The Application of Latour's Modalities to Scientific Texts: A Model of Theory and Fact

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Latour (1987) argues that social context and technical content are essential to written texts. Positive and negative modalities function to convince the reader about the credibility of the results of research given in scientific reports. This discussion will briefly consider Latour's modalities as components in the citation of literature.

Latour (1987) argumenta que el contexto social y el contenido técnico son aspectos esenciales en los textos escritos. Las modalidades positivas y negativas funcionan para convencer al lector de la credibilidad de los resultados de las investigaciones dados en reportes científicos. Esta presentación considera, brevemente, las modalidades de Latour como componentes de las citas literarias.

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Introduction

Scientific research produces articles. These articles advance science by reporting on the emerging findings. However, not everything in science reporting can be considered a fact or should be. Rather facts produce disputes which eventually lead to conjecture and then to new facts and further conjecture. Disputes function as an energy which drives the scientific process to constantly doubt, assess and test its assertions and accepted facts. It is in the path of fact—conjecture—new facts—new conjecture that articles appear. They are the written reports that argue for or against, that raise doubts, that accept facts as indisputable and that present conjecture as arguable.

The scientist becomes a writer as he/she takes on disputes and seeks to reach an audience of peer readers in his field. He is hypothesizing, revealing new results, searching for the significance of those results, tying his results to the bank of accepted facts, testing, raising doubts, and eventually making his point and drawing conclusions. His skill at placing his results in the context of the disputes of his field and writing up those results determines, in part, how successful he will be as a scientist and how much impact his research will make in the field. That is, his results call for an ability to be convincing to his colleagues and to stimulate reactions. In short, his status as a researcher, needless to say, is closely tied to his status as a writer.

Latour (1987) has analyzed science and the process in which scientists are involved in seeking to demonstrate how the social context and technical context interact in scientific activity. He is interested in the product, writing, but more especially in the process used to arrive at the product. He discusses controversies that appear in the literature or research articles studying the strength of the rhetoric in them. He argues that technical writers are involved in a process as they seek to create stronger rhetoric that proceeds from the dichotomy between "ready-made science" and "science in the making". He uses the faces of Janus to represent this distinction in his discussion:

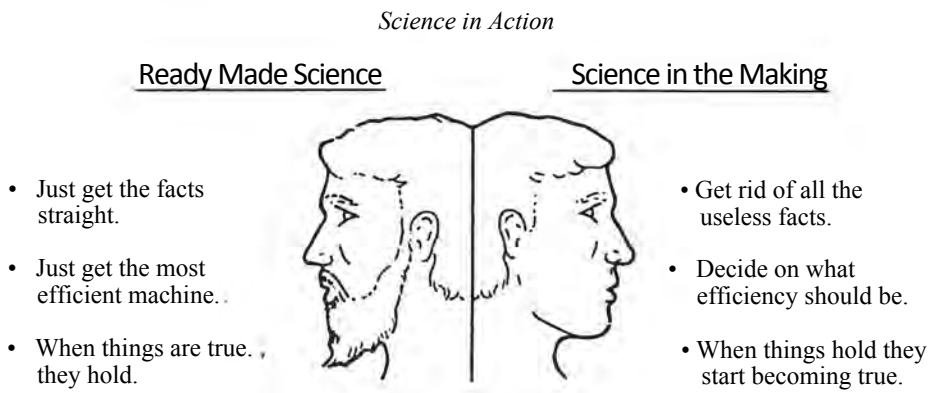

Fig. 1 : Adapted from Latour (1987: 4, 7,9, 10,12). The two faces of science.

Let us look at this area of reporting on scientific articles by considering the modalities, positive and negative, that Latour discusses and present a model that may function as a "shifting guide" for producing a scientific article. This paper suggests that the model can be used in writing courses for postgraduates in the exact sciences or any writing courses having as their objective the writing of scientific articles for publication.

