Let's Get Organised: Practicing and Valuing Scientific Work Inside and Outside the Laboratory

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Abstract

Over the past thirty years there has been a significant turn towards practice and away from institutions in sociological frameworks for understanding science. This new emphasis on studying 'science in action' (Latour 1987) and 'epistemic cultures' (Knorr Cetina 1999) has not been shared by academic and policy literatures on the problem of women and science, which have focused on the marginalisation and under-representation of women in science careers and academic institutions. In this paper we draw on elements of both these approaches to think about epistemic communities as simultaneously practical and organisational. We argue that an understanding of organisational structures is missing in science studies, and that studies of the under-representation of women lack attention to the detail of how scientific work is done in practice. Both are necessary to understand the gendering of science work. Our arguments are based on findings of a qualitative study of bioscience researchers in a British university. Conducted as part of a European project on knowledge production, institutions and gender the UK study involved interviews, focus groups and participant observation in two laboratories. Drawing on extracts from our data we look first at laboratories as relatively unhierarchical communities of practice. We go on to show the ways in which institutional forces, particularly contractual insecurity and the linear career, work to reproduce patterns of gendered inequality. Finally, we analyse how these patterns shape the gendered value and performance of 'housekeeping work' in the laboratory.

Keywords: Women, Science, Laboratory, Epistemic Community, Organisation, Value, Work, Career, Housekeeping

Introduction: gender, practice, science and community

1.1 Women's under-representation in science, especially in senior roles, has been a prominent focus of research on gender and science in recent years (Fox 2002). This research has demonstrated the importance of the material and symbolic structures which systematically organise patterns of inequality in the university. However, the day-to-day experience of epistemic work and their implications for the gendered academy have not been explored in depth. These are prominent concerns within contemporary science studies. However, science studies approaches rarely incorporate concern for gender in practice and have tended to ghettoise feminist science studies for being politically motivated and wedded to traditional institutional models of power. In this paper we seek a more productive approach which attends to organisations and gender in the context of scientific practice. In so doing we draw on ideas of epistemic communities and on data from observation studies in two biology laboratories and interviews with biologists. In the remainder of this section we explore the different approaches of science studies and analyses of the gendered organisation, before introducing the notion of epistemic communities as a potential 'analytical bridge' between the two. We then introduce the research study and the data that we present in our further interrogation of gender, practice and community in science. The main body of the paper consists in two substantial, empirically-focused sections which explore the laboratory and the organisation as sites where gender is variously subsumed, articulated and contested. We show how the focus on practice and epistemic culture in science studies highlights some crucial aspects of the laboratory as epistemic community. But we go on to argue that this approach fails to see the gendered conditions of researchers' work. Understanding these aspects of laboratory life means looking critically at the institutional factors that shape how science work is valued, and how researchers negotiate them. Here we focus upon linking everyday 'housekeeping' work in the laboratory to the institutional dynamics of science careers. We look at how the organisation of science careers cuts across and problematises ideas of communities of practice at the lab level. We end by reflecting on the turn to practice in science studies and the benefits of bringing

subtle notions of community and organisation back in to the study of laboratory life, particularly for understanding the gendered aspects of scientific practice.

Women and science

1.2 Feminist critiques of science have revealed the distinctly masculine rationalities at the very heart of epistemological processes (see *inter alia* Rose 1994, Keller 1984, Harding 1991, Haraway 1991, 1988). They have focused on how natural science methods which privilege objectivity and the autonomous and disembodied knower have positioned women as other, both as objects of knowledge and as knowing subjects. These literatures make a strong epistemic and moral case for inclusive and egalitarian communities of enquiry. They have always run alongside equity critiques of science and the liberal feminist agenda of tackling women's exclusion from and lack of progress in science jobs and careers (Wylie et al 2009; Schiebinger 1999; Rose 1994). In recent years, especially in the US and the UK, questions of gender and science have been insistently reframed by a range of new government policies designed to promote equal opportunities for women in the science and research workforce (DTI 2003a; 2003b). These policy approaches emphasise structural barriers to women's participation in science and from the history of exclusionary traditions in the academy. They stress the need for more open and transparent procedures for recruitment and retention of research workers; flexible working arrangements; and raising the profile of women in science, technology, engineering and maths (STEM) subjects (Garforth and Kerr 2009).

1.3 Guided by the participatory and policy agendas, empirical research on women's under-representation in academic science has sought to explore women's experiences and analyse the production and reproduction of inequalities in knowledge work. Here, questions of equality cannot be reduced to numbers (Fox 2002). Rather, the university is understood as a 'gendered organisation' which reproduces masculine academic cultures (Benschop and Brouns 2003; Acker 1990) even as women have entered academia *en masse* as students and professionals (Goode and Bagilhole 1998; Walsh 2002). The masculine standard of the unbroken linear career (Garforth and ?ervinková 2009); the 'micropolitics' of informal relations such as gossip, humour and harassment (Morley 2006; 1999; Deem and Morley 2005); and the positioning of female researchers as visibly different in contrast to unmarked masculine epistemic subjects (Garforth and Kerr 2009; Harding 1991) are all features of these processes of reproduction. The new managerialism in higher education, especially audit and quality assurance, has tended to reinforce these processes through an emphasis upon transparency and leadership in particular (Rose 1994; Deem and Brehony 2005; Morley 2003; Shore and Wright 1999; Strathern 2000; Walsh 2002; Hearn 2001). These approaches have all offered valuable insights into patterns of inequality in the university. However, they have often sought to focus on commonalities of gendered experience at the institutional level, and as such have had little to say about its relationship to specific practices of everyday knowledge work, or the variety of epistemic and disciplinary cultures through which knowledge production takes place.

