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Unveiling research intermediations in citizen science

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Highlights :

- Citizen science can be considered grassroots innovation
- Research intermediations are crucial for citizen science
- Citizen science involves a range of actors; civil society organizations are strategic actors
- Citizen science can be distinguished as observational science and social innovation

Abstract : Drawing on the conceptual framework of intermediations in grassroots innovation for sustainability, this paper presents the first in-depth analysis of the role of third sector organizations in citizen science. The empirical data are derived from 31 case studies of associations (representing 80% of administrative-type third sector organizations in France). We identify the features unique to the two blurry categories of observational science and social innovation: amateur community management is not confined to crowdsourcing, and legitimization of experiential knowledge is key to inclusion in co-creation processes. We also characterize the activities of these associations as research intermediations. The organizations fulfil three roles depending on the research field and the organization's position in the network, the degree of structuration of their partnerships with academics, and the goals and achievements in the projects in which they are involved. These intermediations are not aimed solely at experimentation and advancement of a particular territory's activities; they try also to influence the dominant system by producing knowledge and recommendations for public policies.

Keywords : innovation studies – transitions – actionable knowledge - inclusion –participatory research

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1 Introduction

The aim of this article is to characterize the role of third sector organizations in citizen science activities with an emphasis on the systemic dimension of knowledge production (Joly, 2020). This framing acknowledges the coproduction of assumptions, rules, and values in these participatory processes. The third sector concept is related to the Anglo-Saxon three-sector societal framework which includes the state, the market, and the third sector. According to Alcock (2010), the third sector is associated with values and principles such as association, mutuality, altruism, and democracy, and balances the values of the state and the market in research and innovation systems. Third sector organizations are major actors in the development and generalization of social innovations (Bouchard, 2006; Klein et al., 2010; Maisonnasse et al., 2013; Stirling, 2008). In France, 80% of third sector organizations are associations. They coordinate the contributions of citizens to research, translate and circulate knowledge, and contribute to the problematization of otherwise unaddressed research questions (Akrich et al., 2013; Cointet and Joly, 2016; Irwin, 2014). By farming out or delegating public services, they steer social innovation hubs, labs, and transfer centers which promote social innovation activities (Terstriep et al., 2020). However, little is known about their role in citizen science activities. These activities have recently been conceptualized as research intermediations (Barré, 2020), drawing on the literature on socio-technical transitions (Hargreaves et al., 2013; Kanda et al., 2020, 2020, p. 14; Klerkx and Leeuwis, 2009; Martiskainen and Kivimaa, 2018; Matschoss and Heiskanen, 2017; Seyfang et al., 2014; Smith et al., 2016; van Welie et al., 2020). To advance our understanding of the mechanisms enabling sustainable transition through citizen science processes, we mobilize the concept of grassroots innovation (Seyfang and Smith, 2007). Grassroots describes the engagement of third sector organizations in solving local problems and representing the interests and values of the communities involved. The literature on grassroots innovation explains how organizations experiment to solve local problems, and network with institutions to contribute to the achievement of the United Nations Sustainable Development Goals (UNSDGs). The UN 2030 agenda set out a series of SDGs that include the end to poverty and reduction of inequality in all its forms and everywhere, the promotion of inclusive and sustainable consumption and production systems, and the tackling of climate change and its consequences. The implementation of actions to address these goals represents a major breakthrough since they call for new science, technology, and innovation policy frames (Schot and Steinmueller, 2018).

Against this background, this paper aims to conceptualize the role of third sector organizations in citizen science. We propose a typology of these roles, drawing on the literature on

grassroots innovation and a conceptual approach to intermediation developed with colleagues at LISIS (Lhoste and Barbier, 2018; Loconto, 2020; Steyaert et al., 2016). This is aimed at providing a better understanding of the boundaries within which it is possible to produce actionable knowledge and innovation. We draw on observation of the work performed by a collective to build a new community while simultaneously attempting to challenge incumbent cultures, organizations, rules, and politics. Our analytical framework articulates the interactions between the spaces and actors engaged in a situation requiring intermediation. Intermediation facilitates both exchanges and circulation of knowledge and practices. We trace how the actors mobilize and translate their values, knowledge, infrastructures, and rules to solve the challenges they encounter. We address the following research questions: What kinds of intermediation are performed and when? Who are the actors involved? What are the objectives of such intermediation? What networks do the actors coordinate and/or participate in? How do they work to foster and facilitate interaction? What is the nature of the boundary work accomplished?