At first Latour draws attention to the collective process scientists are involved in constructing facts. He calls this the *First Principle* and underlines its importance when he says the fate of what we say and make is in later users' hands:

> Buying a machine without question or believing a fact without question has the same consequence: it strengthens the case of whatever is bought or believed, it makes it more of a blackbox. To disbelieve a fact, so to speak, 'dis-buy' either a machine or a fact is to weaken its case, interrupt its spread, transform it into a deadend, reopen the blackbox, break it apart and reallocate its components elsewhere....
>
> Confronted with a blackbox, we take a series of decisions, Do we take it up? Do we reject it? Do we open it? Do we let it drop through lack of interest?... .This is what happens to others' statements, in our hands, and what happens to our statements in others* hands. To sum up, the construction of facts and machines is a *collective process.* (29)

A close look at this principle and the questions Latour has raised reveals the ongoing questioning involved in looking at one black box (a fact) and attempting to either close it (make it an accepted fact) or open another (engaging in conjecture).

The articles as final products contain answers to questions. The discourse of the scientific argumentation is there. To describe statements in the argumentation Latour uses positive (+) and negative (-) modalities to illustrate how the statements in a sentence reflect the disputes being carried on in a field. A positive modality appears as a sentence statement leading away from the conditions of production. By that, Latour means that the statement is one of fact and the scientists do not conjecture about its state. The factual acceptance of the statement allows the writer to move on to his re-son for mentioning the fact. Negative modalities, on the other hand, lead a statement in the direction of its conditions of production and explain its weakness or strength. In both cases, (+) and (-), the construction of facts is integral to the collective process being carried out by scientists and reported upon. (See Appendix A.).

To understand Latour more fully it is useful to consider an example of his that takes a given statement as a fact (black box) and shows its insertion in other statements and its association with these statements. As he points out, a sentence is neither a fact nor fiction. It is made so by other sentences and its status depends on these later statements:

> You make a statement more of a fact if you insert it as a closed, obvious, firm and packaged premise leading to some other, less closed, less obvious, less firm and less united consequence. (25)

The example Latour gives is the black box, a closed file, an indisputable assertion:

> The primary structure of Growth Hormone Releasing Hormone (GHRH) is Val-His-leu-Ser-Ala-Glu-Lys-Glu-Ala. (23)

As it is placed in a sentence, it becomes either (+) or (-).

Positive if it is treated as a fact and the researchers begin to look for cures for dwarfism:

> Now that Dr. Schally has discovered [the primary structure of GHRH], it is possible to start clinical studies in hospital to treat certain cases of dwarfism since GHRH should trigger the Growth Hormone they lack.(23)

or negative and the acceptability of Dr. Schally's research is doubted:

> Dr. A. Schally has claimed for several years in his New Orleans laboratory that [the structure of GHRH was Val-His-Leu-Ser-ALA-Glu-Glu-Lys-Glu-Ala]. However, by troubling coincidence this structure is also that of haemoglobin, a common component of blood and a frequent contaminant of purified brain extract if handled by incompetent investigators. (23)

Thus we can see that statements such as these lead to the context of the researchers' affiliation with groups of scientists .They serve as signposts indicating to the reader the resources the writer can depend upon to advance his argument and generations of research appear —1st, 2nd, 3rd— the latter ones citing the previous.