Science studies

1.4 To understand these aspects of science we need to turn to contemporary science studies which emphasise the heterogeneity of the concrete practices which bring people, natural objects, technologies and techniques together to create specific knowledge claims. The classic methodology deployed to gain this understanding is the ethnographically inspired laboratory study (Woolgar 1982; Latour and Woolgar 1986; Pickering 1992; Knorr Cetina 1995; Hess 2001; Hine 2007). What is important here is not so much knowledge workers' accounts of what they do (for example in interviews), but the witnessing of 'science in action' (Latour 1987). This enables the analyst to make careful and subtle distinctions between the different types of epistemic work that go on in different settings and in relation to different disciplinary orientations. Knorr Cetina's (1999) influential idea of epistemic cultures, for example, emphasises the different resources, modes of work and techniques brought to bear on the natural world in the contrasting fields of molecular biology and particle physics. These accounts produce powerful insights into the everyday practices and cultures of knowledge work.

1.5 However, contemporary science and technology studies approaches are not easily compatible with feminist approaches in general and the concern with women's under-representation and the gendered organisation in particular. For example, in the influential actor-network approach (Latour 1987, 2005; Law and Hassard 1999), power is located not in pre-existing institutions but seen rather as a productive force arising from situationally specific networks of multiple actants – human, natural and technological. These theories have been notoriously sceptical of conventional sociological recourse to the power of structured inequalities to shape or constrain scientific work (Latour 1983). As Singleton puts it:

> Actor-network theory denies the analyst the comfort of drawing upon the existence of dualisms, such as male *versus* female, oppressor *versus* oppressed, science *versus* society, human *versus* non-human, prior to analysis of specific constructions of the science/society

relationship. (Singleton 1996: 457)

1.6 For some feminist critics, however, this postmodern emphasis on dissolving dualisms and its attention to actions rather than actors means that gender has been overlooked in science studies, dismissed as 'a "social" ghost that block[s] real explanation of science in action' (Haraway 1992: 332 n14). In science studies, as Whelan (2001) points out, there appears to be particular resistance to the issues of 'women in' and 'women into' science and technology that are assumed to be the sole concern of feminist science studies.[1] As we have seen above, a concern with women's under-representation in and differential experience of science is central to policy and organisational studies (Whelan 2001: 545). The standoff between these positions is summed up by Singleton as one in which feminists accuse contemporary social theories of science of being 'apolitical', while science studies scholars attribute 'epistemic conservatism' or a 'failure of [theoretical] nerve' to feminist arguments (Singleton 1996: 446; cites Grint and Woolgar 1995).

Epistemic communities?

1.7 We are nevertheless convinced that there is much to be gained from combining insights from these different approaches. In order to realise this potential we need to identify an analytical bridge based on shared understandings across these fields of study. The concept of epistemic community feels intuitively useful and relevant here, although it is rarely used in either social studies of science or women and science approaches. However, like both these approaches, the concept of epistemic community privileges the collective or relational aspects of knowledge production in particular contexts, rather than focusing on independent, atomistic knowers. This chimes with social studies of science, which emphasise contingent, dynamic and unbounded networks composed of non-human as well as human actors. Studies of women and science also work with a concept of communities. Here, however, the focus is on institutionally embedded, stable, and face-to-face collectives. Although it is odd that research in these two areas does not map coherently to explicit discussions of epistemic communities currently circulating in academic literatures (see Amin and Roberts 2008 for a useful overview; also Haas' 1992 notion of epistemic communities in the policy sense), there is much to be gained from thinking of science in these terms. In particular, the 'communities of practice' approach (Wenger 1998; Lave and Wenger 1991) draws attention to the face-to-face, interactional and performative dimensions of epistemic processes. Here, knowledge production and learning are analysed in terms of their tacit, embodied and situated qualities, rather than dynamics of abstraction, codification and networking: key elements of a rounded approach to gender, practice and organisation in science.

Methodology

1.8 Our tactic here is to resist the temptation to attempt a theoretical resolution of these disparate concepts of epistemic community and contested visions of how epistemic actors work together in knowledge production. Instead, we start in the laboratory and work through a series of observations of the concrete practices and relationships of bioscientists. We use them to build an iterative interpretation which foregrounds the need to look at both organisation and practice in science. We develop our analysis through explorations of data generated with researchers in two biology laboratories in one department of a British university. Participant observation studies were conducted over ten months as part of the KNOWING project.[2] During the intensive phase of the observation, lasting for approximately five months, we visited both laboratories for the equivalent of one or two days per week, although the visits were often clustered in three to four day stints in order to get a sense of the labs' weekly routines. The observation study focused on the routine activities of researchers. However, we also attended laboratory meetings, department seminars and administrative meetings, as well as one specialist conference. Fieldnotes were written up and analysed alongside interview and focus group transcripts using thematic coding in NVivo software.[3] We also undertook more contextual forms of analysis by selecting longer examples from the fieldnotes in order to avoid fragmenting our accounts of the researchers' daily practices. These longer extracts from our empirical material feature strongly in the following section of our analysis.

Unpacking epistemic communities: the laboratory

2.1 We begin by positioning the laboratory as a local site at which a specific epistemic culture comprising people, materials, machines, techniques, skills and ideas is instantiated and performed (Knorr Cetina 1999; Pickering 1995; Latour and Woolgar 1986). Science studies conceptualises these ensembles of networked actors as epistemic cultures which are distinctive to particular fields of inquiry. We found numerous ways in which labs functioned as distinctive epistemic micro-cultures and communities of practice in our study. We discuss them below in relation to three themes: shared routines and rhythms in the laboratory; the passing on of tacit knowledges and embodied skills; and collective identities. In each case we show how these are rooted not in abstract definitions of disciplines or fields, but in material practices, and we explore them by

looking closely at extracts from participant observation data gathered in two laboratories: a long-established embryology group headed by a male professor; and a newer and very successful plant laboratory with a female leader.[4] We go on to discuss how gender is largely subsumed or hidden from view in this practice-focused analysis. In order to bring gender to light, we adopt a more organisational lens to look at laboratory life in the following section, entitled 'Organising knowledge work'.

