

A “*problematic*” guy: José Gallego-Díaz’ Centennial

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Abstract

This essay is dedicated to the mathematical life and scientific endeavour of José Gallego-Díaz, a Spanish mathematician and engineer whose career took place between the early 1930s and 1965 in three very different political and social environments: The Spanish Republic and the civil war, then Franco’s dictatorial regime from 1939 until 1956, and finally in the Americas. Although he had been politically involved in the first two stages, regardless of political regimes he was able to develop a body of mathematical ideas and applications that really deserves being considered a breakthrough in the Spanish mathematical panorama, not very prone to applied Mathematics in those times. Gallego-Díaz contributed to mathematical Biology when this discipline was in its infancy, and made some original studies to the mathematisation of certain fields of economic theory. He was also an uncommon teacher who enjoyed problem proposal and elegant solutions, and is still remembered through some of his books on problem-based approaches to mathematical topics. In addition to all that, he wrote on many occasions on very different fields, and left behind him an abundant collection of notes, reviews, recensions, and other materials of non-mathematical nature.

Key words: Applied Mathematics, economic Theory, Franco regime, mathematical Biology, problem solving, Spain.

1 Introduction

José Gallego-Díaz Moreno (1913-1965, henceforth, Gallego) is a rather unclassifiable engineer, mathematician, and economical theorist who enjoyed a rich personal life: he read for –and obtained– three different degrees, published a lot, performed experiments, traveled through Europe and the Americas, made incursions in politics, acted as an unhibited observer and criticist in the hardest times of the Franco regime, had children in and out of marriage, and eventually was recognised in his native Spain and abroad as someone with an enormous potential that could not be duly developed due to his rather early death.

Here emphasis will be put mainly on the mathematical and mathematically related aspects of his biography, although some points will need a contextual explanation, for otherwise they would be difficult to understand. If it were possible to classify Gallego, he would be considered as an applied mathematician with broad interests in engineering, and in some application-prone mathematical fields, but also an outsider in Spanish Mathematics, where consideration of applications was rather small in the mathematical school led by Julio Rey Pastor (1888-1962) before the civil war, and his sucesor after it Tomás Rodríguez Bachiller (1899-1980) in the 1940s. Although a brilliant mind, he was excluded from the official mainstream of

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Spanish Mathematics, thus being an example of interior exile until the mid1950s. In any case, mathematically speaking a leading thread in his scientific endeavour is readily found: Above all, he was a problemist with a tendency to understand life –not only its scientific aspects– as a succession of problems and attempts to solve them, although he was fond of closed and elegant solutions.

Originally, this essay was projected as an overarching consideration of a small group of mathematicians who might be considered as peculiar representatives of the Spanish mathematical panorama during the middle third of the 20th century, formed by Antonio Flores (1913-1992), Federico Gaeta (1923-2007), and Gallego himself. Due to their respective personalities and to the prevailing political, economical, and cultural situation in Spain under the long period of General Franco's dictatorship, they were representatives of a small, unorthodox but otherwise coherent group drifting away from the original Rey Pastor / Bachiller organisation, three *enfants terribles* within the Spanish mathematical community. Flores has been already studied in depth by various authors in connection to the Vienna Circle (Padilla 1998); and Gaeta, who from 1965 onwards spent a large part of his life in the US, has been the object of a comprehensive recent book (Alonso 2010). Therefore, only Gallego will be considered here, with occasional allusions to the other two. There exists a short biographical essay on him (Lorenzo 1987), and other more recent sketch (Guerrero 2001) with no Mathematics in it.

The study is based on the contrasted hypothesis that there existed a clear continuity across the civil war in Spanish mathematical affairs and their European international connections, maintained until the early nineteen-sixties when the American influence eventually became the rule in most West-european Science (Pacheco 2014). A second point of interest is an analysis of social extraction and formation years, with emphasis on the role they played in the post-civil war years and on the personal and professional fate of Gallego. Primary sources have been his papers and books. As secondary sources, especially for most personal details, in addition to the two just cited biographical items, a review of the leading Spanish newspapers *ABC* and *La Vanguardia* between 1930 and 1970 has been most helpful.

