estonia
Catholic	1523 (26,7%)	Italy, Portugal, Hungary, Burkina Faso, (Lebanon), (France)
Protestant	408 (7,2%)	Finland, (Estonia)
Orthodox	518 (9,1%)	Cyprus, Romania
Muslim	2087 (36,6%)	Algeria, Tunisia, Morocco, Senegal, Lebanon
Other	451 (7,9%)	Mainly no answer, in the 14 countries
Total	*5700 (100%)*	

The questionnaire was built with a lot of guaranties that are described in other works (Clément & Carvalho 2007):
* The first step: a clear definition of the research goals and of the theoretical background. We mainly used the KVP model (conceptions as interactions between scientific Knowledge, Values and social Practices: Clément 2004, 2006)
* The second step: gathering questions related to our goals. Most of them were already validated in previous researches, but some were new.
* The third step: questionnaire translation, and validation of the translations.
* Interviews to identify difficulties related to some questions.
* Using a pilot test to analyse the reliability of each question, in each country, to choose the most discriminating questions, and the most pertinent ways to analyse data**.**

The questionnaire was dealing with 6 topics, being evolution one of them. The list of the 15 questions on Evolution is presented in the Annex 1. Four of them were included in the questionnaire A filled in by 19 countries. The eleven other ones were in the questionnaire B filled in together with the questionnaire A in 14 countries. Only the results related to these 14 countries are presented below.

The answers were then analysed by several ways: classical statistical analyses as well as different multivariate analyses that are presented in other publications (Munoz et al 2007 and submitted, Quessada et al, 2007).

Results and discussion

3.1. Answers to the question B29a: The theory of evolution contradicts my own beliefs ☐ Yes ☐ No

This question is very simple, measuring the teachers convictions for or against the theory of evolution. It was surprising to find a large amount of teachers against evolution in some countries. We will call them "creationists" ("not evolutionist creationists").
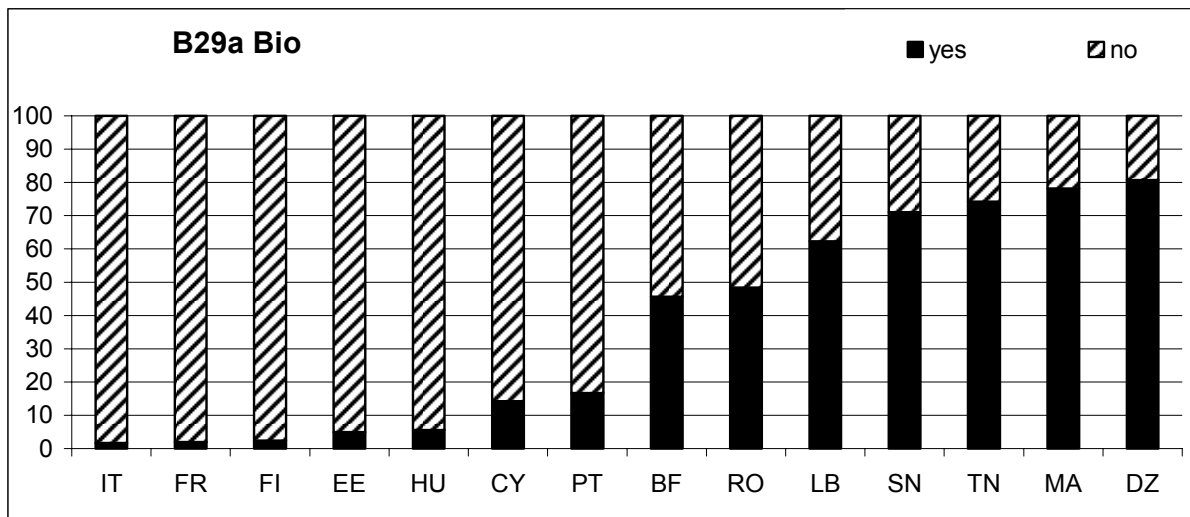
Figure 1 : *answers of the 1836 Biology teachers (in service and pre service) to the question B29A in 14 countries (for the names of the countries, see the table 1). In black : Yes, the theory of evolution contradicts my own beliefs.*
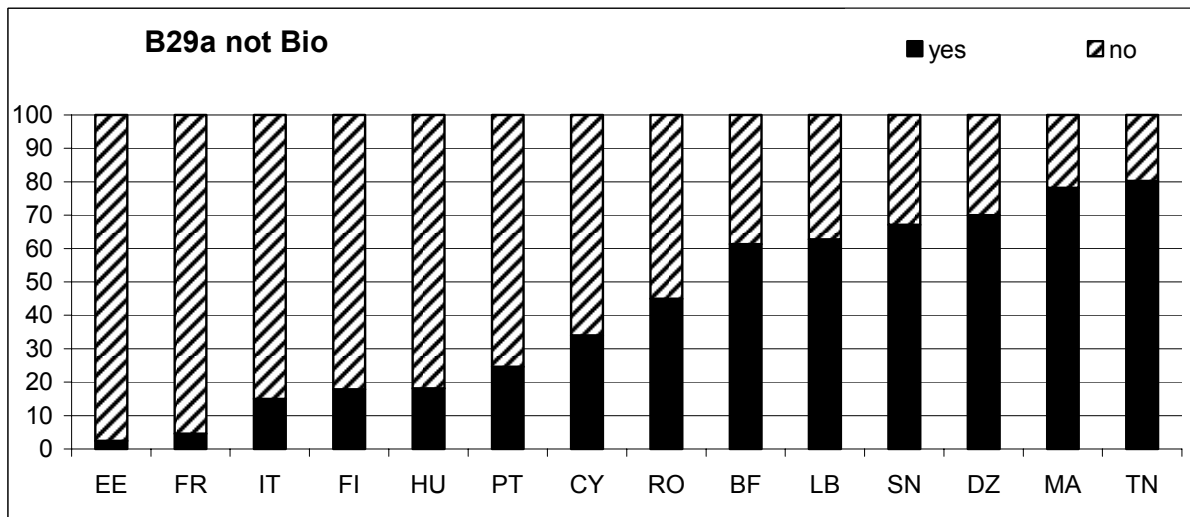
Figure 2 : *answers of the 3864 other teachers (Not Biology: in service and pre service) to the question B29A in 14 countries (for the names of the countries, see the table 1). In black : Yes, the theory of evolution contradicts my own beliefs.*