The paper is organized in four parts. First, we introduce our conceptual framework, research design, and case study methodology. Second, based on analysis of 31 cases we propose a typology of the roles played by associations in citizen sciences. Drawing on a conceptual grassroots innovation framework, we distinguish between two categories based on the sector of activity and values, participatory research domain, and knowledge value. Third, we identify the players' activities as research intermediations in participatory processes. In addition to coordinating research projects and networking with public research organizations and universities, these associations perform the boundary work required to build hybrid infrastructures with institutions and legitimize experiential knowledge. Fourth, this conceptual research intermediation framework helps to explain the crucial role of associations in structuring hybrid epistemic communities aimed at sustainability. We conclude with some reflections which might inform future research on the institutionalization of participatory research for sustainability, and help policymakers identify aspects critical for societal impact of participatory research and tailored policy measures.

2 Conceptual framework and research method

2.1 Conceptual framework

Grassroots innovation for sustainability was conceptualized originally by Seyfang and Smith (2007) as « innovation networks of activists and organizations that lead to bottom-up solutions for sustainable development, solutions that respond to the local situation and the interests and values of the communities involved ». Smith et al. (2017) suggest three features that typify grassroots

innovations. First, they are grounded in civil society forms of organization and follow different strategies and forms of engagement with institutions. Second, they use alternative forms of knowledge production: public participation, epistemic justice, openness, and common good. Third, they are political actors and adapt their strategies of alliances with institutions to advance their objectives. Similar to social enterprises, they are able to weave together the market, state, and community contexts (Defourny and Nyssens 2013).

There is a broad consensus that intermediations catalyze innovation processes in general (Klerkx and Leeuwis, 2009). Systems-changing innovations tend to be based more on experimentation (Matschoss and Heiskanen, 2017), institutional rule-changing (Polzin et al., 2016), political advocacy work (Smith et al., 2016), and championing strategies (Martiskainen and Kivimaa, 2018), and to focus explicitly on disrupting incumbents (Klerkx and Leeuwis, 2009; Seyfang et al., 2014) rather than the dominant innovation system. Previous research on grassroots innovation highlights also the crucial role of intermediations to support volunteer communities with professional skills, transfer of learning across similar projects, and establishment of links between niche actors and regime resource holders in multi-level institutional environments such as eco-housing (Lang et al., 2020) and community energy arrangements (Hargreaves et al., 2013). Hargreaves et al. (2013) suggest that intermediations are aimed at developing niches based on aggregation and learning, stabilization of the institutional infrastructure, and framing and coordination of local project activities. They suggest also a fourth role of intermediations: to broker and coordinate partnerships with actors beyond these niches such as large companies (i.e. institutions in the dominant system). To try to understand how these system-changing innovations could overcome the challenge of generalization, other authors conceptualize intermediations at different system levels. Kanda et al. (2020) propose three network levels within which intermediations occur in systems: 1. between the entities in a network, 2. Between networks of entities, and 3. Between actors, networks, and institutions. They differentiate these roles from mediations which they define as interactions between individual entities (individuals or organizations) required to generate resources and extend networks. However, in practice intermediations are distributed within networks and spread across time (Hargreaves et al., 2013; Kivimaa et al., 2019). Van Welie et al. (2020) proposed three key functions at both the local and global levels: 1. Articulation of activities required to support experimentation and generalization of innovation, 2. Alignment of dispersed resources and talents through networks, and 3. Learning and training-related activities to enhance stakeholder capabilities and share goals and culture i.e. to establish new institutions. This last function includes knowledge development (gathering, processing,

generation, and combination of knowledge), knowledge dissemination (through education and training, provision of advice and support), entrepreneurial activities (prototyping and piloting), and legitimization of action (assessment and evaluation of social impact).

In the French context of citizen science, Barré (2020) identifies three key objectives of intermediations : 1. To provide novel responses to new or unsatisfied social needs or aspirations, 2. To strengthen actors' capacities for action through the co-production and circulation of knowledge, and 3. To develop and disseminate innovative products or services initiated by both professionals and users or recipients (consumers, patients, students, users, farmers, etc.). We attempt to further understand the role of associations in this context. We hypothesize that the interactions among actors in different normative positions are crucial for more sustainable transformations. Drawing on the concepts of grassroots innovation for sustainability and transition intermediations allows us to analyze citizen science at the system level of change. In this systemic approach to citizen science, analysis of the research and innovation process gives importance to networks, objects, and devices which also are vectors of value creation and social change (Darnhofer et al., 2019). Such an approach depends on the socio-historical context, the actors involved in the process, and the chronology of events prior to and during the citizen science project. Thus, intermediation activities occur both upstream and downstream of actor network formation, and at several organizational levels. That is, networks are spaces of anticipation and/or legitimization of the visions/values, knowledge, material artefacts, and rules of socio-technical innovation activities. In these networks, intermediations form the boundaries within which it is possible to produce knowledge.