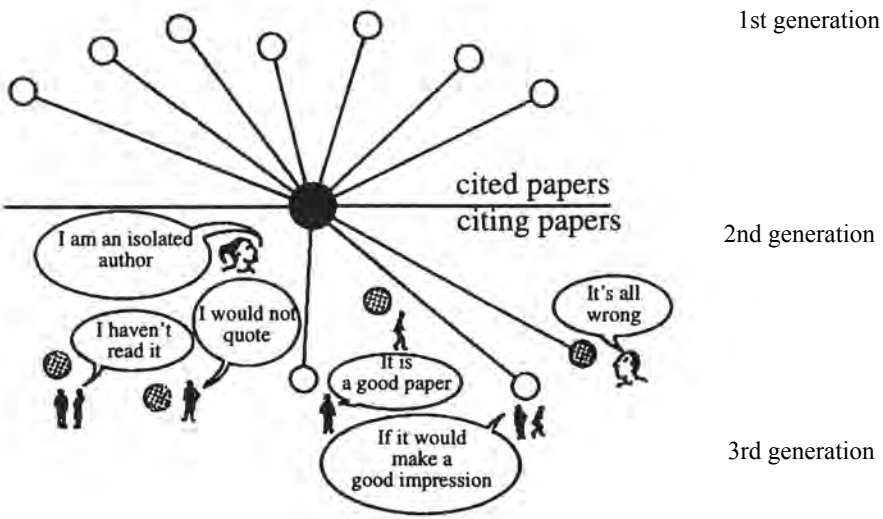

Fig. 2: Adapted from Latour (1987:40).
(Fig. 1.4).

These generations of research stack up until ultimately they (theoretically) become positive modalities leading to the closed black box, acceptance as fact, or they stack up as negative, raising disputes. The goal of such statements in the context of the research problem and its findings is to be accepted by scientific peers, receive recognition (hopefully favorable), be acknowledged and cited.

Fact or theory?

The interplay between (+) and (-) modalities appears when one reads a scientific article. In fact, they can be analyzed in statements or blocks of statements. One way I would like to suggest for viewing the proposal of a theory and its eventual acceptance or rejection as a fact is to draw on Latour's concept of (+) and (-) modalities and place them on an axis which intersects the opposite axis which represents theory and fact. Along the continuum of theory to fact, language realizations can be found. Consider this model:

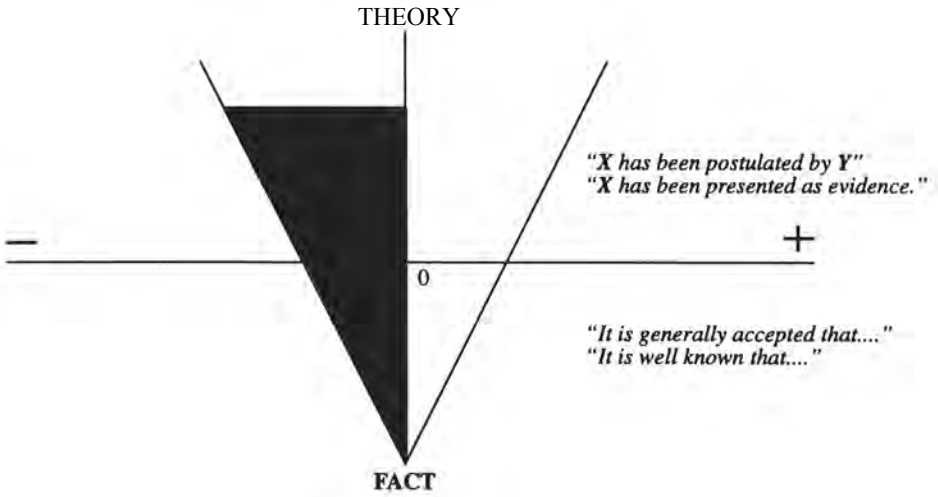

Fig. 3: Theory/Fact Model.

The gray area represents the possibilities of positive statements at any point on the continuum from when a theory is proposed to when it is accepted as fact. Statements such as "X *has been postulated by Y'* and "X *has been presented as evidence"* suggest positive modality about midway along the axis. Other positive statements confirm the reception of colleagues in the field and point to this acceptance as a fact. These statements appear at the end of the axis, ones such as *"It is generally accepted that..."* and *"It is well known that..."*

To further see how this relationship of the continuum of two axes works and how and where linguistic realizations appear, it is useful to turn to two articles published by five marine biologists. (See Appendix B-l and Appendix B-2.)[1]

Note the following statement in the second paragraph of the abstract (Appendix B-l) stating "*Previous reports of temperature ranges for sardine and anchovy spawning have not taken into account the distribution of SST and have mostly referenced the cooler spawning area of the species*". This statement represents negative modality, one that the researchers use as the reason for their study. They immediately point out that *"sardines spawn in a much wider temperature range (13°-25° C) than anchovy (11.5°-16.5° C)"* and continue to give facts that create positive modalities. The findings of Lluch-Belda *et al.* suggest further detailed analyses are needed.

