Are Algae and Insect Producers Forming an Innovative Niche for the Contemporary Agri-Food Industry? The Case of Germany and the Netherlands

Arne Bünger, M.A.

University of Greifswald, E-Mail: arne.buenger@uni-greifswald.de, Ph.: +49 3834 420-4493

Executive Summary[B1]

Many issues and problems in the contemporary world might hardly be solved by single technical innovations but rather by the combination of technological and socio-economical developments. The concept of socio-technical transformation can be seen as a common method to investigate multidimensional change processes and their pre-conditions (i.a. (Geels 2002; Geels 2005; Geels und Kemp 2007; Geels und Schot 2007) . A commonly applied tool for analyzing socio-technical transformations is the multi-level-perspective. The three levels of landscape, regime and niche have a nested character, with regimes and niches embedded within landscapes (Geels 2002).

This paper will focus on the "niche" level, which is a protective space inside the regime or in varying degrees more or less close to the regime. Its main function is to provide a protective space as a shield against pressures from landscape and regime. Actors have more agency and freedom to develop new routines and alternative structures than within the regime, but their power is still limited (Raven et al. 2012). Social learning, experimentation and knowledge-co-creation function as a tool to test visions and to make experiences with new technologies (Hermans et al. 2013).

One main criticism of the multi-level-perspective is its functionalist nature and the negligence of agency (Smith et al. 2005). I agree with that. A deeper understanding of actors within regimes and niches might help to get a more holistic understanding about socio-technical transformations; in particular to assess whether pre-conditions for socio-technical transformations are already in place and to get an idea which transformation paths are conceivable. I like to address this by investigating algae and insect production as an example for a niche in food and feed production.

An expected 76% increase of meat products by 2050, a high dependence of soy bean imports, and its high environmental footprint vote for an urgent search for alternative protein sources as substitutes for soy beans (van Huis 2013; Henry et al. 2015). Algae and insects are seen as promising alternative protein sources, because of its rich protein content and no requirement for arable land to produce them (e.g. van Huis 2013).

Against this background, it is the aim of the proposed paper to clarify the potential of the algae and insect producer industry in Germany and the Netherlands as innovative niches within the agri-food industry.

The emergence of new industries is often path-dependent but proactive strategies of actors to generate momentum (e.g. bricolage) and to shape transition paths are essential as well ((Garud und Karnøe 2003). Therefore I will focus on (legitimation-)strategies of producers aiming to generate momentum for the adolescence of the industry and their own firm.

Against the background of constitutive characteristics of niche actors and pioneering firms in emerging industries, we will mainly focus on learning and innovation processes, co-operation and self-perceived roles. This will draw a picture with strengths and bottlenecks, which might give a hint of the degree of seriousness of these emerging industries.

Within the framework of the research project „Sustainability Transitions in food production: Alternative protein sources from a socio-technological perspective" funded by the Lower Saxony Ministry of Science and Culture and the Volkswagen Foundation, semi-structured expert interviews were conducted with algae and insect producers in Germany and the Netherlands.

Insights derived from the expert interviews show that research about algae and insects and knowledge for production are already in place. A rather critical issue might be the non-existence of a pronounced (European) market, which poses several bottlenecks like the difficulty to find production partners, suppliers and customers. In addition, the unheard voice for several required legislation procedures on EU-level, the struggle with "liability of newness" and a low intra-industry cohesion are also barriers. The characteristics of both industries give evidence for niches in its early infancy. Different legitimation strategies are evident in both industries, e.g. the „Conformance" strategy. Most of them are rather enforced by individual actors than the result of collective intra-industry activities. Therefore the collective action of industry members to attain legitimation, which is especially of high importance in emerging industries and niches, is almost absent. Efforts to align both niches with regime structures of the agri-food industry, thus „Empowering to fit and conform" activities are significant. All in all, the results highly question whether these industries are yet innovative niches which are able to attack the regime seriously.

1 Introduction

The interest in micro-algae and insects for human and animal nutrition has increased significantly in the recent past. This can be proven by scientific publications dealing with this topic: For the search string “edible insects” van Huis (2015) found 10 results for 2000-2004, 18 results for 2005-2009 and 65 results for 2010-2014 in the Web of Science (August 2015). An own search in the Web of Science (November 2017) with the search string “micro-algae OR microalgae and food OR feed” shows a similar increase in publications for micro-algae: 21 results for 2000-2004, 64 results for 2005- 2009, 103 results for 2010-2014, 109 results for 2015-2017.

Legitimacy is a key success factor both for emerging industries as well as for niches. In addition, it is important to understand how niche strategies protect niche activities from selection pressures, foster innovation, and thus provide momentum for the niche. Especially in still emerging industries and niches, such as the algae and insect producer industry, companies have to convince stakeholders or regime actors of their own right to exist and those of the industry. Therefore, this can be seen as a prerequisite for strengthening the niche through niche strategies and to generate momentum.

The aim of the paper is to clarify the potential of the algae and insect producer industry in Germany and the Netherlands as innovative niches within the agri-food industry. Two research questions are central: Which barriers and potentials for a successful further development of both industries are evident and which strategic implications result from this? Which legitimation and niche strategies are enforced by algae and insect producers and are these suitable to the contextual conditions of the two industries?

This paper is further structured as follows: First of all, obstacles and barriers as well as legitimacy are described as important factors in the formation of new industries or niches (Section 2). This is followed by a discussion about the role of legitimation and niche strategies for the emergence of new industries (Section 3). Afterwards, the methodical procedure of the expert interviews will be presented (Section 4). After presenting the empirical results (Section 5), the paper will be finalized by a conclusion (Section 6).