2.2 Methodology and analysis

We collected the empirical material between 2019 and 2022, as part of a formative evaluation of associations receiving public subsidies to contribute to citizen science. We identified 35 associations that received subsidies among which were 31 associations that were involved in citizen science, and therefore are included in our case study. Due to our selection method, the cases do not represent either the diversity of citizen science activities or the range of associations involved in research and innovation. As the manager of the formative evaluation process, the first author participated in the network and had access to the applications of grant winners. We conducted 3 focus groups and 50 interviews, and the first author was involved in several days of participatory observation which allowed her to map the activities related to research in the associations. She is a member of a think tank advocating for support and structuration of a third sector in research and innovation. These embedded practices provided access to empirical data and allowed development of a deep knowledge of the field and the actors involved in citizen science in France. Data analysis

involved several steps. First, we produced a summary of each association that received a subsidy. This included details of their history, mission, size, sector, values, networks, and intermediation spaces. We paid special attention to the organizations' relationships with research institutions, network membership and coordination [c1][EL2], and any other activities related to knowledge production and knowledge circulation. This allowed us to produce a grid analysis to pinpoint the contexts, realities, and difficulties of the research activities in the cases. We also summarized those activities that the actors identified as related to citizen science. Second, we produced an analytical grid of the research intermediation categories. The results are presented below. In the first subsection, we discuss the associations' research domains and values, and other descriptive characteristics. In the second subsection, we propose a typology of research intermediations according to the position of the association in the network (network manager or not), level of structuration of its partnerships with academia, and the type of research and innovation process in which it was involved (advancement, goals). We defined these roles according to the scientific field and the boundary work aimed at structuring the research and innovation ecosystems. This typology is not exhaustive since the 31 cases do not represent the diversity of the associations involved in citizen science but only those that submitted a proposal for a subsidy dedicated to the structuration of partnerships between associations and public research organizations. We would point out that the call for subsidies was launched by the ministry of education, not by the national research agency. This may have favored associations aware of this finance desk.

3 Goals, roles, and epistemic cultures

We differentiate between two clusters of associations – social innovation and observational science based on sector of activity and values, and research domain (table 1). All the associations are involved in grassroots innovations designed to satisfy unmet needs. Most observational science activities are oriented to nature conservation but some associations involved in social innovation also produce data and manage observatories.

Observational science for nature conservation associations differs from the social innovation cluster in their valuation of scientific and actionable knowledge. They differ more broadly in epistemic culture (Knorr-Cetina, 1999) i.e. in epistemologies, history, values, and visions. They have different attitudes to objectivity and neutrality in research practices, and to experiential knowledge. Experiential knowledge may be that of amateur naturalists, field professionals, or users engaged in a citizen science project. Along with professional scientists, they form a heterogeneous community in terms of expertise and engagement in the project. Associations manage this unique community. They

view citizen participation as a way to raise awareness of environmental and social issues. They often develop transversal research projects to address questions such as the effects of the participation of citizens on their perceptions of science and the environment, the objectivity and validity of the scientific data produced in crowdsourcing, and how to raise the engagement of volunteers. They scarcely examine how citizen participation might transform epistemic cultures in academia and research organisations.

The cluster of associations involved in social innovation falls into two types according to the theme of their reflexive questions. The first addresses the positive effects of organizations in the non profit sector (in French, "*Economie sociale et solidaire*") on SDG fulfilment. They question knowledge and co-learning strategies in hybrid groups, socio-economic models and the commons, epistemic justice, and governance of citizen science (and its organization). The second type addresses problems using a more internalist prism. This category defends the French model of strong links between associations and public authorities (MAHdF¹, La Fonda). It advocates for "associative life" in public policy, defends associations interests, and seeks to understand the impacts of a changing world on these organizations and how they adapt to them. These reflexive questions are very different from those addressed by the cluster of associations managing communities of amateur naturalists.

3.1 Social innovation

In the social innovation cluster, citizen science is aimed at producing actionable knowledge (see table 1 for the list of associations in this cluster). The activities are intermediated by leader associations, innovation brokers, or associations providing innovative services for their members and working on problems that previously have been ignored. The first category of leader associations work to manage networks and mutualize resources. For example, BIO-OC represents the interests of the sector of organic food production in the Occitanie Région. As a resource center, it provides R&D facilities/activities to their members. The second category includes associations that act as local innovation brokers and construct hybrid networks to address local problems. For instance, Evaleco, created to enact transitions, manages a open (*tiers lieux*, Lhoste, 2020) lab for research and innovation and conducts experiments, and questions knowledge literacy and co-learning strategies in hybrid groups, socio-economic models and commons, and the governance and organization of participatory research. Fab'Lim is a research-action-innovation pole aimed at sustainable and

¹ See table 1 for a list of acronyms.

inclusive food systems which steers and advises social innovation in a French region (*territoire*)^{[EL3][cl4]}. It is engaged in partnerships with public authorities, and higher education and research institutions (Inrae, Institut Agronomique Méditerranéen, universities), and manages research projects. The third category of service providers includes associations involved in action-research with excluded populations such as youth (La Critic, Ping), unaccompanied foreign minors (FAPI) among others (ATD, AF-UPP, APPUII), or professionals such as librarians (Lecture Jeunesse), sex trade professionals (Les Pétolettes), artists (Tremolino), and social workers (ALIS) (table 1). These associations are often torn between action and research since they are provided with the resources for action. As research intermediaries, they organize participatory research with stakeholders to design, experiment, and expand innovations. They identify emerging topics of interest and elaborate policy-relevant themes. In other words, they bridge different ways of knowing and learning. Their values include epistemic justice, a concept which can result in mistrust of scientific knowledge. UIPP and ATD-Quart Monde have designed specific methodological tools to protect their members involved in the research process.