The paper is structured as follows: to start, a general biographical section followed by a first subsection covering the pre- and civil war years, and a second one devoted to the 1940-1965 period; then an overview on Gallego's Mathematics with three subsections dealing with the various fields where he made the most interesting contributions, *viz.* mathematical Biology, economic theory, and books and problems, including some interests in Science Theory. Three basic conclusions are offered to close the article. A detailed catalogation effort of the many items authored by Gallego and spread in minor journals and periodicals is outside the scope of this work.

2 Biographical details

Gallego was born in the city of Úbeda, in the Andalusian province of Jaén, a son of the lawyer, economist, academician, and politician Rafael Gallego-Díaz (1880-1939), a member of a well considered catholic family in a good cultural and social environment with some aristocratic connections. The father was an active person who had participated in many initiatives and negotiations, he had been elected *diputado en Cortes* as a representative of the liberal Party, and also appointed *Gobernador Civil* in two provinces: his native one, and then Zamora. In the meantime he had had time to make a failed attempt to a university chair on political Economy, to write on historical and economical topics, as well as a translation of the thick three-volume History of the French Revolution by Albert Matthiez. He ceased his political activity when the Spanish Republic was proclaimed in 1931, and died shortly after the end of the civil war. His death is recorded in the nobility catalogue (Mayoralgo 2013).

Therefore, Gallego had an education where the family connections and the home library

played an important role, so no wonder that he became an esteemable writer as observed in his broad production –including some poetry–, and it seems reasonable that this familiar influence had to do with his interest on economic problems from the mid-1940s onwards. Curiously, Gallego and Flores were not only contemporaries: their fathers were both born in the same province and were prominent and influential persons close to the power areas in the 1910s and 1920s, they died within a two-year interval. The sons embraced republican attitudes in the 1930s, in addition to their common scientific interests, and professionally speaking, after the civil war they were forced to be in the outskirts of the official mathematical Spanish panorama, that otherwise presented a clear scientific continuity with the pre war one.

Agriculture being in those times the most relevant economical activity in his native city and its neighbourhood, it may be taken for sure that it had some weight in the decision to move to Madrid in order to read for a degree in Agronomy, or *Ingeniero Agrónomo*. To enter the Spanish engineering schools, inspired in the French model, an entrance examination was needed demanding a mastery of classical Mathematics and Mechanics from the candidates, and this is how Gallego contacted the mathematical group of Julio Rey Pastor.

2.1 The pre- and civil war years, including a *Soviet connection*

Gallego's early career as a mathematician is an amazing one. On starting the Agronomy studies, his mathematical inkling was such that at the age of twenty he was already acting as an editor, problem proposer, and solver, in the journal *Matemática Elemental* of the *Sociedad Matemática Española* (SME), a post he held until the end of the civil war in 1939. Moreover, by 1934-1935 he performed at the engineering school some experiments on the phenomenon of alcoholic fermentation, where he tried to adapt contemporary work in mathematical Biology by Vito Volterra (1860-1940) and Vladimir Kostitzin (1883-1963). This piece of research he most esteemed for a long time, for Gallego was still writing on the topic for the journal *Agricultura*, published by the Agriculture Ministry, twenty years after, in the 1950s.

For a short time during the civil war he was in charge of some official responsibilities in the Agriculture Ministry of the republican zone headed by the communist Vicente Uribe (1887-1961), a fact that surely helped him and a few other enthusiasts to contribute to the survival of the SME and its flagship journal *Revista Matemática Hispano Americana* (series III) in the war years. Among them were José Barinaga Mata (1890-1965) and Tomás Rodríguez Bachiller, see (González Redondo 2011). Later, Gallego acknowledged Barinaga as a notable influence on him. In the war years he even published a short note summarising his findings on alcoholic fermentation theory in the Soviet journal *Bulletin of Experimental Medicine and Biology*, where he is identified as X. G. Diats, affiliated to a so-called *Institut prykladnyj issledovaniy* or Institute of Advanced Research –seemingly a tentative joint translation of the Spanish funding agencies names– at Madrid (Diats 1937). To our knowledge, this is the only paper published by a Spaniard in this journal at that time. This *Bulletin* is still published with the same name.

