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What Roles for Scientific Associations in Contemporary Science?

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Abstract This article aims to discuss the contemporary activities and roles that scientific associations play in science and society. It is based on a comprehensive study of scientific associations in Portugal, relying on a multi-method, quantitative and qualitative approach. After a brief review of the (scarce) literature on associations in the social studies of science, we provide an outline of the expanding field of scientific associations in Portugal. We then proceed to present and discuss the five main roles of associations identified through the research: communication among peers, promotion of research, science dissemination, representation of professional interests and policy advice. We conclude that the external roles of associations (establishing connections between science and society) have become more important than the internal ones. Whereas the internationalisation of science has moved the communication, collaboration and competition between researchers into the transnational sphere, the links that associations forge between science and other social spheres are still deeply rooted in national settings and much dependant on specific configurations and practices by government, business and other social actors.

Keywords Scientific communication · Science dissemination · Representation of interests · Policy advice

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Contemporary scientific associations are quite an under-researched issue. The social studies of science have focused mainly on the 'triple helix' institutions (university, government and business) or on non-formalised collectives in science, such as the 'republic of science' of Polanyi, the 'scientific community' of Hagstrom and Merton, the 'invisible colleges' of Crane, the 'epistemic communities' of Knorr-Cetina and Haas, the 'scientific field' of Bourdieu or the 'extended peer communities' of Ravetz and Funtowicz.

Private non-profit organisations in science not (solely) dedicated to research assume different designations: scientific societies, learned societies, scholarly societies, scientific associations, academic associations. Nevertheless, there are no established typologies that point out the differences between them and there is little reflection on what they do and for what they do it, or on their relation with the context in which they are embedded. And yet, most scientists belong to one or more scientific associations. Also in the case of the social studies of science, familiarity seems to breed neglect. Despite the existence of two large international associations (EASST European Association for the Study of Science and Technology and 4S Society for Social Studies of Science), none has been the subject of any study. In fact, the issue of scientific associations has been conspicuously absent from conferences and publications of these two organisations.

This article aims to kick-start the discussion on this subject, by focusing on the roles played by national scientific associations in Portugal. The small size of this scientific system makes possible a thorough study of its associations; its internationalisation (despite its location in the periphery of Europe) may allow generalisations to other national settings.

State of the Art

Existing literature addresses mostly the historical dimension of scientific societies, such as their role in the birth of modern science or the genealogy of individual institutions, of which the Royal Society takes pride of place (Ornstein 1928; Merton 1938; Shapin 1996; Golinski 1993). A few studies briefly mention the (often minor) role of scientific associations in areas such as the public understanding of science (Gregory and Miller 1998), academic labour activism (Raman 2000), the development of scientific disciplines (Schofer 2003b), the 'boundary-work' of scientific professions (Gieryn 1995), the internationalisation of science (Crawford et al. 1993) or the interplay of interests in the governance of science (Barke 2003).

As to studies specifically focused on scientific associations, just a few cases can be found. Regarding international associations, Greenaway (1996) performs an analysis of the history of the International Council for Scientific Unions (ICSU, which changed its name to International Council for Science in 1998), established in 1931 as a federation of scientific societies, and Petitjean (2008) narrates the creation of the World Federation of Scientific Workers just after the Second World War. Schofer (2003a) goes further in the historical approach and draws a panorama of the evolution of international scientific societies between 1870 and 1990. He distinguishes between two types of international associations in science, one of a

professional nature, focused on "(1) the professional interests of a specific scientific field, (2) scientific standards and nomenclature (…) (3) the production of scientific knowledge"; and the other socially oriented, meaning those that "support science in order to address social problems such as economic development, environmental degradation, war, nuclear weapons, and ethics", including among its activities "(1) bringing scientific information to the citizenry or policy makers (…), (2) promotion of science or science policy that directly ameliorates social problems (…) (3) promotion of ethics in the application of science" (Schofer 2003a: 83–85)

An analysis of scientific associations in a single national scientific system can be found in Schimank's (1988) study of German associations. Relying on the results of a questionnaire survey, the author examines the four main functions of scientific associations (communicational, professional, transfer and promotion), registering variations by scientific discipline and size. This study is the one closest to the research project on which this article is based, but it predates the substantive transformations science has undergone in the past few decades and its purely quantitative nature precludes an in-depth investigation of the roles of scientific associations.

A questionnaire survey was also the chosen method in Moreau et al.'s (2004) study of medical societies in France. The authors aimed to build a definition and a typology of these organisations, drawing from their objectives, size and criteria for membership. However, as the institutional affiliations of the authors and the journal in which it was published (*Presse Medicale*) show, this is an example of internal reflexivity of the discipline rather than an analysis stemming from the social studies of science, a fairly common situation in the publications concerning scientific associations (see, for instance, Siegelman 1998; Doyle et al. 2004; Scott et al. 2008).

As to particular types of scientific associations, there are a few studies on academic trade unions, for full-time faculty members (e.g. Lawless 1981; Kemerer and Baldrige 1981), and on graduate employee's trade unions (e.g. Julius and Gumport 2002; Lee et al. 2004; Rhoads and Rhoades 2005).

Individual case studies of scientific associations are another kind of work in this field. For instance, Rilling (1986) conducted a detailed study of the German Chemistry Society, paying particular attention to its role in establishing connections between the social system of science and external social environments and as channel for social control.

Finally, regarding particular aspects of the activities of scientific associations, three issues have deserved a string of research publications. The role of scientific associations in establishing codes of conduct and ethics has often been discussed in a dedicated publication, the journal *Science and Engineering Ethics* (e.g. Bird 1998; Levine and Iutcovich 2003; Frankel and Bird 2003), as well as in other journals of a wider scope (see, for instance, Didier 1999; Bruhn et al. 2002; Montgomery and Oliver 2009). A second strand of research concerns the role of associations in scientific publication, some of an historical nature (Ornstein 1928), others focusing on the challenge of digital and open access publishing (see, for instance, Doyle et al. 2004; Gunnarsdottir 2005; Leslie 2007; Owen 2007). The third group of works concerns the policy role of some scientific associations, such as the American

Association for the Advancement of Science AAAS (Teich 2002) or the Union of Concerned Scientists (Downey 1988; Moore 2009).

Thus, a comprehensive and integrated perspective on the contemporary roles of scientific societies is missing in the field of social studies of science. This article aims to contribute to addressing this knowledge gap, by focusing on a national case.

Methodology

This article is the result of a research project conducted between March 2010 and August 2012. The empirical evidence for this article stems from a combination of quantitative and qualitative methodologies.