3.2 Observational sciences

This cluster includes associations generally considered intermediaries between academia and non-professional scientists (crowdsourcing). In the natural sciences, they frame scientific knowledge as having potential value for nature conservation rather than value only in itself. They steer communities of amateur naturalists (GODS, PN, CREA, Tela Botanica in table 1). Amateur refers to a category of heterogeneous individuals in terms of expertise -whether academics or field experience-, degree of motivation for collecting samples, and relations to knowledge (Dowthwaite and Sprinks, 2019). Their engagement in the management of natural resources often involves long-term engagement in local environmental activities. For example, PN has been involved in compiling lists of biodiversity in various marine species including seals since 1970. Volunteers are more motivated by seal surveillance and tourist awareness than by sample picking. The staff has also to enroll researchers in new research programs. GODS manages a community of volunteers who contribute to biodiversity inventories aimed at protecting endangered species such as the little bustard in a particular geographical location (Deux-Sèvres). Unlike CREA which claims scientific neutrality, both PN and GODS regularly file complaints against individuals who violate wildlife regulations, and engage in local controversies.

Alongside nature conservation, observational science is employed by some associations as an instrument to improve the development of their own activities. AFA, the French astronomy association, promotes amateur astronomy activities and sees citizen science as a way to renew the

association's activities. Other associations administer surveys and manage observatories to study social and cultural practices (Lecture Jeunesse, La Critic). For many years, La Fonda in collaboration with academia has managed the Observatory of Associative Life (OAL). Adapting the national survey methodology, RNMA developed tools to provide data for the local OALs. In HdF region, these data spawned a research program steered by MAHdF in partnership with Lille University to investigate the impacts of changing public policies and the SDGs.

4 Networks, institutions, and roles of associations

All the associations included in our case study are related closely to the production of knowledge, whether scientific or actionable. In the previous section, we differentiated them according to epistemic culture, values, and goals. In this section, we propose a typology of research intermediations according to the position of the association in a network (network manager or not), level of structuration of its partnerships with academia, and the type of research and innovation process in which it was involved (scientific field, advancement, goals) and the boundary work aimed at structuring the research and innovation ecosystems. As intermediaries in grassroots innovation, associations develop strategies, tools, and methods to identify objectives, link stakeholders, and formulate research questions. They manage a collective dynamic allowing actors from different backgrounds and cultures to interact. They provide technical and engineering knowledge for local networks or networks of associations. They help these networks to identify unsolved problems, identify and mobilize researchers and stakeholders (public authorities, third sector, and private organizations), and formulate research questions. They contribute to managing the intermediation space and experimental activities. They also diffuse outcomes through infrastructures, and/or advocate for transformations to public policies. They produce tools and methods for « crossing scientific and experiential knowledge » (*croisement des savoirs*) (observatories, training, etc.), mobilize researchers, and provide legitimacy for the knowledge field. In other words, they facilitate exchanges and reflexivity while managing conflicts, and promote the cross-fertilization of knowledge and shared decisions (Barré, 2020). Intermediations allow the development of common knowledge and collective learning about others' representations of their contexts and activities.

We identified four categories of functions based on the association's network position, the level of structuration of its partnerships with academics, and the advancement and goals of the projects in which it is involved (table 2). The first category is related to the management of the research project within the association's network. The second category refers to network building and the third refers to the management of an infrastructure. These three categories are not mutually

exclusive. In practice, networking can lead to new research projects and/or the creation of infrastructure. Infrastructures such as open labs require networking with local stakeholders, whereas observatories are fed by the results of research projects and experimentation. However, the [c15]fourth category of translating and legitimizing knowledge, is attached to the specific cluster of social innovation while the management of amateur communities is bound to observational sciences with citizen.

