


université PARIS-SACLAY | FACULTÉ DES SCIENCES D'ORSAY | ESE

SCIENCE FOR THE CONSERVATION OF MARINE TURTLES

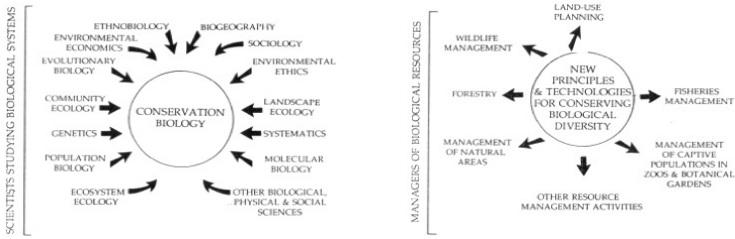
Marc Girondot

Rastoma | WASTCON | WASTCON


Réseau des Acteurs de la Sauvegarde des Tortues Marines en Afrique Centrale




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CONSERVATION BIOLOGY




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WHAT IS SCIENCE? WHAT IS A SCIENTIFIC ACTIVITY?



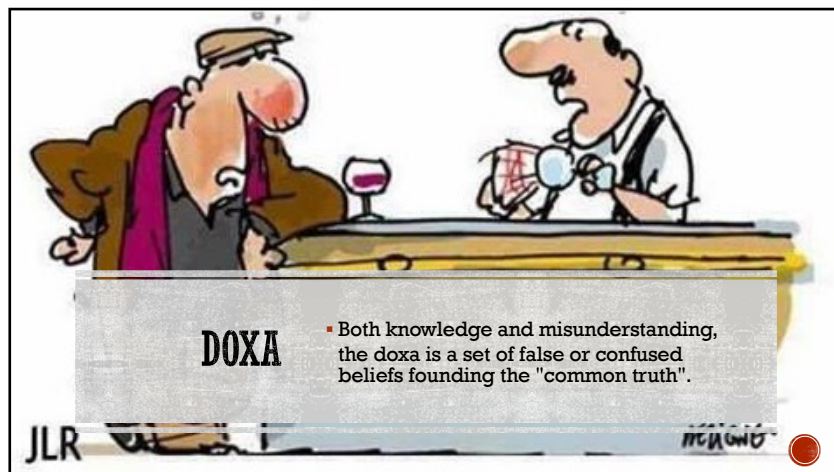
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SCIENCE – RELIGION – DOXA

The triplet Science - Religion - Doxa can be seen as different modalities of knowledge and its application.

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EXAMPLE OF DOXA APPLIED TO MARINE TURTLES

- The sea turtles were on the earth at the same time as the dinosaurs. But they survived!
- In this statement, an equivalence is made between the current sea turtles and those living more than 60 million years ago, but they were not the same species.
- It is claimed that dinosaurs are extinct while birds are dinosaurs.

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RELIGION

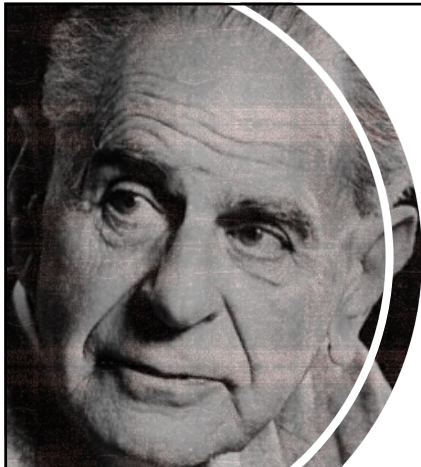
- Religion is based on dogmas.
- A dogma is a point of doctrine that is established or regarded as a fundamental and unquestionable truth, and therefore cannot be challenged and therefore cannot be tested.
- By its nature, dogma cannot be tested.
- Examples
- 325 : First Council of Nicaea - "Jesus Christ is a true God, son of a true God, begotten and not created, consubstantial with the Father."
- « Believe in God, in His Messenger, in the Scripture which He has sent down to His Messenger from above, in the Scripture which He has sent down before from above! Whoever does not believe in God, His angels, His Scriptures, His messengers and the Last Day is in infinite error. » (IV, 135/136)

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DOGMA APPLIED TO MARINES TURTLES

- « Sea turtles do not feed during the nesting season. »
- Miller, J.D., 1997. Reproduction in sea turtles, in: Lutz, P.L., Musick, J.A. (eds.), The Biology of Sea Turtles. CRC Press, New York, USA, pp. 51-81.
- This statement is seen by some as so obvious that it no longer needs to be tested; it becomes a dogma.
- This has never been proven and it is very difficult to show that something is not happening.