Five groups of countries can be distinguished:
(A) Less than 5% of creationist teachers, with no difference between biology and other teachers: France and Estonia.
(B) 3% to 6% of creationist biology teachers but 15% to 18% of other teachers, with significant differences between biology and other teachers: Italy, Finland and Hungary.
(C) 15% to 30% of creationist teachers, with no significant difference between biologists and other in Cyprus, but a significant difference in Portugal (p=0.004, 17% and 26%).
(D) 45% to 48 % of creationist teachers in Romania and Burkina Faso, with no difference between biologists and other in Romania, but a clear difference (p<0.001) in Burkina Faso (with 61% of creationists for the not biology teachers).
(E) 62% to 81% of creationist teachers (with no difference between biologists and others) in Lebanon, Senegal, Tunisia, Morocco and Algeria)
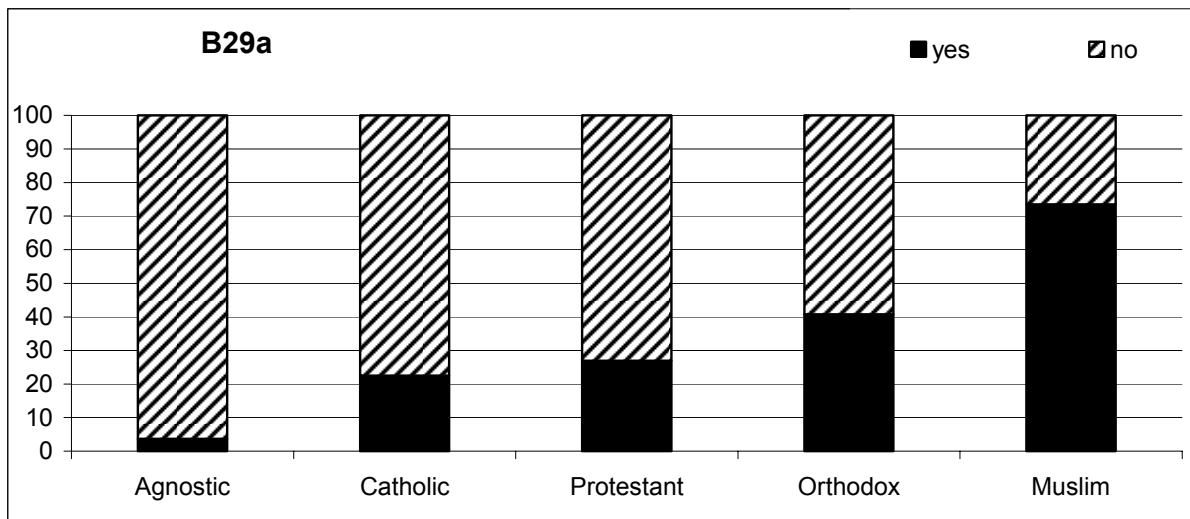
Figure 3 : *answers of 5249 teachers (in service and pre service) to the question B29A for the main religions. In black : Yes, the theory of evolution contradicts my own beliefs.*
(N.B. The difference between the 5700 and 5249 teachers corresponds to the no answer to this question)

The amount of creationists is very different ($p<0.0001$) from one religion to an other, except for the catholic and protestant teachers ($p=0.78$)[3].

Without surprise, the agnostic or atheist teachers are almost all clearly evolutionist. Inside the Christian religion, the Orthodox (most of them are living in Romania and in Cyprus) are more creationist than Catholics and Protestants (41% against about 25%). We will show below that there are differences inside the Catholic teachers, who are more creationist in Lebanon or in Burkina Faso (outside Europe) than in the European countries included in our sample.

The Muslim teachers are the most creationist (73.5%), and most of them are living outside Europe. The question is: Is the high amount of creationist conceptions more linked to the socio-economic level of development of the country than to the religion (Christian or Muslim)?

3.2. Answers to the question B28 related to the origin of humankind

B28. Which of the following four statements do you agree with most? Select **ONLY** one sentence:

1 - ☐   It is certain that the origin of the humankind results from evolutionary processes.
2 - ☐   Human origin can be explained by evolutionary processes without considering the hypothesis that God created humankind.
3 - ☐   Human origin can be explained by evolutionary processes that are governed by God.
4 - ☐   It is certain that God created humankind.