2 Emerging industries as niches

Within the concept of socio-technical transformations, the niche is understood as one of three levels, providing a protected space for the development of non-mainstream compliant ideas and radical innovations. The basis for fundamental socio-technical transformations is often created by niche activities (i.a Geels 2002; Geels 2005; Geels und Kemp 2007). Therefore, it will be investigated to what extent the algae and insect producer industry have the typical constitutive characteristics of niches and which implications result out of its existence or non-existence. In addition, algae and insect production can be seen as emerging industries. In this case, niche activities are therefore not dominated by established players in an already existing industry but determined by rather less well established, relatively young companies in an emerging industry. Therefore, the importance of legitimacy for young companies, emerging industries and niche activities will be highlighted.

New industries are often created by the pioneering activities of a few companies. These companies face increased uncertainty and risks, but often benefit from early-mover advantages (Agarwal und Bayus 2004). Emerging industries are often characterized by "unstructured settings with extreme ambiguity" (Santos und Eisenhardt 2009). There is often uncertainty as to whether sufficient demand already exists and technological uncertainty; which question firm survival in the forming industry (Agarwal und Bayus 2004). Often the activities of new industries are subject to technical problems or are little institutionalized. Pioneering companies must therefore engage in "sector building" to show that they define a new industry independently of the existence of already established companies.

Aldrich und Fiol (1994) point to lower start-up rates and the greater likelihood that new companies will give up when the industry is small. This is in particular induced due to a lack of external legitimacy as a consequence of a small number of market participants. Access to capital, markets or regulatory protection also depends on the legitimacy of the emerging industry (Aldrich und Fiol 1994). New companies often face the lack of role models and the difficulty of engaging with stakeholders who have not realized or understood the existence of new companies (Aldrich und Fiol 1994). For stakeholders it is also a difficulty to assess the opportunity/risk ratio of new companies, because there are still no guidelines on how to adequately assess the performance of companies in an ermeging industry. This makes a lack of cognitive legitimacy apparent (Aldrich und Fiol 1994).

Established industries have a great advantage over new industries through the already institutionalized diffusion of knowledge about their activities (Aldrich und Fiol 1994). For the manner of ensuring cognitive legitimacy, an emerging industry initially also lacks the critical mass of organizations. In addition, the media are unfamiliar with the activities and terminology, and thus inadequate media coverage often occurs (Aldrich und Fiol 1994).

Legitimacy

A company is considered legitimate by third parties if its activities are "desirable, proper, or appropriate within a socially constructed system of norms, values, beliefs, and definitions" (Suchman 1995). Zimmerman und Zeitz (2002) emphasize the importance of legitimacy to acquire other corporate resources and rate legitimacy as at least as important to new companies as other resources (such as capital, technology, human resources, etc.).

Aldrich und Fiol (1994) distinguish two categories of legitimacy - sociopolitical and cognitive. Cognitive legitimacy refers to the knowledge and understanding of a society about an organizational form. Cognitive legitimacy may obtained e.g. through the connection to other already legitimated actors (Suchman 1995, cited in: Marberg et al. 2017). Aldrich und Fiol (1994) define socio-political legitimacy as "the extent to which a new form conforms to recognized principles or accepted rules and standards".

Legitimacy is important for both new and established firms. However, access to resources is often much easier for established firms: Companies often assess the legitimacy of companies based on their performance in the past. However, in contrast to established companies, new companies still do not have a "track record" and therefore need legitimacy to gain access to resources (Zimmerman und Zeitz 2002). Especially young companies are therefore dependent on the perception of stakeholders due to its often high dependence on external resources (Choi und Shepherd 2005). It is an advantage for new companies to associate with accepted members (individuals or organizations) of a community or industry (Fisher et al. 2017).

From a population-ecological perspective, the legitimacy of companies is influenced by the market-specific context and by the population density. It is argued that a "scheme" or "category" can be developed for an existing industry or for a market context. The widespread acceptance of this self-evident scheme or category legitimizes new companies entering this

context. This shows that it is hard to survive for companies when they enter an emerging industry that does not have a contextual scheme yet (Überbacher 2014; Kuratko et al. 2017).

3 Strategies in emerging industries and niches

As explained before, niches, which are in this specific case not well established industries but rather emerging industries, are characterized by multiscale development processes and diverse barriers in general as well as a lack of legitimacy in particular. At the same time, niches are often a seedbed for more controversial ideas and radical innovations. To ensure successful development and growth of emerging industries, targeted, proactive niche strategies are often required. It therefore needs legitimation strategies (Section 3.1) to ensure the right to exist, trust and reputation for the emerging industries, as well as niche strategies (Section 3.2) to protect radical innovations against selection forces, to foster development processes and generate momentum for the niche.

3.1 Legitimation Strategies

In order to generate legitimacy for a new technology, strategies should be implemented that embed the technology in society's belief systems and moral standards (Scott 2014, cited in: Marberg et al. 2017).

Especially in new industries, it is difficult for new companies to gain legitimacy, because the industry itself can not give the company legitimacy. The lack of history, unestablished standards, unaccepted rules and new practices, few market participants and uncertainty about the viability of the industry mean that new companies in such an environment need to work even harder to gain legitimacy (Zimmerman und Zeitz 2002). The creation of legitimacy by "early actors" within a new technological field represents a research gap (Binz et al. 2016).