4.1 Framing and coordinating research and innovation projects

As intermediaries, associations facilitate exchanges within hybrid networks which include problematization of research questions and generalization/diffusion of innovations. Our case studies illustrate the diversity of those projects aimed at nature conservation or social innovation. Some associations are at the stage of framing the research questions based on working groups or surveys; others are involved in coordinating a mature epistemic community participating in a range of different research/innovation projects. For instance, SEED is involved in establishing a research department to formalize the methods and tools with which they have been experimenting for several years. MAHdF has developed several tools to facilitate the involvement of the association's members in research projects that emerge from surveys. Other associations are involved in scaling of innovations through replication, dissemination, and training of professionals. They both « experiment and advance activities of a particular niche » and try to « influence the prevailing socio-technical system » [c16] (Kivimaa et al. 2019). Some associations focus on the concerns of excluded populations, produce recommendations for public policies, and coordinate experiments to change standards and practices. For example, in urban planning, APPUII offers counter-expertise to a non-participatory rehabilitation project, establishes shared diagnosis, and proposes alternative projects with citizens. In social work and inclusion, FAPI manages a network of West African and French child protection non-governmental organizations (NGOs) and researchers to co-construct and assess action-research programs, and organize generalization of practices within professional networks. The organization has developed a social program based on the needs of unaccompanied minors and exchanges between French and Senegalese social workers. Its participation in an Erasmus Plus program should allow its extension to other parts of West Africa and Europe. A comparable approach of “learning in project and remembering in networks” (Grabher, 2004) is mobilized by ALIS, and SEED. The later has developed skills for the integration of migrants in France via education courses and disseminates these skills via participation in training courses and trainee selection and graduation juries, and the director's position as union representative. This boundary work is translated in intermediary objects which also contribute to the generalization of social innovations. For example, La Fonda manages *Le*

carrefour des innovations sociales - a digital database of social innovations - in collaboration with the General Commission for Territorial Equality (*Commissariat général à l'égalité des territoires*). This infrastructure is the outcome of a two-step process of social innovation. First, the association conducted prospective studies on education issues. It first experimented with collaborative programs to reduce school dropout in two areas (Grand Lyon and Essonne). Second, these programs will be extended to other areas through methodological guides and alliance strategies. Another example is RNMA who manages local observatories of associative life, scaling down a method developed earlier for national observatory (OLVA) during a long term collaboration with a CNRS lab (Tchernonog and Prouteau, 2019). After a test phase in 10 territories, RNMA supports local actors to develop their own observatories and is aiming to produce a map of the structure of the local network.

The boundary work of associations involved in natural science differs from those involved in social innovation. Managing an amateur community involves more than just mobilizing citizen to collect data for scientists. Therefore, their activity is not comparable to crowdsourcing intermediaries hired by companies to manage user communities (Ghezzi et al. 2018). The associations staff and volunteer boards manage an heterogeneous community of amateurs (Dowthwaite and Sprinks, 2019) while articulating this communities' expectations to those of the scientists steering citizen science projects and of non-humans (namely animals as agents involved in the project). The role of association staff and expert amateurs in community decision making is often overlooked. As scientific experts, they translate citizen observations into research questions, and perform consulting/training activities for less skilled amateurs. As members of the steering committee, they may be responsible for networking with academic institutions. For example, GODS' technical tasks are coordinated by a geometician and involve tagging birds and performing statistical analysis of data on distances from birth places which are key to the long term protection of birds. They have been involved in the collection of GPS data since 2014 and the geometician works in close collaboration with a scientist from the Centre d'Études Biologiques de Chizé, a public research institute. The data collected become the basis for scientific articles and have provided evidence that wind turbines disturb bird populations. In PN, a professional ecologist observes seals during the reproduction period. She manages a group of volunteers who count the numbers of two species of seal and monitor their reproduction habits on Picardy beaches. This ecologist assists non-expert volunteers, she validates their observations directly in situ, and also can award them expert status. She translates the volunteers' experiential knowledge into protocols co-written with academic researchers not involved in the fieldwork. These co-produced protocols are both acceptable to volunteers and suitable for collection of high-quality data.

In heterogenous communities, intermediations do not only require disciplinary knowledge. It first includes transactions between human and non-human agents - whether objects or living creatures- to articulate the expectations of every type of contributor, and to ensure that the association's program is consistent with the aspirations of the members of the extended peer community (Funtowicz and Ravetz, 1997) and amateur communities (Kuznetsov and Paulos, 2010), whether they are full members of the association, or volunteer contributors to the community. Secondly, it implies to constantly adapt to transformations to the composition of the community. Tela Botanica recently revised one of its projects to take account of the changing aspirations of its community of contributors. Association staff were required to align the association project to the goals of the crowd of contributors who are not full members and not decision makers. To understand the needs and expectations of these various contributors, Tela Botanica engaged in new scientific collaborations to examine the mobilization of volunteers and the impact of participation on their behaviors, and to improve data quality and data processing. Third, it implies to deal with conflicts between divergent interests and epistemic cultures. PN represents different disciplines of zoology: while its founders are systematists, the newcomers are mostly ecologists more interested in environmental protection than in taxonomy. The volunteers might be more interested in wildlife protection activities than in biological sample picking. And finally, intermediations are also framed by boundary objects. The main differences between PN and Tela Botanica lie in their use of digital technologies. The former manages the collection of biological samples and plant and animal data by a geographically-based community. The later manages a large virtual community feeding a massive database with photographs. A digital platform intermediates the relationship between volunteers and the association. Nevertheless, Tela Botanica organizes on-site gatherings for community members to facilitate interactions among volunteers and scientists. The staff encourages researchers to attend these meetings, and assists them in their communication and outreach activities. In other words, both associations experiment with solutions to the needs and expectations of scientists and of a diversity of amateurs, whether they are hobbyists, farmers, public authorities, or other professionals using biodiversity monitoring as a tool for decision-making in natural resources management.