Shared routines

2.2 As the following fieldnotes illustrate, the laboratory groups were bound together by distinctive daily, weekly and longer-term temporal routines and rhythms which were intimately related to the experimental materials and methods that they used:

> *… A departmental porter picks up a batch of pig or cow ovaries from the abattoir once or twice a week. One of the post-docs explains: 'you can't vary the routine' – you can't have the ovaries to order as and when you want them for a particular set of experiments. If you stop for a couple of weeks, say, the routine will be disrupted with no guarantee of further deliveries.* [Lab observation fieldnote].

> *Once or twice a week researchers gather in the culture lab ante room to clean pig ovaries to prepare them for gathering eggs. Then three or four of the group [...] will sit at benches for an hour or so, 'aspirating' eggs from small cyst-like lesions on the ovaries, sucking the eggs up through a needle into a syringe containing a small amount of solution to preserve them.* [Lab observation fieldnote].

> *Technician: 'On Thursday the pig people will do the oviducts, and then culture the cells…' Researcher: 'I'm a mouse person, so I have to deal with the mouse timetable, which is different.'* [Lab meeting fieldnote].

2.3 In the embryology lab, the arrival of animal tissues demanded immediate attention resulting in intense cooperative activity. Routines for dealing with the ovaries were shaped by external considerations – the group had to coordinate their action in relation to the abattoir and the porter. Once in the lab, preparing materials took place in small spaces for concentrated periods of time as researchers and technicians worked together to aspirate eggs from fragile and short-lived ovarian tissue before moving on to fertilise them and culture embryos. For 'mouse people' in the same lab, things were a little different. Mice could be obtained from departmental supplies more or less to order for particular experiments, so researchers were able to organise their own timetable for 'harvesting' eggs. For all the researchers, however, the laboratory's methodological commitment to modelling *in vivo* embryo development in *in vitro* conditions set up the experimental timetables dictated by the growth of embryos from two cells to a many-celled mass.

2.4 In the larger plant lab, researchers grew their own plant material for experimentation. The routines and rhythms of this lab involved comparatively little intensive collective work; rather, researchers were occupied separately in similar and parallel tasks (Kerr and Lorenz-Meyer 2009).

> *Growing and watching – and then cutting and experimenting on – the plants is the thread that joins them and that runs through everyone's day. Anticipating when the plants will be at the right stage for whatever they're needed for, walking back through what is needed to have those plant materials at that time, is key to how everyone schedules their medium-term routines (it takes about 6 weeks to get to the setting seeds stage).* [Lab observation fieldnote].

2.5 The basic temporal building block in this lab was the six weeks it took for the seeds of their chosen plant model to produce a plant that could itself set seed. The lab's work involved analysing the relationship between plant genotypes and phenotypes and so they studied several generations of mutant genes and plant crosses, adding on additional six-week cycles to their timetable. Most researchers worked alone on their own preparation and individually conducted their own experiments. However, all were involved in the same routine experimental tasks: collecting, drying and labelling seeds; planting, growing and observing plant morphology; pollinating, collecting and storing the next generation of seeds. They passed in corridors and overlapped at the bench or in glass houses as each individually attended to the demands of growing material.

2.6 In both labs, then, temporal structures bound researchers together in local epistemic communities. In the embryology lab these were clearly marked by periods of collaborative activity and direct interaction; in the plant lab they were present in the form of the shared routines that researchers individually followed.

Embodied skills and communities of practice

2.7 In the plant laboratory, methods for sharing techniques and passing on embodied skills and tacit knowledges appeared to be particularly important in (re)producing the group as an epistemic community, since researchers rarely physically worked together. Here the idea of communities of practice (Wenger 1998) offers useful insights. This approach emphasises hierarchical aspects of the organisation of knowledge communities, in particular the apprentice/master relationship and the ways in which strong community ties are built around 'replicating and preserving existing knowledge' by 'passing on particular ways of doing things, resulting in cultures of work and professional identities that can clash with standards elsewhere' (Amin and Roberts 2008: 359). In both laboratories we observed the key roles played by experienced post-doctoral researchers and technicians as mentors and teachers of post-graduates and even under-graduate students at the bench. This was most clearly foregrounded in relation to mundane preparatory experimental tasks and in relation to the use of experimental equipment, in particular the standardised kits that are increasingly common in post-genomic bioscience. Many of these processes have written scripts or protocols, and these are excellent examples of what Latour calls 'immutable mobiles' (1987) – textual forms of representing knowledge which remain consistent as they move through scientific networks, and which are therefore crucial to the universalisation and standardisation of knowledges and techniques. However, protocols and instructions also have to be enacted and performed in specific circumstances. Contingencies, failures and unexpected hitches are an ordinary part of translating technical documents into practical experiments, and here the sharing of tacit and informal skills and knowledges come into play.

2.8 In both laboratories a good deal of activity was concentrated on the physical manipulation, movement and care of very small (albeit visible to the naked eye) objects. In the plant lab techniques included sowing individual seeds onto growth media and later collecting, separating and preparing for storage the tiny seeds from the plant. Critical tasks in the embryology lab included the aspiration of ovarian tissue, drawing eggs and fluid from mammalian ovaries using a syringe, and the use of mouth pipettes to transfer eggs and embryos around various dishes and plates:

> *Three of the researchers are sitting around two tables in more or less the same position – feet crossed under their swivel chairs, head fixed over the microscope, right hand operating the tube end of the mouth pipette, rubber end between lips. […Later] one of the post-grads … explained to me that [...]she was frustrated with herself because the process of preparing the fertilised eggs was slow for her because she was uncomfortable with the mouth pipette technique […] one of the postdoctoral researchers said it was 'like riding a bike' – impossible to explain in the abstract, impossible to describe, necessary to find you own way bodily [...] Two of the lab group are so practised in this technique that they can and do talk while pipetting, out of the side of the mouthpiece...* [Lab observation fieldnote].