2.2 1941-1965, a life under the Franco regime and outside Spain

Once the war was over, and after his father's death, Gallego is again in Madrid in 1940-1941 where he is found in the learned society *Ateneo de Madrid*, and studying to complete three degrees: Mathematics (known in Spain as *Ciencias Exactas*) and Chemistry, and then his Agronomy studies in 1943. Moreover he collaborated from the very beginning in the post-war journal *Euclides*, see below. The political depuration process carried over by the Franco regime does not seem to have been very hard with him, a former member of a republican Ministry headed by a communist. In all probability, his family connections must be credited for this rather indulgent treatment. The conservative newspaper *ABC* published for several consecutive

years short condolence notes on the anniversary of Rafael Gallego Díaz' death.

In *Euclides*, Gallego was a fixed contributor for years from 1941 onwards in various topics, mathematical and not. For instance, most of the cultural notes, book recensions, and social chronicle on science talks in Madrid were his in the first issues, as well as many problem proposals and solutions. This periodical was continued until the early 1960s, and in its first years was the tolerated outlet for scientific production of a number of people who in a first instance had not been considered as politically reliable. On obtaining his degrees, Gallego was hired to teach Probabilities and Geometry between 1943 and 1945 at the Agronomy school, and he was eventually awarded a doctorate in Mathematics in 1945 advised by the mathematician and economist Olegario Fernández-Baños (1886-1946), one of the first members of the Rey Pastor group who had worked for a long time for the Bank of Spain, a post he could not recover after the civil war. Gallego's dissertation had the title *Sobre las hipótesis que sirven de fundamento a la Economía Matemática* –clearly a wink to Riemann's 1854 Habilitationsschrift *Über die Hypothesen, welche der Geometrie zu Grunde liegen*– where he attempted to establish a sort of axiomatisation for economic analyses on a non-euclidean framework. Therefore, by 1946 his academic curriculum was already complete, and in the dark and shabby Spanish mid 1940s, he left the Agronomy school to work at various academies by coaching students intending to enter engineering studies through the preparation of the Mathematics and Physics entrance examination. Though a demanding job, it was well paid and helped Gallego to buy books and journal subscriptions for the next years. Quite a number of engineers who were his pupils have written reflections and sketches of him in his activity as a mathematical coach. He appears as a prominent figure in one of the stories –*Barojiana*– of a semi-autobiographic recopilatory book by the writer and civil engineer Juan Benet (1927-1993), who was among the coached students and later became a friend of Gallego (Benet 1987).

From 1945 until 1950 Gallego was also a close friend of Cirilo Benítez Ayala (1917-1950), a civil engineer with whom he shared teaching at various academies as well as an approach to the small neomarxist circles of an incipient inner opposition to the Franco regime. Ten years after Benítez' death in a railway accident, Gallego was to remember him in the dedication of a paper on the future of mathematical Biology published by *El Museo Canario*, a periodical which is still published at Las Palmas (Canary Islands), the native city of his friend: this paper is the only one dealing with Mathematics ever published in the journal history. He also contributed with some book recensions to this periodical.

During those years he kept some contact with other Spanish mathematicians at the *tertulia* (a social gathering of more or less fixed people taking place daily or weekly in a café or at someone's home) organised around Germán Ancochea (1908-1987) from 1947 onwards: There we find him with Flores, a very young Gaeta who already was an *enfant terrible*, the statistician Sixto Ríos (1913-2008), and a number of other people, mathematicians and not.

Between 1950 and 1956 Gallego traveled privately all over Europe, enjoying life and meeting mathematicians and other scientists, *e.g.* the Soviet mathematician Kolmogorov in Paris, and a number of Americans, and also prepared the access to a chair –in Physics, obtained in 1955– at the Agronomy school, but had time enough to be a most conspicuous element in some Madrid cultural areas. In addition to the already cited written portrait by Benet, a cameo of Gallego may be observed in the 1955 film *Muerte de un ciclista* (min. 12) [tu.tv/videos/muerte-de-un-ciclista_1] of the renowned Spanish director Juan A. Bardem (1922-2002), a tolerated communist himself.

