WAGENINGEN UNIVERSITEIT/
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LABORATORIUM VOOR ENTOMOLOGIE/
LABORATORY OF ENTOMOLOGY
LEERSTOELGROEP TOEGEPASTE FILOSOFIE/
APPLIED PHILOSOPHY GROUP

ENTOMOPHAGY AND THE WEST

Barriers and Possibilities, Ecological Advantages, and Ethical Desirability

No.: 08.01
Naam/Name: Joost Van Itterbeeck
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1e Examinator: Prof. dr. Michiel Korthals
Applied Philosophy Group
2e Examinator: Prof. dr. Arnold van Huis
Laboratory of Entomology

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Joost Van Itterbeeck

Master Thesis
Joost Van Itterbeeck
830620-383-060
Contact: joostvanitterbeeck@yahoo.com

Supervisors:
Prof. dr. Michiel Korthals (Applied Philosophy Group)
Prof. dr. Arnold van Huis (Laboratory of Entomology)

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Summary

Entomophagy – eating insects – is widespread in mainly tropical and subtropical regions but not existing in Western food habits. Entomophagy researchers have thought about bringing edible insects to the West for reasons such as insects being a disregarded source of protein and breeding edible insects is ecologically sound as conventional livestock is a major contributor to environmental problems. In order to achieve acceptance of this unconventional food by the West, this thesis explores the barriers to acceptance and possibilities to tackle these barriers. Barriers that are distinguished are: the negative attitude toward insects in general, rejection of food from ideational factors (what it looks like, where it has been, …), and fear of new foods. While the emotion of disgust (and related emotions) is strongly connected to these barriers and disgust being culturally influenced, it may appear that culture in itself is the barrier. Culture is of major influence on food habits which are difficult to change. Nevertheless, this thesis offers insight in possibilities of changing the overall negative attitude to insects and insects as food for which "bug banquets" are a valuable tool. This thesis further focuses on edible insects being an environmentally sound food alternative for the (near) future by comparing performance of edible insects with conventional livestock (cattle, sheep, pigs, an poultry) in efficiency of converting feed into biomass and in emission of methane and ammonia. This thesis further challenges the lack of pluralism in food country (preferences of not all consumers are respected) in order to formulate the right of edible insects as ecological food to at least have the possibilities to become part of Western food habits. The ethical principles of the deliberative approach are used to do so: autonomy, voice, access, and living 'the good life'.

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1. Introduction

Entomophagy – eating insects (entomos =insect, fagus = to eat)– is widespread. Mainly tropical and sub-tropical countries such as Zambia, Zimbabwe, Mexico, Thailand, and many others have well-known insect eating regions. Also in more temperate regions such as Japan and some parts of China insects are being eaten. Unlike the West, is eating insects for these many non-Western regions a cultural habit. Here, insects are renowned for their nutritional and economic benefits (e.g. DeFoliart, 1999).

Many insect species are edible, including grasshoppers, crickets, termites, ants, bees, wasps, caterpillars, and beetle larvae. Approximately 1400 insect species of the world are known to be edible (van Huis, 2003). In Thailand, where edible insects are very popular, 164 insect species are collected en mass and sold in for instance markets and supermarkets in Bangkok (Yhoung-Aree and Viwatpanich, 2005). In Southern Africa the 'mopane worm' (a caterpillar) is the most important edible insect and is being collected and sold in huge quantities as well (Kozanayi and Frost, 2002). Trade in edible insects is economically important.

Many interviewees declared edible insects to be their meat. Edible insects are a good source of proteins and minerals. For many people they are part of the daily diet, while insects can also be an important food in times of food shortage (e.g. Yhoung-Aree and Viwatpanich, 2005 and Kozanayi and Frost, 2002). The widespread Western idea that insects are eaten purely as survival strategy is false. Having witnessed entomophagy in these regions, tempted several authors to think about the combination of the West and entomophagy for reasons of, amongst others, insects being a disregarded source of proteins and such (e.g. Ramos-Elorduy, 2005) and breeding insects being more environmentally sound in comparison to conventional livestock (e.g. Nakagaki and DeFoliart, 1991). But while many insects are edible, they are not accepted as food by Western people. A true and problematic bias against this food exists. Environmental problems are very much present in politics and media and it is realized that conventional livestock has a major impact on the environment which should be dealt with. Livestock requires a high input of feed and makes a huge contribution to greenhouse gas emissions. Edible insects on the other hand are a much more sustainable food and thought of to be a possible solution to the environmental problems related with conventional livestock. It is being suggested to be ironic that many effort is made for growing crops by applying high quantities of insecticides and pesticides while a high quality food (insects) is being totally neglected by the West.

But it is not straightforward to present a new and unconventional food to the West as a solution to environmental problems and have it accepted. Therefore, this thesis offers an insight in developing an approach toward acceptance of edible insects in the West by dealing with three important guideline

questions: (1) *why* does the Western culture *not* take part in it?, (2) *can* entomophagy become part of Western food habits?, and (3) *should* it become part of Western food habits?

The main objective of this thesis is uncovering the barriers to acceptance and the possibilities to tackle these barriers (chapter 2). The first step to uncover these, is by answering the question: why does the Western culture not take part in it? To answer this question, cultural aspects of food habits are discussed in connection with Western people's perception of insects and aspects of food aversions.

A follow-up question is whether entomophagy can become a part of Western food habits? The approach chosen to answer this question is to investigate how (novel) foods become liked. The aspect of food neophobia (fear of new foods) is specifically focussed on. In particular it should be taken into consideration that the constraints of introducing edible insects in the Western world are very high.

To complete the answer to the follow-up question, empirical evidence of changing Western constraints and evidence for acceptance are described (chapter 3). It is then shown that acceptance of entomophagy *is* actually possible.

But whether entomophagy actually *should* be part of Western food habits depends on the reasons for promoting such a new and unconventional food. These reasons should be very well substantiated and form a second objective of this thesis. The focus lays on its environmentally sound features (chapter 4). The environmental impact of livestock production (limited to global warming, acidification, eutrophication, and energy use) is described. Comparison is then made with the ecological advantages of breeding edible insects in which is concentrated on global warming and the efficiency to convert feed into meat.

A further part of the answer to the former question is in regard of ethical desirability. A deliberation is made on the sub-question: with what *right* can the attention of the West be asked to consider edible insects as food and as a possible solution to environmental problems? Ethical principles are being discussed that help to determine whether edible insects should be given attention by Western countries (chapter 5). It is explained that the Western world experiences lack of pluralism in food styles (a new food style is being distinguished: ecological food style) and objections are made against this lack of pluralism. Edible insects are regarded as ecological food following from chapter 4 and a right for attention is formulated. Nevertheless is from an ethical point of view the combination of entomophagy and the West loaded with dilemmas. Five of these dilemmas will be briefly described. How to deal with these dilemmas is then a second discussed sub-question. The deliberation on the two sub-questions gives clues on how consumers and government should deal with idea of entomophagy and the West.

The three objectives of this thesis are then: (1) to distinguish barriers and possibilities to acceptance of edible insects as food in the Western world, (2) to describe the ecological advantages of breeding edible insects as food for the Western world, and (3) to determine whether insects as food should deserve more attention in the West.

2. Barriers and Possibilities

Introducing a new and unconventional food demands for uncovering the barriers to this new food and to detect what the possibilities are to tackle these barriers. The main point of view of this chapter is that entomophagy is widespread, but not existing in the West. This chapter will try to find an answer to the question: why is entomophagy not part of Western food habits? It will also provide clues on the follow-up question: can entomophagy become a part of Western diets? Therefore, this thesis starts off by investigating the influence of socio-cultural factors on food behaviour (section 1). Next, the perception of insects is being uncovered (section 2) and, since this thesis deals with an unconventional food, food aversion (chapter 3) and fear of new food and further aspects that deal with liking a food are dealt with (section 4).

Section 1 : Food Habits: Influence of Socio-cultural Factors

The Food Marketing Institute Survey of Food Shoppers (Food Marketing Institute, 1998) found that according to consumers, taste is the number one factor in food selection (Asp, 1999). However, other factors than the sensory-affective basis might be of primary importance (Asp, 1999). The importance of the sensory aspects according to consumers most probably comes from experience and associates the sensory aspect to other food properties or the context (e.g. Lappalainen and Sjödén, 1992; from Mela, 1999). It is more and more realized that "the impact of culture on food preference is immense and varied" (Rozin and Vollmecke, 1986). These authors state that when asking one "What is your culture or ethnic group?" a lot can be know about that person's food habits. The same accounts for the saying: "You are what you eat" (Rozin and Vollmecke, 1986) or "You eat what you are" (Barer-Stein, 1979; from Axelson, 1986). The former applies to for instance Italians who are called spaghetti or macaroni eaters.

Axelson (1986) states that "a culture's foodways[1] are exhibited by what substances are considered edible as well as the activities related to food selection, procurement, manipulation, storage, consumption, and disposal (Bass et al, 1979)". People's food habits (which is the behaviour showing the foodways) are in fact a reflection of their culture ("you eat what you are") (Axelson, 1986). These food habits are described by Den Hartog et al (2006) as " … the ways in which a community or a population group chooses, consumes, and makes use of available food in response to social, cultural, health, environmental, and economic pressures". Axelson (1986) remarks that (1) culture is a learned feature, being passed on from generation to generation and (2) within a culture there are vast

[1] Foodways can be described, in simplicity, as the effect of culture on food.

differences between individuals. Mela (1999) is more complete and says that "culture is perhaps the most obvious influence on food preferences and choice, and has strong historical antecedents, rooted in unique combinations of environment (geography, climate, and range of native plant and animal species), ritual and belief systems (religious and secular), community and family structure, human endeavour (innovation, mechanization, experimentation), mobility (exploration, immigration), and economic and political systems, which are integrated into a range of particular 'traditional' and accepted rules of cuisine and appropriateness, and 'ideals'" (Furst at al, 1996; from Mela, 1999).
In fact, the biological factors (like innate taste biases) and cultural factors can influence each other. Since a culture exists out of humans with their biological factors, some predispositions have become firmly established. Sweetened products are one example. The innate taste preference for sweet items has established itself in industry and agriculture. On the contrary, innate taste aversions are present in accepted foods such as coffee (bitter) and chilli (irritant). But in fact, the list of this kind of predispositions and establishments is not a long one, presumably because of the limited number of biological predispositions (Rozin and Vollmecke, 1986).

Some aspects in the above descriptions of food habits (Den Hartog et al, 2006) and food preferences and choice (Mela, 1999), are highlighted with regard to entomophagy.

1.1. Culture defines what is edible and what not

An important aspect is that culture defines what is edible and what is not, and therefore, according to Mela (1999), there is a lack of choice. Even though there are very few basic rules in nature on what is and what is not food, culture has made up more of those rules. "Cultural rules of cuisine and appropriateness exert tremendous influences on what may appear on the plate and when" (Mela, 1999).
Insects are not regarded as food in Western societies. Two facts can be stated: (1) insects are not being eaten, and (2) aversion – disgust responses toward insects are very common in the West. The matter of aversion and disgust responses will be elaborated in other sections (see sections 2 and 3).
Vane-Wright (1991) makes a suggestion on why insects are not part of the Western diet: ". . . the very fact that eating insects belongs to the hunter-gatherer stage of human evolution may be a major factor in their rejection by Western people; we may unconsciously reject entomophagy as primitive" (Vane-Wright, 1991; from DeFoliart, 1999). This aversion of primitiveness can be seen in explanations on the emotion of disgust and on taboos (see section 3). But DeFoliart (1999) asks an interesting question which is not explained by Vane-Wright: why weren't insects, being so important for hunter-gatherers in Africa, Asia, and the Americas, not domesticated? While during development of agriculture, plants and animals were domesticated. DeFoliart (1999) suggests that insects might not have been a

competitive food item. Agriculture originates mainly from the Middle East. Crops such as wheat, and animals such as goats and cattle were first domesticated. Although insects were important as food (see below on Jews, 1.3.), this importance can be called minor considering that mainly locusts were eaten and not a huge variety of insects. Agriculture made the development towards greater productivity and efficiency (and spread out to Europe), and resulted in more stable food supplies. The hunter-gatherer system made way for sedentary lifestyles. The unpredictable character of insects as staple food (seasonal variations!) in combination with developing agriculture triggered a loss of interest in insects as food. Resources from the wild in general became less important, so insects were less frequently encountered as food and even became to be seen more of as a threat to agriculture (pests) rather than as food. This development of agriculture might as well have caused the use of only a fraction of edible species (animal and plant) in the world.

Apparently, culture is such a strong feature, that some food habits are difficult to change. One of those is what is considered edible as food (!) (Asp, 1999). Furthermore, food patterns (so food habits) tend to be stable (Mela, 1999). Consequently, culture is dominant over food habits and the determination of what is edible and what not has influence on individuals and families and what they eat (Asp, 1999). This aspect, the acceptance of foods is then of course of interest. Clearly, in Western societies insects are not regarded as food. It is an interesting fact though, that especially the Western world has a bias towards entomophagy, while this practice is extremely widespread. Mignon (2002) asks an interesting question: Is entomophagy a question of culture?

1.2. Availability

Availability is more than physical and economic access (Mela, 1999). But in this case, the physical access is of interest. According to van Huis (personal communication), an important fact (and consequently maybe a logic) for insects not being eaten in moderate climates is their size and number (see explanation of Mela, 1999, above: ‘range of animal species’). Kirkpatrick (1957, p.16) states that since the rate of diffusion of gases increases with temperature, the reason that insects in the tropics are larger is because insects breath through diffusion. This explanation makes the suggestion of Vane-Wright (1991; from DeFoliart, 1999) maybe complete. There are only few insect species in temperate zones which occur in large number at a certain moment during the season. In tropical regions this is different: insects are of greater size and number. And in Thailand for example, edible insects species can be collected whole year round (Yhoung-Aree and Viwatpanich, 2005). Insects never played an important role in Western cultures! Contrarily, insects are being used in many parts of the world for decoration and ornamental purposes, as objects of entertainment, in medicine and sorcery, and they are present in myth, legend and dance, and of course as food (Meyer-Rochow, 1978/79).

Mela (1999) states that 'if it is not available, it will not be eaten'. It depends on culture, as culture is described above, whether edible insects will be made available to those who would want to eat them or not. Will human endeavour, beliefs (as in the perception of insects, see section 2), and economic and political systems make a positive change towards entomophagy? Overcoming social and psychological barriers is a huge challenge (social, as in cultural acceptance; psychological, as in 'disgust' responses). These are crucial aspects for acceptance of entomophagy and making edible insects available. It seems to be a cycle. Another important factor within availability will be the price (economic access).
It is believed that by making it indeed available (at an affordable price), processes as learning mechanisms, which as well will be explained further (see 4.1.), can come into play. Availability is a crucial factor for these processes to start when it comes to edible insects. Neither beliefs can be changed, nor habits can get influenced, nor will any food item get established (or widely accepted) in a culture's cuisine without experience. Nor will any negative attitude, as will be seen toward insects, have even a chance to change without availability. The availability mentioned in the theory of Vane-Wright (1991; from DeFoliart, 1999) is not of cultural nature of course but of natural kind.

1.3. Food habits change all the time

It is mentioned that certain aspects of food habits are difficult to change. Also, Rozin (2002) mentions development of cuisine: the flavouring and preparation are regulated by traditions. These determine / have influence on the preferences of the people. However, both Asp (1999) and Den Hartog et al (2006) stress the continually changeability of food habits. And indeed, throughout history, food habits have changed (Axelson, 1986). Colonization brought new foods (potato and corn) and technology develops new foods. The example of globalization can be used as well bringing sushi to the West, which could be easily compared to colonization. Eating raw fish is something people would earlier be disgusted from by only the thought of it, nevertheless it is an accepted food. It is also possible to think of the influence of beliefs such as totems and ideals (being as slim as a supermodel).
Mela (1999) states that "if learning can take place, it probably will". Of course, availability is a crucial factor for learning and therefore in changing food habits. The question of interest for this thesis is: can the Western world learn to appreciate insects as food? The mechanism(s) for acceptance of new foods will be discussed (see 4.1.).
Food habits specifically in entomophagy change as well. The Jews, which were spread from Israel to Spain, inhabiting Northern Africa (e.g. Tunisia and Morocco), had a tradition of eating locusts. The Torah considered various types of insects kosher. The locusts, both appearing in swarms and those as individuals, were important as food. Very gradually, locusts began loosing their respect as food, mainly due to lack of knowledge and therefore uncertainty on which locusts could be eaten and which ones couldn't. From Morocco, around 17^{th} – 18^{th} century, came the most powerful expression against

eating locusts. There, people were forbidden to eat them. Locusts began to be seen as 'unclean things'. But the spread of this idea was very gradual. The last time locusts were eaten in Israel for instance (by Jews from Yemen), dates from the 50ies of last century when the last plague struck the country. It seems that the aversion toward the locusts became stronger through influence of Western oriented countries. With this being one factor as cause for disappearance of the practice, the other is the efficient precaution to locusts appearing as swarms and therefore affecting the availability (Amar, 2002-2003).