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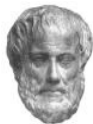
1902 Vienna (Austria-Hungary) -
1994 London (UK)

SCIENCE

According to Karl Popper, science should be an activity which, on the contrary, should use only testable and refutable results.


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Aristotle -384 (Stagire, Greece) à -322 (Chalcis, Greece)



DESCRIBING THE LIVING WORLD


- Aristotle differs from his master Plato: for him the highest degree of reality is not what appears by reasoning, but what is perceived by the senses.



The School of Athens, fresco by the painter Raphael (1483-1520). Plato, in red toga and Aristotle, in blue. Room of the Signature, Papal Palace, Vatican


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Abu Ali al-Hasan ibn al-Hasan ibn al-Haytham (Bassora, c.965 – Cairo, c.1040)



EXPERIMENTS

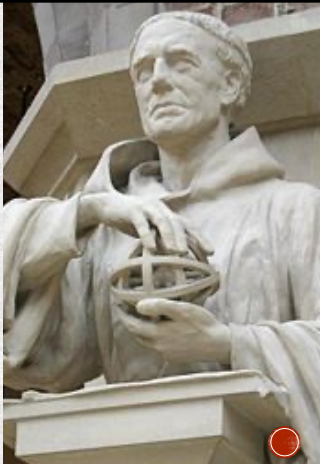
- Alhazen, more rarely Alhacen, from his real name Ibn al-Haytham or from his full name Abu Ali al-Hasan ibn is a mathematician, philosopher, physiologist and physicist of the medieval Arab-Muslim world.
- He almost systematically validated his hypotheses with experiments, which made him a precursor in the application of the scientific method.



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QUESTIONING WHAT HAS BEEN LEARNED

- Roger Bacon (1214-1294), nicknamed Doctor mirabilis because of his prodigious science, English philosopher, scientist and alchemist, is considered one of the fathers of the scientific method.
- For Bacon, "no speech can give certainty, everything rests on experience".
- He is the first in the Western world to question the teachings of Aristotle, with supporting observations.




Roger Bacon 1214 Ilchester - 1294 Oxford

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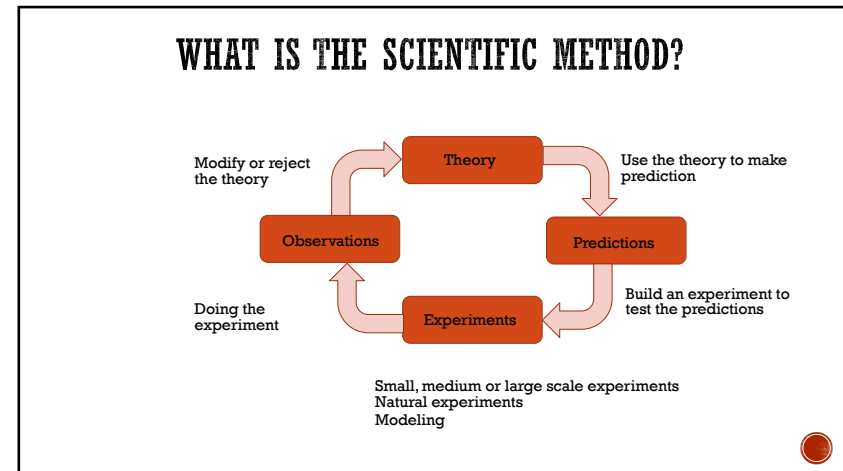
THE DISCOURSE OF THE METHOD

- The scientific method of René Descartes, exposed in the Discourse of the Method in 1637, constantly asserts a break with the scholasticism taught in the University.
- The Discourse of Method is characterized by its simplicity and claims to break with the interminable scholastic reasoning.
- It is inspired by the mathematical method, seeking to replace the Aristotelian syllogistic used in the Middle Ages since the 13th century.