The items 1 and 2 are clearly evolutionist and not creationist, the item 1 being more affirmative, more dogmatic also, than the item 2. The item 3 is evolutionist and creationist, without contradiction because God is governing the processes of evolution studied by the scientists. The item 4 is clearly creationist and not evolutionist (as is the "yes" in the precedent question B29a). Items 1 and 4 correspond to more radical convictions (respectively scientist and creationist). Items 2 and 3 identify explicitly areas for science and religion: evolutionist without God (item 2) or evolutionist with God ("evolutionist creationists": item3).

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[3] Pairwise comparisons using t tests with pooled SD (P value adjustment method: Bonferroni)
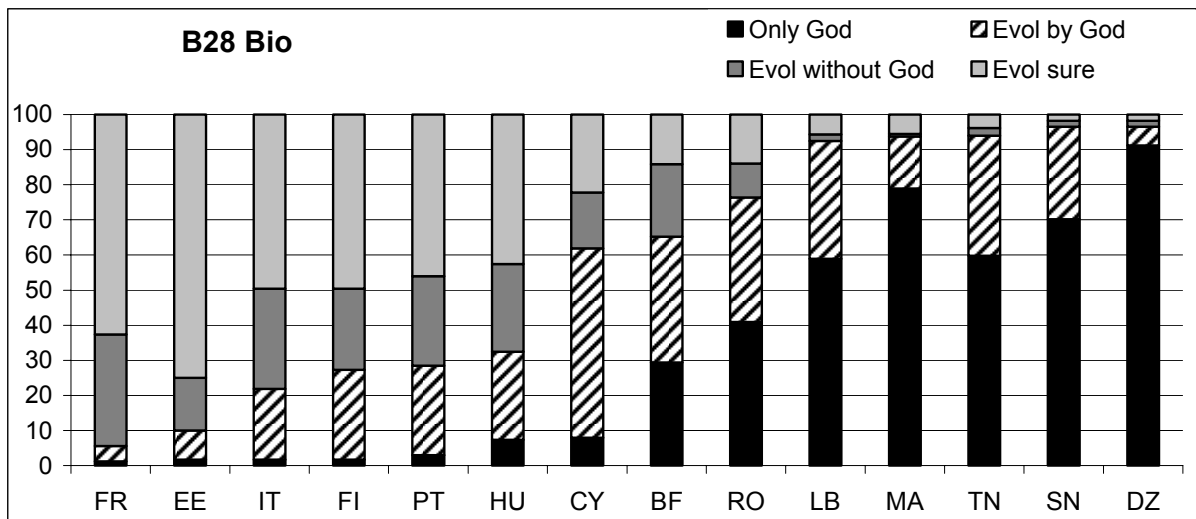
Figure 4 : answers of the 1836 Biology teachers (in service and pre service) to the question B28 in 14 countries (for the names of the countries, see the table 1).
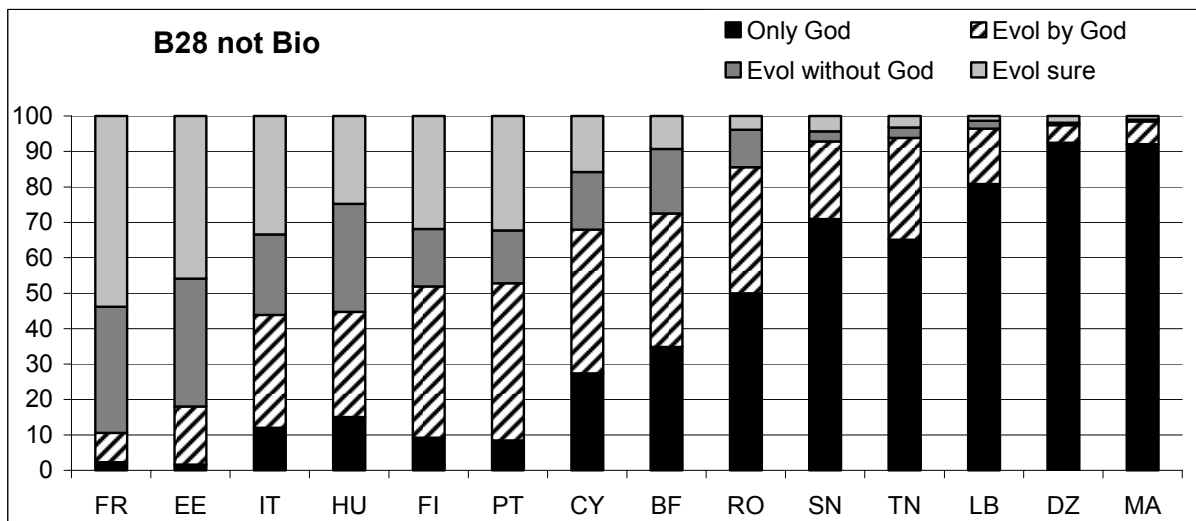
Figure 5 : answers of the 3864 other teachers (Not Biology: in service and pre service) to the question B28 in 14 countries (for the names of the countries, see the table 1).

The figures 4 and 5 confirm the very high amount of creationists in several countries: the percentage of the item 4 of the question B28, in black on the figures 4 and 5 is even more important than the percentage of "yes" in the question B29a (figures 1 & 2)

The same categories of countries can be described:

(A) France and Estonia, with 2% or less of creationist conceptions. The significant differences between biology and other teachers is due to the amount of the other items: more item 1 ("dogmatic evolutionists") for biology teachers; more items 2 and 3, with references to God, for the other teachers.