1.4. Food habits influenced by environmental pressure

Consider the social taboo of resource and habitat taboos (RHTs). The exact mechanism will not be fully explained, the result are of interest in this case. In some parts of Africa, South America, and Asia / Southeast Asia (including the Pacific) several of these resource and habitat taboos exist. It must be clear that they "do not necessarily proceed from environmental concerns or origins" (Colding and Folke, 2001). According to several anthropologists, taboos function in a social way or/and have a religious origin. But, "it may be difficult to distinguish among ecological, social, or religious origins and functions of RHTs . . . social and religious values in most traditional societies are inseparable from ecological factors (Gadgil et al, 1993)" (Colding and Folke, 2001). Nevertheless, in several taboos belonging to the RHTs, the ecologic / conservation aspect is undisputable. For instance in *method taboos* – "a cultural group bans the use of certain methods and techniques for withdrawal of species" (Colding and Folke, 2001) – where the focus lays on the danger of reducing or even depleting a resource (Colding and Folke, 2001). In this way, on Mokil (an island in Micronesia) spear guns and fishing with light torches is forbidden in order to avoid over harvesting since several reef fishes sleep at night and are therefore vulnerable to extinction (Johannes, 1987; from Colding and Folke, 2001). Also *life history taboos* – "when a cultural group bans the use of certain vulnerable stages of a species' life history based on its age, size, sex, or reproductive status" (Colding and Folke, 2001) – are clearly linked to conservation. For example, when deer calves or pregnant animals are caught by the hunting tribe Phasepardhis of India, they are let loose (Gadgil, 1987; from Colding and Folke, 2001).
The point here is that the cultures applying RHTs are aware of negative effects on their environment or specifically on their food source(s). Taken into account that these cultures still practise hunting-gathering (to a certain level) and the sedentary agriculture of Western societies with stable food sources, they act different toward their environment. These cultures applying RHTs are very direct dependent on their environment and change their food habits accordingly. It has been argued by media, scholars, and politicians that the West should be more concerned with the environment. Future problems with meat provisions for growing populations, ammonia exhaust from cattle, and land

deterioration are some of the issues. What about a change in a more environmental friendly food production, or maybe just a more environmental food?
This aspect is mainly an ethical one and will therefore remain briefly mentioned here. Chapters 4 ('Ecological Advantages') and 5 ('Ethical Desirability') will elaborate on it, discussing entomophagy as an environmentally sound alternative food source.

1.5. Social aspect of food

The meaning of food has also shifted from purely ingestion to a social form. Food in general is a strong thing. Food can function to stress identity (regional and national), belonging to a certain ethnic group. It is a social tool aiding in friendships, as a gift, or a sign of hospitality. In religion and beliefs, food can have symbolic meanings or be prohibited (food taboos). Food can be a political tool in protests and hunger strikes (Asp, 1999). Other examples exist of course.
Also, social learning will take place. For instance: children will learn their parents' food habits before developing their own (individual learning). Also peers and heroes may influence children (e.g. Birch, 1999).
The importance of the social environment in food habits will be stressed out in further sections (see 3.3. and 4.1.2.). It is obvious that people influence each other (and culture as a whole) in accepted foods.

1.6. Concluding remarks

Culture has major effect on food preference / choice / liking. While nature only has few basic rules on edibleness of items, culture has made up plenty of rules on what is edible and what not. Changing these cultural rules is very difficult. Also the availability of items is a crucial aspect: when a food item is available, it will probably be eaten. This section explored the importance of culture in order to understand why insects were never part of Western diets, a possible answer has been given which is in line with Mela's (1999) explanation. The cultural aspect in food behaviour and the aspect of availability are clearly present in this answer.
The literature on socio-cultural factors in food behaviour has revealed some interesting insights useful when thinking about promoting edible insects in the West. Evidence exists that food habits can change since they have changed throughout history. Even when culture has strict rules on what is edible and what not, they are changeable. Making things available is a crucial part in changing cultural rules on food. Some non-Western cultures change their food habits to reduce environmental pressure. The ability of breeding edible insects (instead of the conventional livestock) in reducing this pressure might be an important reason to consider entomophagy because of the world wide demand for care for

the environment. It must be bared in mind that food has a social function. Consequently, people influence each other in preference, choice, and liking; people are especially influenced by family and heroes.
These insights reveal that with the right approach, food habits can be changed.

Section 2 : On the Perception of Insects

To develop such a right approach in the case of the unconventional food of edible insects, it is important to understand: 1) how people perceive insects (this is done through an article that discussed the perception of invertebrates in general with attention for insects), and 2) to explore cases of loss of distress towards insects (this will be done using spiders as an example of an often feared arthropod). This section will reveal to what extend the perception of Westerns to insects is a barrier to entomophagy in the West. These findings should then give clues on the changeability of the Western cultural rule that insects are not edible and consequently reveal some possibilities of acceptance of edible insects in the West.

2.1. Perception of invertebrates

The research conducted by Kellert (1993) explored the perception of, the value given to, knowledge on, appreciation of, and understanding of invertebrates through questionnaires. The research was conducted in the light of insect conservation and protection. People that participated in the research had different backgrounds and consisted of (1) general public (most of the participants) which were randomly selected Connecticut inhabitants living in the city of New Haven, in New Haven suburbs, and in rural towns of Killingsworth, Union and Norfolk, (2) farmers which were randomly selected from lists provided by officials of the Connecticut agricultural extension, (3) conservation organization members randomly selected from membership lists of the Connecticut Audubon Society, The Connecticut chapters of National Wildlife Federation and The Nature Conservancy, and Connecticut members of the Humane Society of the United States, and (4) university scientists from the university of Yale, randomly selected and roughly divided into two groups: biotic and abiotic scientists. Basic attitudes towards invertebrates were defined which were adapted from basic attitudes towards animals defined by Kellert (1980) (table 1).

Table 1: Basic attitudes toward invertebrates (from Kellert, 1993)

Aesthetic:	Primary interest in the physical attractiveness and symbolic appeal of invertebrates.
Dominionistic:	Primary interest in the mastery and control of invertebrates.
Ecologistic:	Primary concern for interrelationships among invertebrates and other species, as well as between invertebrates and natural habitats.
Humanistic:	Primary orientation of strong emotional affection for invertebrate animals.
Moralistic:	Primary concern for the right and wrong treatment of invertebrates, with strong opposition to presumed cruelty toward invertebrate animals.
Naturalistic:	Primary interest in direct outdoor recreational contact and enjoyment of invertebrates.
Negativistic:	Primary orientation a fear, dislike, or indifference toward invertebrates.
Scientistic:	Primary interest in the physical attributes, taxonomic classification, and biological functioning of invertebrates.
Utilitarian:	Primary interest in the practical value of invertebrates or the subordination of invertebrates for the material benefit of humans.

After completion of the questionnaires by the general public, the following results were obtained (figure 1).

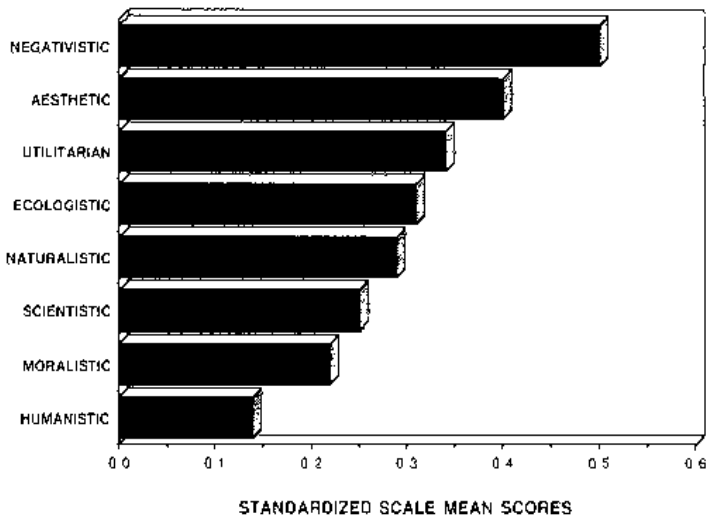

Figure 1: Basic attitudes of general public toward invertebrates (from Kellert, 1993)

The authors state that most frequently feelings of fear, dislike, and indifference were encountered. Disgust as such did not appear in the research. Although fear and dislike are getting close. Affection,

ethical concern, and scientific curiosity were the least encountered feelings. There are some exceptions though. When animals were recognized to have aesthetic value (butterfly), utilitarian value (shrimp), ecological value (bees), or outdoor recreational value (mollusc shells) more positive attitudes were observed. Still, a large majority indicated a dislike of ants, bugs, beetles, ticks, and cockroaches (and crabs). Also an aversion to insects in the home and a fear of stinging insects (and spiders and scorpions) was indicated. Next to this, questioning the desire to eliminate invertebrates lead to mosquitoes, cockroaches, fleas, and moths (and spiders). In the end the cockroaches (and octopus) were mentioned as highly unattractive.

There is importance of the effect of knowledge on the perception of insects. The knowledge the participants had on invertebrates was tested and resulted in the following (table 2):

Table 2: Scores on knowledge on invertebrates (from Kellert, 1993)

Main Groups	*Mean Scores*
General Public	0.53
Environmental Group Members	0.70
Farmers	0.61
Scientists	0.90
$F = 57.8; p = <0.0001$	
Age	
18–35 years	0.53
36–45 years	0.56
46–65 years	0.55
66+ years	0.47
$F = 2.2; p = 0.09$	
Gender	
Male	0.55
Female	0.51
$F = 2.4; p = 0.12$	
Education	
<High School	0.46
College	0.56
$F = 17.6; p = <0.001$	
Income	
<$20,000 annually	0.53
$20,000–$35,000	0.52
>$35,000	0.57
$F = 1.5; p = 0.23$	

It is probably not surprising that the general public has the least knowledge on invertebrates followed by farmers. Scientists know most with environmental group members at second place. But, education does seem to make a difference! The more educated tend to show more protective, aesthetic, and scientific curiosity attitudes while the less educated show more fear and utilitarian viewpoints.

Comparison can also be made of the results between classes of participants in the questionnaires (table 3).

Table 3: Scores of attitudes among general public, (conservation organization) members, farmers, and scientists (from Kellert, 1993)

	General Public	*Members*	*Farmers*	*Scientists*	*F*	*p*
Aesthetic	3.2	4.1	3.3	5.5	10.3	0.0001
Ecologistic	6.0	7.6	6.5	10.6	13.3	0.0001
Humanistic	1.1	1.5	0.5	3.6	23.3	0.0001
Moralistic	2.6	4.5	2.3	5.3	11.6	0.0001
Naturalistic	2.9	4.3	2.2	5.5	13.1	0.0001
Negativistic	8.9	5.2	8.1	2.9	17.4	0.0001
Scientistic	1.5	2.6	1.3	3.5	14.9	0.0001
Utilitarian	3.1	0.9	4.6	0.2	19.1	0.0001

As quite expected, scientists have the greatest overall appreciation, concern, and interest in invertebrates, especially when compared with farmers and the general public. Farmers generally express pragmatic, antagonistic, and emotionally detached attitudes. Invertebrates tend to be seen either as threats or sources of material gain. Conservation organization members have relative appreciative and protectionist attitudes (but less than scientists).

Further questions were asked towards the cognitive and affective capacities of invertebrates, mainly insects. The majority of the participants believed that invertebrates are capable of experiencing pain. Only a small minority thought of these animals as having the capacity for affection, conscious decision making, or future thinking. Farmers (only them), showed the tendency to believe that bees have ability in rational decision making and future action.

A quote from Lockwood (1987:83 from Kellert, 1993) is very useful as conclusion: ”There seems to be an overall aversion to recognizing insects as organisms deserving moral consideration.”.

The above described findings are in agreement with results mentioned in other literature., especially when it concerns the behaviour of the general public towards insects and spiders: “Public sentiment rarely favours insects.” (Hardy, 1988:64; from Kellert, 1993). Further, according to Wood and Looy (2000; from Looy and Wood, 2006) this negative attitude toward invertebrates in general, is most clear in the rejection of these species as food (see also Costa-Neto and Magalhães, 2007). The accompanying reactions of revulsion, disgust, and fear are common (in North Americans), but, these reactions are not innate or universal which can be seen by the importance of invertebrates in many cultures as food (Looy and Wood, 2006) and as part of the culture itself through for instance totemic beliefs (van Huis, 2003 and Meyer-Rochow, 1978/79). In the study conducted by Costa-Neto and Magalhães (2007), conducted in Brazil though, clearly the ideational factor is of importance since the disgust reaction was expressed after actually knowing what the person in question ate and also when just asking participants’ opinion on eating an insect.

So in other research than Kellert (1993), disgust responses are measured and named as such. Disgust, with variants, is an important reaction.

2.2. Theories on the origin of the negative attitude

Kellert (1993) calls the human aversion even a "… consistent pattern of human aversion, avoidance, and disdain for most insects and spiders". Four theories are presented on the overall aversion of insects.

Evolutionary – escape

One possible explanation concentrates on "an innate fear of potentially dangerous insects . . ." (Kellert, 1993; based on Adams, 182 and Bennet-Levy and Martean, 1984). Fear and avoidance of arthropods is being seen as an evolutionary process. It is even being mentioned as an evolutionary advantage. This explanation suggests that these responses represent "a biologically prepared learning tendency" (Kellert, 1993) which occurs even after a minimal stimulus. Kellert quotes the psychologist Öhman (1986) who suggested that "animal fear originates in a predatory defence system whose function is to allow animals to avoid and escape predators . . . It is appropriate to speak about biologically prepared learning . . . likely to require only minimal input . . . to result in very persistent responses that are not easily extinguished." Vernon and Berenbaum (2004) will show that indeed this intention exists, but they will prove that it is not impossible at all to change it (see 2.3.).

Health

Many diseases in humans are caused by arthropods. As a suggestion why the general public shows such responses as fear and avoidance, the author (following Cheng, 1973; Bay et al, 1976; McNeill, 1976) names the "presumed connection between many arthropods and human disease" (Kellert, 1993). This may be enforced by our high hygiene standards, the desire to keep the home environment a sterile place (as is mentioned by the general public in the questionnaires), and today's theories on disease transmission. Apparently this motivation is strongly present in "highly urbanized, industrial societies" (Busvine, 1966 and Cloudsley-Thompson, 1976; from Kellert, 1993).

Another aspect of this theory on aversion can be added, but focused specifically on fear of spiders. This theory sees the origin of this aversion in culture. This spider related theory is relevant because (1) spiders seem to belong according to the general public in the same category of 'creepy crawlies' like insects, so perhaps some generalization can occur, and (2) although many psychologists have tried to explain this aversion as a result of evolutionary selection (some spiders are venomous and therefore selection for fear of these animals occurred), "there is a close relationship between some common animal fears and the food-rejection response of disgust" (Davey, 1994; see Ware, Jain, Burgess and Davey, 1993). The theory states that "the development of spiders as a focus for fear may have resulted from this animal's historical association with disease and infection – particularly in Europe" and this from the tenth century onwards (Davey, 1994). From the Middle Ages on, there was a widespread belief that spiders absorbed poisons from for instance plants. Food or water that has been in contact

with spiders was then considered infected (Renner, 1990; from Davey, 1994). Importantly, in these times of epidemics as the Great Plagues, a cause for this had to be sought and was found in the spider (Renner, 1990; from Davey, 1994). Some spiders bit and this bite could be felt, but they were no threat to survival. One reason for fear of animals and the connection with disgust could be according to Davey: "being contingently associated with dirt, disease or contagion, or acting as signals for infection or diseased food" (Davey, 1994). It is very likely that by social learning the fear got more established. Also, since the origin dates back this far, it could very well be established firmly and therefore difficult to "shake off".