4.2 Designing and co-managing infrastructures

Several of our case associations manage infrastructures for intermediation (Table 1). These could be a collaborative platform for community management, volunteer education, and knowledge production (Tela Botanica, CREA), an observatory (La Fonda, Lecture jeunesse, APPUII, PN, MA-HdF,

a research center (ATD, Réseau des Crefad), or an open lab (Evaleco, Hotel Pasteur, Ping, Crefad Loire, ALIS, etc.). Open labs provide niches to nurture social innovations and experiment with new ways of governing and learning (Lhoste et Barbier, 2017, 2018; Lhoste, 2020). Their managers bring together the actors in their territory within social innovation programs. At the local level, the objective is to extend the collective and its portfolio of projects, to constitute a geographical or thematic network, and to link different networks to appropriate research institutions. At regime level, these associations belong to national networks and thus can contribute to transformation. We have referred to the distribution of intermediary work in open labs (Lhoste, 2020) and how transformation can occur through project to project learning (Lhoste, 2022). Observatories are fed by the associations' databases and provide indicators for public authorities. Both Tela Botanica and CREA manage two supplementary virtual collaborative platforms (*Phenoclim* and the *Observatoire des saisons* - ODS) and their corresponding databases. *Phenoclim* was created by CREA to observe the impact of climate change on mountain fauna and flora and *ODS* was established in 2008 by CNRS as a research group initiative to monitor the phenology of flora and fauna in the plains of metropolitan France. *ODS* and *Phenoclim* work in partnership and share their data and results. A third type of infrastructure are editing houses. Many associations are involved in editing and publishing the knowledge gained from their activities alongside more traditional newsletters and websites. For example, Réseau des Créfad, ATD, ATTAC, and La Fonda publish journals, books, and pamphlets. AF-UPP publishes a report on each of the research projects conducted by its parent.

Infrastructures connect associations to institutions. For example, L'office, a cultural engineering and artistic production organization, collaborates with the *Observatoire des Politiques Culturelles* de Grenoble (Sciences Po), to provide a research and training space to study contemporary forms of cultural policies. Intermediations allow the construction of coalitions around a common vision for transitions although the governance of these hybrid networks often does not favor associations.

4.3 Networking with institutions

Associations are organized in networks steered by leader associations on a geographical (BIO-OC, MAHdF) or thematic (Réseau des Crefad, RNMA, ALIS, AFA, AF-UPP) base. Networks facilitate reflexivity, organize working groups, and steer research projects. They may also merge with other networks to organize training and advocacy, and construct coalitions around a common vision. For example, Réseau des Crefad partners with the RCCCA to publish guide books and a journal, and organize training on various themes. It is part of a group of association employers and contributes to

a training program which involves award of a State diploma. These networks are connected to institutions at the local and national levels, and their boundary work progressively transform them. For example, the UPPs organized under the aegis of the AF-UPP are recognized and co-financed by *Caisse nationale d'allocations familiales*, a public institution that finances all family benefit schemes, and the Ministries of Health and Solidarities, and of National Education. The final colloquia bring together associations, professionals, and institutions (ministries, local authorities, etc.) which work to change public policy. Following their involvement in experimental programs, beneficiaries and institutions can change established rules. For example, a UPP parent group is working with a police station in the Paris region on relationships between families, youth, and the police. Another example is the transformation of the *Haut conseil à la lutte contre la pauvreté et à l'exclusion sociale* (High Council to fight poverty and social exclusion). This national council is comprised of four colleges. ATD advocacy work led to the creation of a fifth college for people living in poverty or precariously.

Networking with academics depends on the association's history. It is facilitated by associations established by scientists such as CREA, APPUI, FAPI, Fab'Lim, La Critic, or IFJD. and/or are staffed by individuals with master's or doctoral degrees. These individuals may be part time university lecturers, part-time researchers, or research associates at a public laboratory. Being affiliated to a public laboratory is mandatory for recognition from the scientific community as a professional researcher. A doctoral degree is not sufficient. In addition, there are discrepancies across disciplines.