Increased "organizational density" in an industry can help companies to overcome the "liability of newness" and gain more legitimacy. However, Binz et al. (2016) emphasize that organizational density is a necessary but not sufficient condition for the legitimation of a new technology. Furthermore, stakeholders need information about the companies and the knowledge to categorize them (Marberg et al. 2017).

In order to gain visibility and gain social acceptance for their own business and industry, various strategies might be pursued, such as disseminating knowledge about the company or industry and activities to build trust, reliability and good reputation (Marberg et al. 2017).

Suchman (1995) proposes three strategies for gaining legitimacy. ”Conformance“ refers to a strategy in which the company tries to embed itself in an already established “institutional regime”. “Selection” goes beyond “conformance”, it allows the selection of the environment in which the company operates. Thus, a company can place itself in an environment in which it receives legitimacy as it is (Suchman 1995). “Manipulation” refers to the purposeful change in the environment in order to establish consistency between companies and the environment, i.e. “to develop bases of support specifically tailored to the distinctive needs of the organization” (Suchman 1995).

However, in particular the “creation” strategy proposed by Zimmerman und Zeitz (2002) is essential for the initial phase of new industries. Entrepreneurs who introduce a new technology into a new market category first have to build the social context for the company through the “creation legitimation strategy” (Kuratko et al. 2017). In the same direction goes the “Collective Action Perspective”, which emphasizes collective measures to generate legitimacy, e.g. through groups of entrepreneurs or “extra-industy activists”. Such collective legitimacy-generating activities are particularly relevant in a context in which third parties do not have a precise idea of goals and offers of the new companies. This is often valid in emerging industries. Representatives of the new companies must act collectively and in a coordinated way in order to create understanding for the new companies and to gain new resources (Überbacher 2014). The awareness of a rising group of actors in a new industry that there are certain similarities, e.g. in terms of practices, forms the basis for such collective legitimation processes. However, there is a risk that emerging companies may develop in “relative isolation” or that different, individual narratives are used (Wry et al. 2011).

Intra-industry strategies are often reflected in collective activities of entrepreneurs in an industry in order to define its standards and parameters. If the competitive environment in an industry is so pronounced that competitors do not work together, the legitimacy of the entire industry might be questioned (Marberg et al. 2017).

Shared, positive expectations about the future of a new technology or industry are an important resource for its legitimacy (van Lente und Bakker 2010). Shared expectations also

play a central role in the generation of momentum for innovation processes and the coordination of heterogeneous actors. Collective expectations often become normative assumptions that are taken for granted and need no further review (Konrad 2006).

Similarly, inter-industrial cooperation with already legitimated industries can strengthen the credibility and reputation of a new industry (Marberg et al. 2017; Rao et al. 2008).

3.2 Niche Strategies

„The niches act as incubation rooms that provide the infant technology with attention, legitimacy and funding“ (Bakker et al. 2012). Bakker et al. (2012) emphasize that protection against selection environments and legitimacy are the core functions of the niche concept.

Smith und Raven (2012) present three different functions of protected space. The function of „shielding“ subsumes activities that keep the niche away from multi-dimensional selection environments (e.g. technology and infrastructure, markets and dominant user practices). The function of “nurturing” refers to processes such as the development of shared, positive expectations, social learning and the formation of networks, with the aim of supporting path-breaking innovations.

The niche as a “protected space” should also fulfill the function of “empowering” niche innovations. Through “empowering to stretch and transform” the regime is infiltrated and “restructured” by niche institutions. This change in the selection environment creates the basis for the establishment of niche innovations. For example environmental regulations, fiscal measures, or quotas are encouraging factors for regime actors to invest in niche innovations and solutions. In other words, the society must be convinced that “the rules of the game” must be changed (Smith und Raven 2012).

In contrast to this, “empowering to fit and conform” is an effort to make niche innovations competitive with the regime without changing the selection environment. The goal is to make niche innovations profitable and competitive in existing markets, which does not require radical change in institutions, infrastructure, skills and knowledge bases (Smith und Raven 2012).

In order to gain legitimacy, niche actors might in particular refer to the “manipulation” strategy proposed by Suchman (1995) or the “creation” strategy proposed by Zimmerman und Zeitz (2002). The (further) development of niche activities also requires a suitable environ-

ment, which is conducive to niche innovations. In addition, it is necessary to create the social context around a niche that is emerging. The approach to embed the company in an already established “institutional regime” through the “conformance” strategy is unlikely to succeed, since institutions in the niche are usually still in their formation phase and therefore unstable in its nature (Markard und Truffer 2008). Therefore, this might rather be a suitable legitimation strategy for regime actors.

4 Method

As part of the investigations, expert interviews were conducted. The expert interview was selected as a method of investigation, because on one hand information about the behaviour of actors and the two industries should be obtained and on the other hand only very few potential “insiders” exist (very small industries).

Embedded within the larger research project “Sustainability Transitions in food production: Alternative protein sources from a socio-technological perspective”, Germany and the Netherlands are regions of interest and it is one aim to evaluate the potential of these countries for a sustainability transition in the agri-food industry.

Therefore, based on an internet research, a total of 38 companies in Germany and the Netherlands could be identified, which are part of the algae or insect production value chain. Those companies were sorted out that are obviously subsidiaries of one of the selected companies or those in which only a very small proportion of the operational acitivities are related to algae or insects. After this selection, 26 companies got a request for an expert interview. Of these, 11 companies agreed to participate in an expert interview. These 11 companies may well be seen as a very good cross section of the algae and insect producer industry, as they represent very small companies, larger companies as well as different value chain positions (primary producers, plant manufacturers and refiners).