According to Benet and other sources, Gallego did never hide his leftist sympathies. See *e.g.* in Hernando 1986: *José Gallego Díaz, imaginativo, extrovertido y un tanto bohemio, Cateadrático de Física en los años 50 en la Escuela de Agrónomos, a quien quizá por su bohemia no tomábamos muy en serio su militancia ni sus manifestaciones confidenciales sobre la colonización rusa como salvación de España, fruto quizá de su admiración por los matemáticos*

soviéticos; and in the episode *El pintor Díaz Caneja* of Benet 1987: ... *a excepción de Gallego Díaz, al que se le perdonaba su filiación (i.e. being a communist) porque además de matemático era todo él un puro disparate*. Therefore he was immediately suspected to be somehow involved in the 1956 student revolt that triggered a profound political reorganisation in the Spanish regime (Mesa 2006). This episode prompted Gallego to leave Spain, which he did by travelling to the US, but it is unclear how he was allowed into the country, still in the wake of the anti-communism phobia in the McCarthy years. Once there he visited a number of universities: he is found at Madison (Wisconsin), where on the wake of a series of talks by the economist Martin Bronfenbrenner (1914-1997), he lectured on his mathematical economic theories; after that, funded by the Ford Foundation he was a participant in the famous Stanford 1957 *Summer Institute on the Applications of Mathematics to the Social Sciences* (June 24th -August 17th). Surprisingly, in a sort of political resurrection, the Spanish newspapers informed at length on this tour, where he was termed *el distinguido y prestigioso matemático español Gallego-Díaz...* He was appointed member of the American Mathematical Society by Vanderbilt University (Nashville, Tennessee) in 1958, and the same year the Universidad de Puerto Rico at Río Piedras hired him, so in 1959 he resigned his chair in Madrid and moved in 1960 to Venezuela, where he worked in the implementation of Agronomy studies at the Universidad del Zulia in the western province of Maracaibo. Eventually, and again with funding by the Ford Foundation, he switched in 1963-64 to the Universidad Central de Venezuela in Caracas with the task of organising there a research and education center in the mathematical sciences. He could not see this program finished, due to his untimely death as a result of an automobile accident at Caracas airport on February 18th, 1965. Long and laudatory necrologies were subsequently published in Spain, and years after he was still well and affectionately remembered by a number of his latin-american disciples, see (Nieto and Peña 2000).

3 Gallego's Mathematics

Some paragraphs above it was pointed out that Gallego should be considered an applied mathematician who dealt with questions not in the mainstream of applications practised in Spain in the 1930s and 1940s. The bulk of efforts in this area had been devoted in Spain to applications in aviation and aeronautics since the creation of the *Escuela Superior Aerotécnica* in 1928, which was continued after the civil war under the name of *Escuela Superior Aeronáutica*. The 1928 *Escuela* was a personal endeavour of Emilio Herrera (1879-1967), then a colonel and member of the Rey Pastor organisation, which provided a few mathematicians in that first epoch. After the civil war the already general Herrera exiled himself, but the engineer, politician, entrepreneur and former mathematician Esteban Terradas (1903-1950) managed to reopen those facilities in 1942 with the aim of fostering an aircraft industry during World War II. See the comprehensive book (Martínez-Val *et al.* 2004) and comments in (Pacheco 2014).

Nevertheless, in the mid-30s Gallego's interests pointed to other areas like biological problems in view of their industrial applications, where very active research lines in different disciplines had internationally developed a large theoretical and experimental body on population dynamics, modeling, Genetics, traveling waves and related topics, most of them emerging from the mathematico-biological considerations formulated in the pioneering efforts of Volterra and a considerable number of mathematicians with various backgrounds.