Pests

Another theory is on "their frequent association with crop loss and other forms of agricultural damage (Pimentel, 1975 and 1991)" (Kellert, 1993). Of course this is mostly seen with farmers (see explanation on table 3). There seems to be some generalization taking place (and a wrong perception) since only a small part of all invertebrates are actually associated with these effects and seen as pests. Kellert (1993) calls it "guilt by association". Especially this generalization is suggested to be an important aspect (van Huis, personal communication).

Distance

Even though Kellert (1993) does not refer to the mentioned articles, he as well mentions the distance from humans as a reason for the negative associations towards insects. In very few words he describes the same as for instance Douglas (in Nielsen, 2000) and Rozin and Fallon (1987): "the possible alienation from creatures so morphologically and behaviourally unlike our own species".

Availability

Recall the theory of Vane-Wright (1991; from DeFoliart, 1999) in connection with the comment of van Huis (personal communication) in which 'availability' is an important aspect (see 1.1.). In the end, Vane-Wright's theory is linked to theory on pests. Van Huis's comment implies the encountering of insects. Although Kellert (1993) does not mention it, maybe this infrequent encountering is part of the reason why insects do not play an important role in Western cultures and therefore inflict a negative attitude or can elicit reactions explained by the other theories mentioned here.

Kellert takes other explanations from Hillman (1991) who has a more psychological view on the origins of avoidance.

Insignificance

The arthropods outnumber humans significantly. Hillman (1991) focuses on this aspect and suggests that humans might consider their number and size as threatening to their individuality and independence: "Imagining insects numerically threatens the individualized fantasy of a unique and

unitary human being. Their very numbers indicate insignificance of us as individuals (Hillman, 1991).” (Kellert, 1993).

Monstrosity – madness / inhumanness

Another suggestion that Hillman makes: “A basis for human dislike of many invertebrates [and so arthropods] is their perceived ‘monstrosity’ from an anthropocentric perspective” (Kellert, 1993). It can be clarified by the English language actually. The English language uses a lot of arthropod related terms which are used as metaphors to stress out ‘madness’ or insanity. Quoting Hillman (1991): “Bug-eyed, spidery, worm, roach, blood sucker, louse, going buggy, locked-up in the bughouse – these are all terms of contempt supposedly characterizing inhuman traits . . . To become an insect is to become a mindless creature without the warm blood of feeling”. But also in the Sena language of Mozambique this is clear: the word ‘pirombo’ is used for both insects and garbage (van Huis, personal communication 2007).

Autonomy – not under human control

Arthropods are radically autonomous from human will and control. This can be seen by their invasion of homes and human space in general in unexpected ways which then is a possible motivation of a threatened feeling.

Mysterious Creatures

Finally, invertebrates are still “mysterious” to humans which may be disturbing to us. They are sometimes seen as from ‘another planet’ (watch Paul Verhoeven’s ‘Starship Troopers’!). While some people get curious and wonder, most people show the (apparently) human reaction of fear and disdain to the unknown. Other movie examples: ‘The Deadly Mantis’ (1957), ‘Mothra’ (1961) with a huge moth, ‘Them!’ (1954) with huge ants, ‘Beginning of the End’ (1957) with huge grasshoppers, and ‘Mysterious Island’ (1961) with bees. And of course as spider-movie examples: ‘Tarantula’ (1955) and ‘Arachnophobia’ (1990). See this internet site for more films, look for the insect categories: www.animalattack.info/PmWiki/English. Up to today, Hollywood finds inspiration in insects to make (bad) horror movies. But do not forget movies like the animated ‘Antz’ (1998), ‘James and the Giant Peach’ (1996) and ‘Bee Movie’ (coming out in 2007) which show insects in a different way!

Unfortunately, the sensation of disgust was left out in this survey. Articles like Rozin and Fallon’s review on disgust (1987) show that disgust is a typical sensation related to encounters with insects. Possibly though the word has not been used exactly because of lack of definition of sensations. It could be though that because of the use of ‘avoidance’ and ‘fear’ that the author refers to all negative sensations, including disgust. Emotions have many variants (Haidt, 2003).

Very briefly, solutions are being mentioned. Kellert (1993) explored the avoidances to invertebrates in the light of conservation because of their biological importance and suggests that by mainly education

a better understanding of these animals can be achieved. This is a logic conclusion after looking at table 2. Less easy to accomplish, the author suggests (following Hillman, 1991) that there is need to "cultivate our sense of communality with all living organisms".

The suspicion that this negative attitude is very well established and dates back many centuries is very much present. Since the reactions are neither innate, nor universal, it is suspected that these negative attitudes can be changed.

2.3. Concluding remarks

This exploration of attitudes toward insects revealed that generally, insects are perceived in a negative way. Several theories have been mentioned that try to explain this negativism. Emotions as fear and disgust are important expressions of this attitude. As a consequence to the overall negative attitude, the idea of insects being inedible is clearly 'a cultural rule' and this negative attitude is therefore a barrier. Although extensive research is lacking, the results presented here show this negativism not to be unchangeable. Bug banquets have shown their usefulness and prove the existence of possibilities of acceptance of edible insects: a combination of information and exposure (availability) is essential in the approach of trying to undo the negative generalisation and negative attitude.

Section 3 : Food aversions and entomophagy

In this section, the focus lays purely on insects as food. Considering the negative attitude to insects in general and consequently on insects on the plate (Looy and Wood, 2006 and Costa-Neto and Magalhães, 2007), most and mostly Western individuals reject insects as food.
By starting this thesis, the suspicion was that a taboo concerning entomophagy exists in the West. According to Meyer-Rochow and Moro (1995), "a food taboo describes any category of food not consumed by a human individual for reasons other than simple dislike or metabolic disagreeability. Food taboos are imposed on individuals from outside, by society and through upbringing, instruction and example." By approaching the topic of entomophagy and the West as a taboo, interesting mechanisms arise and the importance of disgust in food taboos / food rejections gets more clear. But also, entomophagy as a taboo as such is not completely correct. Nevertheless, it offers valuable information useful for the topic of this thesis. This chapter then, deals with food taboos and food aversion in order to fully understand the emotions (disgust) and mechanisms involved in the rejection of insects as food by Western people.

3.1. Tabooing entomophagy?

For the Western world the word ‘taboo’ has its origin in Polynesia, more specifically on the island Tonga (Bender and Beller, 2003). The word, ‘tapu’, was picked up by captain James Cook in 1777 when he arrived on Tonga during his 3rd voyage around the world. He wrote about taboo as “a peculiar native custom called ‘taboo’ in the native tongue” (Onishi, 1999). His description of the act involved in taboo is as the following: something sacred or profane for which direct access for normal people (mainly children and women) is forbidden, in case of breaking a taboo the punishment can be very severe and even death. The word reaches Europe and from the 19th century on is taken up in dictionaries. Anthropologists start using the word. The general explanation of the word is: “a cultural or religious inhibition characteristic of some primitive society”. So often, the word was used to describe differences between Western and non-Western civilizations (Onishi, 1999). Mainly thanks to Freud this idea of ‘taboo’ changed. He realized that taboo was not something primitive, but was present in all cultures. By seeing prohibitions that are present in Western cultures as taboos and not regarding taboos as having religious origins only, he changed the explanation of ‘taboo’. This change, making a prohibition the centre of the explanation and realizing that it is present in all cultures with the possibility to be applied in different fields, reached dictionaries. Consequently, the Oxford English Dictionary changed the explanation into: “Prohibition or interdiction generally of the use or *practice of anything*, or of *social intercourse*; Ostracism” (from Onishi, 1999).
Entomophagy could be regarded as something that is ‘not done’ because it has a disgust component for many people which makes it having some ‘taboo aspects’. On the other hand, entomophagy is not a prohibition, today. It was never present! Something new is not prohibited directly either. DeFoliart (1999) makes clear though, that missionaries have prohibited entomophagy in for instance Africa. Also, if respondents say (something like): “If they want to, they can eat it, but not me!” (Costa-Neto and Magalhães, 2007), can we really say that eating insects is a ‘taboo’? Fessler and Navarrete (2003) stress though that in many cases when animals are not eaten, this can be accounted as ‘unconsciously tabooed’ (Leach, 1964, from Fessler and Navarrete, 2003) because they are just not seen as food. This seems the case in entomophagy. So, there are some aspects of ‘taboo’ present in entomophagy. Even if it isn’t completely regarded as a taboo (‘not done’) today, discussing taboo with special interest for ‘disgust’ reveals relevant information for this thesis.

3.2. Link between taboo and disgust

Fessler and Navarrete (2003) focus on animals and “. . . explain the link between disgust and the centrality of meat in food taboos, [by turning to] the premise that each feature of the human mind is a response to an adaptive challenge faced by our ancestors”. The connection between disgust and food

taboo can be found in the so called 'omnivore's dilemma' which is also found in humans: "new potential foods are explored, but they are subjected to scrutiny and tasted cautiously" (Haidt et al, 1997). This is because omnivores can have a very wide range of foods, but they can encounter toxins in it as well. Moreover, humans must learn what to eat, in contrary to many other omnivores which are born knowing what they can eat. It is believed that food related disgust has its origin in this mechanism and therefore has its importance for survival (Looy, 2004). So on the one hand people are sensation seekers and on the other hand they are neophobic, cautious about new food, particularly animal food. In their efforts to "construct a scale to measure disgust sensitivity (Haidt et al, 1997), [the authors] have repeatedly found that individual differences on Zuckerman's (1979) Sensation Seeking Scale are significantly correlated (negatively) with individual differences in disgust sensitivity" (Haidt et al, 1997). So apparently a connection can be made between disgust and looking for new food, and also between disgust and avoided foods.

Disgust is believed to be one of the basic human emotions (Ekman, 1992; from Looy, 2004) and this disgust is even a moral emotion (Haidt, 2003). Further, it is more and more realized that emotions play a more important role in (moral) judgement than reasoning does with attention to specifically disgust (e.g. Sripada and Stich, 2004 and Fessler and Navarrete, 2003). A 'gut reaction' (emotion) forms the moral evaluation and is then justified rationally, as is suggested by cross-cultural studies (e.g. Haidt and Hersh, 2001; from Looy, 2004). There is even evidence from psychosocial and neurobiological research that this disgust is embedded in the human body (see Looy, 2004).

But, disgust as part of an evolutionary mechanism has "extended far beyond immediate physical survival" (Looy, 2004). A taboo can be regarded as a judgment on what to eat and what not. Taboos being human constructions and present in cultures around the world, the question is: how to explain? When similar ideas occur in different cultures, they might be "a product of either 1) features of panhuman psychology, 2) recurrent features of the environment, or 3) the interaction of (1) and (2)" (Fessler and Navarrete, 2003). Haidt (2003) believes the 3rd point, that ". . . moral emotions are simultaneously panhuman products of evolution and cultural scripts that are shaped by local values and meanings".

The cultural part is definitely important: association and enculturation play an important role (Damasio, 1994; from Looy, 2004). The elicitors of disgust differ enormously among cultures (Looy, 2004 and Haidt, 2003) and these are learned (Haidt et al, 1997; Haidt, 2003 and Looy, 2004). Moral emotions are meant to make people care about their world and trigger reactions and actions. When their world is threatened, the emotions trigger actions. Therefore, disgust is an important feature in preserving cultural identity which is very clear in food (e.g. Looy, 2004).

To explain taboo formation, Fessler and Navarrete (2003) turn to "understanding the workings of the human mind and its relationship with the physical world". Following Simoons (1994), the authors state that "in general, it appears that informants' initial explanations as to why some animal is not

eaten is often simply “It’s disgusting!” The underlying logics discovered by symbolists may in fact exist, and some informants may be able to articulate some portion thereof. However, these concepts seem unlikely to be foremost in informants’ minds when reacting to the prospect of eating a tabooed or avoided food” (Fessler and Navarrete, 2003). The attitude toward insects and insects on the plate can be recognized here in. Also because Freud determined that taboos often lack any explicit rational explanation (see Onishi, 1999) which is not found by the authors researching attitudes toward insects. They have come up with some rational reasons, but certainly not all of them can be called rational or they seem to be more or less unconsciously. Also, especially Costa-Neto and Magalhães (2007) could not determine a rational explanation for (disgusting and) fearing / rejecting a huge amount of insects species. Generalization definitely is a problem. The emotional part seems to be an important one to consider in food taboos or aversions, especially in the case of insects.

3.3. Disgust: a definition

Just like Rozin and Fallon did in ‘A perspective on Disgust’ (1987), disgust is here approached as a food-related emotion. Disgust is a basic (moral) emotion (even Darwin, 1872/1965 and Haidt, 2003) and has several characteristics: characteristic facial expressions, an appropriate action (distancing of the self from an offensive object), a distinctive physiological manifestation (nausea), and a characteristic feeling state (revulsion) (Rozin and Fallon, 1987). The following is a definition used by Rozin and Fallon in which the properties of the organism and object interactions that elicit disgust are central. Disgust:

> “Revulsion at the prospect of (oral) incorporation of an offensive object. The offensive objects are contaminants; that is, if they even briefly contact an acceptable food, they tend to render that food unacceptable.”

There are three important parts in the definition: incorporation into the self, the nature of objects of disgust, and contamination. The most important one is the second and will be dealt with below and explains disgust as food rejection.
This definition seems to be correct towards entomophagy. Following from research of for instance Costa-Neto and Magalhães (2007), insects are seen as possible contaminants and seem offensive. Revulsion is indeed present with incorporation, as mentioned before even literally as disgust.

3.4. Disgust as food rejection

In fact, the word ‘disgust’ means “bad taste”. But Rozin and Fallon point out that there is more to it by adding ‘offensiveness’ (contamination). “Disgust is triggered not primarily by the sensory properties of an object, but by ideational concerns about *what it is*, or *where it has been*. In fact, we

conceptualize disgust as a distinct form of food rejection, different from rejections based on bad taste or on fear of harm to the body (Rozin & Fallon, 1980; 1987).” (Haidt et al, 1997). By the fact of the “omnivore’s dilemma”, disgust might have evolved through natural selection. But caution is warranted, because of the lack of disgust in young children. It therefore might not just be a product of biological survival: “Disgust may have some roots in evolution, but it is also clearly a cultural product. Like language and sexuality, the adult form of disgust varies by culture, and children must be "trained-up" in the local rules and meanings.” (Haidt et al. 1997). So just like food habits are culturally defined, so are disgust elicitors. The role of disgust in food is that it is a signal which indicates whether a certain food is morally wrong to eat or not (Looy, 2004).
Besides disgust as a food rejection, there are other origins of disgust responses according to Haidt et al (1997). They can be useful in determining the origin of disgust more in general. These aspects are less relevant for considering entomophagy and will therefore not be discussed.

First, food rejections will be discussed to understand the role of disgust in it.
Rozin and Fallon (1987) have come up with a psychological classification of food rejections. This classification is first of all based on three possible *motivations* for food rejection.

- Sensory-affective: this implies the belief that the object has negative sensory properties, mostly bad taste or odour.
- Anticipation of harm following ingestion: this can be literally harm to the body (toxins, allergy, stomach cramps) or it can be social harm.
- Ideational factors: this implies knowing the origin or nature of the food

Especially the ideational motivations are a human product and account for a big part of all food rejections (Rozin and Fallon, 1987)! To clarify the meaning of the ideational factors, the authors already gave an example that is very useful to the topic of the thesis: “rejection of a grasshopper just because it is a grasshopper”.
It can be understood now that the responses of participants in research described above on the perception of insects, are of ideational nature. But it is not just that easy when recalling the theories explaining the avoidance. Some theories underline the ideational nature while others do not (some theories are of non – rational other of rational nature).

Through these three *motivations*, four *types* of rejection can be distinguished (cited from Rozin and Fallon, 1987):

- “*Distaste* is a type of rejection primarily motivated by *sensory factors*. The focus is on bad taste and/or smell but may include texture or appearance. In a “pure” case, the substance is not thought to be harmful or undesirable on ideational grounds. Such rejections usually involve

foods accepted as edible within the culture, and they account for most within-culture individual differences in food preferences. Examples of distastes in American culture (for those who dislike them) include black coffee, chilli pepper, broccoli, or lima beans."