The first stage comprised a census of scientific associations in Portugal, since our aim was to obtain a comprehensive picture of this phenomenon and there was no organised or reliable registry. A broad definition of scientific associations was devised, comprising all kinds of non-governmental, non-profit organisations that meet one or more of the following criteria: calls itself a 'scientific association'; has scientific aims in its mission statement; carries out scientific activities (other than research, namely funding, disseminating, communicating, regulating science or representing the interests of scientists); scientists make up a significant portion of its members (in total or in the governing bodies). Information on scientific associations was collected from a variety of sources: the Portuguese Foundation for Science and Technology (FCT), the Agency Ciência Viva, a previous research project on professional associations, other administrative databases, bibliography, online lists and portals, personal recommendations, web searches. A database comprising the name, year of foundation, discipline, type and mission of 366 associations was thus compiled and made available online (www.socsci.ics.ul.pt). Concurrently, the statutes of 262 associations (those available online) were also collected and subjected to content analysis, in order to provide information on aims, internal structure and functioning.

An online questionnaire survey was then applied to the scientific associations with the purpose of assessing their roles in science by obtaining more detailed information on their activities, internal structure, membership, human and financial resources, connections with other national and international associations and with other organisations. The survey was conducted between October 2010 and May 2011 and its response rate reached 32% (N = 107).

Based on the survey, 24 scientific associations were then selected for in-depth study, comprising document analysis (of reports, regulations, publications, websites, leaflets, news articles), interviews with presidents (and other board members, when it was deemed necessary), a questionnaire survey of members and ethnographic observation at events promoted by the associations (conferences, general assemblies, science dissemination activities, meetings, awards ceremonies). These case studies were selected based on the different roles identified previously as well as on disciplinary diversity. They allowed us to understand practices and processes that could not be gauged solely through the survey findings.

In April 2012, a workshop was held with association representatives, with the aim to discuss and refine preliminary results of the project. The discussion was taped, transcribed and subjected to content analysis.

Findings and Discussion

The Expanding Field of Scientific Associations

In order to discuss the roles of scientific associations in the particular context of science in Portugal, it is vital to begin by a brief characterisation of these organisations and their development.

According to the data collected through the census of scientific associations, there are 366 scientific associations active in Portugal. Without sufficient international research on scientific associations, it is hard to ascertain how this figure compares with other national scientific systems. Regarding just international science associations, Schofer (2003a) registered over 300 organisations active at the end of the 1990s, two-thirds of which were professionally oriented, the remaining socially oriented (see above). In Germany, in the 1980s, Schimank (1988) identified 374 scientific associations. In France, the *Comité des Travaux Historiques et Scientifiques* maintains a data base of learned societies, 186 of which are of a scientific nature.

In view of the size of these scientific systems, the number of scientific associations in Portugal seems unusually high. However, it is consistent with the proliferation of private non-profit organisations in other areas (e.g. 117 Environmental NGOs, 431 professional associations, over 5,000 social welfare organisations, 18,000 cultural and recreational groups) in a country of just 10 million inhabitants with a comparative low rate of associative affiliation. One must take into account at this purpose that Portugal gained the right of free association in 1974 after almost half a century of dictatorship and that there is an apparent trend to the associative fragmentation. In fact, in labour movement, for instance, we perceive, as in other Southern European countries, a clear trend to the existence of parallel organisations which inevitably weaken collective action (Crouch 1994). Also, a weak welfare state has led to the emergence of a "secondary civil society" (Santos 1990; Ferreira 2006), in which private non-profits are promoted (and heavily funded) by the government to perform its duties and pursue its politics. This has been further reinforced by membership in the European Union: in order to access financial support or to be recognised as a stakeholder, interest groups have to be legally registered as associations.

At the same time, the growth of scientific associations in Portugal is also associated to internal factors of the scientific field and is a fairly recent phenomenon, connected to the impressive development of science in Portugal in the past few decades (Fig. 1): researchers in Portugal have gone from a little under 5,000 (Full Time Equivalent) in 1980 to over 50,000 in 2012 (GPEARI 2013). Although the oldest associations date from the 19th century, close to 90% of associations identified in the census were founded after 1970, slightly more than

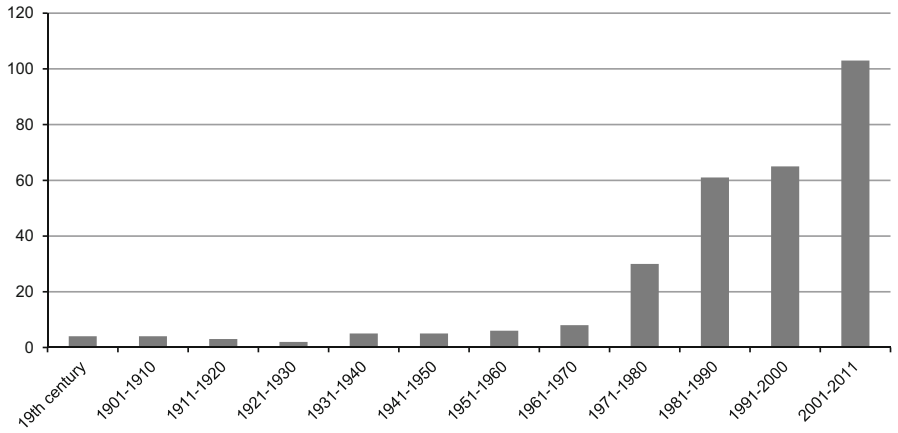

Fig. 1 Scientific associations by year of foundation. *Source*: Census of Portuguese scientific associations, N = 306

one-third in the last decade alone. Again, in the absence of updated international data, it is difficult to assess how common this growth rate is. According to Schofer (2003a), 70% of international science associations were founded after the Second World War. Conversely, Schimank (1988) ascertained that the over one-third of German scientific associations had been founded before 1945 and the growth rate since the 1970s was just 5% a year, indicating "a gradual saturation of the need for scientific associations in the German research system" (1988: 75).

This development of the Portuguese scientific system development has brought opportunities, such as accrued 'critical mass' and specialisation (responsible for the growth of disciplinary scientific societies—see below), but also threats, namely increased competition for resources and instability in the academic occupations (a significant proportion of researchers work under grants and temporary contracts), which may explain the rise of professional associations (see below). These opportunities and threats have both favoured the emergence of 'collective action' or a 'social movement' in science, materialised in the creation of associations.