The content of the interviews was based on the following fields: “Value Chain, Cooperations /Networks”, “Knowledge”, “Innovations”, “Motives/Sustainability” and “Actors”. The interviews were fully recorded using a voice recorder and covered a timeframe between 30 and 156 minutes.

The analysis is essentially based on the five-level evaluation concept of Gläser and Laudel (closely following Mayring 2000) (Bogner et al. 2014). Qualitative content analysis was

carried out at the level of paragraphs, which should contain complete statements from experts (Bogner et al. 2014; Kaiser 2014).

Respondents (anonymised)

A-1 (NL)	A-2 (GER)	A-3 (NL)	A-4 (GER)	A-5 (GER)	A-6 (GER)	A-7 (GER)	A-8 (NL)	I-1 (GER)	I-2 (GER)	I-3 (NL)
Algae Producer								**Insects Producer**		

5 Empirical results

5.1 Barriers and potentials of the insect and algae producer industry

Operational and market limitations

Two respondents identify their own small size as a reason for the lack of operational resources and thus address the problems of the "liability of smallness" (I-1, A-1). Many barriers are linked to the hitherto insufficient market development. One algae producer criticizes the strong focus on technological development and the negligence of (time-consuming) market development:

> *"(...) the sale - what I've seen - lasts, so I think two to three times as long as the technology to develop (...) How do I sell this? And in which market do I sell it? And what can the algae do? I can only say 'Okay, the algae have a lot of protein (...)' But there has to be a specific market first.*" (A-3)

As a result, many value chain-related interactions are difficult. So, it is for example difficult to find suppliers and especially (large) customers:

> *"There was the facility, then at some point there was the product, but there was no one who bought it."* (A-7)

Thus, in addition to "liability of smallness" also "liability of newness" on firm and industry level is evident, because limitations due to a still underdeveloped market and associated problems are quite evident.

Innovativeness

A special relevance of scientific knowledge is also reflected in the dominance of technical

innovations in the algae and insect producer industry. Innovations that enable large-scale production on an industrial scale were most frequently mentioned as important own innovations in the past (A-7, A-1, I-3):

> *"I'm not talking about the many thousands of [plants] that stand somewhere as a pilot (...), but I'm really talking about production and sales. Well, that's really economically relevant. That was, let's say, the first big innovation and that took a (...) relatively long time."* (A-7)

A high frequency of innovations, which should enable production on a large industrial scale, show that there is often the will to significantly increase production volumes. However, this also implies that obviously technical development was more enforced than market development in the past.

Actors as push factors

Different actors, like Politics (A-3), Science (A-3) and the Media (I-2), were identified as push factors. This shows that there is no common actor that represents a push for the majority of actors.

Assessment of the potential of algae or insects for the food industry

Increased (contextual) attention is currently being shared by the algae and insect producer industry (A-7, I-2, I-3, A-1, A-8, A-4, A-2, A-3). It is evident that all Dutch experts respond to this, but only about half of the German experts indicated this (4 out of 7 respondents).

> *"So you notice that in the market is very much going on. Many (...) are in the press and so on. Also press inquiries, Deutschlandfunk, Südwestrundfunk, Arte wrote this week (...)"* (I-2)

All in all, one can state that for both human and animal nutrition potential for own products is identified. However, there is only further potential for micro-algae if they discard the niche status, make the products capitalizable, and reduce their production costs in line with market-conforming prices (A-1, A-3, A-5, A-6) :

Replacing soy by algae is therefore still rated as a distant future scenario:

> *"Then the whole cost price is too high to use that instead of soybeans. (...) [I think that's possible] if you sell enough algae and the technological development can do enough. (...) But we are still very, very far away."* (A-3)

Also experts of Marberg et al. (2017) identified most frequently a competitive price and the upscaling of production as factors, which are critical for the success of the Dutch insect producer industry.

One respondent (A-4) pointed out that even larger food companies are already showing interest in his products:

> *"And Oetker is very interested, Nestlé is very interested in this field."* (A-4)

Also according to Marberg et al. (2017), multi-national companies are already observing the market, but are (not yet) actively participating. Basically, there are mostly shared, positive expectations regarding the success prospects of the algae and insect producer industry. Thus, at least one important precondition for its legitimacy and a promoting factor for generating momentum for innovation processes can be considered as given (van Lente und Bakker 2010; Konrad 2006).

Competition

The respondents often do not really deal with their own competition situation, since competitors are not seen as a threat. On the contrary, many respondents see in competitors important (co-)market designer. One reason for the view that competitors do not pose a threat to their own business might be seen in the many years of experience of some companies and the associated advances in knowledge. However, some statements also make some kind of self-importance obvious.

> *"[The competition] does not interest us. (...) We are the only company that is certified organic (...). Who should be able to deliver bioalgae in the near future? (...) So there we have a few years, ten years ahead."* (A-4)

Interestingly, despite competitors are not perceived as a threat, there is no close cooperation with them. However, many respondents are in direct competition and intense competition with actors producing similar products for the same needs, particularly e.g. feed producers (8 out of 11 respondents). This means having to compete with often much larger companies, with quiet different resources:

> *"And most of our competition is from substitutes. But those are non algae products, which have the same functionality, which we have to compete with. And we have to compete in the human nutrition market with small to big companies. If you look in the aquaculture market, we are competing with multinational companies, so that's very difficult for us."* (A-1)

The experts of Marberg et al. (2017) see cooperation between the insect producers as the most important success factor for the Dutch insect producer industry (13 out of 19 interviewed experts). In the own survey, however, representatives from both industries unanimously stated that there is no good basis of trust for competitors. This is not a good prerequisite for intra-industrial cooperation and counter-check the opportunity to exchange knowledge and ideas and to jointly promote market development:

> *"So when we talk to our market entrants, there is a lot of secrets and everybody thinks he's the only one with the right technology, relatively aggravated in the algae industry."* (A-6)

Thus, many of the identified barriers in the algae and insect producer industry are typical of an emerging Technological Innovation System (TIS): markets are underdeveloped, there is little articulation of demand, the value for money of the new technology is poor, and there are many multi-dimensional uncertainties.