In the Introduction of Appendix B-2 we find a statement of tacit knowledge about the collapse of the sardine population.

> It is generally accepted that an intense fishery can at least potentiate the collapse of a population, and perhaps delay its recovery if the population has been severely depleted. (50)

The selection of verbs is another way modalities appear. Note these examples through the first pages of the Introduction:

> Bakun (1990) *suggested* that...,
> Lange et al. (1990) *obtained...*
> Lange et al. *found...*
> Ahlstrom *noted...*

The verbs convey degree of assertion by the researchers.

Other formulaic indicators signal inconclusive evidence, ones such as "*Unfortunately*", "*However*", and *"Evidence must be considered inconclusive because...* " The researchers used these ways of citing data based on low periods of sardine abundance and point out the lack of indicators of primary production during a high abundance mode.

Discussion

The application of the axis model serves as a way of visualizing the shifting movement in written discourse that advances the argument that best serves the writer. During the phases of decision-making about what to include and how to express it, the writer is

1. I taught the technical writing course, *La Elaboración de Reportes Científicos,* at El Centro de Investigaciones Biológicas del Noroeste, S.C., May 1996. The two published articles in Appendix A and B were used in that course.

compelled to convince the scientific audience of the importance of his research to the scientific community. To do so, he has to decide about what information should be included and how to include it. He may profit during this process from being guided by an awareness of the shifting nature of his argument back and forth in disputes about his specific problem. As he, in effect, is choosing how he wants to express himself linguistically along the axis of theory to fact and the axis of positive to negative modality and is revealing his affiliation.

This paper has sought to propose a way of visualizing Latour's poles of modality that could be applied to analysis of research articles when one reads receptively but also to the productive skill of composing. Latour describes the social context in which scientists work, the activities they carry out and the dynamics of the scientific setting and, most importantly, the interaction between scientists which produces research and articles. He aims at tying technical activity to the social setting as he seeks to find out how it is that scientists produce their articles. This discussion has looked only at his aspect of modality and its application to written texts and found that a way of drawing together the (+) and (-) modalities is needed, especially as modalities are applied to the writing of technical articles.

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APPENDIX A

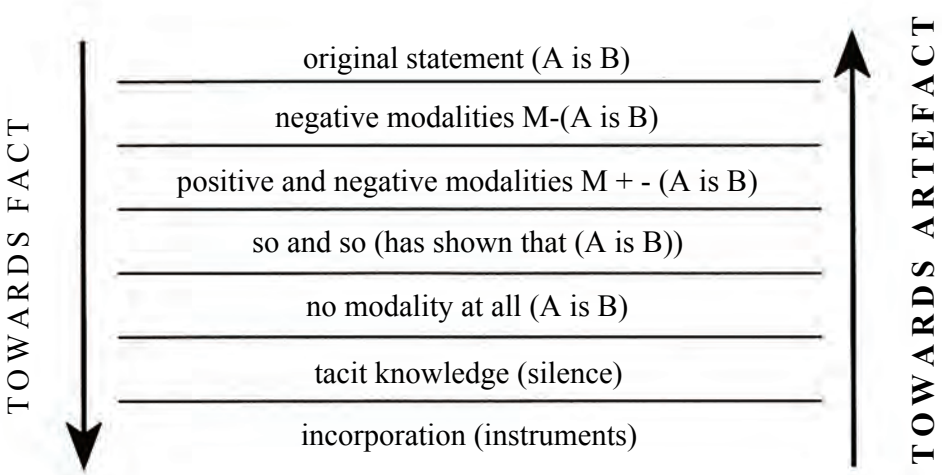

Fig. 4: Adapted from Latour (1987:44)
(Fig. 1.6)