(B) Italy, Finland, Hungary, here with Portugal: less than 15% of creationist conceptions, even less for biology teachers, with in each country a significant difference between biology and other teachers: item 1 ("dogmatic evolutionist" conceptions) is more important for biologists, and the item 3 ("evolutionist creationists") is more important in other teachers: 20% to 25% for biologists against 30% to 45% for the others.

(C) In Cyprus, there are great differences between the biologists (8% "creationists" and 54% of "evolutionist creationists") and the others (27% "creationists" and 40% of "evolutionist creationists").

(D) Burkina Faso and Romania, with respectively 30% to 40 % of "creationist" biology teachers and 35 to 50% for other teachers (significant differences after Chi^2)

(E) Lebanon, Senegal, Tunisia, Morocco and Algeria, with 60% to 93% of "creationists" ("not evolutionist") teachers and no significant difference between biologists and others in Algeria, Tunisia and Senegal. In Lebanon, Tunisia and Senegal, there are about 30% of creationist evolutionists for biology teachers, but only 15% in Morocco and 5% in Algeria (and respectively 6% and 5% for the not biologist teachers).
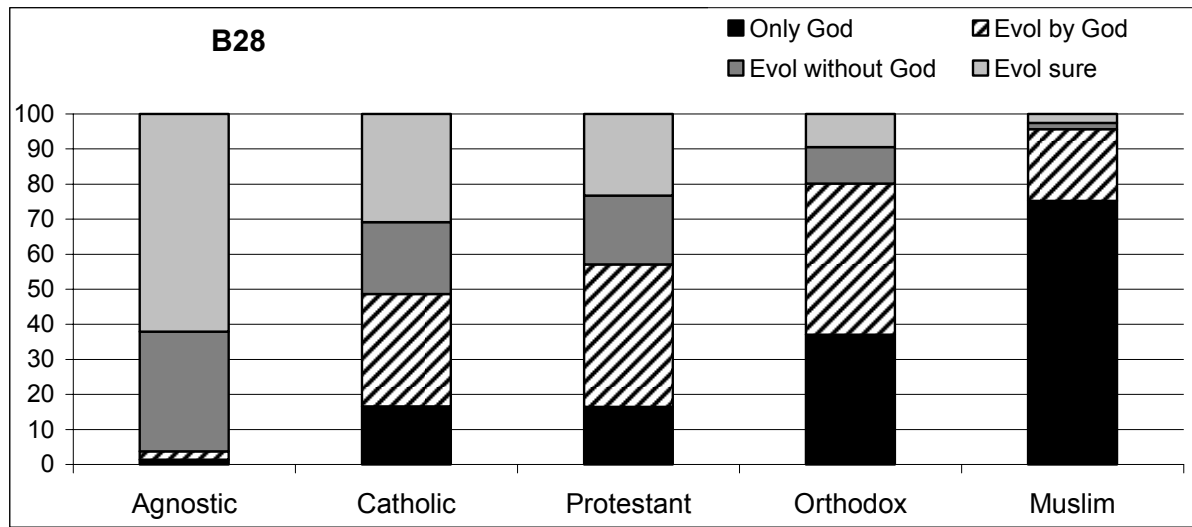
Figure 6 : answers of the 5249 teachers (in service and pre service) to the question B28 for the main religions.

The interpretation of the figure 6 is similar to the figure 3 concerning the amount of "creationists not evolutionists". Nevertheless, we have more information inside the "evolutionist" conceptions. The main important result is the large number of "evolutionist creationists" (item 3) inside the Christians: 43% of Orthodox, 41% of Protestants, 32% of Catholics. Inside the Muslims, 20.5% are evolutionist creationists.

Furthermore there is a repartition of "evolutionists not creationists", about half - half item 1 and item 2 in each religion, even if more item 1for agnostic and catholic teachers.

The teachers' answers to the same question B28 are significantly different depending their level of instruction (figure 7). We defined 3 categories of teachers' level of training:
- 2 years or less than 2 years of training in University (1-2 on figure 7);
- 3 or 4 years of training in University (3 on figure 7);
- 5 years or more than 5 years of training in University (4-5 on figure 7).
The difference is very significant : higher is the teachers' training level, more they are evolutionists. This difference is partly a consequence of the "country effect": the teachers' level is less important in the non European countries. Nevertheless, we will show below that the training level effect remains very significant even after suppression of the country effect (see the multivariate analyses in the paragraph 3.3).
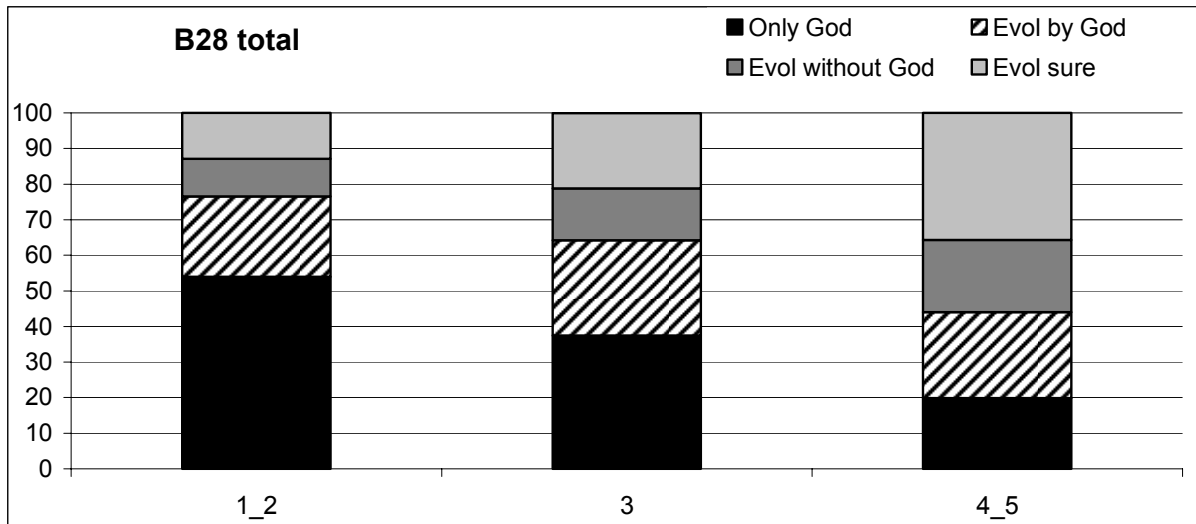
Figure 7 : *answers of the 5700 teachers (in service and pre service) to the question B28 for the three levels of teachers' training .*