The niche markets focused by the algae and insect producer industry can be seen as "nursing markets". Although the size of the market is clearly limited, it opens up to further develop in the "learning space".

In terms of strategic direction, this implies that producers should continue to push the optimization of production technology so as to be able to scale up their production volumes and thus enter into bridging markets. However, perhaps even more significantly, there is a need to enforce collective legitimation strategies within the two industries, as many of the barriers identified, such as insufficient market development, can be implicitly seen as the result of a lack of legitimacy.

However, low intra-industrial cohesion, due to the lack of trust between producers, is not an adequate basis for collective legitimation strategies. Therefore, establishing a basis of trust seems necessary at first. Greater reflection on similarities and shared, positive expectations of industry development might be first suitable steps.

5.2 Constituent features of a niche

The "niche" in the multi-level perspective is a protected space within the regime or to a varying degree more or less close to the regime (Geels und Schot 2007).
In the following, it will be clarified to what extent the described characteristics of the two industries coincide with the typical characteristics that constitute a niche.

Isolation can result from cognitive, social and spatial distance (Geels und Schot 2007). In the case of algae and insect producer industry, there might be the question from whom actors should be isolated. As regime actors, those actors are understood who shape the mainstream within the conventional agri-food industry. Of particular interest in this case are the regime actors in the value chains of meat production (especially feed and primary producers) and feed and food producers in general. Therefore, it is of interest to know whether algae and insect producers are isolated from these regime actors and if so, which are the factors inducing that distance.

The question to what extent the algae and insect producers are isolated from regime actors is not easy to answer. Spatial distance does not matter, as three of eleven experts (I-1, A-4, A-5) are located in a region of intensive agriculture and a strategic spatial selection was not obvious in any of the interviews. Two of these respondents (I-1, A-4) consider proximity to companies of the food industry to be an advantage. Social distance is also not apparent, because all algae and insect producers work together with regime actors. However, for most of algae and insect producers, there is a certain cognitive distance to regime actors. This is reflected in the emphasis on sustainability aspects of their own production and the sketching of sustainability deficits in production processes in the agri-food industry. Furthermore, own solutions to address these sustainability deficiencies were mentioned. However, sustainability aspects play only a subordinate role as business guidelines. Only two actors in particular (I-1 and A-8) clearly distance themselves cognitively from the regime of the agri-food industry.

The protected space provides a shield against pressures from the regime or landscape level (Raven et al. 2012), so that "niche actors can nurture the path-breaking innovation" (Smith und Raven 2012).

So far, the product portfolio of algae and insect producers has hardly any products that can compete with conventional (mass) products of the agri-food industry. The majority are niche products, which as such are not at all comparable to the conventional agri-food industry (e.g. additives to dietary supplements) or are (still) niche products (e.g. insect meal in dog food) due to low production volumes.

Therefore, these products, in this form, still do not seem to pose a real threat to the regime. A proper (intended) protection mechanism does not exist. Regulations are regarded by the

algae and insect producers as main barriers (I-1, I-2, A-7, A-1). However, the Novel Food Regulation, which e.g. prohibits insects for human and animal nutrition might also be positive for the industry. As a result of the fact that the adjustment of the Novel Food Regulation and thus legalization is still pending, the products of algae and insect producers have not (yet) made their way into the mass market of the conventional agri-food industry. Thus, these products do not necessarily have to compete with mass market products. So this could be a protection mechanism for the still young industry and give the industry time and scope to develop it further.

One of the experts interviewed by Marberg et al. (2017) cited the high importance of the niche protection mechanism: forcing a push strategy and overheating the market could be an impediment to the success of insect farming in the Netherlands. First of all, the professionalization within the niche should be promoted better, and only when the production costs are competitive and testing and risk assessments completed larger markets should be addressed.

Actors have more freedom to develop new routines and alternative structures than in the regime (Raven et al. 2012).

This can only be partially confirmed. Actors may have more freedom because very few actors are part of their peer group or community of practice. However, the agri-food industry has very strict rules and regulations, especially for novel food products.

For instance, Insects in Europe count as "Novel Food" (Regulation 2015/2283), which means "food that did not contribute significantly to human nutrition in Europe before 1997". According to this only live insects or oils derived from insects, fats and proteins may be fed to livestock and insects for human nutrition are prohibited in most european countries (Lang et al. 2017; Laaninen 2016). In this respect, regulations limit the scope for action of the actors very much.

The assertiveness of actors is limited (Raven et al. 2012).

A low assertiveness is observed for insect producers and especially for algae producers. In the algae producer industry in particular, the producers either do not even try to adequately articulate their interests or do so alone. Due to the lack of trust among each other, hardly any collective activities are carried out (i.a. A-2, A-4, A-6) and in the insect producer industry a branch association is lacking (A-4). However, the strength of the assertiveness in the insect

sector should also be questioned. It is questionable how strong the lobby of the branch associations IPIFF and Venik in Brussels is at all and how effective these institutions are (Marberg et al., 2017).