The breakdown of associations by scientific area (Table 1) shows that it does not mirror exactly the internal makeup of the scientific system. The weight of medical and health sciences associations is disproportional to the weight of their researchers in the S&T System, whereas the reverse is true for engineering and technology, where a small proportion of associations represents a far greater number of researchers. This unbalance is due to diverse disciplinary traditions and associative strategies; in fact, these are not representative associations but rather knowledge-based associations. The specialisation in medicine (see Weisz 2003) has led to a fragmentation in multiple associations. Also, specialised medical associations tend to gather not just researchers but also medical practitioners, interested in keeping abreast of the latest developments in their sub-field (Moreau et al. 2004). In engineering, it is curious to note that the major disciplines (civil engineering or electronic engineering, for instance) do not have their own associations, while

Table 1 Distribution of scientific associations and researchers (FTE) by areas of S&T (%)

	Scientific associations[(1)]	Researchers[(2)]
Exact sciences	8.7	15.5
Natural sciences	15.6	9.7
Engineering and technology	9.0	31.1
Medical sciences	29.2	12.7
Agricultural sciences	3.3	4.3
Social sciences and humanities	26.2	26.6
Interdisciplinary	7.9	–

[(1)] *Source*: Census of Portuguese scientific associations, N = 366; [(2)] *Source*: GPEARI (2013), N = 50,061.2

smaller sub-specialities (such as seismic engineering, structural engineering) do. That may be due to the considerable influence of the Chamber of Engineers, a professional association and representative body (all engineers must be affiliated in order to practice) that is internally divided into speciality colleges. In other areas, such as exact and social sciences, this specialisation is also attained by internal sections and groups within a single association.

Finally, a further distinction should be made between organisations under the broad designation of scientific associations, according to their different purposes. Based on data collected throughout the research, a typology has been built with three 'ideal types': scientific societies, professional associations of scientists and science dissemination associations.

The boundaries between these three types are fairly fluid. For instance, in some areas, the same association functions both as a scientific society and as a professional association (such is the case of the Portuguese Sociology Association). However, some distinctions can be made.

Scientific societies are mainly focused on the promotion of a scientific discipline and they represent 73% of the universe of scientific associations (Table 2). The oldest organisations can be found in this group (Table 3) and the majority of their members are researchers or other S&T professionals (Table 4).

Professional associations of scientists focus on the representation of interests of science and engineering professionals and can be either disciplinary (e.g. associations of geologists, geographers or biochemists) or interdisciplinary (for instance, trade unions of university teachers or associations of grant holders). This type constitutes just 8% of the universe (Table 2), and it began to emerge in the 1970s with the democratic regime (previously, professional associations were heavily restricted) (Table 3). New associations reflect the growing heterogeneity of research careers, focusing on grant holders or fixed-term contract researchers (precarious labour situations). The majority of members are S&T professionals other than scientists (Table 4).

Science dissemination associations focus mainly on the promotion of public understanding of science and represent 22% of the universe (Table 2). This type comprises organisations such as astronomy clubs, nature conservation associations,

Table 2 Typology of scientific associations: distribution of scientific associations by type

	Number	%
Scientific societies	266	72.7
Professional associations of scientists	18	7.6
Science dissemination associations	82	22.4

Source: Census of Portuguese scientific associations; N = 366

Table 3 Distribution of scientific associations by type and year of foundation (number)

	Scientific societies	Professional associations of scientists	Science dissemination associations
19th century	4	–	–
1900–1950	19	–	–
1951–1970	14	–	–
1971–1980	23	2	5
1981–1990	52	3	6
1991–2000	45	3	27
2001–2011	73	4	26

Source: Census of Portuguese scientific associations; N = 306

Table 4 Membership of scientific associations by type of association

	Scientific societies	Professional associations of scientists		Science dissemination associations		Total	
	Mean	Mean Rank	Mean	Mean Rank	Mean	Mean Rank	Mean
Researchers[(1)]	41.15	51.56	31.17	40.38	14.69	30.06	48.38
Other S&T professionals[(2)]	48.38	45.21	67.67	56.96	32.23	34.13	46.19
Higher education students[(3)]	6.79	40.77	1.0	23.79	19.46	57.63	9.81
Other students[(4)]	0.83	36.58	0	32.50	9.77	61.35	3.42
General public[(5)]	2.96	35.69	0.42	28.71	24.65	64.75	9.16

Source: Survey of Portuguese scientific associations, 2011, N = 86; Kruskal-Wallis Test: [(1)] p = 0.002; [(2)] p = 0.025; [(3)] p = 0.000; [(4)] p = 0.000; [(5)] p = 0.000

archaeology groups and associations for the diffusion of robotics or information and communication technologies. Professional scientists are under-represented in these associations, which have a strong proportion of members from the general public (amateurs of science) (Table 4). The growth of these associations dates from the 1990s (Table 3) and has been strongly influenced by the rise of scientific culture as a policy priority in Portugal, consubstantiated in the creation of a government agency (Ciência Viva) in charge of promoting and funding science dissemination activities (Gonçalves and Castro 2002).

The differences between these three types of scientific associations can also be seen on the activities they perform (Table 5).

Thus, quantitative data shows that there are differences among types of associations but at the same time there are no activities performed exclusively by a type of association. Qualitative data will allow us to understand how these activities are connected to the roles played by scientific associations.

Internal Roles of Scientific Associations

Scientific associations play a number of roles that are directly connected to the internal functioning of the scientific field. Though the position of scientific associations in the science system has gradually been moving from the centre (in the early days of modern science) to the periphery (replaced by universities and research centres) and the internationalisation of science has transformed (or mostly eroded) the roles played by national associations (in small scientific systems, such as the Portuguese), they still maintain some activities that are relevant for the production and reproduction of the field, the generation of a sense of community and identity and the distribution of scientific capital.

Production of Science

The production of science was at the core of the activities of the early scholarly societies. The emergence of experimental research is greatly indebted to the demonstrations performed at the halls of the Royal Society and the Academie des Sciences (Schofer 2003a; Ornstein 1928). However, this function has gradually migrated to universities and to public and private research institutions (Ben-David 1972; Gingras 1991; Gregory and Miller 1998), which currently dominate knowledge production. Though private non-profit is still considered as a sector of performance in R&D statistics, it represents less than 10% of expenditure in Europe (Eurostat, 2012). However, according to Schimank (1988), scientific associations retain some influence over the thematic orientation of disciplines, through the funding of research projects.