1596 La Haye-en-Touraine - 1650 Stockholm (Sweden)

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OBSERVATIONS AND DESCRIPTIONS

- The field naturalist will record observations in notebooks.
- The difficulty is to be able to draw generalizations from these observations.
 - "The plural of anecdote is not data"
 - Roger Brinner (Economist)

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TESTS OF HYPOTHESES


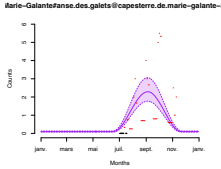
Experiments at different scales

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HYPOTHESIS TESTING

- Natural experiments
 - Natural experiments involve identifying a control group that is different from a test group following a natural or at least unintended exogenous shock.
 - The test group is the group that was hit by the shock while the control group was not hit.
 - To ensure that the groups are similar, they should be compared prior to the event to ensure that they have the same behaviors.

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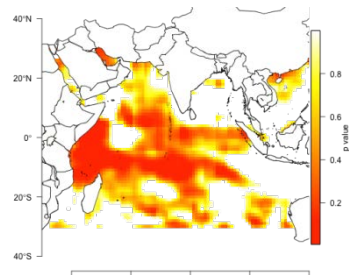



EXAMPLE: NITROGEN SUPPLY

- Is the beach stabilized by vegetation?
- **Hypothesis:** If we enrich the sand with nitrogen, vegetation will grow better and the beach will be stabilized.
- **Experimental protocol:** Fertilizer is applied to the backshore and vegetation growth and erosion are assessed.
- But... the beaches are protected. It is forbidden to do this kind of experiment!
- Fortunately, the sea turtles do the job for us!

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MODELING

















- Ecology is the field of life sciences that uses modeling the most
 - Allows to manage the great complexity of the studied systems
 - Allows you to make replicates when you only have one land

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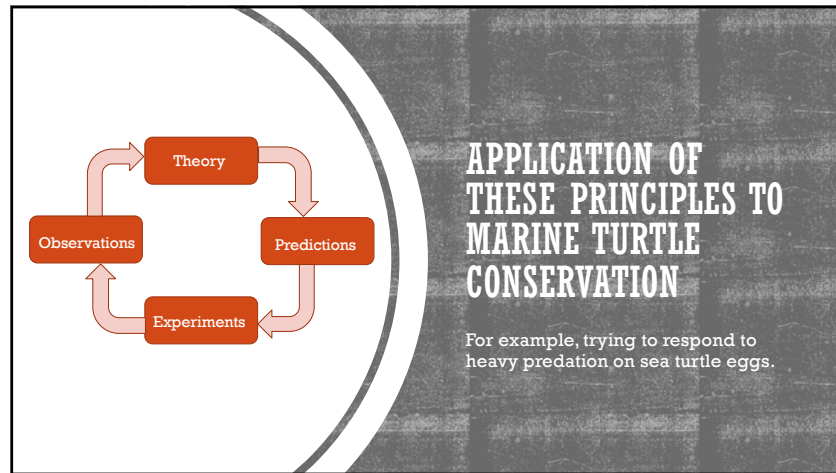
WHAT IS A SCIENCE?

WHAT IS NOT A SCIENCE?

SCIENCE VS PSEUDOSCIENCE

 Makes findings based on the evidence collected	Starts with a pre-established conclusion and seeks to confirm it 
 Takes into account all the data to conclude	Selects the data that support him and neglects the others 
 Uses clear and precise technical vocabulary	Uses vague and confusing concepts by mixing in scientific words 
 Makes cautious statements and uses the conditional tense	Makes extraordinary claims without sufficient evidence or evidence 
 Uses a rigorous, reproducible method that can be verified by the entire community	Uses a fallible method with little or no verification of reproducible results 
 Evolves and corrects itself with the discovery of new information	is dogmatic and inflexible 
 Accepts criticism and can be reluted	Refuses criticism and is irrefutable 

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PLAN OF ATTACK

- Evaluate the level of predation on eggs
- Identify the causes - human, physico-chemical factors, predators, others
- Propose a method to reduce certain causes and evaluate the expected impact
- Implement the method
- Evaluate the level of predation on eggs
- Identify the causes - human, physico-chemical factors, predators, others
- **Test whether the method implemented has had the expected results**

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WHAT IS A TEST?