Social learning, experimentation and the co-production of knowledge serves as a tool to test visions and to gain experience with new technologies (Hermans et al. 2013). In the algae and insect producer industry, experimentation is part of the development of (alternative) products and the further optimization of production processes. Social learning and the co-production of knowledge is applied by the majority of actors (8 out of 11 respondents), nevertheless not with competitors, i.e. not with actors of the same niche.

The niche is seen as a source of "path-breaking innovation" (Smith und Raven 2012). Radical innovation therefore plays an important role (Bergman et al. 2008).

This can only be partially confirmed for the algae and insect producer industry. Although innovations play an important role, these are rather incremental innovations for the optimization of production processes. However, legalization might open a window for radical innovations, especially insects for human nutrition, e.g. in the form of burger patties from insects are promising.

What role does the presence or absence of niche features play in the algae and insect producer industry? In the following, I will discuss what possible implications result out of the outlined features for the formation of the algae and insect producer industry as serious, innovative niches.

A certain isolation from the regime, at least through social and cognitive distance is to be considered positive. This promotes the initiation of own solutions e.g. to address sustainability issues as well as the ability to create an identity that exists independently of the conventional agri-food industry. At the same time, however, there are some links to the agri-food industry. These regime-niche interactions show that regime and niche can communicate in principle and that the mutual exchange of ideas and concepts is in principle possible. This is essential for regime transformations. However, no proper protection mechanism for the two niches could be identified.

Although strict EU regulations might be understood as a passive "shielding" of the niche against selection pressures, they can also be eliminated by amending the laws in the near future. This raises the question of whether the two niches in such a scenario are already

competitive enough to compete in markets dominated by the agri-food industry. Linked to this is the observation that innovations in the algae and insect producer industry often have an incremental rather than a radical character. Therefore, the question arises how much protection these innovations require at all.

A significant weakness for the two niches is the strong restriction of freedom of action, especially due to the strict regulations. The lack of legalization prevents the products from entering the conventional (mass) markets of the agri-food industry. Thus, the possibility to supply the products to a quantitatively larger market is denied. This means that there are only a few possibilities to test the sales of the products and to get feedback. Another typical feature of niches – the actors' limited assertiveness – is also evident. Although some collective lobbying activities are being pursued, it is questionable to what extent branch associations such as VENIK and IPIFF have power to assert the industries´ interests adaquately. The individual activities, which are uncoordinated between the actors, are less likely to strengthen the collective power of assertiveness. Social learning and the co-production of knowledge does not take place together with actors of their own niche. This can be seen as a weakness, because no exchange can take place about divergent niche developments. Consequently, the accumulation of niche innovations as well as the common understanding of following a particular technological path is hardly possible. The attibut “dynamic frontrunner” might be valid in general to the algae and insect producers. In principle, the basis for technological development, agility of the industry and the accumulation of innovations seems to be well pronounced.

5.3 Strategies

The overarching questions are, which legitimation and niche strategies are enforced in detail by the algae and insect producers and whether these fit with the specific conditions of the two industries.

5.3.1 Legitimation Strategies

Generating attention

As a consequence of the pioneering status of the actors and the activities within the industry, there is also the need to generate attention to the industry. As already mentioned, an

increase in organizational density of an industry can often help to create legitimacy at the industry and business level. This is also conducive to counter the barriers raised by the "liability of newness". So the majority of respondents (6 out of 11) rate new competitors or initiatives as positive to generate awareness and legitimacy for the industry.

> *"(...) with the generally rising attention, also with the (...) alleged competition or with new products, so also the general interest rises. So that's important, too, so that the overall market is growing."* (A-7)

Often, however, an increased organizational density alone is not enough to generate legitimacy for the industry. There are a number of collective as well as individual activities to be observed by actors with the aim of providing information about the companies and attracting attention to the industry.

For this purpose, three respondents would also support joint activities with competitors (A-6, A-7, I-1):

> *"(...) I still believe in it; if we all work together to develop this subject together, we will achieve our goal faster than if everyone tries to tell his own story, which is basically the same."* (A-6)

Such collective activities to create legitimacy are particularly relevant in emerging industries, because third parties often have no precise idea of the new companies, their goals and offers. It is also obvious that some actors are very concerned about a positive media response. As already described, positive media resonance is an important organizational attribute to create legitimacy, credibility and trust in new companies (Überbacher 2014).

Cooperation with research, actors of the value chains and the agri-food industry

New knowledge is generated in both industries especially by research. The most common sources of new knowledge are universities (6 out of 11), own research (5 out of 11) and joint research with third parties (3 out of 11). Scientific institutions (all respondents except A-5 and A-4), suppliers/upstream value-added positions (A-2, A-8, I-3, A-6, I-1) and customers (A-7, I -3, A-3, A-8) were most frequently as cooperation partners.

Inter-industrial co-operation mainly takes place with food and feed industry actors (9 out of 11 respondents, only A-5 and A-1 did not specifically state this). These connections to an

already legitimated industry can be conducive to the credibility and reputation of each company and the industry.

Collective legitimation processes

One algae producer reported about the plan to set up the innovation network "Algae Food", primarily to connect different players who deal with micro-algae:

> *"It's about creating a network that only deals with algae as food, as a big topic (...) And to really connect plant engineers, producers, research people, development people, marketers, so that all actors get together, that really have to do with the issue of algae as food and have to struggle with same challenges." (A-7)*

This can be seen as an attempt, collectively with market participants, to create legitimacy for the industry. So far, algae producers can not properly articulate their interests and problems, as there is no industry association yet. This may also be due to the fact that intra-industrial cohesion and trust are still lacking.