APPENDIX B-1

LLUCH-BELDA ET AL: SARDINE AND ANCHOVY SPAWNING AS RELATED TO TEMPERATURE AND UPWELLING
CalCOFI Rep., vol.32, 1991

SARDINE AND ANCHOVY SPAWNING AS RELATED TO TEMPERATURE AND UPWELLING IN THE CALIFORNIA CURRENT SYSTEM

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ABSTRACT

Sardine and anchovy spawning was analyzed regarding its relation to sea-surface temperature and upwelling, using CalCOFI cruise data and Bakun's upwelling indices.

Previous reports of temperature ranges for sardine and anchovy spawning have not taken into account the distribution of SST and have mostly referenced the cooler spawning area of the species. By obtaining the proportion of positive stations to total sampled stations for each tenth of a degree Celsius in the SST distribution, we were able to discriminate the ranges of preferred temperatures of spawning for both species. Sardines spawn in a much wider temperature range (13°–25°C) than anchovy (11.5°–16.5°C). Two maxima of spawning occur in the California Current: at 15°C and 23°C. An additional peak is present in the Gulf of California at about 19°C. Only one maximum is evident for anchovy spawning, at about 14°C.

The distribution of spawning as a function of upwelling was also analyzed for both species. There is a maximum for sardines at intermediate values of upwelling. There are two maxima for anchovy: a minor one at low levels of upwelling and a major one at the maximum values of upwelling. We conclude that sardines are eurythermic as compared to anchovies, but spawn only at intermediate values of upwelling, whereas anchovies are stenothermic but spawn at much wider ranges of upwelling, particularly at low and high values. The differences suggest exclusive competition, but more detailed analyses are needed.

RESUMEN

Se analizó el desove de sardina y anchoveta con respecto a su relación con la temperatura superficial del mar y las surgencias, utilizando los datos de los cruceros CalCOFI y los índices de surgencia desarrollados por Bakun.

Los intervalos de temperaturas de desove de sardina y anchoveta que se habían señalado anteriormente no tuvieron en cuenta la distribución de la temperatura superficial; además, se habían referido mayormente al área más fría de la distribución del desove. Mediante la obtención de la proporción de las estaciones positivas a las totales por cada décima de grado en la distribución de frecuencias de la temperatura superficial, fué posible discriminar los intervalos de temperaturas preferentes para el desove de ambas especies. Las sardinas desovan en un intervalo de temperatura mucho más amplio (13° a 25°C) que el de anchoveta (11.5° a 16.5°C). Se presentan dos máximos de desove de sardina en la Corriente de California: uno a 15°C y otro a 23°C. Otro máximo adicional se presenta en el Golfo de California a 19°C. Sólo se registró un máximo de desove en la anchoveta, alrededor de 14°C.

La existencia de tres máximos no es, proponemos, un fenómeno inherente de la especie, sino una característica inducida ambientalmente. Creemos que algún factor relacionado con las surgencias puede ser el responsable de esta desusual distribución.

Se analizó también la distribución del desove de ambas especies en función de las surgencias; hay un máximo para la sardina a niveles intermedios de surgencia. Hay dos máximos para la anchoveta: uno menor que se localiza a niveles bajos de surgencia, y el más importante, que ocurre a niveles máximos de surgencia.

Concluimos que las sardinas son euritérmicas en comparación con las anchovetas, pero que desovan a niveles intermedios de surgencia, mientras que las anchovetas son estenotérmicas pero desovan en una amplitud mayor de valores de surgencia, particularmente a valores bajos y altos. Los resultados sugieren exclusión competitiva, pero se necesitan análisis más detallados.