The mathematisation of Economics and the Social Sciences, for years a deep concern of many schools and scholars, was another field where Gallego contributed. Many attempts had been made to establish the foundations of those sciences in ways similar to, or inspired in, classical Mechanics, and Vilfredo Pareto (1848-1923) had even written down a table with the analogies needed to formulate an economic theory parallel to classical Mechanics that was not further developed. There was as well a Spanish attempt to mathematisation of the Social

Sciences in a similar line by Antonio Portuondo Barceló (1848-1926), the author of the 1912 book *Mecánica Social*, later translated into French in 1926, but no relationship has been found with Gallego (Pacheco 2008).

3.1 Mathematical Biology

Due to its industrial interest, the modelling of various fermentation techniques had been an active research field in applied Chemistry for many years. In particular, the alcoholic fermentation had been studied by several scientists under a variety of assumptions, which eventually led to take into account the role of the biological environmental conditions, *i.e.* the evolution of the yeast population involved in the process, that prior to these studies had been considered only as a sort of catalyst. The British chemist Arthur Harden (1865-1940) was even awarded the 1929 Nobel Prize in Chemistry for research in the topic. See Harden and Young 1913, Hopkins and Roberts 1935, Slator 1906. On the other hand, the mathematicians Volterra and Kostitzin had developed a number of mathematical tools for integral and integro-differential equations and their applications (Israel and Millán 1993, 2002; Kostitzin 1935). Then Gallego made his first research steps under the guidance of the engineer and enologist Juan Marcilla (1886-1950), the discoverer of a particular yeast named *Saccharomyces beticus*. We may note here that Gallego did not have any stipend of the funding agency *Junta de Ampliación de Estudios* as his colleague Flores had, but Marcilla had some funds from the newer agency *Fundación Nacional de Investigaciones Científicas y Ensayos de Reformas* created in 1931 in order to bring applied research to the forefront of scientific activity. Gallego tried to contribute to the field by adopting an approach directly inspired on the above mathematicians for describing the evolution of the yeast population responsible for the alcoholic fermentation, stressing its role and tracking it in order to optimise the results. He employed as a case study the wine of the producer domain Moriles in Córdoba, close to his native province, and in a presentation to the SME on October 5th, 1935, he claimed having obtained good agreement between experimental results and those of his model for the evolution of yeast biomass (Anonymous 1935).

In a most typical engineering viewpoint he started by writing down a logistic for the yeast biomass, and then complemented it with a negative growth term accounting for environmental conditions, with a coefficient including the convolution of the biomass and a biologically interpreted memory function $\varphi(t)$, so the basic model equation was

$$X'(t) = \alpha X - \beta X^2 - \gamma X \int_0^t \varphi(\tau) X(t - \tau) d\tau$$

In his already cited 1937 paper in Russian –essentially the 1935 presentation– Gallego claims to have solved this equation with adequate side conditions, writes down the solution in closed form, presents some graphs illustrating its behaviour, and comments on the agreement between his theoretical results and experimental data. In fact, he only worked and solved the particular case with $\varphi(t) = 1$, for which the closed form solution presented by Gallego was present in the 1935 memoir by Kostitzin on integral equations. Nevertheless, he proudly writes: “Kostitzin has recently found the same results...” (Diats 1937, p. 576).

Maybe it is worth to note here that citing the Jew Volterra, who had already been dismissed in Italy in spite of his enormous scientific and human value, and Kostitzin, a Russian émigré to Paris in the nineteen-twenties, might have been considered a risky affair in 1937 Soviet Russia under Stalin’s dictature, and it is also notable that mathematisation of biological questions raised interest in Nazi Germany in connection with racial politics: The book by the applied mathematician Friedrich Ringleb *Die mathematische Methoden der Biologie, insbesondere der Vererbungslehre und der Rassensforschung* has an unequivocal title (Ringleb 1937). No connection has been found between Gallego and this line of mathematical Biology.

The interest on these questions was a life-long concern for Gallego, though he did not publish much on them: In addition to the few notes in the journal *Agricultura* during the 1950s, the 1960 paper published in Las Palmas, and a 1964 short note on a model for cellular division inspired on some ideas on biological time (Nouÿ 1936) have been recorded (Gallego 1960, 1964).