Thus, it can be stated that, especially in the insect producer industry, collective lobbying activities are enforced to gain socio-political regulatory legitimacy for the industry. However, it has remained unclear in the interviews to what extent the activities in the industry associations or the lobbying activities are an expression of collective activities or whether these activities are primarily driven by only few actors. Only one actor has specifically addressed the need for a representation of interests among the algae producers. Collective measures of lobbying and marketing can be seen as very important in providing information and influencing legislators (Marberg et al. 2017). Venik is working to establish industry standards. This often helps to ensure cognitive legitimacy. However, the effectiveness of this industry association is questionable (Marberg et al. 2017).

The mistrust between competitors and the low intra-industrial cohesion in the algae and insect producer industry, as mentioned earlier, results in few collective and coordinated intra-industry activities. As a result, creating legitimacy for the two industries is likely to be a major challenge.

Necessity of socio-political regulatory legitimacy

Regulations in the EU represent a major barrier (van Huis 2015). This is also confirmed by own expert interviews (I-1, I-2, A-7, A-1).

"*Due to the regulations, we were slowed down. And also some difficulties in raising money from investors side. Because the investor always asks about the market."* (I-2)

Two respondents also criticize the non-conformity of regulations and research with market- or industry-relevant aspects. Research is sometimes not relevant to the market, and laws bypass reality (A-7, A-4).

Individual legitimation processes

One of the interviewed microalgae producers (A-4) tries to enforce his interests at EU level alone. This might also be an expression of lacking collective legitimation processes:

> *"Then I went to Brussels five years ago and said: ´Guys, we have to get the microalgae into category A, like spinach and kale.´- until they first understand what a micro algae is - (...) We needed two years (...) That the microalgae came in category A and became a plant."* (A-4)

However, this algae producer also tried to create socio-political (regulatory) legitimacy together with associations, chambers and ministries. This not only improve the legitimacy of the company, but also contributes to improving the legitimacy of the entire industry:

> *"There are still no rules for microalgae, then we started two years ago (...) to develop the private standard for the production of microalgae (...) in Lower Saxony, together with the ministry and the state Control Authority of the Ministry (...)"* (A-4)

Strategic orientation

One of the algae producers (A-7) emphasized that key to success in the industry is not necessarily having the best technology, but a very good product and its market. Just as many companies have emerged, have disappeared again, because they have not found their specific advantage. Market development is therefore also an important strategy.

As far as the assessment of market penetration is concerned, it is relatively common (A-6, A-7, A-8) for companies to be involved in market development. This should not only be beneficial for individual companies, but also for the further development of both industries. As already stated, market development in emerging industries is essential. However, a lack of market development has been identified as a major barrier.

The described individual legitimation processes as well as the collective lobbying activities fit relatively well with what Suchman (1995) describes with the "manipulation" strategy. The

intention is, as already described, to target change in the environment in order to ensure consistency between the company and the environment and thus to obtain suitable support.

The algae and insect producer industry have a relatively high level of innovation newness. Although the technology for production is already relatively well-established and more incremental in nature, the end-products have rather the character of radical market innovations. The producers therefore act in an "institutional void", because the algae and insect products do not really fit with an already existing category. In such a scenario, stakeholders find evaluation and assessment of corporate legitimacy particularly difficult (Kuratko et al., 2017). Against this background, it is questionable whether the demonstrated efforts of the two industries to generate legitimacy might be sufficient.

5.3.2 Niche Strategies

The results of the interviews show no active part of the actors in the performance of "Shielding". However, as already argued, the strict regulations (Novel Food etc.) could be a form of passive (not intended) "shielding".

"Nurturing" activities, however, are not evident. Activities for "empowering" the niche are definitely obvious. Instead, there are efforts to make the niche innovations competitive for the regime, i.e. to establish "Empowering to fit and conform" activities. For example, upscaling and extrapolating production and establishing standards are important action strategies (all respondents, except A-2, A-5). A radical change in the selection environment, such as an intended institutional change, is not evident.

Intra-industry co-operation with major feed producers, food producers (e.g. Nestlé) or large retailers (e.g. Albert Heijn and Jumbo) (I-1, I-2, I-3, A-3, A-4, A-8) or farmers threatened by bankruptcy (as adopters of algae production) (A-4) as well as with universities like the Wageningen University (I-3) show closer contact to Regime compliant actors. This and the addressing of standard institutes are another indication of "Empowering to fit and conform". Only a small proportion of motivations and visions of the producers indicate that "the rules of the game" should be really changed. As already described, although sustainability aspects play a more or less important role (I-1, I-3, A-1, A-2, A-3, A-4, A-6, A-7, A-8), they are not understood as an important criterion for action (the above mentioned, except I-1).

Thus, there is hardly any possibility of a credible mobilization of the message that algae and insects have clear advantages with regard to various sustainability aspects. Although sustainability aspects might be seen as one of the "advantages" of both industries, they are not instrumentalized as aspects for differentiation.

For "Empowering to stretch and transform" no evidence could be found. However, this niche strategy also appears to be rather inappropriate for the algae and insect producer industries. As a consequence of the young history of the two industries and the few market participants, no specific institutions for the two niches were formed yet. Thus, a change in the selection environment for niche innovations by restructuring the institutions in the regime seems less promising. Undoubtedly, there is a need to intensify nurturing processes, in particular shared, positive expectations.