2.9 In both cases these techniques demanded both the passing on of acquired and embodied skills and for researchers to learn to improvise a style suited to their particular strengths. For the most part, researchers would work closely with someone at the next academic level for a period to take on the relevant skills, although experienced technicians play a significant role. We see in action here the hierarchies of skill that Lave and Wenger (1991) refer to, as well as the constitution of communities through passing on particular practices. In the embryology lab, the teaching of practical techniques was accompanied by narratives in which post-doctoral researchers talked admiringly of their own predecessors and mentors in terms of their effortless skills, although they usually referred to their own technical competence self-deprecatingly. They also pointed out that mouth pipetting was now a relatively unusual technique in bioscience labs; this was frequently commented on by a new member of the group with a different disciplinary background, drawing attention to the distinctiveness of specific laboratory work cultures.

Experimental materials and collective identities

2.10 Crucial elements of experimental practice - materials, machines and methods - also helped to constitute aspects of self-conscious group identity in the laboratories. In the embryology lab people frequently referred to themselves in terms of the animal model that they worked on: there were 'mouse people', 'cow people' and 'pig people', although there was a degree of overlap in practice which reflected the laboratory's historical commitment to exploring early embryo growth in a range of animal models. In the plant lab the researchers self-identified as 'plant people' informally; in more formal settings they were 'plant biologists'. This label enabled and produced wider connections within the biology department, for example taking part in a plant biology seminar series with invited speakers and working with plant specialists in the department's technology facility and glasshouses. The distinctive characteristics of methodologies and resistances of materials were also cited when members of both groups explained that they worked in a 'slow field'. In a context that demands high outputs in terms of publications and new knowledge claims, researchers felt that they were at a disadvantage working with materials that demanded a lot of care and

nurture. In both cases the groups worked with whole living organisms (embryos and plants respectively) and the replication of *in vivo* conditions, necessitated by epistemologies that focused on the growth and development of these entities. As we have seen above, these materials take their own time, which may not be easy to reconcile with external schedules of career and research outputs. Researchers often compared their materials unfavourably with more conventional biological models (drosophilia, yeasts, mice and frogs) where, as one post-doctoral researcher put it, you *'dependably get results'* (observation fieldnote). The idea of the 'slow field' also had the connotation of being unfashionable and adrift from cutting edge science. This was particularly marked in the embryology lab, but the plant biologists also on occasion remarked that *'plants aren't sexy'* (lab observation fieldnote).

2.11 These forms of collective identification are particularly important when we consider another key aspect of laboratory groups – that the members are ever-changing. This was one of the first things pointed out to us by members of the plant lab when we began the observation study. The lab leader remains a fixed point, and is recognised as such by the department, the institution, and the wider discipline, especially in the convention of referring to the group and its work using the name of the leader. Most of the other researchers, however, are passing through for a fixed period of time before moving on to another post. The question, then, is how laboratories achieve a coherent and continuous identity over time. One – partial – answer is that groups work within an intellectual and analytical framework set out by the laboratory leader. In the plant lab this was partly driven by new developments within the wider field of post-genomic biology. In the embryology lab, there was a sense of the accretion and inheritance of successful experimental practices building over many years into a coherent methodological approach. However, in both cases the shared analytical vision was realised in experimental practice through interactions and exchanges between researchers in shared spaces at the bench. In the two laboratories that we studied, the everyday community of practice emphatically did not include the lab leaders, both of whom no longer worked at the bench and were not present in the day-to-day experimental work of the group.[5] Thus the routines, skills, narratives and identifications that were generated through practice and passed on through generations of researchers can be seen as crucial both to developing new knowledge and innovation and to the preservation of skills and incremental development of techniques that are entangled in knowledge work (Amin and Roberts, 2008).

Epistemic communities as gendered spaces?

2.12 This data indicates how we can read laboratories as face-to-face communities constituted in and by their practice. The production of new knowledge in both cases depended on embodied skills, day-to-day routines performed in shared spaces, and the reproduction of epistemic cultures that brought together specific combinations of materials, machines, and know-how. This approach tends to generate a vision of the lab as a mutually supportive community that develops over time and is reinforced through shared daily practice. It emphasises cooperation, relationality and sameness, in which the only hierarchies are those of skill and experience (Lave and Wenger 1991). Seen from this angle, the relevance of gender to the practice of lab science is difficult to establish. The labs we studied featured women in equal numbers to men in all positions, from professors to PhD students and technicians. Both men and women were involved in all aspects – practical, intellectual, mentoring, and social - of the epistemic community. Both labs had well-liked and academically admired senior post-doctoral researchers, male and female, who took the lead in activities from organising the celebrations for a successful PhD candidate, through teaching key experimental skills to new researchers, to co-authoring journal articles with junior colleagues. We noticed that the temporal routines, master-apprentice relations of the laboratories and even, to a certain extent, the experimental identities of the laboratory groups could be gendered. Experimental routines do not necessarily fit with family life; apprenticeship relations took on a different flavour when the authority figure approached their role with a paternal or a maternal sensibility; and soft toys and fridge magnets of animals are associated with femininity, for example. However, these gendered interpretations seemed marginal. When we commented on them to participants they treated them as irrelevant, and were quick to point out other differences and similarities between men and women in the laboratory which did not chime with any kind of overarching notion of the gendered laboratory. These findings appear to reflect the enormous influx of women scientists into biology and other life sciences over the past 25 years,[6] and to support the claims of the women and science policy literatures that that lingering structural blocks to the advancement of women in academic science are steadily being overcome (DTI 2003; Garforth and Kerr 2009). However, this vision of an increasingly equitable work culture is hard to reconcile with large-scale issues of women's under-representation and lack of progression in science careers. The mutually supportive epistemic community constituted in practical activity, then, is only one part of the story. In order to understand gender in the laboratory we need a better appreciation of how different kinds of practice are defined and *valued,* both within and outwith the lab. This requires us to place the laboratory in the wider organisation of the discipline and the university.