Networking with institutions is a long, time consuming, and uncertain process. To create new networks, most associations invite researchers to sit on their boards or create scientific councils that facilitate regular exchanges with academics outside the research partnership. They also organize seminars involving academic researchers and field workers. They participate in training programs: students play an important role in the creation of links between labs and associations which benefit from Master's level research. They may also experiment with formal arrangements such as agreements to normalize their interactions with universities. For example, MAHdF shares resources and steers research programs with the University of Lille Science Shop. Networking with institutions involves transformations to rules and practices. For example, partnership agreements have been standardized to suit private partners. They have to be adapted to third sector organizations and negotiated. For example, Evaleco encourages its academic partners to identify administrative solutions based on exchanges of knowledge rather than remuneration for a service. It was the first association to coordinate a formal cluster of research laboratories and third sector organizations interested in federating their skills for the development of research (*Groupement d'intérêt*

scientifique). It also diffuses and adapts existing policy instruments. For example, Evaleco has used an instrument designed for business model assessment to assess its research partnership. Among the outcomes of this assessment, associations can apply for institutional accreditation for training sessions. When negotiations fail, associations have to go on un formal partnerships. For example,; Lecture Jeunesse experimented an agreement with Cergy Pontoise university for the sharing of books and training materials. However, this initiative has proved "administratively heavy" and the association continues to rely on personal networking with researchers and on benchmarking, although this is impaired by inadequate updating of laboratories' websites.

4.4 Translating scientific knowledge and legitimizing experiential knowledge

Intermediation includes knowledge brokering and is bidirectional between actors from different worlds. Associations play an important role in the structuring of more horizontal relationships among the actors in participatory research processes. Although experiential knowledge is more often considered essential for social innovation (and policies), fear of its improper use by activists, and the quality of the data collected by volunteers continue to be the subjects of debate in the natural science communities. In addition, the work of *non-professional scientists* could discredit the boundary work started in the 19th century by academia to legitimize the profession of public scientist (Joly, 2020). Therefore, it is important to develop tools to enable the building of trust, construct a common vision, identify the barriers to participation, and investigate power relationships that may disadvantage associations. For example, the integration of the repository of French names produced by Tela Botanica into the national taxonomic repository of the flora of France distributed by the National Museum of Natural History acknowledges but may also invisibilize the essential, expensive, and time-consuming boundary work accomplished by the association and the community. This work involves designing and providing digital and manual collaboration tools, managing data bases (observatories), promoting volunteer stewardship and awareness, checking the quality of the data collected, and managing large amateur communities. In addition to participatory research projects involving professional scientists, communities pose new questions, and develop new research projects and extensive programs from which they are excluded as full partners.

Legitimizing experiential knowledge requires experimentation with new governance frameworks for everyday management within the associations. For example, the board of AF-UPP includes several members representing parents, academics, stakeholders, and social workers. At the project level, the interactions among actors with different social statuses and different knowledge introduce power differences. Association staff and expert volunteers are not only spokespersons for excluded people, they encourage them to speak out to assert their experiential knowledge. They can

coordinate and manage tensions among actors, design and use adapted tools, and mobilize the resources required to take into account experiential knowledge. They have to convince either volunteers or scientists to contribute to mixed groups. For example, when Tela Botanica proposed a new project to survey Guyana's flora, the association had to convince researchers unfamiliar with citizen science. ATD pioneered the development of sequential methods to guarantee epistemic justice. Its permanent volunteers had to persuade researchers that, when a new problem arose, people living in poverty had to problematize in peer groups prior to discussion in mixed groups (Carrel, 2017). ATD draws on its experience of advocacy to change public policies and provide training programs for social workers. There is a group of associations that are working to try to overcome the multidimensionality of interculturality and imbalances in power relations but research on this topic is scarce. AF-UPP developed a method of knowledge cross-fertilization based on over 20 years of action-research with groups of parents. They encouraged parents to share their experience, helped them to identify common problems, and mobilized researchers to provide research tools rather than scientific knowledge. AF-UPP organized the presentation of research results at university seminars and their publication.

However, this boundary work depends on individual initiatives and interest groups. It is also disrupted by current debate within the French social sciences community around the scientificness of minority studies. Nevertheless, new epistemologies are recognized by institutions. For example, ATD-Quart Monde recently signed an agreement with CNRS (via a *Groupement d'intérêt scientifique*), and the Conservatoire National des Arts et Métiers (Cnam), a; following a conference held in 2016. As a member of the network of Ethnopoieses (a CNRS label²), MPOB transforms this label from heritage resource management into a social lab managing popular crossbreeding popular knowledge and ethnography. At the regime level, research institutions and associative network leaders can negotiate new rules and norms. We can mention the recent transformation of the financial regulations of *the Agence nationale de la recherche*. This regulation defines the terms and conditions for awarding grants for research projects. Since 2022, associations can be financed in full costs up to 50% of the salaries for their research activities.