As seen in Table 5, some Portuguese scientific associations still take part in research projects and science dissemination associations take the lead, with half of them doing it on a regular basis, even though data from the interviews shows that scientific societies and professional associations openly state they refrain from research activities because they do not see them as part of their role in the research system, and they do not want to get involved in competition with research centres. Science dissemination associations are the most prone to take part in research projects, as a means of obtaining funding and getting involved in networks, a strategy which is often encouraged by European programs. A prime example of the involvement of associations in research projects is the work carried out by the Society for the Study of Birds (primarily a science dissemination association, also registered as an Environmental NGO) on data collection concerning birds. Several

Table 5 Activities of scientific associations, by type (%)

	Scientific societies	Professional associations of scientists	Science dissemination associations
Publication of scientific journals[1]			
Yes	53.2	54.5	38.9
No	46.8	45.5	61.1
Organisation of scientific meetings[2]			
Often	83.6	77.8	46.9
Occasionally	12.7	22.2	21.9
Never	3.6	–	31.3
Awarding grants and prizes[3]			
Often	36.4	11.1	15.6
Occasionally	21.8	11.1	15.6
Never	41.8	77.8	68.8
Participation in research projects[4]			
Often	20.0	–	50.0
Occasionally	29.1	55.6	37.5
Never	50.9	44.4	12.5
Representing the professional interests of researchers[5]			
Often	49.1	16.7	59.4
Occasionally	29.1	33.3	15.6
Never	21.8	50	25
Representing the professional interests of other S&T professionals[6]			
Often	65.5	11.1	65.6
Occasionally	21.8	11.1	21.9
Never	12.7	77.8	12.5
Taking part in advisory committees[7]			
Often	7.3	27.8	12.5
Occasionally	36.4	44.4	28.1
Never	56.4	27.8	59.4
Issuing advice for public policies[8]			
Often	16.4	50.0	15.6
Occasionally	50.9	44.4	53.1
Never	32.7	5.6	31.3
Science dissemination activities for students[9]			
Often	16.4	22.2	71.9
Occasionally	38.2	38.9	18.8
Never	45.5	38.9	9.4
Science dissemination activities for the general public[10]			
Often	50.9	16.7	71.9

Table 5 continued

	Scientific societies	Professional associations of scientists	Science dissemination associations
Occasionally	40.0	55.6	15.6
Never	9.1	27.8	12.5

Source: Survey of scientific associations, 2011; N = 101; X^2 test: (1) p = 0.080; Cramer's V = 0.227; (2) p = 0.000; Cramer's V = 0.318; (3) p = 0.031; Cramer's V = 0.225; (4) p = 0.000; Cramer's V = 0.334; (5) p = 0.032; Cramer's V = 0.224; (6) p = 0.000; Cramer's V = 0.410; (7) p = 0.089; Cramer's V = 0.196; (8); p = 0.018; Cramer's V = 0.238; (9) *p = 0.000; Cramer's V = 0.377; ** p = 0.003; Cramer's V = 0.279; (10) p = 0.003; Cramer's V = 0.279

annual censuses are conducted, with the assistance of professional ornithologists and amateur bird watchers, in what constitutes a typical 'citizen science' initiative. The association also participates in nature conservation projects, supported by European funds, with a strong applied research component:

> We haven't done pure research, in bird behaviour, flight dynamics and such. We trust universities to do their part. And we have a good communication with ornithologists working in universities, they are almost all members of our association, so we have a good network. Our role is mainly in bird census and monitoring. We have this project of a census of common birds, we have a census of maritime birds, we have the census of the Azores Bullfinch. […] From the moment we started to be acknowledged, that we are seen as a national reference in ornithology, people come to us naturally. We have a huge success rate in EU applications, very high indeed. In all LIFE projects we submitted, only one was rejected. People recognise that, they see how professional we are and our success rate. So we are highly sought after for project partnerships. [President of the Society for the Study of Birds]

In other instances of 'citizen science', Portuguese astronomy clubs also have been involved in large-scale collaborative projects, mobilising the contribution of amateur astronomers, teachers and students in elementary and secondary schools for the analysis of astronomical images and the identification of celestial bodies.

Some local scientific associations in paleontology also carry out fieldwork, do their own diggings, have laboratories for cleaning and examining the remains and create museums to show them, host postgraduate theses and collaborate with university teams. They have taken advantage of the scarce development of this discipline in Portuguese universities, of the wealth of dinosaur fields in the central coast of the country, and of fortuitous discoveries by local inhabitants. A fairly similar situation can be found in local archaeology associations.

Nevertheless, scientific associations on the whole play a minor role in the production of science, leaving this function as an almost monopoly of universities and research centres.

Reproduction of the Scientific Field

Another core function within the scientific field is its reproduction, through the training of junior researchers. Here again, scientific associations have lost their historical role in favour of universities and other higher education institutions that confer academic degrees (Bourdieu 1974). However, scientific associations retain some reproduction role through the informal training of researchers. Calleigh states that scientific associations are instruments of socialisation and standard setting, thus "the important societies in a field shape, to a large extent, what their members and leading institutions consider mainstream and orthodox, what is expected and acceptable" (2003: 222).

Associations contribute to the advanced training of human resources by giving support to postgraduate theses, running training courses, advertising jobs and internship placements:

> We think graduates have some difficulty in creating their own business and finding employment opportunities. So we decided to create a knowledge transfer network through graduates. A network of professional internships is also starting, to which graduates can have access. We have already several proposals for a scientific internship, in universities, in business companies […] graduates can register for an internship and do research in the real world, in academia, in companies, in an analysis laboratory. [President of the Biochemists Association]

The reproduction of the field is also done through conferences and the publication of scientific journals, which, as seen above, are activities that most Portuguese scientific societies (as well as professional associations) carry out frequently. However, in peripheral scientific systems such as the Portuguese, what were once leading forms for the communication of discoveries among peers have become mainly instances for the socialization and training of young practitioners. National conferences and journals have lost out to international ones in terms of relevance for the production of knowledge and for acquiring scientific capital (see below). Thus, national conferences are nowadays more geared towards the needs and interests of young researchers (who often join the associations in order to have the opportunity of presenting their work):

> …congresses on a national level are more restrictive, we are relatively few. In the case of the Biochemistry Society, the target audience of these congresses are the younger cohorts – undergraduates or PhD students. Senior members – researchers – are less prone to come to these congresses, since they have few peers to talk to and exchange information, since the main aim of these congresses is to get young people and to make them interested in these activities. [President of the Biochemistry Society]

Many Portuguese scientific associations have also abandoned the publication of traditional scientific journals (see below) and created other types of publications, more attuned to the needs of the researchers in training. For instance, the Portuguese Chemical Society publishes a bimonthly over 100 pages long colour bulletin (since

1977, but revamped in the early nineties), in Portuguese, with news, reports, features, interviews and book reviews. It is aimed not just at researchers, but also students, high school teachers and even the general public, so it goes beyond the communication between peers and is mainly a vehicle for scientific dissemination.