3.2 Economic Theory

The standpoint adopted by Gallego to address the fields of Choice Theory and Demand Analysis was inspired on a variation on the concept of utility known as “ophelimity”, defined by Pareto in 1896 as the driving force leading people to make decisions regardless of their effective usefulness. Because of its deep psychological implications, it is a more complex idea than just utility, and in our time it is usually termed “ordinal utility” or “revealed preference”, see Bruni and Guala 2001, Chipman 1976, Donzelli 1997, Mirowski 1995, Tarascio 1969, Wold and Jureén 1953. Actually, it was on the basis of this research that he travelled later to the United States to initiate his life in the Americas.

In his doctoral thesis Gallego undertook a mathematical treatment of the ophelimity concept, where he introduced ideas of riemannian Geometry into economic analyses by describing everything –an election inspired on the lorentzian distance of restricted relativity, with an adequate change in a sign– in a $(2n + 1)$ -dimensional “economical space-time” where the usual euclidean metric was abandoned in favour of a riemannian metric approach by introducing in the punctured positive orthant of this spatio-temporal continuum a distance concept via the differential expression

$$ds^2 = \psi(x_i, y_i, t) = \frac{dt^2}{t^2} + \sum_{i=1, \dots, n} \frac{dx_i dy_i}{x_i y_i}$$

In the above formula n is the number of different goods x_i offered for consumption, the y_i being their respective prices. In the stationary case $dt = 0$, instead of the rotational invariance of the usual euclidean metric, this one translates a conception of invariance under homotheties, *i.e.* the distance between two points is a function of the quotients of their coordinates, which was thought by Gallego more appropriate for dealing with his scale-free vision of economic concepts:

$$dist[(z_{11}, z_{12}, \dots, z_{1,2n}), (z_{21}, z_{22}, \dots, z_{2,2n})] = f\left(\frac{z_{11}}{z_{21}}, \frac{z_{12}}{z_{22}}, \dots, \frac{z_{1,2n}}{z_{2,2n}}\right)$$

where the first n coordinates represent (quantity of) goods and the other n are their prices. An expression satisfying this property is:

$$f\left(\frac{z_{11}}{z_{21}}, \frac{z_{12}}{z_{22}}, \dots, \frac{z_{1,2n}}{z_{2,2n}}\right) = \left(\prod_{i=1, \dots, n} \log\left(\frac{z_{1i}}{z_{2i}}\right)\right)^{\frac{1}{2}}$$

The simple case $n = 1$ yields the differential expression $ds^2 = \frac{dx}{x} \frac{dy}{y}$, for which geodesics in the first quadrant are the curves $y = kx^m$. Then a variational formalism was provided: If the ophelimity for a certain individual be expressed as $\omega = \omega(x_i, y_i, t)$, then her economic trajectory would be defined as an extremal curve Γ –if it exists one for which a maximum is realised– for the integral

$$\int_{\Gamma} \omega ds.$$

There is a clear connection between Gallego’s doctoral thesis and the work proposed by Bachiller to Pedro Abellanas (1914-1999) for his doctorate in 1941 on Hopf-Rinow manifolds, and it was Bachiller who actually approved Gallego’s thesis for public presentation. It must be remembered that at the end of World War II, the Franco regime experienced a hardening episode

–it culminated with the UNO sanctions– and most possibly Bachiller’s explicit authorisation was a necessary gesture ensuring the thesis presentation.

The biographer Javier de Lorenzo complains that Gallego could not publish his work as a whole in Spain and therefore had to split it into several papers (Lorenzo 1987; Gallego 1947, 1949, 1951a, 1951b, 1951c, 1951d) published in Portugal and in France. Indeed it is true that Gallego, who highly appreciated his results, and published several variants of them on possible applications to the axiomatisation of political Economics and even to problems in mathematical Biology and Biophysics, never published anything in the official outlet for Spanish mathematical production in his time, the *Revista Matemática Hispano Americana* (series IV), even if he had contributed to its survival through the civil war. The explanation lies in the inner politics of the post-war *Instituto Jorge Juan de Matemáticas* that had taken over the role of the SME, but quality of his production has little or nothing to do with that implicit prohibition, as a study of the *Mathematical Reviews* of those years easily shows. Some of those papers were re-published a few years after in Spain (*e.g.* Gallego 1949, published in Portugal, is Spain’s Gallego 1954) during the years of the Education minister Joaquín Ruiz-Giménez (1913-2009), who was in office between 1951 and 1956 and fostered a certain regime relaxation in cultural matters. Among them was the authorisation in 1952 to publish the philosophical-scientific journal *Theoria*, where Gallego’s paper was recovered as an exponent of the non-official mathematical production of the post-war years.