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INTRODUCTION

Environmental temperature has long been considered the most important factor affecting marine organisms; their geographical distribution is closely associated with the latitudinal temperature gradient. Temperature affects the rate of metabolic processes. Cold winter temperatures can depress the activity of

APPENDIX B-2

LLUCH-BELDA ET AL.: SARDINE RECOVERY AND GLOBAL CHANGE
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THE RECOVERY OF THE CALIFORNIA SARDINE AS RELATED TO GLOBAL CHANGE

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ABSTRACT

California sardine abundance has fluctuated significantly in the past, and the population has remained at either low or high levels for sustained periods longer than a decade. Abundance now appears to be increasing from the low values in the mid 1970s. In a previous paper, evidence that small pelagic fishes from the main fisheries of the world vary synchronously with each other and also with global climatic variations was presented and named the "regime problem." This paper extends that analysis by looking for coherence between interdecadal variations in temperature both at local and global scales, and at variations in California sardine abundance. Possible relationships between this approach and previously presented ones are discussed, including the "recruitment problem" and the "fishery problem." Possible implied mechanisms are also briefly discussed.

RESUMEN

La abundancia de la sardina California ha variado considerablemente en el pasado; la abundancia ha permanecido bajas o altas por periodos sostenidos mayores de una década. En la actualidad, hay indicios de que la abundancia se ha incrementado respecto de los valores bajos de mediados de los 70. En un trabajo previo, se presentó evidencia de que tanto las fluctuaciones climáticas globales como las variaciones de la abundancia de pelágicos menores de las principales pesquerías del mundo ocurren simultaneamente, lo que se denominó el "problema del régimen." El presente trabajo extiende el análisis mencionado buscando coherencia, tanto entre las variaciones interdecadales de temperatura a nivel local y global, como en las fluctuaciones de la abundancia de la sardina California. Se discute este enfoque y sus posibles relaciones con otros que se han presentado, entre los que se incluyen el "problema del reclutamiento" y el "problema de la pesquería." Los posibles mecanismos involucrados también son discutidos brevemente.

INTRODUCTION

In spite of the difficulties of precisely determining the population size, it seems evident that the sardine population off northern Baja California and California has fluctuated widely, with changes of orders of magnitude. Population abundance changed from supporting the most voluminous fishery in North America (reaching some 800,000 MT during its production peak) to a total biomass estimate of less than 5,000 MT (Wolf 1992).

Changes in abundance have occurred over relatively short periods, but the population has remained at either a high or low mode for sustained periods. Recently, the population has been increasing from the low levels of the mid 1970s. The spawning biomass in 1990 may have been as high as 82,000 to 214,000 MT (Barnes et al. 1992). This recovery may be explored through different approaches.

Historically, the first proposed mechanism affecting the abundance of sardine populations was overexploitation of the stocks, or the "fishery problem." The idea is that heavy fishing exerts major predation pressure on the population; this is particularly important if nonspawning fish are affected. This intense pressure has been assumed to severely affect the reproductive capabilities of the species.

It is generally accepted that an intense fishery can at least potentiate the collapse of a population, and perhaps delay its recovery if the population has been severely depleted. When fishery pressure is eliminated, the population is expected to increase, particularly after periods of heavy exploitation. The California sardine remained at low abundance levels from the early 1950s to the late 1970s, but subsequently increased; thus there seems to be a relationship between the recovery and the fishing moratorium imposed since 1967.

However, questions regarding the fishery problem remain. Previous papers presented evidence that the magnitude of the changes in abundance of sardine populations is beyond the mere effect of the fishery (Clark and Marr 1955; Radovich 1982). Moreover, it is well known from scales deposited in marine sediments (Soutar and Isaacs 1969) that the high-low abundance patterns may exist even in the absence of a fishery.

A second approach, the "recruitment problem," stems from the early work of Hjort (1914), and has been postulated by a number of authors. It is based