3.3. Answers to the 15 questions related to evolution

The 15 questions herein used are listed in the Annex 1. Since there is no space to show the precise results question by question, we present here only the multivariate analyses to illustrate the differences of conceptions between countries and between the level of instruction.

3.3.1. Between analysis for countries (figure 8)
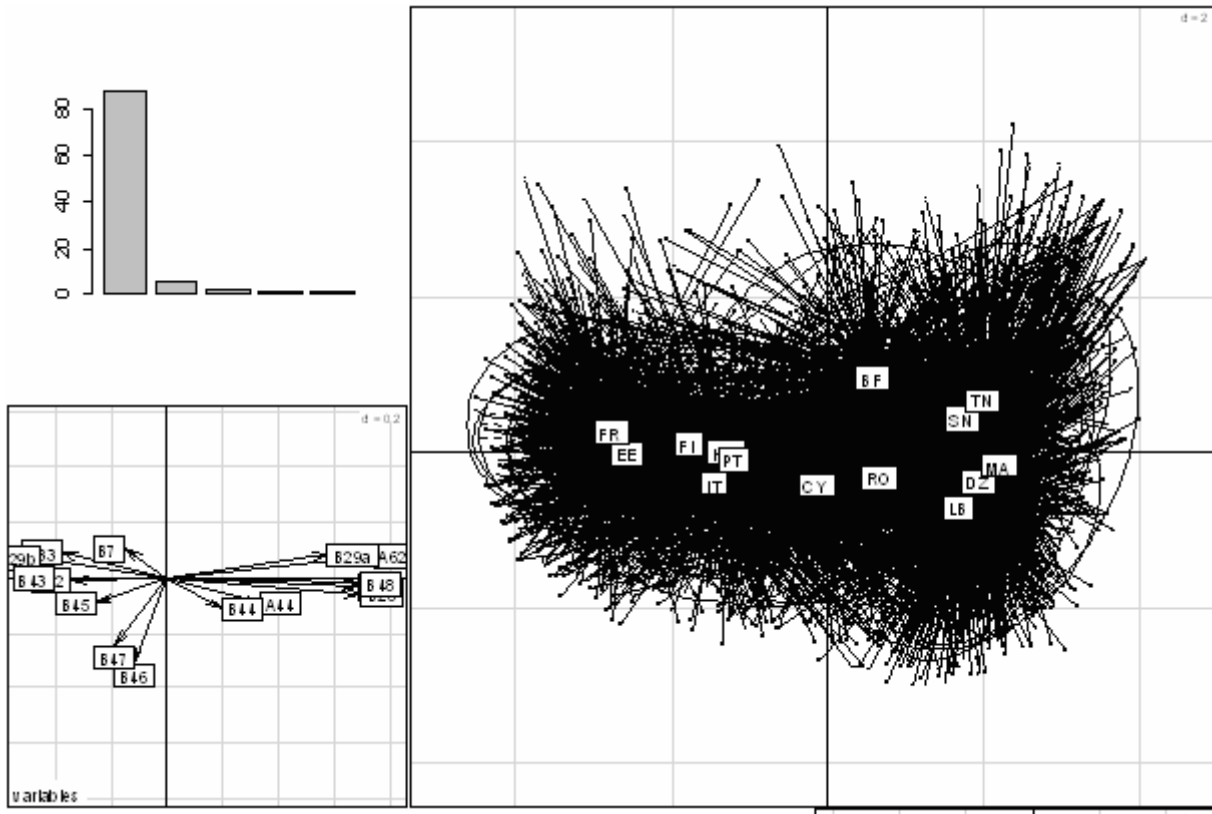
Figure 8 - *Between analysis comparing the 14 countries from the teachers' answers to the 15 questions related to evolution.*

8a - Variance explained by the Principal Components: the axis 1 (horizontal) is the most important. The axis 2 (vertical explain just a little part of the variance.

8b - Relationship between the Principal Components and the 15 variables. The axis 1 is mainly explained by the creationist conceptions (at right) opposed to the evolutionist conceptions (at left). Two questions related to knowledge on the processes of evolution are explaining the axis 2. The other questions (on finalism, or on other knowledge) are related to the axis 1, showing interactions between knowledge and creationist or evolutionist values. To identify the variables, see the annex 1 (the number of each question).