- "*Danger* is a type of rejection primarily motivated by *anticipated harmful consequences*. Some of these are culture-wide or even universal (e.g., poison mushrooms); others are more individualized (e.g., allergenic foods)."
- "*Inappropriate* is a type of rejection primarily motivated by *ideational factors*. These are items not classified as foods in the culture, and they include most things in the world: cloth, paper, rocks, tree bark, sand, grass, and so on. The full list is culture dependent. Inappropriate items are typically of minimal nutritional value and are almost always inorganic matter or plant or plant products. There is not a strong affective response to them as foods, and they are usually not thought to be particularly bad tasting."
- "*Disgust* is a type of rejection primarily motivated by *ideational factors*: the nature or origin of the item or its *social history* (e.g., who touched it). Unlike inappropriate items, disgusting items have *offensive properties*, with the result that there is a *presumption that the item would taste bad*. Thus, disgusts are negatively loaded on both sensory-affective and ideational motivations. Disgusting items have the *capacity to contaminate* and are usually animals or animal products, with faeces being a universal disgust object among adults (Angyal, 1941; Rozin and Fallon, 1981)."

These findings demonstrate the importance of looking at "disgust". It does seem that insects as food can be well fitted in terms of ideational factors, offensive properties, the presumption that it will taste bad (although this was not part of any research referred to) and the capacity of contamination (see Costa-Neto and Magalhães, 2007).

Table 4: Psychological categorization of food rejections (from Rozin and Fallon, 1987)

Psychological Categorization of Food Rejections

	Rejection Category			
Item	Distaste	Danger	Inappro-priate	Disgust
Motivation				
Sensory-affective	P			P
Anticipated consequences		P		P[a]
Ideational		P[a]	P	P
Disgust attribute				
Oral incorporation discomfort	P	P	P	P
Offensive				P
Contamination		P[a]		P
Facial expression	P			P
Nausea	P[a]			P

Note. P = present. Upper part modified from Fallon and Rozin (1983).
[a] This motivation or attribute holds in some but not all cases of the category in question.

Rozin and Fallon (1987) state that: "… disgusting items are undesirable at any stage of interaction where there is a potential of ingestion (preingestion [e.g. sight on a plate], contact with skin, in the mouth, or in the body). They are most undesirable, however, in the mouth.". Above, the table from the article is added (table 4).
It makes clear that offensiveness and contamination are quiet unique to disgust; that disgust is the only type present in the three motivations; and the overlap between danger and disgust. But, in the end it is clear that the contamination feeling often is just a matter of offensiveness. "… it almost always becomes clear that over and above any possible harm, the item itself is offensive." (Rozin and Fallon, 1987). This quote follows from a small experiment with a cockroach: (1) confronting with the disgust item → people justify their rejection on the basis that it will cause harm; (2) asking if they would eat a sterilized cockroach → since they don't, the item appears to be offensive itself.
Rozin and Fallon (1987) conclude: "all the features of disgust successfully distinguish disgust-as-food-rejection from other food rejections." What exactly distinguished disgust from the others is important for this thesis (ideational factors, offensiveness …).

3.5. Nature of objects of disgust/taboo

Already in 1941, Angyal "suggested that all disgust objects are animals or animal products" (Rozin and Fallon, 1987). This has been confirmed by the authors through questionnaires and interviews. Also a cross-cultural test confirmed this (from Fessler and Navarrete, 2003). The authors also mention Pliner and Pelchat (1991) who found that in experiments with Western subjects, they "are more likely to reject novel foods of animal origin than other novel foods" and "animal products are prototypical elicitors of disgust" (Fessler and Navarrete, 2003).
In Western culture, a lot of animals are being considered disgusting as food (e.g. all reptiles, almost all amphibians, all insects, almost all mammals) (Rozin and Fallon, 1987). Of course there is difference among cultures, but still a lot of animal species are found disgusting. It is being mentioned in several articles that since humans are omnivores, they still avoid a whole range of acceptable food (very nutritious food from animal origin mostly) (see Fessler and Navarrete, 2003 and references).
Rozin and Fallon consider all animals and animal products potentially disgusting items. Therefore non-disgusting animals are considered an exception rather then a rule.

There are several theories regarding taboo/disgust from animal origin.

Animalness

This is the most broad theory. Rozin and Fallon (1987) and Fessler and Navarrete (2003) mention the importance of 'you are what you eat'. This means that one believes that he/she takes over the

properties of what he/she ingests. This believe is mostly seen in “savage” cultures like Frazer (1890/1959; from Rozin and Fallon, 1987) explains. But Rozin and Fallon insist that this does not count only for non-Western cultures. They believe that this is also being seen with us by the fact that “a person becomes offensive to us by consuming something that we find disgusting” (Rozin and Fallon, 1987).

So assuming that the belief ‘you are what you eat’ is really present in Western cultures, so people take over properties, Rozin and Fallon (1987) must answer the question: why consider animals and not plants disgusting? They say, by the way, that some people tend to call some vegetables disgusting. This though, is not true disgust but more distaste which is a different thing. The ‘why animals?’ question can have three answers. The first is concerned with the characteristics of animals. Rozin and Fallon (1987) mention that: “In contrast to plants, animals seem to have more relevant and salient characteristics of the sort that might be expressed in a human”. It could be that the similarity between animals and humans plays an important role in the believe that one takes over the properties. This is a symbolic explanation according to Fessler and Navarrete (2003) and is more specifically an explanation on ‘magical thinking’ and ‘totemic beliefs’. Totemic beliefs are “dominated by ideas about animals”. Meyer-Rochow and Moro (1995) describe this as an important origin of taboo for indigenous people. Animals are more likely than plants to be of origin in myths through their characteristic of being animate. This means that they “possess a far greater number of attributes that are potentially relevant to actors in the social world.” (Fessler and Navarrete, 2003). The magical thinking is in line with the shared properties and taking over properties. So through a certain level of identification totemic beliefs and magical thinking occur which is followed by a restriction in the shape of taboo. But again, according to the authors these explanations are not sufficient for the understanding the origin of taboos although they are certainly part of the explanation. In several cultures though, insects are important and some species achieve totemic beliefs. In certain parts of Africa for instance, some termite species are totems and therefore winged termites are forbidden to be eaten (Silow, 1983, from van Huis, 2003). And the Pygmies consider the Goliath beetle sacred which is therefore not eaten (although the larvae and nymphs can be eaten) (Bergier, 1941, from van Huis, 2003). It may very well be that through this, a taboo on these species (and spiders) rests to not eat them (references are missing though).

But totemic beliefs and magical thinking do not count for al animal species on the planet; and indeed, another theory (on distance from humans) will go into that fact.

A second explanation goes about the human-animal boundary. The main idea behind this is that humans tend to think themselves as superior to other animals. They feel a kind of distinction and want to keep this distinction. The view on animals in this part of the animalness theory lays in the fact that people do not want to consume animals that are too similar in a physical way nor to eat animals with

which humans are in close contact with (pets like cats and dogs), so empathy (e.g. Meyer-Rochow and Moro, 1995).

The overall point that is being made, is that the working of the body is too similar. Rozin and Fallon (1987) concentrate therefore much on faeces (which they regard as the number one elicitor of disgust). They use this fact as well when they look at the acquisition of disgust in children. This acquisition is chosen to be left out of my thesis. But an important point regarding the working of the body is mentioned and that is a thing humans do not have in common with animals: tears. This is the only body fluid that is not being disgusted. Experiments have shown that when people spit in their own soup, they feel less willing to eat that soup. Tears are the only fluid that does not remind us of similarity with animals.

The third point is our attraction to animals. Rozin and Fallon (1987) mention that: "Unlike many other rejected potential foods, animals are usually high in nutritive value." Indeed, meat is the favourite food of mankind. At the same time, there is clearly a great ambivalence about eating animals. As Tambiah (1969) puts it, "Animals are good to think and good to prohibit," and this ambivalence may further intensify emotional reactions (Tomkins, 1963). Simoons (1961) scholarly review of animal food taboos repeatedly exposed the strong attraction to and abhorrence of animals as food".

Spoilage and decay

"Because spoiled or decayed items are often objects of disgust, and because such items may be disease vectors, it is natural to suggest that these particular substances form the core of disgusts. This view could account for the widespread disgust for animals on the grounds that (a) animals are all potentially decayed; (b) many animals consume decayed material or garbage or, as carnivores, consume other animals; (c) many animals, particularly carnivores, produce putrid faeces." (Rozin and Fallon, 1987). But important with this is that this form does not exist with young children. This form only pops in at a later stage through maybe cognitive-emotional development or more possibly by "acquisition of culture" (Rozin and Fallon, 1987). Eel is being eaten too!

On first sight this does not seem that important for food aversions in the sense that it does not explain all disgusts, Rozin and Fallon realize this. They believe though that it increases an object's disgust capacities.

The interesting part is the health aspect related to this. As Meyer-Rochow and Moro (1995) say that a large proportion of food taboos originated in "the aim of protecting the health of a individual". Examples are given from non-Western cultures. But the authors do not make a link to disgust! These seem more of a practical ground. This is a so called functionalist approach to explaining food taboos according to Fessler and Navarrete (2003). The health aspects of meat taboos is of a Direct Benefit Explanation (that fall under the functionalist approach). Pork avoiding by the Hebrew is the best known example: it is believed to avoid trichinosis (Fessler and Navarrete, 2003; reviewed in Douglas 1966, Simoons 1994). But according to the authors the explanation does not cover the whole aspect: it

misses a psychological part (as mentioned above). This health aspect can be seen in a different way as well: the personal hygiene in relation to animalness, as Haidt et al (1997) state: “Thus concerns about the personal hygiene of the self and others turn out to be good predictors of disgust sensitivity (Haidt, McCauley & Rozin, 1993). And the linkage of concerns about hygiene and animality helps explain the otherwise puzzling statement that "cleanliness is indeed next to godliness" (attributed by Bartlett to the theologian John Wesley, Sermon XCII). There is a long tradition in Western religious practice (Douglas, 1966), as in Indian religious practice (Fuller, 1992), in which bodily cleanliness and "purity" are required before one can approach God. Human beings are suspended between God (or Gods) above and animals below, and we rise and fall as a function of our success in hiding or overcoming our animality”. This is in the line of the further explanation of Mary Douglas. This symbolic explanation (in contrary to the functionalist approach) is grounded on the belief that “many taboos revolve around issues of purity and pollution” (Fessler and Navarrete, 2003, from Douglas 1966 and others) and this purity and pollution is strongly connected to disgust (e.g. Haidt et al, 1997). Concerning insects, they are often perceived as dirt / dirty (see also section 2), so the connection to spoilage or decay might not be far from truth.

Distance from humans

An interesting theory that will be very useful when talking about food taboo on insects, is the one on *distance from humans*. The matter is: how far from the self is an object concerned disgusted (or/ and therefore taboo) as food.

Items that are very close to or very far from a person are being rejected. Insects and other invertebrates are too far from humans. Being too far means that they are to different. The items considered too close are the ones that are too similar like it has been expressed earlier; primates, pets and other humans belong here (empathy). Although for instance primates are not that similar, they are emotionally too close because of their emotional properties. Of course exceptions exist like shrimps, which are very far from humans but are eaten with delight.

But then there is definitely a cultural context involved as well: next to shrimps being eaten here with us, in China dogs are being eaten (but are they considered pets in China?).

Anomaly or the problem of categorization

This symbolic explanation is also being called ‘categorical ambiguity’ (Fessler and Navarrete, 2003). Next to the distinction of animals being too far or too close to humans, the anomaly makes another point of the position of animals towards humans. Anomaly means that the item of disgust is not necessarily too far or too close, but means that it is difficult to place it in the right category. Humans tend to make clear-cut classifications of the objects in the world (Rozin and Fallon, 1987). Leach’s opinion (1964) is being described in Fessler and Navarrete (2003): "… proposes that taboos focus on entities classed at the periphery of categories, the antithesis of prototypicality.” So animals having properties of different classes are disturbing and may lead to being tabooed. The idea behind it is again

the pollution or being considered ‘dirt’. Pets can be fitted in here because they “challenge the basic human-animal distinction.” (Rozin and Fallon, 1987). But both duos of authors are aware of the difficulties for anomaly to explain taboos. “… large number of disgusting but common animals such as insects cannot easily be explained as anomalies.” (Rozin and Fallon, 1987). Therefore, this theory will not be able to explain rejection of insects as food.

Ecological circumstances

Another possible origin of taboos is due to *ecological circumstances* (Meyer-Rochow and Moro, 1995). This aspect has been mentioned in ‘food habits influenced by environmental pressure’. Meyer-Rochow and Moro (1995) mention some other examples.

Social nature

The last possible origin mentioned here is of *social nature*. Two aspects of this theory can be distinguished: to “aid in cohesion of a group” (Meyer-Rochow and Moro, 1995) and to stress social constructions within a culture. Concerning the first, an example from Jewish and Muslim belief is used: it is suggested that “taboo on pigs may be regarded as a kind of cultural rationalization after the event: the animal was difficult to manage anyway” (Nielsen, 2000). Simoons (1994) argues that the Jews and Muslims are originally nomadic. Since it is impossible to keep pigs, they used a pig prohibition to identify themselves from sedentary farmers who could (Nielsen, 2000). In the same way as food serves this function, food taboos serve it. This cultural importance might have implications toward entomophagy: who will dare to join in if it is barely accepted (and seen as something disgusting)? Concerning the second, a research in the village Bun in Papua New Guinea, revealed that food taboos can arise in maintaining the existing social construction and relations (McDowell, 1979). The Anufo of Ghana show that food taboos can arise to stress hierarchy: separating those who look for food (the men) from those who prepare it (the women). Women may not collect frogs for food (Kirby, 1987).

Especially in food taboos, it is clear that the social aspect is of huge effect: how to render a not accepted food (tabooed food) accepted? Where lays the social harm?

A positive answer can be given to this question. Even though a strong moral emotion, disgust, is strongly linked to the practice of entomophagy in the West, the moral judgment seems to not take place firmly. At least with a low degree of social harm! Suggesting that disgust is (likely to be) a personal barrier, and when this barrier has overcome, the ‘social barrier of disgust’ to beat, is not that strong (varying obviously on culture, specific characteristics of the social environment). For instance, both in beginning days of the aversion of the Jews and in the research of Costa-Neto and Magalhães (2007) it was stated literally and cited something in the way of: “if they do it, okay, let them, but not me”. This can not be regarded this as full proof though, since there was only a minimum of attention to the social aspect of harm, specifically on entomophagy.

Food taboos can be categorized in temporal and permanent taboos (Den Hartog et al, 2006). It can be recognized that the taboos due to ecological circumstances mentioned are of temporal kind, however, they can also be of permanent kind (e.g. Meyer-Rochow and Moro, 1995). Taboos related to totemic beliefs are clearly of only the second category.

3.6. Connection of theories

There are some clear similarities and even overlap between the theories on origins of taboo (this section) and the theories on origin of negative attitude toward insects (see perception of insects).
Health – spoilage and decay. The theory on health aspects as origin of negative attitude involves the link between human diseases and arthropods. The taboo theory on spoilage and decay is also concerned with this health and disease aspect.
Distance – distance from humans / animalness. These three theories clearly overlap: all three of them regard insects being morphologically and behaviourally too distant making them too different.
Insignificance / autonomy – animalness. These three theories are similar in the way that humans tend to find themselves superior. This superiority is under threat by realizing the insignificance of the human being in comparison to insects and in relation to insects being quite autonomous from humans.
Further, there can also be made some connection between the theories on negative attitudes / taboo toward insects and the characteristics of disgust as a type of food rejection. Remember disgust having sensory-affective and ideational aspects, only the ideational aspects can be dealt with here (there is no taboo theory or negative attitude theory based on this aspect).
Especially in *Monstrosity* and *Mysterious Creatures* there are ideational components: these theories reflect on what the item is. They focus on the morphology and behaviour, clearly ideational aspects. *Insignificance* and *Autonomy* being the other two psychological explanations also seem to refer to what the animals are (nature, origin) and can then be seen as ideational aspects too.
Making a link to the morphology and behaviour, the *distance* theory should then also be added as having 'disgust features'.

3.7. Some important processes on the rise, spread and persistence of taboos

Fessler and Navarrete (2003) have come up with four processes that can be of influence on the rise, spread and persistence of taboos. They help to understand the 'tabooing' of entomophagy in the West and the difficulties of changing cultural rules, even though these rules can be changed as has been mentioned. These processes are of social importance and show that tabooing an item is very much human. Indeed, taboo formation (and disgust) has a strong cultural component. As Meyer-Rochow and Moro (1995) state: "Any interpretation of food taboos has to consider the region they operate in and

the era or circumstances they came into existence. Even so, rational explanations are not always possible and what to one group is strictly taboo, to the other may be perfectly acceptable".