² Ethnopoiesis, National Cluster of Research and Resources in Ethnology, is a label created by the Ministry of Culture in 1996. It is attributed to cultural institutions leading a strategy of excellence in research, information and cultural action, around the intangible cultural heritage.

5 Discussion

This comprehensive analysis allows the conceptualization of research intermediations from the perspective of associations, using the theoretical framework of grassroots innovations for sustainability. We distinguished between associations' missions and networks, the place of research in their strategies, the infrastructures they share with institutions, the epistemic communities involved, and the values they espouse. First, we differentiated two epistemologies: social innovation and observational sciences. We observed that associations involved in social innovation value experiential knowledge and coordinate action-research and other forms of co-construction of research projects, while observational sciences may be mobilized to build knowledge either on social innovation or in nature sciences. We also noticed that the latter value scientific knowledge and manage amateur communities. Second, all associations performed intermediations and these intermediations cover the range described in grassroots innovations for sustainability. We identified three key functions of associations: 1. Framing and coordinating research and innovation projects, 2. Coordinating some networks and contributing to others, 3. Designing and co-managing infrastructures. These categories are comparable to the three key functions of the intermediations described previously. Authors highlighted the boundary work in networks (Kanda et al, 2020, van Welie, 2020), infrastructures (Hargreaves et al. 2013), and with institutions (Van Welie (2020). Third, we highlighted unique functions in each of the two categories of social innovation and nature sciences: 1. Amateur community management in natural sciences, and 2. Legitimizing experiential knowledge in social innovation. We thus confirm that epistemic cultures influence the relationships of professional scientists with knowledge but that the boundary between observational sciences and social innovation is blurrier than the two normative categories of co-creation and crowdsourcing currently institutionalizing in France under the notions of *Crowdsourcing* and *Participatifs* (co-creating)³. Crowdsourcing - level 1 in the ladder of citizen participation (Arnstein, 1969) - involves managing a community of amateurs, boundary working with academics, mobilizing the relevant field and scientific expertise, contributing to data collection and analysis, and pursuing association goals. These intermediations are distributed among volunteers, members, and employees. Co creating - level 2 of citizen science- includes assisting grassroots actors in identifying common problems, and

³As as evidenced by the two categories of the prize awarded each year to researchers involved in citizen sciences. <https://www.inrae.fr/actualites/prix-recherche-participative>

paving the way towards collective experimentation i.e. an open process in which many actors develop and stabilize new socio-technical objects and/or new practices (Chesbrough, 2003; Felt, 2007; Geels, 2002; von Hippel, 2005). In this conceptual framework, associations are crucial intermediaries in sustainability transitions although they are mostly unaware of their role (Hodson et al., 2013; Moss, 2009). At the interface of radical innovation/experimental activities and the prevailing regime, they problematize research questions, coordinate or participate in research projects, design, and co-manage tools and methods for experimentation in niches such as open labs, and manage observatories in partnership with research institutions. Although institutions confine their activities as facilitators in two normative epistemic practices, they produce knowledge and have their own goals. In other words, they are strategic actors (Lhoste, 2022).

These intermediations are not aimed solely at experimentation and advancing activities within a territory, they also try to influence the dominant system by producing knowledge and recommendations for public policy. Facilitating co-construction and monitoring participation in the different phases of a single project whether led by academics or grassroots, is one of the challenges that intermediaries must address to fulfil their goals. Another issue is the generation of a completely new knowledge structure and cognitive framework (Irwin, 2014). We have shown that associations design and develop tools to facilitate networking such as physical spaces for intermediation, collaborative platforms, and observatories. Meeting in networks facilitates individual and organizational learning essential for the transformation of organizations, rules, cultures, and epistemologies. Finally, research intermediaries offer advice, share experience, and engage in advocacy activities for the inclusion and legitimation of experiential learning. At the interface between niche and regime, they link niche actors with regime structures in hybrid networks. These hybrid networks are spaces where negotiations and alliances can be built between the actors in the dominant regime and outsiders (Elzen et al., 2012; Hargreaves et al., 2013; Ingram et al., 2015; Smink et al., 2015). In conclusion, third sector organizations can contribute to sustainability through a variety of situations, objectives, and epistemological practices. Intermediaries build hybrid networks in specific domains based on their experience in projects. These hybrid networks can transform into epistemic communities bearing SDGs. They are both indicators and drivers of system governance transformation (Moss, 2009). As institutional entrepreneurs, associations may contribute to change. In participating in the governance of infrastructure and processes, they can determine the course of the transition. Therefore, it is essential to support their evolution. Future research should examine how to articulate the needs of associations with those of research organizations, how to organize the governance of knowledge infrastructures, how to transform rules and norms in both strategic action

fields. It is important to organize social learning to disseminate research intermediations and contribute to the generalization of strong participatory paradigms in networks.

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