Organising knowledge work

3.1 In this section we complement the image of the non-hierarchical epistemic community that emerges from our research focus on daily practice with a contrasting picture of gendered inequalities produced through differential evaluations of different types of work. We begin by describing the singular and linear career path for bioscientists that has become increasingly dominant in recent years, underwritten by powerful institutions including the main funding body for life sciences, the Biotechnology and Biological Sciences Research Council (BBSRC), universities themselves, and powerful professors in the field. We go on to consider the tensions and inequalities that sit alongside this, focusing upon the organisational context of contractual insecurity, particularly for post-doctoral researchers. Secondly, we look at how these organisational conditions produce inequalities at the level of the laboratory itself, through a discussion of the gendered meanings and performances of 'housekeeping' work. We argue both that women tend to be concentrated in non-progressing, reproductive housekeeping roles in the laboratory, and that the association of certain kinds of epistemic work with women reinforces a gendered culture in which conventionally masculine attributes are valued and undervalued work is feminised.

Precarious positions and the science career

3.2 In the KNOWING study (see Garforth and Kerr 2009; Garforth and ?ervinková 2009) and especially in the UK, we found a dominant discourse of the standardised career embedded in both national and organisational policies. The ideal career path in the biosciences was linear and concentrated, beginning with a PhD undertaken immediately after the undergraduate degree and progressing immediately to a period of short-term post-doctoral research posts. Post-doctoral research was defined as a transient career phase leading either to a permanent, core-funded lectureship, or an independent research fellowship. In 2002 the Roberts report estimated that only around 20% of post-doctoral researchers in science, engineering and technology subjects in the UK would find permanent posts in academic research (Roberts 2002: 12), and large numbers of post-doctoral researchers are continuously moving through the system.[7] This was reflected in our research findings, especially in a focus group undertaken with lecturers and professors in the biology department. In the words of one of our participants, current policy in UK universities aims to '*make the postdoc duration short and well defined as a training period, and then they need to move on'* [focus group, male professor].[8]

3.3 Another professor emphasised that *'…there is no such thing as a long term postdoc in the biosciences. I feel quite strongly that there shouldn't be any'* [interview, female professor]. Others endorsed the idea that *'[t]here's no position as researcher as such in the UK... no setting for using your skill to work in a group as a researcher'* [focus group]. As one senior professor in our focus group put it, researchers should not remain in laboratories as '*perennial postdocs'.* In the past, he explained, there were people

> *' who were somehow managing to spend nine and ten years maybe [working in labs] but weren't particularly going anywhere. […] The pressure wasn't on. They were on two years, three years, one year with not much chance of an academic post. Maybe we've taken note of that now and are trying to avoid that situation.'* [Focus group, male professor].

3.4 The ability of postdocs to progress in science is of course predicated on their capacity to establish a reputation in their field in the form of concrete outputs: novel findings; highly cited publications; winning independent grant funding. Alternatively, researchers are encouraged and supported to leave academic research. This situation is captured in the circulation around the biology department and the main UK disciplinary grant funding council of the emphatic message that *'post-doc is not a career'* [observation fieldnote, BBSRC early-career researchers support meeting].

3.5 This sat somewhat awkwardly against our observations that much of the crucial work of organising the materiality of the laboratory, supporting the progress of more junior researchers, and even developing the detail of future research projects was performed by researchers in the most institutionally precarious and marginalised positions. These researchers were on fixed-term or otherwise open-ended contracts that depended on continuing external grant funding. They included one or two technicians, whose 'invisible' contributions to both the practical and the epistemic aspects of science work have been well acknowledged in the sociology of science (Shapin 1989; see also Goode and Bagilhole 1998). Here, however, we focus on the position of post-doctoral researchers. Our observations and discussions with people in the laboratory, about their own trajectories and those of others who had 'passed through', suggested that researchers in the labs divided into two groups. Many were progressing towards a stage (usually towards the end of a second post-doctoral research project) where they would try to convert their epistemic experience into an independent research fellowship or lectureship. Others had passed into a stage (having moved onto a third or subsequent fixed-term contract) where this seemed less likely. Researchers in these positions might be described as 'hanging on' or 'stuck' (Garforth and ?ervinková 2009). In terms of their job descriptions, they

were fulfilling their roles: conducting original research, writing up findings in publications (at varying rates), developing project and funding applications. In terms of the epistemic community of the laboratory, they were supporting colleagues, juniors in particular, enhancing skills and techniques, and developing the group's epistemic work. However, their continuing employment and scientific career prospects were highly uncertain.