Normative Moralization

"In response to a *common* environment, a *shared predisposition* often leads to patterned behaviour across members of a group. Observers may then note the prevailing pattern and *imbue it with rectitude*, a process we term *normative moralization.* Motivated by moral sentiments, actors then proscribe violations of the pattern" (Fessler and Navarrete, 2003). However, this process is poorly understood (Sripada and Stich, 2004). Sripada and Stich are apparently preparing a paper on this mechanism (unpublished up to this date).

As an example Fessler and Navarrete (2003) mentioned the association of being right-handed with purity (a word that as previously noted is closely related with disgust) and politeness. This common behaviour is being justified and seen as correct in contrary to left-handedness. This was (is) seen in Christian families as I know my grandfather (raised in Christian way, still goes to church) is actually left-handed, but was forced as a child to write with his right hand.

Humans cooperate. This is a complex cooperation. To make such a cooperation work, to trust each other, "human beings, then, live in a rich moral world of reputation and third-party concerns" (Haidt, 2003). Haidt (2003) also suggests that humans tend to have "negative feelings toward individuals with whom we never interacted" and that people care about each others acts (what one does to another). Fessler and Navarrete (2003) explain that when this cooperation has evolved, to maintain the cooperation some features are necessary: to identify to shared standards and to conform to these standards. Some predictability should be present which is seen through the acceptance of standards. This should ensure the maintenance of a cooperation between human individuals. The standards are eventually moralized: this is the right behaviour. Not taking part of this behaviour should then be punished: my grandfather was forced with the according punishments to write right-handed. Importantly, "many standards are tacit" (Fessler and Navarrete, 2003). It is therefore suggested that our ancestors had this behaviour of cooperation based on setting such standards, conforming to them, and moralizing them, especially because this would have given them advantages for easier cooperation. This being such an old rooted and passed on behaviour, the authors follow Bateson (1983; from Fessler and Navarrete, 2003) suggestion that all humans tend to have this behaviour. Therefore, a spontaneous common behaviour (such as being right-handed), will be favoured over an exception (being left-handed) which by normative moralization results in a taboo. As disgust is a moral emotion pointing out non-moral behaviour in that culture (Haidt, 2003).

Could this be connected to food taboos? People all over the world leave many nutritious animals untouched. Maybe it never occurred to try them out? Is this a spontaneous common behaviour to not

consider certain animals as food? Then, it would be possible that a taboo has arisen on this animal. Meyer-Rochow and Moro (1995) state: “Although mere avoidance of potential food (for whatever reason) does not in itself signify a food taboo, it is easy to see how regular avoidance can turn into a tradition and eventually end up as a food taboo”.

Egocentric Empathy

This process concerns the “evocative power of others’ behaviour” (Fessler and Navarrete, 2003). Egocentric empathy is being triggered when one witnesses another person’s actions and one imagines him- or herself in that person’s position. In this way, “individuals experience others’ *behaviour* as if it were their own, yet ignore others’ subjective states, relying on their own dispositions instead” (Fessler and Navarrete, 2003). When adults watch children play with or even consume their faeces, they feel disgusted although the child shows no sign of disgust. This egocentric empathy is suggested to have its origin in evolution. Disgust and fear (associated with harm) seem closely related to this mechanism. Evolutionary speaking, avoiding possible harm is an advantage: “… it led individuals to either distance themselves from others engaging potentially dangerous actions or seek to prevent such actions from occurring” (Fessler and Navarrete, 2003). The authors suggest that it is a panhuman feature and therefore easy to be firmly established: “when a significant fraction of a group experiences the same aversive response to a given action, egocentric empathy can contribute to the formation of taboos, as observers seek to prohibit actors from doing things that cause the observers pain (cf. Westermarck, 1906)” (Fessler and Navarrete, 2003).

Socially Mediated Ingestive Conditioning

In this part, the “omnivore’s dilemma” is at stake. Rozin (1979; from Fessler and Navarrete, 2003) states that omnivory gives more possibilities in encountering toxins than other diets. Therefore omnivores rely on social information regarding new foods (Strum 1983; Visalberghi et al 1998; from Fessler and Navarrete, 2003)). The clue here is that through the experiences of a few, being observed by others, food avoidances can be established. According to the authors, an important feature here is nausea. Human have the ability to rapidly learn to avoid items that elicit nausea (Bernstein, 1999; from Fessler and Navarrete, 2003). Through the nausea (vomiting) experience of one, seen by others, these others quiet easily elicit the feeling of nausea and disgust. The authors claim that this process is an evolutionary one: “By making the *sight* of toxicosis nauseogenic, natural selection has bootstrapped an existing mechanism to serve a new purpose.” The food item is being avoided and a taboo may be formed when also normative moralization and egocentric empathy come into play, which is according to the authors very likely.

Biased Transformation, Direct Observation, and Self-Serving Manipulation

Social learning is important in human interaction. There are two ways distinguished by Sripada and Stich (2004): directly biased social learning – trying out different cultural variants to find the best one, and indirectly biased social learning – copying the cultural variant from a marker such as "the commonness of a cultural variant or the prestige of cultural variants" (see also Fessler and Navarrete, 2003). Considering the omnivore's dilemma the indirect one is most interesting as trying out all food is costly (toxins!) and time consuming. This type of social learning is foremost then. It is stated by Boyd and Richerson (from Fessler and Navarrete, 2003) that this approach is indeed most likely in variable environments, and when information is costly. I will not go into this.

Prestige bias. Here, the focus lays on the status of individuals, the success that person has for that culture relevant aspects of life (Sripada and Stich, 2004). It is difficult though, to exactly point out which aspects that make that person so successful and therefore should be copied. But mathematical models have shown the usefulness and successfulness of this strategy (e.g. Boyd and Richerson, 1985; from Sripada and Stich, 2004). Then, prestige bias being an interesting strategy for individuals, there is room for errors so maladaptive (and neutral) cultural variants can be copied.

Conformist bias. This strategy copies the cultural variant at a certain location that is most common with the underlying thought that this variant most probably is the most adaptive one at that same location (Henrich and Boyd, 1998; from Fessler and Navarrete, 2003). This strategy also being a very successful one, also here errors can be made. Maladaptive cultural variants can get established through for instance prestige bias.

To stay on the food path, it is not difficult to see that both of these strategies are believed to work on food habits as well. As explained earlier, food habits are under major influence of culture: both copying what is common (culture defines what is edible and what not) and copying a prestigious person (heroes) is applied. Consequently, food taboos arise in the same manner (considered maladaptive variants by Sripada and Stich, 2004).

Fessler and Navarrete (2003) make a suggestion how these four processes interact with each other with tabooing meat:

Most probably, the *socially mediated ingestive conditioning* is the core mechanism to have developed aversion to meat.

Poisoned individuals and their witnesses will have learned the dangers with meat; therefore, avoidance of meat can easily occur.

↓

Next, when the avoidance of meat is common in a given population, *normative moralization* comes into play to institutionalize the pattern of avoidances and to justify them by several possible explanations (for instance cosmological beliefs such as, most probably, totemic beliefs). Here, consuming an item that is considered aversive is now morally wrong and sanctions may follow. The taboo is formed (Sripada and Stich, 2004).

↓

Following from this, *egocentric empathy* will aid in institutionalizing by preventing "others from engaging in behaviours that elicit an aversive response in themselves" (Fessler and Navarrete, 2003).

↓

Socially mediated ingestive conditioning can be a possible tool for the spread of the taboo and aversions, "as observers may acquire the responses of those who are nauseated at the prospect of violating the taboo or eating something that 'is not food'" (Fessler and Navarrete, 2003).

↓

Conformist bias and *prestige bias* are suggested to make bigger contribution to this spread: ". . . from a small sub-set of the population to a much wider section of the population: prestige bias when the aversion is still rare, and conformist bias when the aversion has reached critical mass" (Sripada and Stich, 2004).

By the very likeliness of meat being avoided and by the strength of the prestige bias process, the chance that meat will be the food tabooed increases.

Then, more opportunities are met to witness (possible) negative reactions to meat so that conformist bias further firmly establishes the taboo.

This diagram can not be used on entomophagy in the West since it was never present and the 'taboo' does not seem more than: 'not considered a food' in regard of the overwhelming negative attitudes. What is the use then of discussing these processes in this thesis?

By mentioning *maladaptive variants*, the topic of the irrationality of emotions is briefly touched which was the actual topic of Sripada and Stich (2004). Eating something that is not considered 'food' can become morally wrong following from normative moralization. Indirect bias (conformist and prestige) has the possibility to set a taboo, even maladaptive taboos in which norms and values are accompanied. When this has established in individuals, and emotions concerning these maladaptive variants are triggered when facing this variant (which is perceived as adaptive), the emotions are according to Sripada and Stich (2004) irrational.

The disgust emotion in connection to the negative attitudes toward insects, which are barriers to entomophagy in the West, might be irrational. But unfortunately, there is no time and space to elaborate on this aspect further. Can the aversion of entomophagy be regarded as maladaptive? But the

aversion originated with other aspects of insects than eating them (see 2.2., 3.5., and 3.6.)! These aspects should be discussed first in regarding (mal)adaptive aspects and (ir)rationality.
These processes show that something unconsciously tabooed, can be 'actively' tabooed (found morally wrong) through normative moralization and indirect bias. In promoting an unconventional unconsciously tabooed food it is important to acknowledge the existence of this chance. That insects are not food is already a cultural law in the West. This law can get even more fixed by entomophagy becoming a taboo through these taboo formation processes. By understanding these processes, possibilities to avoid a complete taboo on insects can be sought.

3.8. Concluding remarks

As insects are being rejected as food by Western people, they are unconsciously tabooed because they were never regarded as food. The emotion of disgust, an often seen expression of the negative attitude toward insects, counts as one of the food rejections. This emotion is often at stake out of ideational factors: because of what the food item is. Several theories explain origins of food taboos on meat and the accompanied disgust. These clearly overlap with the theories on negative attitude toward insects. The processes have been described in which something that is not seen as food can become morally wrong and therefore tabooed. This would be problematic when the contrary, acceptance, is the goal. Understanding these processes is a huge step toward prevention of taboo formation. Information can be a helpful tool (see section 5), while other tools may need to be sought.
This section has shown the existence of a clear-cut connection between: (1) the aversion of insects with disgust, consequently (2) the emotion of disgust, as food related emotion due to ideational factors, resulting in rejection and aversion of insects as food, and (3) the possible fixation of the cultural law in Western society as a taboo.

Section 4 : Aspects in Liking Foods

Two aspects in liking a food are relevant considering the promotion and acceptance of insects as food. First, due to dealing with an unconventional food item and the related aversion to it, it will be useful to explore food neophobia (fear of new foods). Also the emotion disgust will get some attention. Second, an exploration on the origins of food likes and dislikes revealed the importance of cognitive aspects. Due to the fact that insect eating has ethical advantages in comparison to eating conventional meat, the importance of cognitive aspects in liking a food should be stressed. These aspect could give clues on developing the approach toward acceptance of insects as food.

4.1. On food neophobia

Pliner and Salvy (2006) stress that studies on food neophobia most of the time concentrate on "ethnic" foods (an ethnic food is novel to one culture but familiar in another culture). Edible insects were never regarded as a food by Western people and are therefore a novel food. Moreover, since in many non-Western cultures insects are being eaten, insects can be regarded as a novel ethnic food. Importantly, "there is evidence suggesting that willingness to try ethnic novel foods is related to scores obtained on the Food Neophobia Scale (FNS)" (Pliner and Salvy, 2006). Therefore, discussing food neophobia can give clues on how to approach people with the new food: insects.
To further explore the possibilities of acceptance for this new food, food neophobia then has to be discussed. It can be (carefully) concluded that indeed neophobia is an important aspect when considering the perception of insects and the importance of disgust in it. As will be made clear below, this disgust factor is also an important aspect in food neophobia. Although in possibly many cases the disgust reaction is not expressed, discussing food neophobia can give clues on how to approach people with this new food.
Neophobia gains more and more scientific attention. The most important scholar researching this field for several years now is Patricia Pliner. Since the lack of other constant work in this field, mainly her research is used for the exploration of food neophobia.

4.1.1. Characteristics of food neophobia

The mechanism of the "omnivore's dilemma" (explained above), suggests that neophobia serves a protective function (see also Birch, 1999) and might imply that people generally tend to be neophobic (see Pliner and Salvy, 2006). The opposite of neophobia is neophilia, interest in new foods.
Considering the "omnivore's dilemma" and the knowledge we have nowadays on foods, one might think though that neophobia is maladaptive. This neophobia cooperates with the learning mechanisms (the predispositions to learn preferences and aversions; for instance to like foods that taste sweet and to dislike foods that taste bitter or can be irritant, respectively coffee and chilli) which are intended to reduce the neophobic response. The initial neophobic reaction could be transformed through learning into a preference where experience is then an important aspect (coffee and chilli are widely accepted nowadays and are part of many people's food habits) (Birch, 1999). It is most interesting to learn how the neophobic reaction can be reduced (and transformed into a preference).
Even though little seems to be understood (Birch, 1999), a few characteristics can be distinguished of food neophobia. First, the neophobic rejection is species-typical which changes during development from child to adult: neophobia decreases from childhood through adulthood (e.g. Pelchat and Pliner, 1995 and Pliner, 1994; from Birch, 1999). In fact, when these findings are connected to the research

conducted by Koivisto and Sjödén (1996; from Birch, 1999), it seems that the relation between age and the neophobic reaction is of curvilinear nature: “Neophobia is minimal in infancy, increases through early childhood, and declines from early childhood to adulthood” (Birch, 1999). Second, the strength of the neophobic response differs among individuals (and between genders). Third, there is some evidence for familial similarities. And fourth, neophobia “may be linked to other temperament and personality characteristics (Pliner and Lowen, 1997)” (Birch, 1999). While the last characteristic is known to have a genetic link (Birch, 1999), the other characteristics suggest that genetics come into play as well. Therefore, it might be possible to find out whether someone is neophobic and how strong this reaction is in that person. Of course, from these findings follows that the eating environment created by the neophobic parents influence the further reaction of the child to novel foods which then can influence it further in life (Birch, 1999). One important expression of the neophobic reaction is “not because [people] believe [that] the foods are potentially dangerous but because they anticipate that the foods will taste bad (e.g. Martins et al, 1997)” (Birch, 1999). Even more, this occurs in rather “safe environments” such as school cafeterias (Birch, 1999).

Further, Pliner (unpublished data; in Pliner and Salvy, 2006) “. . . found a strong positive correlation between scores on the Food Neophobia Scale (FNS), a measure of the trait of food neophobia, and the Disgust Scale.”! While Rozin and Fallon (1987) concentrate on familiar foods, Pliner and Salvy (2006) are confident that the same categories of food rejection (dealt with before) account for novel foods as well.

Pliner and Salvy (2006) distinguish large *situational differences* (in general, humans tend to reject novel foods but there are situational differences “in the extent to which such neophobic behaviour occurs” (Pliner and Salvy, 2006)). They recognize also large *individual differences* (where it involves “a relative preference for familiar over novel foods that is stable over time and consistent across situations” (Pliner and Salvy, 2006). From this insight, Pliner and Salvy (2006) have made an attempt to create a definition for the behaviour of ‘food neophobia’:

> “Neophobia is defined in terms of the average willingness to taste the novel foods, usually divided by the average willingness to taste the familiar foods (so as to take into account willingness to accept any food at all at that time and in that situation).”

But not only is neophobia related to willingness to try novel foods, it is also related to the expected liking for novel foods (Pliner and Salvy, 2006).

4.1.2. Situational factors affecting food neophobia

Here, food neophobia will be discussed “. . . as a behaviour involving rejection of a novel food or foods in a particular situation” (Pliner and Salvy, 2006).

Indirect information

In indirect information, the stress lays on expectations. According to Rozin (1988; from Pliner and Salvy, 2006), the expectations in food acceptance are dual. First of al, the expectation is of good taste, and second, the food is beneficial. When these expectations can be secured, a reduction in neophobia can very well be accomplished. Several studies (e.g. Pelchat and Pliner, 1995 and Martins et al, 1997) confirmed that information on the good taste increases willingness to try the new food (Pliner and Salvy, 2006). But, concerning information on the beneficial consequences of the food, a more complex situation appears. A research conducted by Pelchat and Pliner (1995; from Pliner and Salvy, 2006) revealed that this kind of information does not increase the willingness to try the new food. This is consistent with two other studies (see Koster et al, 1987 and Woodward, 1945). The studies by Pelchat and Pliner (1995) on this indirect information were conducted in a students' cafeteria by putting signs at the new food saying "tastes great!" and in the other case: "a good source of iron". They were not present at the same time. Information on the beneficial consequences is not useless though. While there is an overall decrease of willingness among students, there is an increase in the willingness in "individuals for whom this information is important or relevant" (McFarlane and Pliner, 1997; from Pliner and Salvy, 2006) or "in a context where the new food is believed to be readily available" (Martins et al, 1997; from Pliner and Salvy, 2006). This could mean that for people, in the first case, concerned with ecologically sound breeding of animals or healthy natural products, this information is valuable.