Another form of participation in the reproduction of the scientific field is by boosting 'vocations', encouraging school children and youngsters to take up careers in science (Gregory and Miller 1998). Though universities are also actively engaged in these activities (specially aimed at increasing the number of enrolments in their courses), associations (especially, of course, science dissemination associations) have come to channel their efforts increasingly to this role.

Association representatives state that they are often contacted by schools asking for experts to deliver lectures or demonstrations, working as intermediaries between young people and members of the scientific community.

> We have information sessions aimed at secondary education students. These students hesitate on which field of study they will choose in university. We have had requests from schools and we also offer our services. We have been asked to do information sessions on what is biochemistry, where can you get a degree in biochemistry […] what does a biochemist do, what do we study, what are our areas of expertise. [President of the Biochemists Association]

In some cases, associations take the initiative and involve students in their dissemination activities. For instance, the Neurosciences Society is in charge of the activities of the International Brain Awareness Week, during which its members deliver lectures at schools, but also students are invited to visit laboratories, alongside other public events, such as round-tables, exhibitions and seminars.

Some scientific societies are responsible for organising competitions for students, generally designated 'Olympiads'. This occurs in 'traditional' science subjects (mathematics, physics, chemistry), but is expanding to a growing number of fields of knowledge (biology, computer science, philosophy) and in some cases is acquiring an international scope.

Some scientific societies, such as the Biochemical Society, even make room in their annual conferences for sessions aimed at high school students, who are allowed to attend other sessions and to visit the posters section, in what is clearly an effort to attract potential undergraduates to university degrees in their field.

Allocation of Scientific Capital

The most important resource in the scientific field, that determines the relative positions of individual actors, is scientific authority, which is made up of both technical competence and symbolic power, according to Bourdieu's theorising (1975). This symbolic power, or prestige, is acquired by scientists through several different means: university degrees, professional positions, awards and prizes, publication in reputed journals.

Scientific associations are thus one, among others, institution of the scientific field that controls the allocation of these resources. Though election to national

society office or appointment to association committees also confer prestige (Bloland 1982), it is the awarding of prizes and the publication of journals that are the core activities in this function as carried out by the scientific associations.

Awards and grants are given by scientific associations for multiple purposes: to fund new research projects, to reward completed ones, to support conference attendance or training abroad, to distinguish conference papers, published articles or books, to celebrate individual careers or collective achievements. They are a way to support scientific research, but also a means to confer prestige and symbolic recognition to scientists: "its control of a discipline-wide reward system makes the [German Chemistry] Society an indispensable, even if indirect, actor in the cycle of reproduction of scientific work" (Rilling 1986: 250). Bourdieu (1975: 98) included awards in the category of "specific signs of acclaim that peer/competitor groups bestow their members according to the distinctive value of their products and collectively acknowledged originality". Crosland and Gálvez (1989) distinguish between prestige prizes, which reward past research, and monetary awards to younger researchers, aimed at funding future research.

Award ceremonies also can improve the associations' visibility. They are usually public events, held in prestigious locations, to which preeminent public figures in science (university rectors, the science minister, heads of foundations, senior civil servants) are invited. Award granting can also reinforce the ties between scientific associations and business companies through sponsorship agreements. This is particularly common in the medical sciences, where prizes are frequently supported by pharmaceutical companies.

> … the Medical Sciences Society has its awards, in partnership with the Pfizer laboratories for the past 50 years. It has been an excellent relationship, a very important contribution to medical research […] the accuracy and meticulousness in assessing the projects, solely based on merit, that has turned the Pfizer Award into an award given to the best researchers, the highest prestige. [President of the Medical Sciences Society]

Nevertheless, in terms of a scientific career, international prizes are far more valued than national ones. Here also the national scientific associations are losing ground to international ones.

The publication of scientific journals is one of the oldest missions of scientific societies (Ornstein 1928; Levitan 1979; Siegelman 1998) and one that has experienced the most acute transformations in contemporary science. The Philosophical Transactions of the Royal Society has played a primordial role in the dissemination of 17th-century experimental science (Merton 1938; Siegelman 1998), but also on the regulation and control of science communication, drawing the borders of legitimate scientific knowledge (Zuckerman and Merton 1971; Ben-David 1972; Caelleigh 2003). The ownership of journals confers a special power over the reproduction of the scientific field. As Rilling has noted on the German Chemistry Society, "[t]hrough its control over chemical publications, particularly journals, the GDCh holds a very strong position vis-a-vis the knowledge production sphere of academic science, since the selective filtering function of scientific

journals and their importance in the allocation of reputation and social status make them one of the most powerful institutions in science" (1986: 248).

However, significant changes have occurred in the past few decades in scientific publication practices. Whereas on an international level the main challenge to traditional scholarly society journals are commercial publishers, the transition from paper to electronic publishing (Wood 1998; Owen 2007; Elvebakk 2010), and the open access movement (Doyle et al. 2004; Leslie 2007), on a national level associations have had to contend with the overwhelming dominance of international (and English language) journals (Zitt and Bassecoulard 1999; Paasi 2005; Lillis and Curry 2011).

Most of the older Portuguese scientific societies used to publish a scientific journal in Portuguese, containing both translations of articles by leading international researchers and articles written by Portuguese researchers describing their research results. Thanks to digital libraries and journal subscriptions, Portuguese researchers have almost universal access to the original articles and also prefer (or are impelled) to publish in international journals, in order to meet the requirements of a successful scientific career.

This has led to a change of strategy in most scientific associations. Some have ceased altogether to publish scientific journals:

> We had a journal of the Neurological Society, which is over, was extinguished. It started out all right, but then people stopped sending quality work. We have a problem with the journal, it's Portuguese. Naturally if people do things that can have international visibility, a bigger impact, they seek a foreign journal. That's the dilemma. We can have a Portuguese journal where we publish just parochial stuff that doesn't get published anywhere else. But if we want to have a high prestige journal, we have this problem, people naturally want to value their work and seek a foreign journal. […] we don't have enough critical mass to have quality and quantity for a journal. [President of the Neurological Society]

In another example, the Chemistry Society joined the international consortium ChemPubSoc Europe. It ceased to publish its almost centenary journal, the Pure and Applied Chemistry Journal (started in 1905), but became co-owner of ten high impact European chemistry journals, which provide a substantial annual income to the Society.