3.6 We were particularly struck by the fact that most postdocs in these positions were female, with one notable exception. We observed the career trajectories of three experienced post-doctoral researchers in the embryology lab (one male and two female), and seven post-doctoral researchers in the plant lab (three male and four female).[9] During the study, all three men in the plant lab progressed along the career track into more permanent academic positions (one to a lectureship in a research-intensive UK university and two to independent research fellowship positions in Europe). The others – six women and one man - did not. One of the female postdocs in the plant lab was hoping, with the support of her lab leader, to move sideways into an academic lab manager role. One male postdoc in the embryology lab was in the course of negotiating his next position as he came towards the end of a second post-doctoral project. The other three female postdocs in the plant lab continued to work on precarious fixed-term research projects and expressed uncertainty about their futures. Of the two female postdocs in the embryology lab, one moved sideways to work on a research project at another university, and the other remained in the lab, working primarily as an editorial assistant on a journal edited by the lab's leader. Her position in the organisation of scientific work gives a particularly vivid example of the tensions between institutionalised career expectations and the epistemic life of the lab. During our study we observed an incident where this researcher ('T') was brought into the lab by a second year post-graduate student who was panicking because she could no longer see through the microscope some of the cell cultures she had been growing. 'T' expertly manipulated the microscope, examined the barely visible cell cultures, and diagnosed the problem, as well as reassuring the student. Seen as part of the practice and culture of the laboratory group, her skill and experience were invaluable; the postgraduate student called 'T' *'the goddess of the cells'* , and our fieldnotes observe that in the lab she was *'white-coated, expert, and reassuring'* . As a 'perennial postdoc', however, she was institutionally marginal.

3.7 'Hanging on' and 'getting stuck' (Garforth and ?ervinková 2009) in non-progressing academic roles is a structural tendency of academic career systems whose disadvantages are borne by individual researchers rather than by the organisation as a whole. At the heart of this clash between organisational imperatives and the day-to-day practices of epistemic communities is a contradiction between what we call the *visibly individual excellence* that must be demonstrated by researchers in order to gain organisational recognition and career progression, and the *everyday epistemic work* on which communities of practice depend. The idea of gaining a 'name' in a particular field is telling; individual reputation and personal visibility are crucial in conventional definitions of scientific success. But this name must be built in and out of particular communities of practice. In an important sense, then, demonstrating visibly individual excellence means dissociating oneself from the community that makes it possible. We discuss the some of the problematic dynamics produced by this situation next.

Lab housekeeping

3.8 Our study suggested that the consequences of this tension between individual excellence and everyday epistemic work were gendered, albeit in complex ways. We have argued elsewhere that the intense linear career based on building visibly individual excellence reproduces a masculine model of scientific success (Garforth and ?ervinková 2009). The admittedly small-scale findings reported here tend to suggest that it also empirically benefits men. In what follows, gender inequities in epistemic work are explored through the example of what we call laboratory housekeeping. Feminist studies of women in academia have argued that women are disproportionately 'responsibilised' (Morley 2003; 155-159) for communal caretaking, particularly in teaching and administrative roles, while men are positioned to take up competitive leadership and epistemic styles with the emphasis on producing research outputs (Bagilhole 2000; Acker and Feuerverger 1996). Here we show how these dynamics are reproduced within research practice itself. We found that lab housekeeping was mainly but not exclusively performed by women. Perhaps more importantly, however, the organisation of knowledge work was itself being gendered as feminised practices were devalued.

3.9 By housekeeping we refer to the range of tasks, activities and roles that are dedicated to the reproduction and maintenance of the laboratory. This includes taking care of workspaces, experimental materials, and technological equipment, similar to the activities of lab caretaking discussed in Knorr Cetina (1999). We extend this notion to refer also to the work of maintaining the epistemic community itself and its ongoing knowledge projects; Star and Strauss refer to similar sorts of activities as 'articulation work' (1999; see also Star 1995). For the most part, such work 'disappears into the doing' (Star 1995; Suchman 1995). Like domestic tasks of reproduction, it is repetitive, routinised and frequently undervalued. It constitutes the

material foundations on which more valuable activities – experiments and analysis – are built, and hence involves the labour required both to support measurable, visible outputs of knowledge practices (findings, claims, results, papers) and keep the lab's individual and collective work moving.

3.10 Technicians of course have dedicated roles in this respect, but housekeeping is undertaken by everyone as part of their laboratory life. Indeed, viewed from the angle of practice, few hard and fast distinctions can be drawn between 'real' epistemic work and 'merely' supporting activities. This has certainly been the argument from science studies, which insists that all knowledge is produced through practical activity, and explicitly rejects the idea that there is anything special about science's cognitive, theoretical or methodological processes (Latour and Woolgar 1986; Latour 1987). In rather different ways, this was also the case for bioscientists in our study. Few made hard and fast distinctions between the practical and analytical aspects of science when discussing their own work. Professors and laboratory leaders were more likely, in interview settings, to make claims to the specific value of *'intellectual'* or *'analytical'* vision in academic research (interview, female professor; focus group, biology professor), but even here they acknowledged that the bench was a space for analytic reflection and that analysing data to make findings could sometimes be seen in terms of a set of relatively prescribed operations. However, our data also suggests that this blurring of the distinction between routine practice and epistemic production does not translate easily into the structured ways that institutions value both specific researchers and the different kinds of work that they do.

3.11 We use the idea of housekeeping primarily as an analytical concept which emphasises gendered divisions of labour. However, it was suggested by the domestic metaphors that were present in the laboratories in the way that researchers and technicians described their work. During our initial tour of the plant lab one of the female researchers described one of the preparation rooms as the '*kitchen of the laboratory*'. A senior lab technician described her role as the '*mother of the lab' – supervising machines and experimental preparation and 'clearing up'* [observation fieldnote]. In the larger plant laboratory the senior technician coordinated these tasks, which were prominently displayed in the form of lists of roles such as 'filter hood monitor' or 'bin prefect' and so on. The jokey titles were perhaps designed to offset the worries that the senior technician expressed that allocating these jobs would be seen as fussy, bossy and infantilising [observation fieldnote]. Care-taking issues that concerned everyone were often raised in the weekly lab meeting. In the smaller lab, maintaining stocks and organizing the work appeared to happen in an *ad hoc* and more or less spontaneous fashion, managed through day-to-day interactions rather than explicitly raised in particular settings.