8c - Repartition of teachers' conceptions on the plane explained by the axes 1 and 2. Each point corresponds to the conceptions of one teacher, an ellipse surrounding the 2/3 of teachers of the same country. For the meaning of the letters, see the table 1.

Figure 8 is confirming the categories of countries shown in figures 1 and 2 (variable 29a), and from the figures 4 and 5 (variable B28).

At left of the figure 8c, the most evolutionist conceptions correspond to the French and Estonian teachers. Next to them (a little less evolutionist conceptions) are Finland, Italy, Hungary and Portugal. At right are the most creationist conceptions (Tunisia, Morocco, Algeria, Senegal and Lebanon). In the middle position are Cyprus, Romania and Burkina Faso). The correlation with religion (not shown in the figure 8) is very clear, with at left agnostic convictions, at right Muslins and between them the Christians. We'll analyse below more precisely the teachers' conceptions among Christians.

3.3.2. Between analysis for level of instruction (figure 9)
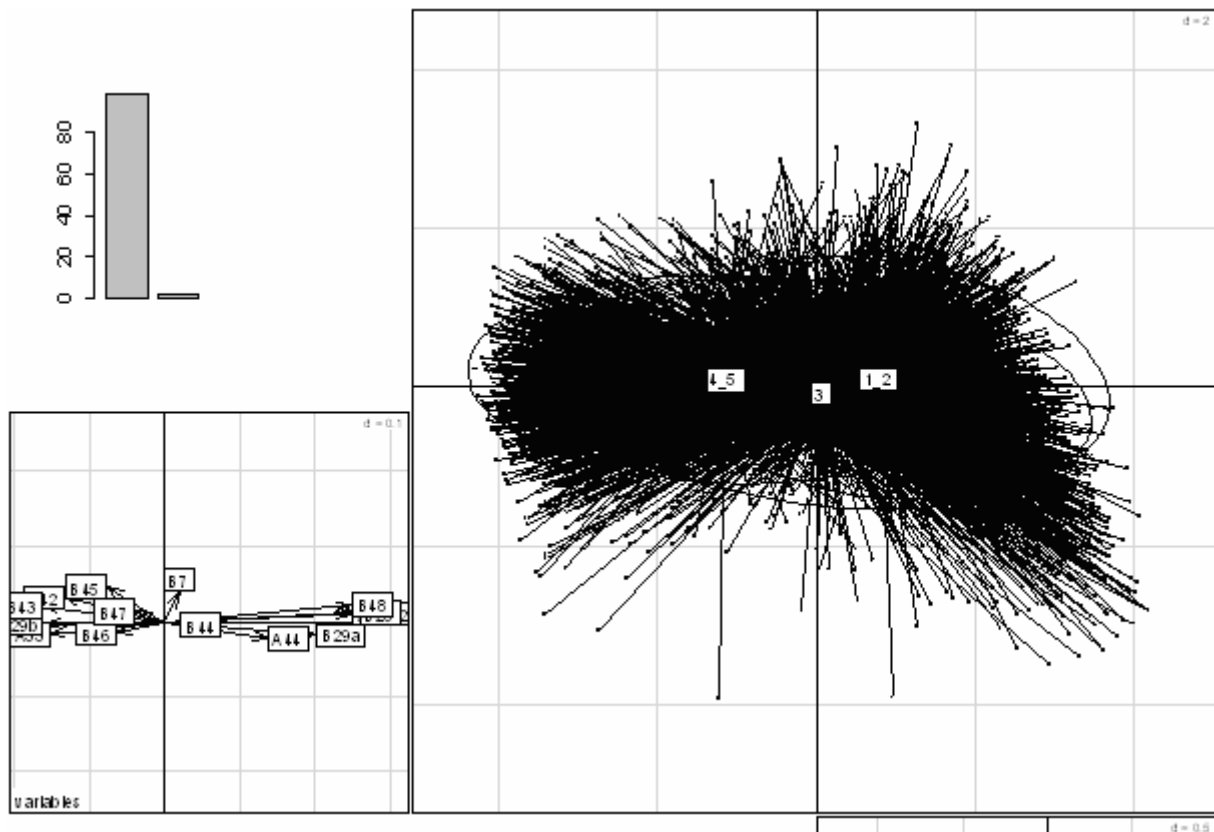
Figure 9 - *Between analysis comparing the teachers' levels of instruction from the teachers' answers to the 15 questions related to evolution. The captions are the same as those of the figure 8 but, here, only the axis 1 is explaining almost all the variance, opposing the evolutionist conceptions (at left) to the creationist ones (at right). The graph 9c shows that the higher level of instruction (4,5 = 5 years in the University or more) corresponds to the most evolutionist conceptions, and the lowest level of instruction (1, 2 = 2 years in the University or less) corresponds to the most creationist conceptions. In the middle is located the level 3 (= 3 or 4 years in the University).*

The effect of the level of instruction is clearly shown in the figure 9 and might be a consequence of the effect of countries, because the teachers are often more qualified in the European countries. In consequence, we did a new analysis suppressing the effect of countries (and the effect of religions, very linked to the effect of countries; the resulting graphs are not shown): the effect of the level of instruction is still very significant, as shown by a randomisation test, Monte Carlo type: the more teachers are instructed the more they are evolutionists, independently of the country. We also showed that the effect of the level of instruction is independent to the age effect.