Other associations (mainly from emerging or less dominant scientific fields) have tried to adapt to the changing circumstances by publishing their journals in English or even trying to have them admitted to Thomson Reuters' Web of Science and other citation databases and digital repositories:

> We publish a scientific journal twice a year (it was four times, but we had to reduce it to two because of costs). It's a thick volume with scientific articles, news and events announcements. […] It's becoming more visible because we have had access to the Scielo platform and from then on our journal has become more sought after. We don't have any difficulty in harnessing collaborations for the journal. And we also make the pdf of the articles

> available on our webpage. […] We are trying to include the journal in ISI [Thomson Reuters' Web of Science]. So far we were publishing good quality articles but not necessarily impartial so now we are introducing peer review. [Representative of the Materials Society at the workshop]

Nevertheless, publication in Portuguese journals has ceased to have almost any relevance in terms of scientific capital. The allocation of symbolic prestige is another role that national scientific associations have seen severely curtailed as a result of the growing internationalisation of science. Of course, this only applies to peripheral national systems. Journals from core countries (though some are no longer owned by associations) are thriving and the main source of scientific capital for researchers worldwide.

Community-Building

Since so many traditional internal roles are gradually escaping the grasp of national scientific associations, transferred either to international ones or to other institutions of the scientific field, what is it that makes them endure and even multiply?

Building a sense of community and a collective identity seems to be one of the few roles that is still going strong and that sets scientific associations apart from universities, immersed in competition among themselves. In fact, as was seen above, many scientific associations are composed mainly of academics and thus they constitute an alternative platform to universities and research centres for expression and action.

Conferences are still one of the expressions of this community-building: "meetings provide the discipline with occasions for expressing the solidarity, integrity, and breadth of the field" (Bloland 1982: 79). On the one hand, conferences are an opportunity for face-to-face contact between peers and to transmit tacit or informal knowledge.

> … it's a place where all people meet, it's an opportunity to socialise, to exchange thoughts, to talk about several things. Otherwise it's hard to find a place where neurologists come together spontaneously, so this is important for people to talk, to exchange ideas, to talk about everything, the important stuff, the less important stuff, even clinical trials and works. Just by meeting socially we get to know what's going on. [President of the Neurological Society]

On the other hand, by bringing the disciplinary or professional community together, conferences contribute to the rapprochement between academic researchers and other professionals (physicians, engineers, teachers, other specialised personnel) and students.

> It's one of the cornerstones of the Society, the meeting point par excellence of the entire community, of all people doing biochemistry in any of its dimensions, or research, of education, of dissemination. [President of the Biochemical Society]

Conferences also foster the enrolment of new members and inter-institutional cohesion, since they are usually held at different locations, relying on the collaboration between the association's governance structure and a local organising committee:

> For us, as well, it's [an opportunity] to see what others are doing in different areas of knowledge, but also these meetings rotate through different universities. In the institutions themselves we can see what's going on inside them. [President of the Chemical Society]

Even though the hyper specialisation of science also constitutes a threat (researchers see no point in discussing their work with peers from other sub-disciplines, who are little better at understanding it than the general public), scientific associations address this problem by organising smaller interim conferences and seminars, dedicated to specific sub-disciplines or transversal subjects, such as education or dissemination, although most maintain a regular large conference aimed at the whole discipline.

Internationalisation of National Science

As seen above, the dynamics of internationalisation of science has threatened some of the traditional roles of national scientific associations. Publication, presentation and membership practices at the international level bring far more rewards in terms of scientific capital than national ones (Crawford et al. 1993). The Portuguese scientific system has become more internationalised in recent years (this is visible, for instance, in the growth of publication in co-authorship with foreign researchers and of participation in international projects), mainly as a result of policies encouraging the training of human resources abroad (Delicado 2010).

National scientific associations have also been playing a role in fostering the participation of scientists in international networks and organisations, mainly through contacts with international associations (Table 6).

Over half of the Portuguese scientific associations are affiliated to international associations and some are even founders of international associations. The international affiliation awards them participation in international meetings and journals, as well as voting rights.

> International representation is an important part for the association. We are represented in two international associations, the European Association of Seismic Engineering and the International Association of Seismic Engineering. We have voting rights in both associations, as national representatives. These associations are important because, just as we have our national conference, they hold European and international conferences, respectively, every four years. [President of the Portuguese Society of Seismic Engineering]

National conferences also constitute an occasion for forging and reinforcing international ties by sponsoring the visit of renowned invited speakers, attracting foreign participants or even organising events in collaboration with associations

Table 6 Contacts between Portuguese and international or foreign associations (%)

Any type of contact	84.4
Joint projects and activities	56.4
Exchange of information and publications	56.4
Affiliation	53.8
Informal contacts	52.6
Partnerships/platforms	39.7
National chapter of an international association	16.7

Source: Survey of scientific associations, 2011; N = 78

from neighbouring countries. Concurrently, some associations give financial support for their members to attend international conferences.

> This is already a big meeting, even on an international scale. We always have a few foreign guest speakers. And some people come from Spain, in the past there were more, but they still come. [President of the Biochemical Society]

Joint initiatives with international associations are a way of building up 'critical mass' and political weight for addressing common issues, such as, for instance, the dominance of the English-speaking countries (and the English language) in science, particularly problematic in the social sciences:

> We cooperate with ESA, the European Sociological Association. They invited us to a meeting of national associations in Paris, 23 associations took part and the aim was not just to get to know each other but also to prepare some common actions. […] the Network of Southern European associations was also created, bringing together Portugal, Italy, Spain, France and Greece, and our work has been to discuss our sociologies, to discuss ways of coming together, to debate whether there is anything different in doing sociology in the south and work also on the issue of dissemination of sociological production in Latin languages. [President of the Portuguese Sociological Association]

External Roles of Scientific Associations

Scientific associations play other roles that are external to the scientific field and that constitute forms of mediation between science (and scientists) and other social spheres. These roles have also been undergoing transformation (mostly in the sense of increasing their relevance) as a result of the ongoing reconfiguration of the relations between science, government and society.

Interest Representation and Lobby

In the literature on voluntary associations (see, for instance, Sills 1968), the representation of interests is one of the main drivers for their formation. In this respect, scientific associations are no exception. More than perhaps any other institution of the scientific field, associations play an important role in the

aggregation and representation of interests of researchers and other science professionals. Associations thus act as intermediaries between researchers and employers (universities, research centres, companies, or government agencies) or funding agencies or those in charge of designing science policy.

Although scientific societies also speak frequently on behalf of their members, the growth of science and transformations in scientific careers spurred the creation of associations specialising in the defence of professional interests: first academic trade unions, for full-time faculty members (Lawless 1981; Kemerer and Baldrige 1981), later on graduate employee's trade unions (Julius and Gumport 2002; Lee et al. 2004; Rhoads and Rhoades 2005).

This representation of interests is done in several ways, according to the type of associations. Academic trade unions support their members in disputes with their employers (universities and other higher education institutions), sometimes offering legal advice, can call strikes and street demonstrations and are legally entitled to be heard by the government whenever new labour legislation in higher education is being prepared.