3.12 As we have indicated above, all members of lab groups were expected to take part in these activities to some extent. However, it was very noticeable in our study that male researchers exhibited a reluctance both to undertake and especially to be publicly associated with mundane housekeeping tasks. They rarely engaged with these discussions in lab meetings, and responded with indifference when they were raised in lab settings. We have a number of examples of this in our data. Some incidents were relatively trivial and private, as we observed when a very junior female PhD student half-jokingly told off an experienced male postdoc in the embryology lab for not tidying up after himself: '*haven't you ever heard of emptying the bin?'* [observation fieldnote]. It could also manifest in more serious tensions, such as when the embryology lab's incubating machines became infected, interfering with and slowing down the group's experimental work. Two of the lab's female researchers explained their growing frustrations with the lab's male postdoc, who was reluctant to break off from his experimental programme for the three or four days required to disinfect the machines [observation fieldnote]. In the plant lab, housekeeping issues arose from the group's increasing success in producing useful experimental material in the form of different lines of genetically modified seed stock. They found themselves with a haphazardly organised store of seeds which took up precious physical space in the laboratory. This became particularly pressing after the departure of a very successful male postdoctoral researcher, who in the previous year had made a significant finding and secured a lectureship at another university – leaving behind a good deal of unlabelled material and some rather frustrated colleagues.

3.13 Consequently the lab leader recognised a need to reinvent the group's archiving and storing systems. The task of conceptualising and communicating the new seed archive system was given to a male member of the group who had recently completed a PhD and who was working there on a very short-term contract while applying for research fellowships. The lab leader took great pains to present this task as a necessary and valuable one, and other group members volubly agreed, especially in the lab meeting at which the researcher gave his presentation on the seed archive. Our observation notes stress that the presentation was *very detailed, precise, systematic*, but that he referred *several times during the talk to how 'tedious' and boring this must be for everyone, or adopted an ironic tone to talk about how 'important and fascinating' the issue of the seed archive is.* After the meeting we asked if we could look at the slides from the presentation and he very reluctantly agreed, explaining that *he doesn't like the thought of 'being known for giving such a boring talk' or 'being the seed archive guy.'* Although far from conclusive, this male

researcher seemed to be experiencing, and perhaps more importantly publicly *performing*, some discomfort and embarrassment at being associated with this trivial housekeeping work [italicised extracts from observation fieldnotes].

3.14 This response contrasted strongly with the orientation of many (although by no means all) female researchers in the lab, including the two senior postdocs who carried out the physical reorganisation of the seed stock that the ex-PhD student had designed. These female researchers commented on the value of housekeeping to the epistemic life of the group and on their pleasure in this work, explicitly contrasting it with the instrumental modes of operating associated with the valued norms of academic career paths:

> *I've always kind of thrown myself a bit more into sorting things out. And I've always been the one that's managed the students [...] There's certain people you can see in the lab that you know are going to run their own labs. They're very, very focused on their research… they can't be bothered with the minutiae of what's going on in the lab. They've got a very strong mentality about their experiments and stuff. [...] the focus is on the next thing and getting it done…* [Interview, female postdoc].

3.15 Other female researchers, who unlike male colleagues moving through their laboratories, found themselves negotiating the problems of being a 'perennial postdoc', wondered whether they were '*too fulfilled by the bench stuff*' [interview, female postdoc]. They contrasted this to their male colleagues' tendency to take the *'strategic view*', always '*thinking about the possible outcome'* [interview, female postdoc]. Others felt that they had few choices other than to pursue supporting roles in large laboratories, as they had not been ambitious enough earlier in their career to aim at a later stage to establish their own lab [observation fieldnote, female postdoc].

3.16 These examples are suggestive rather than conclusive, but they do indicate some of the ways in which housekeeping was interpreted and performed in gendered ways by researchers in the laboratory. We do not want to suggest that only women undertook laboratory housekeeping. Indeed, we have been keen to assert that when knowledge production is viewed as a matter of practice rather than cognition, distinctions between reproductive/support roles and properly epistemic practice are hard to maintain and defend. We do suggest, however, that in the context of a career structure that recognises only findings and outputs, and of academic institutions which undervalue necessary epistemic and practical workers by allowing them to continue to be contractually insecure and non-progressing, housekeeping can be seen as a liability in relation to the production of visibly individual excellence. If such work is to be made into a successful career trajectory, its outcomes must be made visible, in the form of publications and individual reputation. This logic of academic life – emphasising product over process – has been reinforced and modified in recent years by audit and performance regimes, particularly in relation to quantifying research outputs (Strathern 2000; Shore and Wright 1999; Felt 2009). Research work that cannot be translated into publication capital, or remains invisible to audit and promotion mechanisms, might be valuable to oneself, one's peers and one's students, but it does not count in formal career terms. Active, goal-oriented, productive tasks are more highly valued than relational and reproductive ones. Taken together with the large numbers of women who have entered the biosciences, in particular as post-graduates, post-doctoral researchers and technicians (see footnotes 7 and 8), we believe we can point to gendered organisational cultures that feminise work that is characterised as collective, materially oriented, ongoing and supportive, in contrast to highly valued masculine work which is associated with outputs, reputation, publications, individual excellence, and linearity.

Conclusion

4.1 We have been concerned in this paper with gendered inequalities in academic research and the ways in which they are shaped both by epistemic practices and organisational structures. We have explored the kinds of work that are necessary to the production and reproduction of knowledge communities, which form the social and epistemic contexts of the production of facts, but which do not themselves become directly visible in terms of outputs and individual reputation. They include the relational work of supporting junior colleagues, the communal work of passing on skills and techniques, and the indispensable tasks of housekeeping and 'articulation work' that maintain and extend laboratory communities. As contemporary science studies has made clear, producing knowledge is not simply a matter of individual cognition or intellectual insight, but is rooted in collective action and is social through and through. Recognising the importance of this practical work by focusing on the epistemic community of the laboratory tends to produce an image of science work as cooperative and mutually supportive. However, feminist critiques of science have shown over and again that epistemic communities viewed at the institutional level are deeply marked by gender inequalities. In this paper we have tried to relate these institutional patterns of inequality to the ways in which everyday work in the laboratory is organised and performed by researchers. We have sought to open up the laboratory as both a community of practice *and* as a site where work is structured and valued in line with wider institutional priorities.