3.3.3. Age effect and gender effect

We have not space to illustrate the age and the gender effects, but the results show a clear age effect: the more teachers are younger the more they are creationists. This effect is still significant when we suppress the effects of countries, of religions and of the levels of instruction.
We also found a gender effect, which is still significant after suppression of the countries effect and of the religions effect: the women are a little more finalist than the men (question A44) and have a little less knowledge on some processes of evolution (question B47).

3.3.4. Different conceptions among the Christian teachers (figure 10)
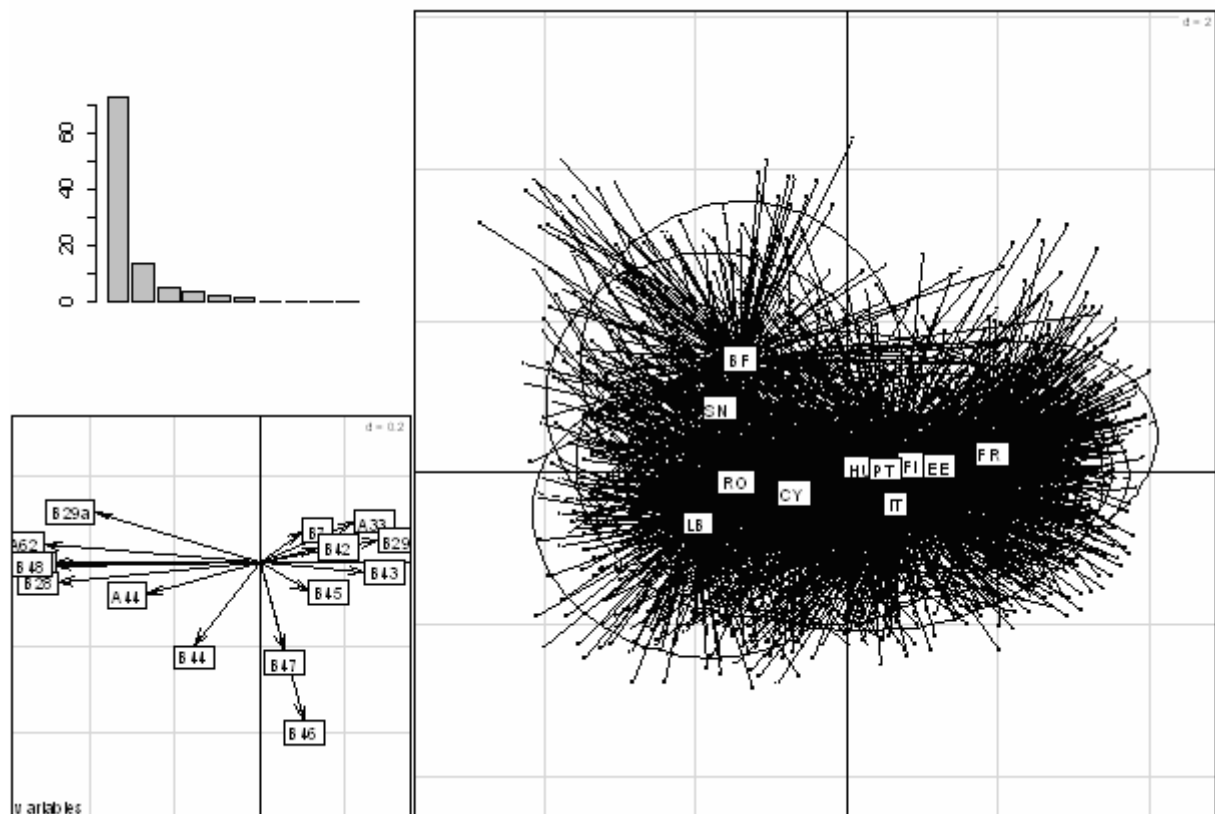
Figure 10 - *Between Analysis to differentiate countries, from the answers of only the Christian teachers to the 15 questions related to evolution. Only 11 countries are taken into account because the amount of Christian teachers is too low in Algeria, Tunisia and Morocco. The legend of this figure is the same as for the figure 8, but the direction of the axis 1 is opposite: here, the creationist conceptions are at left and the evolutionist ones are at right. The weight of the axis 2 is very low and is linked to 2 variables on knowledge.*

The results shown in the figure 10 are particularly interesting: the creationist or evolutionist values are very different within the Christians, mostly depending of the country. The French Catholics are mainly evolutionist whereas the Lebanese Catholics are mainly creationists. The Christian Lebanese teachers are mostly Maronites, but there are also other categories of Christians. In Burkina Faso, about 2/3 of our sample are Christians (Catholics or Evangelic Protestants) and they are mostly creationists. The same is observed with the few Senegalese Christian teachers.

The opposition between evolutionist and creationist conceptions seems to be linked to the opposition between European countries and less socio-economical developed non-European countries. In the middle, but very near the creationist pole, there are the two European countries where the majority of teachers are Orthodox: Romania and Cyprus.

In consequence, the nature of the religion but also the level of the country development as well as the country identity, seem to be important parameters linked to the creationist or evolutionist teachers' conceptions.

4 - Conclusion.

We presented here some of our results, showing that the creationist convictions are much more present that it was expected and are linked to several parameters: the country, the

religion, the degree of believing in God, the level of practising religion, the age of teachers, their taught matter and their level of training.

The first unexpected result is the great amount of "creationist and not evolutionist" conceptions in several countries: in our sample, in all the African countries (Tunisia, Algeria, Morocco, Senegal and Burkina Faso), in the Middle East country (Lebanon), but also in some European countries (at least Romania and Cyprus).