Providing information can help to increase willingness and seems to work for some kinds of foods, but "it appears to be relatively ineffective for reducing rejections mediated by strong emotional reactions *such as disgust*" (Pliner and Salvy, 2006). Even more discomforting: "Martins et al (1997) found that neither taste information nor beneficial consequences information increased participants' willingness to taste novel *animal* foods" (Pliner and Salvy, 2006)! The suggestion made in the section on the human perception of insects that disgust (and fear) can be reduced, might then, following the authors, not apply for insects on the plate. But, Rozin and Fallon (1987) mention that by contact, the disgust response can loose strength, either by extinction, or by adaptation.

Direct information

Direct information refers to one's own experience. The mere exposure theory (developed by Zajonc, 1968) is at stake here (Pliner and Salvy, 2006): ". . . the neophobic response is reduced by repeated opportunities to consume new foods (Birch and Marlin, 1982)" (Birch , 1999). This implies that this reduction is achieved when one learns that the food is not harmful (it is safe) and it does not cause illness (Kalat and Rozin, 1973; from Birch, 1999), meaning that it does not cause negative gastrointestinal consequences (Pliner and Salvy, 2006). It could be seen in the light of the danger

aspect of the psychological classifications of food rejection (see section 'disgust as food rejection' and Rozin and Fallon, 1987). The danger of harmful consequences is gone and the good taste and beneficiality make the food accepted. Next to this, because the presumption of a food tasting bad could be proven false (not in all cases of course), disgust as rejection could be reduced? This effect is called 'learned safety' (Pliner and Salvy, 2006). It counts for both children and adults (e.g. Birch et al, 1998 and Pliner, 1982; from Pliner and Salvy, 2006). When children are offered several new foods in different amounts of exposure, "there was a positive effect of number of exposures on choice and liking" (Pliner and Salvy, 2006). Although this mechanism's correctness is not fully proven, Rozin and Vollmecke (1986) make an important point that has been mentioned previously (see 1.2.): "Whether or not mere exposure is a sufficient condition for increased liking, exposure is surely critical in making it possible for other processes to operate that influence liking".
But still there is an issue concerning giving information: (1) disgust is very difficult to reduce, (2) novel animal foods is a difficult category, and (3) taking into account (1) and (2): the role of proving the wrongness of the presumption that a food will taste bad for reducing the disgust response.

And indeed, when positive experiences are created (good taste and beneficiality) a certain generalization occurs. Meaning that the barrier to taste other new foods is lower. This only seems to work to some extend though, which was shown through experimentation by Loewen and Pliner (1992; from Pliner and Salvy, 2006) when children (7-9 years old and 10-12 years old) were offered good-tasting familiar, good-tasting novel and bad-tasting novel foods. Exposure of both novel foods decreased willingness to taste other novel foods in the younger children while the older children expressed an increase in willingness with no effect of the bad-tasting novel foods (curvilinear nature of neophobia and effect of the good taste). On the other hand, Pliner et al (1993; from Pliner and Salvy, 2006) found that in experimentation with adults, pre-exposure to good-tasting novel foods increased the willingness to taste other novel items. This willingness was expressed through asking the participants to choose foods to taste later on. The adults that were pre-exposed to good-tasting familiar foods chose less novel items (Pliner and Salvy, 2006).
But consider the success of the event 'City of Insects' (Wageningen, September 2006) and the willingness of children in trying insects at the '4ème Festival International du Film de l'Insecte (Narbonne-Gembloux, du 17 au 21 octobre 2001)' (Mignon, 2002). Of course, for this last one, the 'amount' of disgust in these children should be compared to grownups[2]. The successes of the two events might have triggered a more positive attitude: these (single) experiences did not lead to a rejection, but neither did they lead to a demand for edible insects. But on the other hand, where should

[2] Although this is valuable information, I will not go into the aspect of the acquisition of disgust. For this, I refer to the excellent article of Rozin and Fallon, 1987.

those that want to eat it more turn to? The events did not study any *change* in people, they did detect willingness though. Could those both events have been examples of 'sensation-seeking'? These events might have elicited an acceptance of this food. Accepting insects as food does not necessarily mean that it immediately turns to preference and becomes part of the food habit. These two events were cases of a (most probably) single experience. And in the case of 'City of Insects', there might have been influence of the context considering media attention and setting the world record of the most people eating insects at the same time. None the less, just these two single experiences trigger a certain willingness and therefore is a positive result.
Can these two cases be considered as pre-exposure?

Social influence

First of all, "social pressure (custom, the behaviour of elders, the foods made available to the child) forces exposure, which may directly (mere exposure) or indirectly produce liking" (Rozin and Vollmecke, 1986). Especially with children, peers and parents are of major influence on their likings. The same seems to account for the neophobic reaction. When mothers eat an item first for instance, it is more likely that the child will taste it too (Harper and Saunders, 1975; from Pliner and Salvy, 2006). Moreover, it is important to recognize that "the perception that a food is valued by respected others (e.g. parents) *may* itself be a mechanism for establishment of liking" (Rozin and Vollmecke, 1986). Especially on behalf of the peers though, a certain enthusiasm is needed. It is mentioned before that when a child is forced, liking does not seem to occur. Similarly, children like a food less when they notice that others (like peers and adults) "do not value that food for itself" (Rozin and Volmecke, 1986). Therefore, the social context is of major importance. But the relationship of the child with the peer or adult defines the success of the reduction. It is very easy to understand that a mother has more effect than a stranger (see Harper and Sanders, 1975; from Birch, 1999) which also counts for heroes being more effective than an 'ordinary' adult (Birch, 1999). Didn't Timon and Pumbaa in 'The Lion King' feast on insects? Two suggestions are made by Birch (1999) how these findings can explain reduction in neophobia: "They may induce the individual to sample the foods, and once this occurs, associative learning processes that reduce neophobia can come into play", or, through the fact that ". . . children form associations between foods and the social context in which eating occurs".
On the other hand: Mignon (2002) describes the effect on the '4ème Festival International du Film de l'Insecte (Narbonne-Gembloux, du 17 au 21 octobre 2001)' when parents and children were offered different kinds of edible insects. The children were more curious and did not hesitate as much as their parents did when trying them out! The children tried more different species than their parents did. So in this case, the hesitation of the parents didn't make the children hesitate themselves, on the contrary!
Also, regard the following experiment. The experiment is conducted with grasshoppers, although the grasshopper was not the goal of the experiment: "A relevant study compared a variety of techniques

designed to increase adults' liking for grasshoppers (Smith, 1961). The most effective technique used the smallest financial reward and a communicator (person encouraging the ingestion) who was relatively cool and not especially likable. This technique inclines subjects to account for their ingestion of the grasshopper in terms of internal motivation, since external causes were minimal. As the theory predicts, the result is an increase in liking." (Rozin and Vollmecke, 1986). This provides evidence for the possibility to actually like an insect, a grasshopper in this case. The participants were not forced to eat it, there was no social valuation present. It was just the participant and the grasshopper. Therefore, the participants relied only on themselves to appreciate or not appreciate the grasshopper, and they did.

Type of food

Section 3.4. discussed the fact that food of animal origin is more easily rejected than other kinds of foods like plants. It was also mentioned that the reaction involved in this rejection of novel animal foods resembles a disgust reaction. This reaction does not seem to exist in young children (age 5 to 11, Pliner, 1994, see also Fallon and Rozin, 1987). This group of children does not reject novel animal foods more than novel non-animal foods. As said before: "the rejection of novel animal foods is mediated by disgust which is acquired at older age" (Pliner and Salvy, 2006). Then of course, the neophobic reaction toward novel animal foods might be explained by the theories mentioned in 'nature of objects of disgust/taboo' (section 3.4.). At the same time, it might prove why the 'insect-tasting' at the film festival was more successful with children than with adults. Very likely, in the context of the film festival and possibly the age of the children made them more sensation seekers and less disgusted / influenced by the parents. That situation may have even had a certain level of social valuation?

Amount of novelty

Decreasing the amount of novelty, facilitates the willingness of both adults and children to try a novel food item (Pliner and Salvy, 2006). Adding familiarity can be done by adjusting flavours (as was already being proposed by Rozin and Rozin, 1981; from Pliner and Hobden, 1992). Consider the company Hotlix®, producing crisp-like-flavoured dried crickets. Perfect to eat in front of TV.

4.1.3. Individual differences in food neophobia

Very briefly, the following is considered: "food neophobia as a personality characteristic involving a relative preference for familiar over novel foods that is stable over time and consistent across situations" (Pliner and Salvy, 2006).

Individual differences occur mainly in sensation seeking, age and through living environment (and also, but less relevant in gender). The difference in age has been discussed before (curvilinear nature). Concerning the living environment, people in rural areas seem more neophobic than people living in urban areas (see Flight et al, 2003 and Tuorila et al, 2001; Pliner and Salvy, 2006). On sensation seeking, the Sensation Seeking Scale developed by Zuckerman (1979), correlates in general with the FNS. Further explanations on the how and why are not given by Pliner and Salvy (2006).
Considering these individual differences, the conclusion can be made that neophobia is a personality trait.

4.1.4. The mechanisms of food neophobia

Pliner and Salvy (2006) quote Wong (1995) who stated that "there have not been many systematic attempts to uncover the mechanisms of food neophobia". The suggestion is made though, following animal research, that a clue in understanding the mechanism lies in the emotional responsiveness. When pre-exposed to novel foods, acceptance of other novel foods is increased (e.g. Braveman, 1978; from Pliner and Salvy, 2006). The pre-exposure makes animals less emotionally responsive, and therefore less neophobic.
This is consistent with findings of for instance Pliner and Hobden (1992; from Pliner and Salvy, 2006): there are correlations between scores on the Food Neophobia Scale and the General Neophobia Scale ("a measure of the willingness to approach novel people and situations" (Pliner and Salvy, 2006)). Further, Pliner and Loewen (1997; from Pliner and Salvy, 2006) found that "emotionality was significantly related to food neophobia" when examining children's temperament. The same accounts for anxiety in adults (see Pliner and Hobden, 1992 and Galloway et al, 2003) where correlations exist between anxiety and the Food Neophobia Scale. But, this remains unclear since other studies (e.g. Potts and Wardle, 1998) have failed to reach the same results (Pliner and Salvy, 2006). Nonetheless, the emotion of disgust (and fear) plays an important role in food neophobia. Food neophobia is very much an emotional reaction. The emotion of anxiety can be linked to the aversion category of danger.

4.2. Importance of cognitive aspects

Two bases of food attitudes can be distinguished: affective and cognitive bases. The affective bases of food attitudes cover ". . . the sensations, feelings and emotions one experiences in response to food, like pleasant taste and mouth feel, the pleasure of sharing it with friends, or the emotions that arise from its consumption." (Cervellon and Dubé, 2004). Important aspects in this definition are: taste and mouth feel, the social function and ingestion consequences. Contrasting to the affective bases, the cognitive bases ". . . contain positive and negative attributes and consequences of a more functional or

symbolic nature, like nutritional value, convenience, or health consequences." (Cervellon and Dubé, 2004). These aspects (sources of influence) have been put into a detailed scheme for origins of food likes and dislikes (Letarte et al, 1997).

Table 5: Codification scheme for the origins of food likes and dislikes (from Letarte et al, 1997)

Nature of the origin	Category	Sub-category
Affective	Sensorial aspect	taste; texture; smell; visual appearance; food combinations; pleasure/displeasure*; intense pleasure/ displeasure†; temperature; other
	Emotional aspect	relaxation; happiness/love/friendship; stress/anxiety; reward
	Social aspect	family tradition; cultural tradition; interrelation with people; other memories; in family; in pairs (lovers); with friends; alone
Cognitive	Physiological consequences‡	nutritional value, satiety; anticipated reactions; health
	Functional aspect	flexibility; preparation; variety; price; innovation; consumption; storage
	Symbolical aspect	identification of beliefs about origin or about quality, specific ideologies such as nature, environment, etc.

* Expression of light or moderate level of general pleasure/displeasure.
† Expression of intense level and general hedonic response with no reference to any specific aspect of sensual experience (e.g. "I simply love it").
‡ Benefits for likes and anticipated consequences for dislikes.

Studies conducted by Cervellon and Dubé (2004) and Letarte et al (1997) have shown that aspects as health, functionality (think of fast-food) and ecology do have influence on liking a food (table 6). These aspects are not of the same value as affective aspects following from research by questionnaires. Nevertheless, their importance cannot be disregarded.

On liking or disliking a food, the importance of affective aspects (with dominance of sensory aspects as taste and smell) seem overwhelming. The cognitive aspects seem to have more influence on liking a food than disliking a food. Therefore, it can be concluded that these aspects could be of a surplus value for people turning to entomophagy. Considering vegetarians, very often they are vegetarian because of some ethical/moral issues. Therefore, entomophagy with its ethical advantages (chapter 3 and 4) can gain interest by focusing on these advantages when presenting it to people. But due to the overall importance of sensory aspects and that it seems that when a culture encounters a new food, the main criteria is taste (see Cervellon and Dubé, 2004), information on the taste[3] of insects should be given. People are also vegetarian because they do not like for instance the smell and/or taste of meat. Then,

[3] In most literature, when referred to 'taste' the scope of sensory cues are taken into account. Birch (1999): "In the strict sense, the term refers only to those sensations arising from the taste system, which includes basic tastes of sweet, salt, sour and bitter. In common usage, it tends to be used instead of the word flavor, a more inclusive term used to denote the complex of sensory cues, including those arising from olfaction, taste, and touch systems, which have a major influence on our food preferences."

the taste of insects should be cleared out in the way that they are not slimy or anything like that when in the mouth.

Table 6: Subcategories of origins of food likes and dislikes

(from Letarte et al, 1997)

Type of origins	Likes (%)	Dislikes (%)
Physiological aspects		
Nutritional value	70·8 (85)*	22·4 (15)
Satiety	23·3 (28)*	7·5 (5)
Health	3·3 (4)*	7·5 (5)
Anticipated reactions	2·5 (3)*	62·6 (42)
Total	100 (N=120)	100 (N=67)
Sensorial aspects		
Taste	53·7 (244)*	40·0 (196)
Texture	15·6 (71)*	24·9 (122)
Smell	1·8 (8)*	11·4 (56)
Appearance	3·5 (16)*	10·2 (50)
Combination of ingredients	13·2 (60)*	2·9 (14)
Pleasure/displeasure	5·3 (24)*	1·8 (9)
Intense pleasure/displeasure	3·5 (16)*	8·2 (40)
Temperature	2·6 (12)	—
Others	0·7 (3)	0·6 (3)
Total	100 (N=454)	100 (N=490)
Functional aspects		
Flexibility	35·1 (47)*	12·5 (2)
Preparation	34·3 (46)	8·8 (3)
Variety	10·4 (14)	—
Price	7·5 (10)	12·5 (2)
Innovation	6·0 (8)	6·3 (1)
Consumption	4·5 (6)*	43·8 (7)
Availability	2·2 (3)	—
Storage	—	6·3 (1)
Total	100 (N=134)	100 (N=16)
Symbolical aspects		
Origin	40·0 (4)‡	54·3 (19)
Personal ideology	10·0 (1)	25·7 (9)
Quality/poor quality	40·0 (4)	20·0 (7)
Other	10·0 (1)	—
Total	100 (N=10)	100 (N=35)

* p<0·01.
‡ p<0·06.
N= number of reasons.

This importance convinces me to see entomophagy as an alternative. Not specifically for vegetarians, but to all people of course. It can be learned here that by presenting people with a new food, not all the focus should lay on affective aspects. But on the other hand, the cognitive aspects concerning insects will not necessarily trigger a change: they will still have to taste good!