6 Assessment of the potential as innovative niches

At present, a lack of demand and strict regulations in Europe are key limitations both for algae and insect producer industries. Both industries are generally certified as having high potential, but only if they succeed in meeting certain requirements, in particular the significant reduction of production costs and a significant expansion of production capacities.

Following some experts, the insect producer industry in the Netherlands will have the potential to become a global leader and concerning the algae industry the EU has the potential to become the market leader within the next decade (Marberg et al. 2017; Vigani et al. 2015).

By describing specific characteristics of the two industries, many characteristics typical of new industries and niches have been identified. Many of the respondents (I-1, I-2, I-3, A-1, A-2, A-3, A-4, A-5, A-6, A-7) see themselves as either niche, pioneer actors or market leaders and emphasize first-mover advantages. However, the markets for algae and insects are still poorly developed, with negative consequences for production and sales. Furthermore, the lack of individual and collective legitimacy as well as low intra-industrial cohesion are major bottlenecks.

This implies that within the two industries, but especially within the algae industry, only a few collective legitimisation processes, e.g. in the form of joint lobbying activities were enforced. There are approaches to generating socio-political and cognitive legitimacy. However, these are usually an expression of efforts of individual actors to generate legitimacy, such

as in the development of private standards. Niche strategies have more the character of an "empowering to fit and conform" approach. On one hand, intra-industrial cooperation more likely takes place with regime-compliant actors, on the other hand the individual motivations do not indicate that "the rules of the game" should be changed.

Overall, it can be said that the niches of the algae and insect producer industry, are not (yet) well established, legitimate and powerful enough to build momentum and to struggle the agri-food industry regime seriously.

7 Conclusion

The algae and insect producer industries in Europe are still relatively young industries and niches in the agri-food industry.

Which barriers and potentials for a successful further development of the two industries are evident and which strategic implications result from this? Many of the identified barriers in the algae and insect producer industry are typical of an emerging industry: only a few pioneering companies, markets are still underdeveloped, there is little articulation of demand, the value for money of the new technology is poor, many multi-dimensional uncertainties exist and a lack of legitimacy.

A lack of trust within the two industries can be seen as a key barrier for stakeholder collaboration and collective legitimation strategies.

The adressed niche markets by the algae and insect producer industry can be seen as "nursing markets". In terms of strategic direction, this implies that producers should continue to push the optimization of production technologies in order to scale up production volumes and to reduce production costs.

In addition, the promotion of collective legitimation strategies within the two industries seems absolutely necessary. Because many of the barriers which have been pointed out, such as insufficient market development, are also the result of a lack of legitimacy and (collective) legitimation processes. The context of radical new products from the algae and insect producer industry also requires a "broad range of proactive social construction processes".

A clear weakness for the two niches is the strong restriction of freedom of action, especially due to strict regulations. The certain isolation from the regime, at least through social and cognitive distance, is to be considered positive. This promotes the initiation of own solutions, e.g. to address sustainability issues as well as the ability to create an identity that exists independently of the conventional agri-food industry. However, the frequent collaboration of algae and insect producers with agri-food industry actors shows that regimes and niches can, in principle, communicate and thus have the potential for a reciprocal exchange of ideas and niche-regime-interactions. Overall, the majority of the constituent features of a niche are valid for the both industries; and there is potential for regime-niche interactions. With largely shared, positive expectations regarding the prospects of success in the algae and insect producer industry, an important prerequisite for legitimacy and niche strategies can be considered as given.

Which legitimation and niche strategies are enforced by the algae and insect producers and are they suitable to the characteristics and contextual conditions of both industries? Some strategic approaches to achieve socio-political (regulatory) and cognitive legitimacy, such as the “conformance” strategy, are evident to the algae and insect producer industries. Collective legitimation processes are evident as well, at least in the insect producer industry, represented by lobbying activities within the industry. Nevertheless, also in the algae producer industry, collective legitimitation processes are visible as well. However, most strategies are an expression of the commitment of individual actors. Against the background of new industries and a high level of “innovation newness”, which makes it particularly difficult for stakeholders to evaluate the legitimacy of companies; it is highly questionable whether the demonstrated efforts of the two sectors to generate legitimacy will be sufficient.

However, niche strategies are also important for the successful further development of the industries. There are efforts to make niche innovations competitive for the regime, i.e. “Empowering to fit and conform” activities. The motivations and visions of the producers show no evidence for the intention of a radical change in the selection environment, i.e. the intention to really change “the rules of the game”. The closer contact with regime compliant actors fits to this argument. The upscaling of production and the establishment of standards are important strategies for action. “Nurturing” processes for the targeted support of path-breaking innovations are only observed in the form of shared, positive expectations. Thus, a stronger focus of “Nurturing” processes is recommended.

Overall, although the potential of innovative niches for the algae and insect producer industries is recognized, niches are currently still at an early stage due to a lack of intra-industrial cohesion and lack of collective legitimation processes, and therefore (still) not established, legitimized and powerful enough to build momentum and to have a significant impact on the agri-food industry regime.

This paper describes the key niche actors and their strategies for a socio-technical transformation and thus takes up the criticism of (Smith et al. 2005) that “agency” often does not receive sufficient attention in the concept of socio-technical transformations. In addition, legitimation strategies have been described as central to the formulation of new industries and of high importance for the further development of niches.

Concerning the own investigation a low degree of differentiation between the two countries and the two industries, which is mainly the result of a small number of cases, might be viewed critically. Therefore, a next step could be to interview other producers of the algae and insect producer industry in other European countries. Another interesting point might be the discussion about global and local niches. A comparative case study of producers in Asia and Europe might discuss the extent to which global and local niches interact and influence one another's development.

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