3.3 Problems, books, and interest in Science Theory

Gallego’s book production was mostly inspired on his guiding idea that Mathematics could be taught –and learnt– via an adequate choice of exercises and problems in addition to the usual theoretical expositions, as shown by his activity as a mathematical coach and problem proposer and solver that was a lifelong concern for him. In the pre-war years the journal *Matemática Elemental* had seen a number of his contributions as the starting point of an activity he cultivated during his whole life, both in Spain and internationally, and after the war he was an assiduous contributor to *Euclides* and to the *American Mathematical Monthly*, the *Mathematical Magazine*, and an early proposal in the *Revue de Mathématiques Spéciales* has also been recorded. Problem production by Gallego is a broad one, both as a proposer and as a solver, and over thirty items have been recorded in the usual mathematical databases. Quite a number of his proposals are like clockwork pieces where the solving technique may be found by close inspection of the formulas or texts. As an example, in *Euclides* I(4), p. 110, the following problem is found: To solve the functional equation

$$F(x) = -\frac{F[x + 2F(x)F'(x)(1 + (F'(x))^2)]}{1 + 2(F'(x))^2}$$

but others are found showing deeper insight on apparently simple questions, like (Gallego *et al.* 1964) on how to obtain a characterisation of the parabola.

He was also well aware of the importance of having at hand good bibliographical resources, and while in the Universidad del Zulia at Maracaibo he compiled a long annotated list of books and journals needed for the Physics and Mathematics courses he had planned for the university (Gallego 1963b).

By blending problems, books, and the economic situation in the early post war, his first incursion in book writing was the 1942 *Curso de Matemática en forma de problemas*, with a foreword by Antonio Flores de Lemus, father of his colleague Antonio Flores, who later in the 1950s added the “de Lemus” family name to his own. This text had two companion books: *Formulario de Matemáticas generales* (Gallego 1942b), and *Nociones de cálculo vectorial y complementos de Matemáticas* (Gallego 1943a). A revised printing of the *Curso* appeared in

1944, and it deserved a second and enlarged edition in 1955 with a supplementary presentation by Rey Pastor and a dedication to Barinaga. In 1948 *Problemas de cálculo de probabilidades* was presented, and in the early 1950s two editions of a joint book with Rey Pastor *Norte de problemas*, were given to print (Gallego and Rey 1950). As a translator he prepared three editions of the classic 1879 book by the Dane Julius Petersen (1839-1910) that was an almost compulsory reading for entrance examination in the engineering schools, for problems on geometrical constructions were a must in them. The third one includes a very readable theoretical appendix and footnotes by Gallego himself, but no notice is given on the non-Spanish version used for the translation, for sure it was some of the many French ones over the years (Petersen 1955).

By the time he died he was busy with the preparation of *Nuevos problemas de Matemáticas*, which was posthumously published. In his Maracaibo years he prepared a more ordinary type of textbook, *Curso general de Matemáticas I*, a thick volume with more than 500 pages including items like quaternions and their applications. Unfortunately, the book was reviewed in an unfavourable way by *Mathematical Reviews* in 1965 (MR173608) stressing the sketchy character of the text. Death of the author made it impossible to prepare a revised edition, and a supposed and expected part II never appeared.