> We have been involved in another intervention at the justice level. Recently, we filed a complaint about a regulation that allowed hiring 200 unpaid teaching volunteers by the Faculty of Medicine. The Faculty ended up acknowledging that this regulation should be revoked and backed down, which was an important step in the fight against unpaid work in universities. [President of the Higher Education Trade Union]

Researchers and grant holders' associations have an even closer connection with the Ministry of Science, since in most cases their salaries are funded by the central government and not the institutions in which they work. Without formal rights of representation, meetings depend on the good will of government officials. Lobbying in favour of labour rights (pay rises, social security benefits, allowances in case of unemployment, contract renewal) has met with varying degrees of success in the past few years.

> The association, besides continuing its political struggle to improve the Grant Holders Statute and also to make sure the Statute is upheld, is also starting to look for solutions for scientific employment in general. Grants shouldn't be it. Besides, we think it's very important to keep publicising the rights grant holders have. Because many of them don't know the Statute, they don't exercise their rights. [President of the Grant Holders' Association]

Disciplinary professional associations strive mainly to defend the interests of non-academic professionals, negotiating with employers but especially with other ministries that regulate professional careers inside and outside public administration (Ministry of Health, Ministry of Education).

> … we have had a great deal of difficulty with the qualifications for teaching in secondary education, well, in that case I think we have failed miserably. […] it's an issue that seems perfectly reasonable to us, it's in our Statutes, in our obligations, it's routinely part of our election manifesto, it's part of our line of

> activity, we ask for meetings with the Ministry [of Education] to present our case for the umpteenth time, but frankly, we haven't succeeded at all. [Vice-President of the Association of Sociology]

The representation of professional interest is a role that is gaining more prominence within the activities of scientific associations. The expansion of human resources in science in Portugal has brought about more precariousness (untenured researchers) and more competition for dwindling funds, increasing the complexity of labour issues that must be addressed.

Policy Advice

The role of science in public policy advice is a widely debated issue in social studies of science (see, for instance, Jasanoff 1990; Martin and Richards 1995; Irwin 2009), though seldom taking into consideration the part played by scientific associations. According to Barke (2003: 319), "science also requires special representatives at the interface between science and policy. Scientific institutions have evolved to translate professional interests into policy. Specialized organizations speak for disciplines, while more general organizations (such as the American Association for the Advancement of Science) are active in advocacy".

Schimank (1988) includes policy advice within the function of promotion of science, materialised in the involvement in decision-making by political and administrative actors and participation in advisory councils. Schofer (2003a: 97) links the emergence and growth of international socially-oriented scientific associations to the model of 'science for society', in which "the advent of science and rationality [is] a dominant model for organizing social activity" – "(1) scientists increasingly shape and define social issues and the identification of problems worth solving, (2) scientific expertise and information is increasingly integrated into governmental organization and decision making, (3) scientific discourse increasingly infuses policy discussion and debate". Other studies focus on the role of associations in providing advice for environmental and health policies (Scott et al. 2008; Vesikari 2008). For instance, Teich (2002) offers a detailed account of the influence of AAAS over policy, through dedicated programmes, public debates and statements. Scott et al. (2008) list the tools that scientific societies in the United States can use to contribute to policy development, a wider repertoire than the one available for individual scientists: congressional visits, letters or testimonies to policymakers, newspaper commentaries and news releases, policy briefs or white papers, policy position statements, policy office, programme or centre, forums on science and policy, resolutions.

However, the weight associations in general can have over policy decisions is strongly dependent on the administrative and bureaucratic tradition and the political system of each country, and in this matter Portugal may be a particularly weak example at least among European countries. There is a scant tradition in Portugal of using scientific advice to support policy decisions (Gonçalves 2002), and several case studies have shown that, when decision-makers do resort to scientific advice, largely from universities or individual experts, they do it mainly to legitimise

decisions and dispel public controversy in risk issues (Gonçalves and Delicado 2009).

In this sense, considering formal procedures of influence, more than half of the associations do not have a seat in any kind of advisory council (Table 5). Regarding the particular area of science policy, the National Council of Science and Technology is currently made up of only individual members. In the 1980s, this Council included a position for the Association of Science and Technology for Development and in the 1990s five places were reserved for scientific associations. Successive changes in the regulation of this Council (which in effect has had very little influence on policy) withdrew participation rights from associations. Other advisory bodies, such as the four Scientific Councils of the FCT (one for each scientific area), also rely solely on individual members, representing their universities and research centres. This situation is criticised by some interviewees:

> In truth we think that scientific societies should be consulted, as a rule, by the science management structures. We think that no one better than scientific societies represents the scientific community. The management of science in Portugal is usually done by consulting groups, individual scientists or science laboratories. This is all very well, but it has perverse effects. There is a direct influence over decision makers by interest groups. Scientific societies are completely independent. They only represent scientists. [President of the Neurosciences Society]

However, in other governmental areas, such as education or health, some of the advisory councils include members from scientific associations. For instance, there are 24 scientific associations and teachers associations at the Advisory Council of the Evaluation Office of the Ministry of Education, whose mission is to give advice regarding national exams. Still, a dedicated study would be needed to know the extension of this kind of representation, the process of selection of associations and their actual influence.

On a less formalised basis, scientific associations are sometimes requested to proffer their views on new legislation and policy documents. These invitations come from government or from parliament (parliamentary committees, party groups) but there is no legal requirement to do it, unlike what happens with trade unions concerning labour issues. Occasionally, associations also provide advice on their own initiative, in their fields of expertise (though lobby on more general interest issues, such as climate change, is not common in Portugal, unlike what happens in the US, for instance, with the Union of Concerned Scientists – Moore 2009):

> We have been doing a series of demarches to get this information to social and political circles. There was an extensive contact with […] political agents in the past eight or ten years that resulted in a recommendation that was approved in Parliament […] defining a policy to tackle seismic risk. […] it was a very long process, […] we asked for meetings with members of parliament, public works committees, members of government […] So the Society has this function of lobbying for things to move on. Whenever we can, whenever there is an earthquake, we do a little lobbying. […] We have also written letters to

> politicians, to government, to say what should be done. [President of the Seismic Engineering Society]

Scientific associations also exert influence over policy through informal channels and personal connections. High-profile board members have access to policymakers and government officials:

> It's an Achilles heel. But it's not just in Portugal that there isn't a direct connection between scientific societies and governmental agencies. But people are always the same […] When I'm called upon to assess grant applications […] it's not because I'm president, or teacher, or researcher, it's all at the same time, it's because they see in my CV that I have the ability to do it. So, if it's true that scientific societies don't have a formal direct connection with government agencies, it's also true that people [from the societies] are there, they end up being heard by FCT. […] People are always the same, they dress in different clothes but the community is the same. [President of the Biochemical Society]