A test is a working method in many fields, both in the exact sciences and in the humanities.

It consists of a comparison between an observation and a prediction.

It is necessary to make sure that the observed value corresponds to a prediction of the model. It is necessary to make sure what is the part of chance in the obtained results.

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TEST OF A HYPOTHESIS H_0

- In an H_0 - H_1 test, the H_0 hypothesis is called the null hypothesis. It is clearly stated. The H_1 hypothesis is the alternative hypothesis. These are all the hypotheses that are not H_0 .
- When we do a test, we look for whether the data set could be obtained under the H_0 hypothesis. Note that the answer is always "yes" but with a higher or lower probability. The "p value" designates this probability (Sir Ronald Fisher, Statistical Methods for Research Workers, 1925).

H_0 : Null hypothesis
 H_1 : Alternative hypothesis

x: Dataset
 P-value: Probability that dataset x could have been obtained under H_0 hypothesis

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CONCLUSIONS FOLLOWING THE TEST

- Thus the "p-value" represents the probability of being wrong if we reject H_0 as a valid hypothesis to explain the data structure.
- For example, if $p\text{-value}=0.2$, it means that if we reject H_0 , we know that this data set had a 20% chance of being obtained when H_0 was true. So we are taking a rather large risk by rejecting H_0 . It must be said that we do not reject H_0 .
- Be careful!: we never accept H_0 because we can never reject H_1



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FIRST-ORDER RISK

- We therefore define the first-order risk, often called α , as the probability of being wrong if we reject H_0 .
- This is $\text{prob}(x | H_0)$, with | being « knowing ».



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THE LIMITS OF P-VALUE

- Suppose an article reports a p-value of 0.001.
- This p-level may be related to
 - a not very strong effect in the population with a large sample size, or
 - a large effect in the population with a moderate sample size, or
 - a very large effect in the population with a small sample size.
- Similarly, a p-level of 0.075 may represent a large effect combined with a small sample size, or a tiny effect with a very large sample size.



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THE LIMITS OF P-VALUE

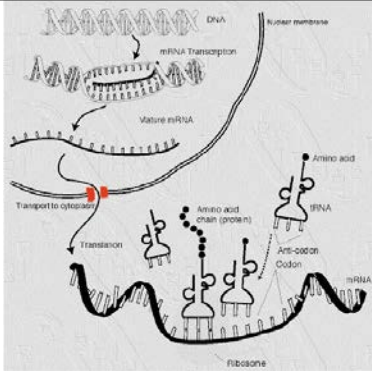
- The p-value or $\text{prob}(x | H_0)$ does not give us the probability that H_0 is true but the probability that the data x could have been obtained under H_0 .
- Now we are interested in $\text{prob}(H_0 | x)$ which reads: what is the probability of H_0 knowing that the data x were observed.
- The p-value gives us an indication but not the real value that interests us.



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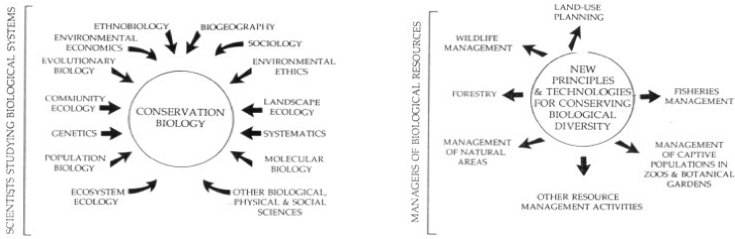
REAL EXAMPLE

- No significant correlation between sod gene expression and SOD activity in liver, kidney or blood was found ($p = 0.27, 0.11$ and 0.49 , respectively).
- How to explain such a result?



Cortés-Gómez, A.A., Morcillo, P., Guardiola, F.A., Espinosa, C., Esteban, M., Cuesta, A., Girondot, M., Romero, D., 2018. Molecular oxidative stress markers in Olive Ridley turtles (*Lepidochelys olivacea*) and their relation to metal concentrations in wild populations. *Environmental Pollution* 233, 156-167.

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CONSERVATION BIOLOGY

- Conservation biology must behave like any science and every action must be evaluated.

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TO BE SURE YOU HAVE UNDERSTOOD...

<https://forms.gle/sexv4NyABwa8awwQ7>



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