4.3. Concluding remarks

"Allthough food neophobia has clearly been adaptive for our species, it could be argued that culture has taken over much of the protective function of food neophobia. Except in rare circumstances, the culture prevents encounters with dangerous ingestibles by removing them from the immediate environment and/or by labelling them as unsafe. In a sense, then, food neophobia may have outlived it usefulness" (Pliner and Salvy, 2006). Further, nowadays it is possible to detect whether a novel food item is dangerous or not. The case of insects has pointed out that this type of food has a long history in cultures outside the West. A possible danger though might be allergy. Insects might contain allergenic substances in the way that people with for instance an allergy to shrimp should not eat insects. Further, a lot of knowledge exists on the species that are edible and even those that can be 'made' edible (e.g. Tango Muyay, 1981; from van Huis, 2003) . In general, there is hardly need for a neophobic reaction. Scientific research has stressed the safety (and good) of this food type, attention should be paid though to allergenic substances. Nevertheless, neophobic reactions can be reduced in the right approach such as adding familiarity to the novel food item.
Clearly, not only sensory-affective aspects of food determine a liking or a disliking of a food item. The importance of the cognitive aspects has to be acknowledged and can even be an aid in the approach toward acceptance as for some people ethical advantages may increase their willingness to try the novel food. Since there is greater importance of affective aspects in liking a food, attention has nevertheless to be paid on aspects such as flavouring (when sold in supermarkets) and recipes (for home cooking).

Section 5 : Conclusion

It has to be mentioned that researches referred to here had their restrictions. This makes it less easy to draw correct conclusions. Also, not all aspects have been dealt with, like the social harm concerned with eating an unaccepted food and whether or not neophobia is culturally and/or economically influenced. Also, in this thesis insects as food were thought of whole animals and not insects unrecognizably crushed into for instance flour or unnoticeably present in for instance a quiche.
Culture plays a dominant role in food preferences / choice / habits and in acceptance of food items. It defines what is edible and what is not. The food habits of culture are difficult to change, especially what is considered edible and what not. In Western societies, insects were never regarded as food. The theory developed by Vane-Wright (1991; from DeFoliart, 1999) in connection with van Huis (personal communication) and Kirkpatrick (1957) gives an insight in why insects were never part of the Western diet.

An important barrier to acceptance of edible insects is the perception of Western people toward insects in general. In the West, there is an overall negative attitude toward insects and insects as food. Several theories have been mentioned that try to explain the origin of this attitude. Disgust, as a strong moral emotion (with its variations) and as 'gut reaction', plays an important role in this attitude and so also forms a barrier. This disgust varies among people and is culturally influenced. Disgust as food related emotion is difficult to counteract especially with novel animal food items. Strictly seen, entomophagy is not tabooed in the West, it is just 'not done' and can be considered unconsciously tabooed. Several theories have been discussed why animal products are easily tabooed (and found disgusting). These theories are connected to and show some overlap with the theories on the origin of negative attitudes toward insects. There is also a clear connection between these theories on negative attitudes and the characteristics of disgust as food rejection (especially the ideational factors). The omnivore's dilemma suggests that disgust is an evolutionary mechanism but it has lost its evolutionary use. Culture is of major influence on the perception of what is disgusting. Considering the difficulty of changing food habits in connection with the overall negative attitude and the disgust factor related to it, it is a huge challenge to try to make insects accepted as food.

But whether edible insects can or can not be part of food habits in Western societies seems to depend on at least two crucial factors: availability and learning. These two factors are connected to each other. On one hand, (possible) food items that are not available will not be eaten. But on the other hand, when there is a possibility to learn to like a food item, learning will probably take place. This learning is necessary for acceptance since one's own experience with the new food determines whether he or she likes it or not. Although food habits are difficult to change, the history of colonisation has proven that food items can get accepted and therefore a change in food habits is possible. Indeed, the era has to be taken into consideration. Clearly, availability is a necessary feature to make the possibility of learning possible. It then depends on culture (for instance its political institutions) to make food items available or not.

Education is suggested to be crucial and effective to change the negative attitude to insects and a means to develop acceptance of edible insects as food. Specific education on ethno-entomology of which entomophagy is a part is needed to counteract general negative attitudes and fight the problem of generalization that all insects are bad. Disgust being a cultural feature, can also be tackled in this way although it will take a lot of time and effort.

Peers, heroes and famous people that are being looked up at influence other people's food behaviour and food acceptance, in the same way they can elicit a taboo. Especially heroes and famous people can be helpful in bringing entomophagy to the general public. Information on taste, health, convenience, and ecological advantages should be provided. These aspects are important features for accepting a new food and can be helpful in tackling possible neophobia, which can be regarded as the third barrier. Neophobia is not illogic considering the attitude toward and disgust related feelings to insects. This

information must form part of the education since the assumption that the new food will taste bad and/or will do harm is also present. Also for some people, the ethical / ecological advantages are of importance in choosing a food. These advantages should be stressed out.

In the end, within the Western culture, barriers to acceptance of entomophagy can be distinguished such as the negative attitude to insects in general, disgust related reactions to insects in general and insects as food itself, and neophobia. It could be stated that Western culture itself is the barrier to entomophagy. This part of the thesis carefully concludes that these barriers can be tackled and possibilities for entomophagy are present. There is a possibility for change in which education, availability, and learning are essential parts.

This chapter has distinguished barriers and possibilities of entomophagy in the West. The aspects dealt with are useful in developing an approach toward acceptance of edible insects as food by Western people.

3. Actual Possibilities

To answer the question whether entomophagy *can* become part of Western food habits properly, empirical evidence is needed of change of attitude. The negative attitude, disputed on in section 2, is being suggested neither to be innate nor universal. Changing the attitude then is not impossible which is being described here. Also, bug banquets have shown their use as valuable tool by a combination of an educational talk and a possibility to try edible insects. Results are discussed here and give clues on improving people's attitude toward insects and the acceptance of the idea of eating them by experience / learning.

3.1. Changing the negative attitude in a naturalistic way

The following is an examination of changes in distress (most often towards spiders) with students in a naturalistic way, meaning that no professional help took place such as therapy. In this investigation, disgust was seen as a very important factor. It was mentioned often by participants. Attention was also paid to the distinction between fear (scared, frightened, terrified) and disgust (revolted, sickened, repulsed). In the case of spiders, movies for instance are of high influence (Kleinknecht, 1982; from Vernon and Berenbaum, 2004). Importantly, "Interviewers considered features that have been empirically demonstrated to be characteristic of disgust reactions, including: (1) distraction/cognitive avoidance, such as turning one's head away to avoid looking at the stimulus or trying to avoid thinking about the stimulus (Ellsworth & Smith, 1988); (2) attention to stimulus attributes, including statements that the stimulus was "dirty" or "slimy" or "hairy" (Rozin & Fallon, 1987); and (3) nausea (Rozin & Fallon, 1987). Interviewers also considered features that have been empirically demonstrated to be characteristic of fear reactions, including: (1) a focus on harm/safety consequences, such as being injured or bitten by the stimulus (Ellsworth & Smith, 1988; Roseman et al., 1994); (2) attention to the stimulus, such as watching the stimulus closely or keeping an eye on it (Roseman et al., 1994); and (3) increased heart rate (Roseman et al., 1994)" (Vernon and Berenbaum, 2004).
The four findings of the research are described below.

- ". . . negative events and negative expectations play an important role in changes in responses to spiders and insects"
- ". . . the absence of an expected negative experience as a cause of positive change"
  (a student described after an entomology class and lab work that insects and spiders weren't as sticky and slimy as she thought they would be)
- ". . . positive experiences played an important role in positive changes"
  (another student said that the things spiders do were "actually cool")

- "In contrast to the important role of positive experiences in positive change, the absence of expected positive experiences did not seem to play a role in negative change."

Most of the changes occurred gradually (+/- 74%).

Table 7 shows the importance of fear and disgust as causes of change in response to spiders and/or insects according to the participants.

Table 7: Disgust and fear as cause of change

(from Vernon and Berenbaum, 2004)

Percentages of disgust and fear responses as causes of change

Cause of change (%)	Direction of change	
	Positive	Negative
Disgust only	41.2	31.3
Fear only	17.6	25.0
Disgust and fear	41.2	43.8

Both fear and disgust play an important role. While one student referred to insects and spiders, saying "they make things feel dirty" another one experienced a growing appreciation and testified that ". . . bugs weren't disgusting . . .". These responses show the 'disgust' being the cause of change, while other participants mentioned only 'fear' to be the cause of the change. As Kellert (1993) did not focus on the exact emotions, which is done here, it is clear that disgust and fear are different and do not necessarily appear together. Nevertheless, fear and disgust seem to work together often. This is consistent with other research (like research on emotional responses to spiders: Vernon and Berenbaum, 2002) and even was suggested in literature on emotional processes (see Berenbaum, Fujita and Pfennig, 1995; Ekman, 1982; Watson and Clark, 1992). Fear and disgust do not operate independently! ". . . Several respondents reported to increasingly like spiders and insects and described losing both their fear (e.g., learning that most spiders were harmless) and disgust response (e.g., coming to appreciate the anatomy of spiders rather than be disgusted by it). In some cases one emotion reportedly led to the other. One respondent described her reaction to spiders and insects, saying, ''In the past I was so disgusted by them that it led to a fear." (Vernon and Berenbaum, 2004).

According to the authors, the findings suggest the following:

Firstly, there is no need for high exposure: change does not have to occur after large numbers of sessions dealing with the distress factor. A naturalistic way can do a lot. So exposure helps, but is not needed in high amounts. In the case of entomophagy in the West, exposure might help to reduce the 'surprise' and novelty of insects on the plate. At the same time it can reduce the (fear and) disgust

associated with them. Even though, as will be seen in neophobia (sections 3.3., 3.4. and 4.1.), that disgust is a difficult thing to counteract food-wise.
Secondly, it appears that the cognitive part is as least as important as the behavioural part. Gaining knowledge and seeing the animals from close-by, helps in the change towards more appreciation. A student confirmed on the behaviour of a spider that he did not expect it to behave like it did: like scratching itself, or hiding behind the legs.
So mainly disgust, but also fear are important in the perception of insects. They can be counteracted though so that a change in distress towards spiders and insects *can* occur. The behaviour of the animals (exposure) and by gaining knowledge (cognitive) on them helps to reduce distress. Although, in the case of disgust, there is a difference in reduction of distress on encountering the animals and having the animal on your plate.

3.2. "Bug banquets"

As mentioned in section 2.2. that Kellert (1993) proposes to focus on education, it is wise to follow this path and take a look at a way of education: classroom presentations and "bug banquets". Several scientists have made attempts to create such educational programs and "bug banquets", according to Looy and Wood (2006). As the authors understand, the emotions have to be 'attacked', of which "bug banquets" might and probably will be helpful since they trigger emotional responses. Following Grob (1995; from Looy and Wood, 2006), they agree that values and emotions are not closely linked to factual knowledge. In fact, "emotional appeals also may be more effective in changing attitudes formed on the basis of affect (emotion) than cognition-based arguments (Edwards, 1990). However, Millar and Millar (1990) have argued that well-established affect-based attitudes are likely to respond to cognition-based arguments (i.e., information, education), because cognition-based arguments do not threaten the way we previously have thought about a topic (emotionally) and do not permit effective development of counterarguments" (Looy and Wood, 2006). Therefore, a combination of both education and encounters with invertebrates (or just insects of course) could change the attitudes. Important is that strong emotional responses are triggered which occurs at bug banquets (Looy and Wood, 2006). Whether these bug banquets, preceded by educational talks (obligatory class lectures), do actually change attitudes and specifically toward eating insects is being researched and is in fact the first attempt to research the effects of "educational bug banquets" (Looy and Wood, 2006).
In this research, conducted with junior high, high school and 1st year university students of which every of these three grades were divided into experimental and control groups with average age respectively 13.2 – 13.1, 16.5 – 16.2, 20.3 – 20.7, change in attitude (following the descriptions of Kellert, 1993) and scores on the Food Neophobia Scale for university students only (Pliner and Hobden, 1992) was examined. Questions asked were in relation to entomophagy. The difference

between experimental and control groups is that the latter did not have the ability to attend the bug banquet. For the university students, first, a pre-test (questionnaires) was conducted. The bug banquet (which was voluntarily and only for experimental groups) and the presentation (which was obligatory for the experimental groups) took place 4 to 6 weeks after the pre-test. Another 4 to 6 weeks later, the experimental group conducted the post-test questionnaires. The control group took these 8 to 12 weeks after the pre-test. Both the schools though, had the presentation and bug banquet after both pre- and post-test. The overall effects of the educational talk in combination with the bug banquet were diverse, complex, and subtle, with difference between age groups.

Only the university students showed a positive change after the presentation (comparison was made between experimental and control group of which the latter did not attend to the bug banquet). These students appeared to be more ecologistic and scientistic, they showed greater aesthetic appreciation, and were less negativistic. After the presentation and bug banquet, these students showed less disgust toward eating insects. The other two school groups also showed little change and change in attitudes, but this in different categories: changes in scientism, aestheticism , and negativism (those hoped for that changed) were almost untouched.

Interestingly, confronting the students with a novel food of this emotionally loaded kind lead to two different reactions. Using the Food Neophobia Scale, learning to consider insects as food and learning to appreciate it by use of a bug banquet, can increase willingness to try other novel foods. A certain generalization can occur which will be discussed further in the section on food neophobia (4.1.). But also the opposite can occur: ". . ., being confronted to consider species that previously were not only completely ignored as potential food but were viewed with active fear, dislike, and disgust might result in an increase in food neophobia because previously unquestioned boundaries are being threatened" (Looy and Wood, 2006).

The fact that most groups showed a small to moderate increase in neophobia, proves the difficulty in overcoming these kinds of aversions. These neophobic aspects will be death with more in detail in the section 4.1..

Three questions were asked on eating insects of which the first two were:

"What is your first reaction to the idea of other people eating insects?" (Looy and Wood, 2006), and

"What is your first reaction to the idea of your eating insects?" (Looy and Wood, 2006).

Students could choose between Disgusting, Interesting, Both disgusting and interesting, and Neutral as answer. Most of the time, answers were either Disgusting or Interesting.

The third question was: Which of the following experiences is most likely to make a difference in your attitude toward eating insects? Choice could be made between: (1) visiting or working in another culture, (2) attending an educational talk, (3) being dared to, (4) actually eating insects, (5) reading an educational article, and (6) nothing could change my attitude. The results from the research are copied into an excel file (table 8).

Table 8: Frequency of responses to the third question

(taken from Looy and Wood, 2006)

Response	Experimental group		Control group	
	Pre-test	Post-test	Pre-test	Post-test
Visiting or working in another culture	**49**	**60**	**45**	**56**
Attending an educational talk	23	**44**	17	10
Being dared to	16	19	15	15
Actually eating insects	51	56	31	32
Reading an educational article	10	7	8	6
Nothing could change my attitude	**27**	**19**	**28**	**24**

Note: some respondents selected more than one option.

The most important relevant results are highlighted.

Overall, the participants thought that visiting or working in another culture (where entomophagy is practiced) would increase their willingness to eat insects themselves. Apparently, the educational talk did have an influence. Several students declared that nothing could change their attitude, again pointing out the difficulty of overcoming the aversion.
These results also show the importance of role models, availability, knowledge, cultural acceptability, and even necessity (because participants showed more interest if it would be necessary for survival). This necessity part can be interesting as Arnold van Huis mentions the necessity of looking at different food sources in a world with an expanding population and with conventional meat becoming an environmental threat. This will be mentioned in chapter 4: the ecological advantages of entomophagy.

Effects are subtle. This research was only a single attempt to change attitudes. Also it should be taken into account that there is a long history of aversion toward invertebrates. There is also a lack of opportunity to encounter invertebrates in general and the role they play in nature, including its edibility. Nevertheless, this attempt – the combination of educational talk and bug banquet – seems to show that there is hope. This research confirms Drews (2002; from Costa-Neto and Magalhães, 2007) who states that "attitudes toward animals are formed through the values, knowledge, perceptions, and nature of the interactions that are established between human beings and animals" (Costa-Neto and Magalhães, 2007).
Further more, the BBC Natural History Unit has paid a lot of attention to insects as food and this topic was covered in the series on insects, called 'Alien Empire'. In a letter to The Food Insects Newsletter published in July 1995, Rupert Barrington (the producer of the series) states the following: "The gratifying thing is that most people react with fascination rather than disgust when they see this footage. We are very much pushing the angle that this is no different to eating crustaceans, so Western

attitudes to eating insects are groundless". As TV can be educational in a very pleasant way (as the BBC has shown for many years), this can be a way for improving the attitude of Westerns toward insects in which the above theories seem to be proven (to some extend). It has to be stated though that although watching something on TV can also elicit disgust responses (clearly by for instance horror movies), having a possible disgust elicitor right in front of your nose is very much different. The BBC series, although being very useful, is not to be expected to make a direct change in attitudes. Direct interactions are necessary as revealed by studies referred to above (Vernon and Berenbaum, 2004 on general perception of insects and Looy and Wood, 2006 on insects as food). But maybe TV can be a tool.