4.2 We do not endorse a monolithic, rigid or static conception of organisational structure that determines a gendered division of labour within epistemic communities. We recognise Law's (1994) account of the complexities of ordering in *Organizing Modernity*, which addresses the plural, dynamic and open-ended modes through which scientific work is arranged, and argues that 'organisation' is not a reified singular entity but rather a site of productive power. We recognise that organisations are concepts as much as entities, that their ontological status is not given, and that institutions can be seen as 'temporary patterning[s] of a mosaic of tactical interactions and alliances which form relatively unstable and shifting networks of power, always prone to internal decay and dissolution' (Reed 2006: 30). However, organisational processes and divisions – such as the two-tier fixed/permanent contract system in universities, the insecurity of contract research positions, and the differential distribution of reward for different kinds of work – shape the experiences of researchers and the unequal constitution of epistemic communities. Obdurate patterns of inequality, such as contractual status and gendered differentials in career success, cannot simply be dissolved into another type of practice. If ordering is a form of practice, it is one which can have unequal outcomes that need to be recognised. It is perhaps not surprising that formal organisations – universities, funding bodies – do not recognise the necessary and communal everyday work of housekeeping in epistemic communities. 'Deleting the work' (Law 1994: 132; see also Star 1995) is an unavoidable part of ordering – organisations need to ignore, simplify and reify complex processes. However, high profile initiatives to support women's progress and participation in science are unlikely to be successful unless we also ask basic political and feminist questions:

> *...cui bono*? Who is doing the dishes? Where is the garbage going? What is the material basis of practice? Who owns the means of knowledge production? (Star 1995: 3).

4.3 The idea of knowledge work as messy practice and of ordering as dynamic, contingent and prone to dissolution makes science studies resistant to the usefulness of the concept of 'community' – it is too rigid, too stable, too bounded. It assumes a social (and/or epistemic) cohesion that is seen as part of the problem. The preferred focus is on dynamic, shifting knowledge networks that come together around problems rather than in institutions. The idea of community seems too close to the Mertonian emphasis on the institutional nature of science, with its stable norms and structures (Merton 1973). But what is lost in this shift away from institutions is, perhaps ironically, a sense of individuals and their experiences. If the idea of epistemic community has any value, it is precisely its multivalence. It allows us to see shared practices and tacit knowledges, but it also functions as a lens to direct our attention to *who* is involved in epistemic production, and how, in the context of organisational structures of value. Seen from this perspective, epistemic communities allow us to bring to light both the work and the organising principles that reproduce gendered inequalities in science.

Notes

[1] It is emphatically not the case that feminist science studies are reducible to these kinds of policy and liberal equity concerns, as our brief outline of debates in feminist epistemology begins to indicate. Wylie et al. (2009) offer a useful contemporary overview of the range of strands of analysis at work in feminist science studies.

[2] KNOWING (Knowledge, Institutions and Gender: An East-West Comparative Study) was funded by the European Community's Sixth Framework Programme for Research and Technological Development; see acknolwedgements, above. The final international comparative project report, (ed.) Felt, Ulrike, *Knowing and Living in Academic Research* (Prague: Institute of Sociology AS CR) can be found online at <http://www.knowing.soc.cas.cz/?page=materials>.

[3] A number of semi-structured individual interviews and focus groups were conducted as part of the KNOWING project. Here we refer specifically to four interviews with bioscience researchers who worked in the laboratories where we undertook our observation studies (two female post-doctoral researchers; one male post-doctoral researcher; one female professor), and to a focus group conducted with academic staff working in the wider biology department (two female lecturers and two male professors).

[4] The identities of individual participants and institutions have been concealed. Some details of the work of the two lab groups have been changed in order to preserve the anonymity of participants.

[5] In a focus group with different lab leaders within the same biology department, however, we found that earlier career staff (in this case two female lecturers) did still work at the bench, and gave accounts in which they emphasised their reluctance to give up experimental work and with it a sense of ownership and control over the whole research process.

[6] The proportion of female academics in the biosciences in the UK was around 40% at the time of our study, notably higher than the proportion for the natural sciences as a whole which is around 26% (AUT 2004: 12-13). According to HESA statistics for biosciences from the academic year 2003-04, women comprised 11.5% of professors, 19.5% of senior lecturers and senior research fellows, 37.3% of lecturers and 45.2% of researchers.

[7] In 2005 short-term project and programme funding accounted for 68% of the total research income of UK Higher Education Institutions (Universities UK 2007). In the academic year 2005-06 just under 41% of the UK's 164,875 academic staff were on a fixed-term contract (HESA n.d staff data tables 2007). Most of them are research-only staff, who are particularly numerous in the biological sciences (AUT 2004; UCU 2007). Women are over-represented generally in contract research-only roles in UK higher education institutions (AUT 2004; 2002).

[8] For the remainder of this paper we adopt the conventions of the participants in our study by using the term 'postdoc' to refer to post-doctoral researchers working on short-term externally funded research contracts in the biosciences.

[9] In fact there were 5 female post-doctoral researchers in the plant lab during the study, but one had only recently begun her first post-doc project having completed her PhD some months before, so we do not include her case here. There was also an unpaid post-doctoral researcher loosely affiliated with the embryology lab. She had also completed her PhD very recently, and during the course of the observation fell out of contact with the lab, so we do not include her case here.

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