The second surprising result is that the same category "creationist and not evolutionist" is also very high for the biology teachers, even if often (but not always) it is a little less "anti-evolutionist": in several countries, the amount of "evolutionist creationists" is higher for the biology teachers. This is an important result, showing the possible compatibility between "creationist" and "evolutionist" convictions

Less surprising is the degree of correlation between the religion and the creationist values. Nevertheless, we have analysed more precisely this correlation. A co-inertia analysis (not presented here) related to the socio-political-economical-religious variables characterizing the opinions of the teachers, has been correlated to their conceptions from the 15 questions about evolution, showing that only the religious questions are strongly explaining the axis creationism / evolutionism: mainly the degree of believing in God and the degree of practising religion.

We also showed a clear relation between the religion (considering "agnostic-atheist" as a category) and the amount of creationist or evolutionist conceptions (figures 3 and 6).

Nevertheless, several parameters must be taken into consideration: the degree of practising religion can be more important than the nature of the religion. This practice is more important for Muslims in general, but also for Lebanese Christians (Maronites and others) and for Christians in Burkina Faso and in Senegal (with a large amount of fundamentalist groups, evangelist Protestants as well as some Catholics). A strong hypothesis may be the correlation between the increasing of the fundamentalist religious groups and the poverty or under-development, in the non-European countries of our sample, thus explaining the large amount of "creationist not evolutionist" teachers' conceptions in these countries.

The influence of the country (national context) is another important parameter, not to be reduced to the degree of economical development. For instance, the Christian teachers of Estonia (mainly Protestants) and of France (mainly Catholics) are more evolutionists than the Christian teachers in Finland (mainly Protestants) or in Italy and Portugal (mainly Catholics). In our samples, France and Estonia are the only countries with half of teachers being agnostic or atheist; that means a national secularisation culture which is probably influent on the evolutionist conceptions of Christian teachers in these two countries.

In Romania and Cyprus, the relatively high amount of "creationist not evolutionist" conceptions of teachers is probably linked to the Orthodox religion with a high degree of practising religion.

The age is also an important factor. The youngest teachers are more "creationists" than the older ones. This fact is probably related to the renewed fundamentalism movement in the monotheist religions in most of the countries of our sample. The roots of this movement are complex and probably involve sociological, political and economical dimensions where the educational level is just one of the parameters.

The most promising effect for a renewal of the educational systems is related to the level of teachers' training. We found that the more a teacher has studied in the University (primary teachers as well as secondary teachers in languages and in biology) the more he/she is

"evolutionist". This effect is clearly significant after suppression of the effect of countries, of religions and of ageing. The level of instruction is general, not linked to a matter, just linked to the number of years for university degrees.

This last effect is not to be confused with the differences we have shown between biologists and not biologists. These differences mean also that the "creationist not evolutionist" convictions are decreasing after some instruction in biology.

These two last conclusions suggest clearly the need for increasing the level of teachers' training in order to struggle against the current increasing creationist / anti-evolutionist movement.

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ANNEX 1 : the 15 questions related to Evolution <mark>METTRE MIEUX EN PAGE</mark>

Indicate to what point you agree with the following statements by ticking only one box between "I agree" and "I don't agree" for <u>EACH</u> of the following statements:

A33.	The emergence of the human species (*Homo sapiens*) was just as improbable as the emergence of any other species.	I agree				I don't agree
A44.	The emergence of the human species (*Homo sapiens*) was the aim of the evolution of living species.	I agree				I don't agree

A62. **In the list below, tick the <u>THREE</u> expressions that you think are the most strongly associated with the origins of humankind.**

☐ Adam and Eve   ☐ Australopithecus   ☐ Creation   ☐ Evolution   ☐ God   ☐ Natural selection

A64. **Which of the following four statements do you agree with the most ?** (tick only <u>ONE</u> answer)
   ☐ It is certain that the origin of life resulted from natural phenomena.
   ☐ The origin of life may be explained by natural phenomena without considering the hypothesis that God created life.
   ☐ The origin of life may be explained by natural phenomena that are governed by God.
   ☐ It is certain that God created life.

Indicate to what point you agree with the following statements by ticking only <u>ONE</u> box between "I agree" and "I don't agree" for EACH of the following statements:

B7.	The Chimpanzee should be included in the genus *Homo*, notably because 98.5% of i DNA is identical to that of *Homo sapiens*.	I agree			I don't agree

B28. Which of the following four statements do you agree with most? Select <u>ONLY</u> one sentence:

☐   It is certain that the origin of the humankind results from evolutionary processes.
☐   Human origin can be explained by evolutionary processes without considering the hypothesis that God created humankind.
☐   Human origin can be explained by evolutionary processes that are governed by God.
☐   It is certain that God created humankind.

B29. Tick "Yes" or "No" for each sentence:
B29a - The theory of evolution contradicts my own beliefs   ☐ Yes   ☐ No
B29b - Creationism (including the creation of human beings by God) contradicts my own beliefs ☐ Yes   ☐ No

Indicate your evaluation of the importance of the following factors in species evolution (tick only <u>ONE</u> box for each line):

		Great importance	Some importance	Little importance	No importance at all
B42.	Chance				
B43.	Natural selection				
B44.	A program inside the organism (intelligent design)				
B45.	Surrounding environment				
B46.	Transposons (jumping genes)				
B47.	Viruses				
B48.	God				