On browsing Gallego's written production on various non mathematical fields, emphasis on a number of topics is easily observed, the engineering and familiar background of the author being responsible for the choices. Many short notes appear without author or just with a couple of initials, and even pseudonyms, but the range of their contents is surprisingly broad: From quotations of known authors in many fields to the agricultural applications of radioactivity to social questions to science theory considerations. Book and booklet reviews are found as well during 1946 and 1952 in the humanistic journal *Insula*, where many poets and writers have published since 1946 –it is still published in our days. Among them, the high-school 1945 book *Aritmética racional* by the Portuguese mathematicians António Aniceto Monteiro (1907-1980) –the founder of *Portugaliae Mathematica* (1939) and co-founder of *Gazeta Matemática* (1942)– and José Silva Paulo, as well as the polemic *The poetry of Mathematics and other essays* of 1934 by the historian of Mathematics David Eugene Smith (1860-1944) . Gallego was remembered in two obituaries published in this journal (Cordón 1966; Núñez 1966).

An interest in science-theoretical questions led Gallego to undertake the 1954 translation of John L. Synge's *Science: Sense and Nonsense* of 1951 under the name *Sentido y contrasentido de la Ciencia* (Synge 1954), as well as the 1964-65 translation, with José M^a Gimeno, of a famous symposium based on radio programs of the BBC, *Quanta and Reality*, with texts by David Bohm, Stephen Toulmin, Mary Hesse and others. The Spanish edition was named *Física cuántica y realidad* (Bohm 1965). In the same line, shortly before his death Gallego had contributed three appendices and compiled an updated bibliography for the Spanish translation of Gilbert Cahen's 1953 book *Les conquêtes de la pensée scientifique* (Cahen 1966) prepared by his co-translator Gimeno and two other people. On the occasion of Einstein's death, the journal *Physicalia* –the bulletin of the *Asociación nacional de físicos españoles*– published a monographic issue, where Gallego contributed with a biographical essay (Gallego 1955b). Years after that, he published an article in the newspaper *ABC* intitled *Einstein tenía razón*, in a polite polemic with the anti-einsteinian Spanish physicist Julio Palacios (1891-1970) (Gallego 1963c).

The “canary” paper on the future of mathematical Biology (Gallego 1960) was also an incursion in science theory, where a blend of the Agronomy engineer and the mathematician presents a plea emphasising the ever growing role of Mathematics in the development of Life Sciences. Unhappily, he did not live enough to see the enormous interdisciplinary approaches that conform today's leading viewpoints on this field.

4 Conclusions

In addition to the primary classification of Gallego as an applied mathematician, a most accurate description of his life and work would be conveyed through a single word: He was a *possibilist* or, in longer wording, a crude example of *survival of the fittest*, to use a very appropriate darwinian expression to describe his trajectory across political regimes, mathematical fashions, and cultural ambients. Several conclusions may be drawn from the above paragraphs, organised in two groups, the first one on the influence of the social environment on Gallego, and the second one on his mathematical contributions.

It may be first concluded that, doubtless, Gallego's familiar extraction played an important role in his life, including both his republican commitment as a young man, as well as the non-official support he was offered in the early postwar and that highly helped him to obtain his academic degrees, to survive in the early francoism, and to make a living on Mathematics, but indeed he was never allowed into the hard core of regime mathematicians controlling the few funds, publications, and tenures. Although a declared leftist who had been in touch with intellectual circles of the inner opposition to general Franco's regime, he often acted publicly as a devout catholic (Pasquau 1965). Nevertheless, traveling through Europe in the early 1950s made him aware of the narrow horizons awaiting him in Spain, and eventually led him to migrate to the Americas.

Second, the originality of Gallego's Mathematics lies in his entering the mathematical arena via problem solving and experimental work in engineering questions of an applied nature, which he translated into writing by preparing a number of books with that particular leitmotiv: learning and teaching Mathematics through problem solving. His main contributions to the mathematical sciences are his juvenile studies on mathematical Biology where he employed contemporary techniques in the analysis of alcoholic fermentation –a retrieval of (Diats 1937) is at the heart of this paper–, and a much longer commitment, well documented through a number of articles, with the intricacies of economic thought and its relationship with the Social Sciences, discovering other mathematical fields of application and contributing to the expansion and divulgation of applied Mathematics in his last life years.

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