Another way for scientific associations to accrue their weight over public policy is by forming coalitions or federations (see, for instance, the political weight achieved by ICSU or AAAS – Greenaway 1996; Teich 2002). Again, while a federation of scientific associations was formed in Portugal in the early 1990s, it has been practically inactive and so has little or no say over science policy. In one particular area (neurosciences), a federation was constituted in 2011 and one of its aims was to be consulted by policymakers, although its efficacy remains to be seen:

> The very idea of forming the Portuguese Council for the Brain is also an initiative that aims to highlight that. By increasing the visibility of this structure, of a federation of scientific societies, it may also alert the decision makers for the fact that there is another level of consultation that should be taken into consideration. [President of the Neurosciences Society]

Scientific associations in Portugal have thus a very limited role as 'boundary organisations', which facilitate communication and collaboration between research and policy organisations (Guston 2001). Despite their growing number, they have so far failed to be taken into account in the policymaking sphere, partly due to their lack of inter-organisational action.

Amassing Social Support for Science

In a context of growing public investment in research (see, for instance, the European target of 3% of the EU's GDP to be invested in R&D in 2020) but also of mounting mistrust in science (following a series of high-profile risk controversies), scientific institutions are increasingly aware of the need to be accountable to citizens and to amass social support.

> A lot of people - I think mainly in the area of biology - have found out that scientific dissemination helps promote your field of knowledge. If you

> promote your field of knowledge in public opinion, then your field of knowledge will never be undervalued. People do science dissemination because they like it and they believe in it, but a lot of people do it because it's an activism weapon. By valuing the knowledge they produce, they can safeguard that area. [Representative of the Grant Holders Association at the workshop]

The past few decades have witnessed the emergence and growth of an 'industry' of public understanding of science (Gregory and Miller 1998), and scientific associations are only one of the players. However, this is not a new function of these institutions. Public lectures and demonstrations were a part of everyday activity of 18th-century academies and 19th-century scientific societies (see Rasse 2002; Chaline 2002). Much more recently, the pivotal role the Royal Society has played in diagnosing and attempting to remedy the social problem of the lack of public understanding of science cannot go unmentioned, from its 1985 report to its numerous initiatives in training and raising awareness among scientists, journalists, decision-makers and the general public (Gregory and Miller 1998). The International Council of Scientific Unions has also played a relevant part in this domain (Greenaway 1996). Several authors have identified scientific associations as privileged actors in building bridges between science and society (Rogers 1981; Miller et al. 2002; Evans 2010) and some even point out to their comparative advantages: the ability to mobilise scientists, an added legitimacy stemming from their collective nature, the neutrality in view of particular interests of universities and research institutions (Rogers 1981; Evans 2010).

Activities aimed at the general public tend to be less specialised than the ones aimed at students (as seen above): lectures and debates; publication of books and newsletters; exhibitions; field trips and visits to laboratories; theatre plays and stand-up comedy shows; websites, blogs, YouTube channels and social network profiles. They often occur in collaboration with universities, research centres, local authorities, civic centres, museums, libraries and other public venues.

> We have other kinds of events. For instance, vineyard visits. They are aimed at the general public. We visit an emblematic wine region. […] We visit the wine cellars, the horticultural companies. Then sometimes there were talks. A part of the day was set aside for a technical-scientific talk. […] there were visits to gardens, to parks, technical visits that also have a cultural side. […] these visits are very amusing because it's a completely different audience, some of them have nothing to do with horticulture and they have just joined the association because of the visits. [President of the Horticultural Association]

Publishing research results in Portuguese is considered in some cases important for disseminating information to the general public, as well as other non-English speakers (older academics, science and engineering professionals, technicians)

> … people need this kind of publications [conference proceedings] because there is not a lot in Portuguese. For instance, the Spanish and the Brazilians translate everything, we don't […] since we don't translate technical books to Portuguese, there isn't much in this area, people have to resort to this, so I

think it's an added value for this association and we have to keep this going. [President of the Horticultural Association]

A fundamental distinction can be made between dissemination activities carried out by scientific societies and by science dissemination associations. Whereas the former tend to opt for 'traditional', one-way communication formats (typically lectures), the latter are more prone to promoting participative, 'hands-on' experiences and even citizen science projects (see above).

Finally, though it is far less common, associations can also channel social expectations and needs and convey them to the scientific system, a role played in other countries by science shops, which do not exist in Portugal.

We created an online platform for answering questions about ecology. People send their questions and we direct them to our members, according to their area of expertise. […] I'll give you an example: yesterday we received a question from someone who wants to plant trees but he wants trees that are suitable to the local ecosystem, to produce honey. So we redirect the question (we have a quite wide contact network in the area of ecology) to the right person and he replies and we give feedback to the person who asked. [Representative of the Ecological Society at the workshop]

Conclusions

Scientific associations play multifarious roles in contemporary science. Though not directly involved (in most cases) in the production of science, and thus outside the core of the scientific field, associations play a part in it, both upstream (funding research) and downstream (disseminating results, lobbying policymakers). They also contribute to the reproduction of the field (stimulating vocations, participating in the training and socialisation of young researchers), fuel its symbolic reward system (through awards), transmit tacit knowledge, generate sociability and intergenerational connections (through conferences).

Nevertheless, as Schofer (2003a), Rilling (1986) and Schimank (1988) have concluded, the external roles of associations (establishing connections between science and society) have become more important than the internal ones. Whereas the internationalisation of science has moved the communication, collaboration and competition between researchers into the transnational sphere, the links between science and other social spheres are still deeply rooted in national settings. Since associations are presumably above individual university interests and rivalries, they may be better equipped to represent science (or particular disciplines) vis-à-vis political authorities, business companies or the general public.

However, the degree to which this role is fulfilled strongly depends on the context. In Portugal, associations have invested heavily in science dissemination activities because there has been a favourable environment for them (a governmental agency that develops multiple programmes and provides funding). Conversely, their participation in policy advice is weak.

Overall, scientific associations have had to change in order to survive. Disciplinary societies have had to diversify their publics and activities, as well as to reinforce their international ties. At the same time, new types of associations emerged, to cater the need for professional representation of new actors in the field (with precarious labour ties) and to invest in the new 'market' of science dissemination.

This research would have certainly benefited from international comparisons, so more research is needed to ascertain how general our findings are, or, contrariwise, how country-specific they are. We hope this article will prove fruitful in starting up a discussion on the roles of scientific associations and on their relation to the socio-political contexts and the transformations of contemporary science.

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