3.3. Indications and impressions

For some first and simple indications and impressions on the perception on entomophagy being introduced in the West, small interviews were conducted with acquaintances of the author of this thesis. Interviewees were five vegetarians, five non-vegetarians, and five non-vegetarians that eat very regularly vegetarian. Three of this last group eat vegetarian meals regularly because they live in a student house that "officially" is a vegetarian cooking house. The other two of that group (the author's parents) are influenced to eat vegetarian meals by their oldest son who is a vegetarian.
The main idea behind these interviews is to (1) have the barriers affirmed on both insects in general and entomophagy, and (2) have indications the willingness to (at least) try insects as food after having given information on ecological advantages and an example of preparation (cooked with soy sauce, sugar, and sake). A division of the three groups was made to detect possible difference in attitude. There was neither time nor space to include a broad measure of the perception. Interesting remarks are quoted here.

Insects in general

All interviewees seem to agree on the fact that insects such as butterflies are beautiful and/or interesting, but the majority can be categorized as "creepy crawly". One interviewee realized: "I do belong to the large group of inconsistent people who like butterflies and ladybirds but who are *disgusted* by ants and grasshoppers". As one interviewee stated on insects very clearly: "Annoying creatures, I like to keep distance".

First impression

At first, very clearly, the majority does not seem to be eager on the *idea* of eating insects: the first impression is not a good one.

One interviewee (a meat eater) explained: “I think I first saw it when I watched the 'Lion King'. There's a scene where Timon and Pumbaa are feasting on insects and Simba disgusts it. I think I felt quite the same way as Simba”.
Or a similar reaction from a vegetarian:
“I first thought: ieuwwwwwww that is disgusting!”.

Nevertheless, another vegetarian declared: “It seemed quite natural to me, the first time I saw indigenous people eating insects on television. I was very happy to have the opportunity to try them myself the first time I ran into them on a fair”.
And also, from a meat eater: “I was curious in how it would taste like, I would like/love to try. But it also depends on which insect.”

Some people refuse to try them: “I never had the chance to try them. But I am also not really willing to taste them”.
One vegetarian declared: “I had the chance, but I guess it was last minute *disgust*. It’s just a little different if you’re talking about it or if there’s actually whole grasshoppers in front of your face.” This same person did eat grilled grasshoppers a few weeks later, declaring: “Mmm, is quite nice”.

Future perspectives

No difference has occurred between the interviewed groups. Almost all of them (12 of the total of 15) are behind the *idea* of eating insects after having received (minimal) background information on nutrition and sustainability.
“If eating insects is a practice that is sustainable, then it would be worth considering.”
“I support it!”
“My attitude toward insects becomes more positive when I hear about these advantages.”
“I could be convinced, but I have to conquer a feeling of *distaste* first.”

Three persons are not behind the idea because of (1) “hardly consuming meat, so there is not a direct reason to eat them”, (2) finding it too disgusting (two persons).

From these minimal interviews it is also clear that *availabilit* and *price* are important features for future success:
“I would like to eat them much more often if they would be offered in shops”, and;
“I would consider buying them if they are decently priced. Often meat is very pricy. Perhaps if insects would be cheaper than meat, I would consider them as a replacement for meat”

Also leaning how to prepare them is important: “I would consider buying them, if I knew *how to prepare* them (perhaps *recipes* on AH cards)”.

3.4. Conclusion

In this chapter, clues of the answer to the question whether edible insects *actually* can be part of Western food habits are given.

Several attempts to counteract the negative attitude toward insects in general have been successful: change is possible. Also, bug banquets have shown the possibility of accepting insects as food. But whether edible insects can or can not be part of food habits in Western societies depends on at least two crucial factors: availability and learning. These two factors are connected to each other. Chapter 2 has shown that on one hand, (possible) food items that are not available will not be eaten. But on the other hand, when there is a possibility to learn to like a food item, learning will probably take place. This learning is necessary for acceptance since one’s own experience with the new food determines whether he or she likes it or not.

Education can then no longer be *suggested* to be crucial and effective to change the negative attitude to insects and a means to develop acceptance of edible insects as food (chapter 2), it *is*. Bug banquets show that specific education on ethno-entomology of which entomophagy is a part is needed to counteract general negative attitudes and fight the problem of generalization that all insects are bad. Vernon and Berenbaum (2004) have also proven that influencing / adjusting emotions is possible, nevertheless it takes time and effort. Bringing people in close contact with insects during the education to elicit a positive change in attitude (emotion) is a necessity. Bug banquets have shown its usefulness and deserve more attention as they increase awareness on edible insects. The bug banquet experiments have shown that tackling the general negative attitude and working on the acceptance of insects as food can be dealt with together. Bug banquets could therefore be implemented more. It is also useful to add familiarity to the new food. This facilitates the willingness to try it (see section 4.1.2. in chapter 2).

Media coverage as on TV can be an aid to reach a large part of the population. Special events can trigger curiosity and can make edible insects more available than they are now. The influence of peers, heroes, and family has to be taken into account (see section 4.1.2.). On the bug banquet occasions and the special events (film festival at Gembloux and Narbonne), a possibility to learn is offered by trying insects yourself.

The suggestions made here are in line with the future needs according to Gene R. DeFoliart (1999). He underlines the importance of public education, moreover: re-education in which e.g. zoos, nature centres, museums, and universities can take part. Entomology textbooks should mention the aspect of entomophagy. Some books already do this (e.g. Gullan and Crantson, 1994: *The Insects: An Outline of*

Entomology). Books on insects written in a more popular language can also contribute to making entomophagy known (e.g. Comby, 1990: *Délicieux Insectes*). An interesting idea is the development of a field guide (or an extension to existing field guides) specifically on edible insects. For increasing exposure to edible insects, they can be sold in ethnic food shops. And last but not least, entomologic congresses must be continued to be organised to increase brainstorming and gaining and exchanging of knowledge on entomophagy. Entomophagy has had attention on international gatherings (e.g. *Seminar on Invertebrates (Minilivestock) Farming* which was held in La Union, Philippines, 1992), but this should be continued.

This thesis can then conclude that there is an actual possibility for change. There is a possibility for change in which education, availability, and learning are essential parts.

4. Ecological Advantages

Livestock is of global importance, socially and politically. With growing populations and incomes, the demand for livestock products increases. Trade in livestock inputs and products is also increasing due to globalization. It is estimated that the global production of meat will continue to grow (Steinfeld et al, 2006). This chapter will summarize the effects that conventional meat production – including organic meat production – has on ecology. The discussed impact categories are: global warming, acidification, eutrophication, and energy consumption. Steinfeld et al (2006) underline that "the environmental impact per unit of livestock production must be cut by half, just to avoid increasing the level of damage beyond its present level". Steinfeld et al (2006) and others, present suggestions in order to achieve this cutback. But all of these suggestions focus on the livestock production itself and do not look for an alternative meat production – alternative in the sense of an alternative meat. This chapter will therefore briefly explain some ecological advantages of breeding edible insects in comparison to conventional livestock. In this way, arguments are found to answer whether edible insects should be part of Western food habits. Not much information on these ecological advantages is available unfortunately, due to insufficient research in fields such as greenhouse gas emissions of insects. The acknowledged ecological advantages are nevertheless straightforward and provide hope to find more of these advantages and incentives for more detailed research of these advantages.

3.1. The environmental impact of livestock production

Global warming

Steinfeld et al (2006) state that ". . . climate change is the most serious challenge facing the human race" and it includes rising temperatures, rising sea levels, melting icecaps and glaciers, shifting ocean currents and weather patterns. Livestock plays an important role in this global challenge by being responsible for 18% of greenhouse gas emissions (in CO_2 equivalents[4]).

"The livestock sector accounts for 9 percent of anthropogenic CO_2 emissions" (Steinfeld et al, 2006). These CO_2 emissions are mainly due to changes in land-use of which gaining and preparing land for feedcrops – deforestation – is then most important. Other gasses emitted by livestock have a higher warming potential though. The livestock sector emits 37% of anthropogenic methane (CH_4). Methane has a global warming potential (GWP) which is 23 times the GWP of CO_2. The main source of methane emission is enteric fermentation by ruminants. The sector emits 65% of the nitrous oxide

[4] The contribution of the atmospheric emission of greenhouse gasses to global warming (global warming potential, an estimate) was derived from CO_2 equivalent factors by Intergovernmental Panel on Climate Change (2001) for CO_2: 1, CH_4: 23 and N_2O: 296 (based on the time horizon of 100 years).

(296 times GWP of CO_2) which comes mainly from manure. Further, it emits 64% of anthropogenic ammonia (NH_3) and therefore makes a significant contribution to acid rain and acidification of ecosystems.

Ogino et al (2007) have explored the environmental loads of the cow-calf production system in Japan. "The total contribution to global warming throughout the life cycle was 4550 kg of CO_2 equivalents" (Ogino et al, 2007). Enteric methane emissions accounted for 61,2% of the contribution. The amount of emitted methane is dependent on the feed type (mixture of roughage and concentrate): an increased level of roughage leads to an increased CH_4 emission. The downside is though that producing and transporting concentrate feed increases CO_2 emission (in this Japanese research it is 2,1 times more). Feed production and feed transport contributed significantly (18,4% and 8,3% respectively), which was mainly due to CO_2 emissions. Another significant contribution was made through animal waste management by emitting N_2O derived from nitrogen in the waste of the animals. In order to analyse the whole beef production system, Ogino and colleagues (2007) added the outcomes of the beef fattening system in Japan (from Ogino et al, 2004) to the first results. The total environmental impact per animal in the whole beef production were then determined to be 10 500 kg of CO_2 equivalents. This implies that 1 kg of beef contributes 36,4 kg of CO_2 equivalents to global warming. Also in the beef fattening system, the feed production and feed transport processes, animal waste management, and methane emissions from the guts of the animals contributed most.

The environmental impact of Swedish organic beef production is significantly less: 22,3 kg of CO_2 equivalents (Cederberg and Stadig, 2003; from Ogino et al, 2007). Organic production implies no use of concentrate feed and therefore large amounts of CO_2 from production and transport that would be emitted from these processes are not emitted.

The researched pig production systems in France revealed that the contribution of 1 kg of pig to global warming was 2,30 kg of CO2 equivalents in the conventional production system (table 9) (Basset-Mens and van der Werf, 2004). The main contribution comes from feed production. In the organic alternative it was measured that the contribution was 3,97 kg of CO_2 equivalents due to increased emission of greenhouse gasses from the WS stage[5]. These measurements reveal that organic farming is not necessarily more ecological than conventional farming.

Acidification

As mentioned above, livestock contributes to acidification (acid rain and acidification of ecosystems) on a global scale by emitting 64% of anthropogenic ammonia (Steinfeld et al, 2006).

[5] WS stands for Weaning to Slaughtering. Its characteristics are: kind of housing, surface per pig (m^2), feed to gain ratio etc. These differ between the conventional and organic production system.

The Japanese cow-calf system makes a contribution throughout the life cycle of 40,1 kg of SO_2 equivalents[6]. The total environmental impact per animal of whole beef production (cow-calf system and beef fattening system) was then 98,2 kg of SO_2 equivalents. Analysis of the whole beef production system revealed that 1 kg of beef makes a total contribution of 340 g of SO_2 equivalents to acidification. The cow-calf system analysis and beef fattening analysis show that waste treatment, feed production, and animal management are main contributors. The SO_2 comes mainly from NH_3 emissions which originate from cattle waste and chemical fertilizer used for the feedcrop (Ogino et al, 2007).

The contribution per kilogram of pig in France was measured at 0,0435 kg of SO_2 equivalents in the conventional production system (table 9). The PP[7] and WS stages count as main contributors as well as the crop and feed production. The contribution in the organic system was little less per kilogram of pig: 0,0372 kg of SO_2 equivalents (Basset-Mens and van der Werf, 2004).

Eutrophication

The global contribution to eutrophication is mainly due to water pollution. The sources of this pollution are (among others): animal wastes, fertilizers and pesticides used for feedcrops, and antibiotics and hormones. Exact global numbers are not available. In the USA, as an example, the estimated contribution of livestock to pesticide use is 37%, 50% of antibiotic use, and 1/3 of the nitrogen and phosphorus loads in freshwater resources (Steinfeld et al, 2006).

In the Japanese cow-calf system, the contribution to eutrophication throughout the life cycle was 7,0 kg of PO_4 equivalents[8]. The total environmental impact per animal of whole beef production were then determined to be 17,1 kg of PO_4 equivalents. Analysis of the whole beef production system revealed that 1 kg of beef contributes for 59,2 g of PO_4 equivalents to eutrophication. These contributions originate mainly from NH_3 emissions from waste treatment, animal management, and feed production (Ogino et al, 2007).

In the French conventional pig production system, 1 kg of pig contributes 0,0208 kg of PO_4 equivalents to eutrophication whereas in the organic system a comparable 0,0216 kg is measured (table 9). The main contributors are crop and feed production (Basset-Mens and van der Werf, 2004).

[6] SO_2 equivalent factors were derived from Heijungs et al (1992); SO_2: 1, NO_x: 0.7, NH_3: 1.88.
[7] PP stands for Piglet Production. Its characteristics are: kind of housing, weaned piglet/productive sow/year, weaning age etc. These differ between the conventional and organic production system.
[8] PO_4 equivalent factors were derived from Heijungs et al (1992); NO_x: 0.13, NH_3: 0.33.

Energy use

The production of 1 kg of beef in the Japanese production system (whole beef production) consumes 169 MJ of energy. In the Swedish organic beef production system this energy use appeared to be less: 25,9 MJ (Cederberg and Stadig, 2003; from Ogino et al, 2007).

The French conventional pig production system costs 15,9 MJ per kg of pig (table 9) (Basset-Mens and van der Werf, 2004) of which the crop and feed production, as in the Japanese system, are the main contributors. The organic production system reaches higher energy costs: 22,2 MJ per kg of pig (Basset-Mens and van der Werf, 2004).

Table 9: The environmental impacts of pig production
(from Basset-Mens and van der Werf, 2005)

Impact category	Per kg of pig		
	GAP	RL	OA
Eutrophication (kg PO_4 eq.)	0.0208	0.0166	0.0216
Climate change (kg CO_2 eq.)	2.30	3.46	3.97
Acidification (kg SO_2 eq.)	0.0435	0.0226	0.0372
Terrestrial toxicity (kg 1.4-DCB eq.)	0.0165	0.0184	0.0304
Non-renewable energy (MJ LHV)	15.9	17.9	22.2
Land use (m^2 year)	5.43	6.28	9.87
Pesticide use (kg active matter)	0.00137	0.00144	0.000239
Pig produced (kg)	1	1	1

(GAP = conventional system; OA = organic system; RL not relevant)

3.2. The ecological advantages of breeding edible insects

Greenhouse gasses

Methane According to Hackstein and Stumm (1994), a substantial contribution to atmospheric methane is made by terrestrial arthropods, these are obviously not bred but naturally living arthropods. A screen of more than 110 representatives of the different taxa of terrestrial arthropods revealed methane excretion of the taxa Diplopoda (millipedes), Blattidae (cockroaches), Isoptera (termites), and Cetoniidae (rose chafers, Scarabaeidae) of which almost all tropical representatives contained methanogenic bacteria in the hindgut (table 10). This implies that almost all tropical species included in this study belonging to methane emitting taxa, emitted methane. Differences in quantitative emissions are due to variations between individuals, the sexes, the different developmental stages, and the different populations (indicated by the large standard deviations in table 11). The presence of intestinal protists aids significantly in emission quantity (table 11) (the nonrandom distribution of these protists among the different taxa suggests this symbiosis to be very specific).

Arthropods that do not emit methane (where fluorescence microscopy – a reliable method – revealed absence of methanogenic bacteria) are: locusts and crickets, springtails (but not eaten), bugs, bees, beetles, butterflies, and flies (table 10).

Table 10: Screening for methane emission

(from Hackstein and Stumm, 1994)

Species	H_2	CH_4	Met	Hgut	Source
Araneae (spiders)					
*Araneus diadematus** (A)	+	–	ND	ND	Gr
Acari (mites and ticks)					
Boophilus microplus (A)	–	–	ND	ND	By
Isopoda (sowbugs)					
*Oniscus asellus** (A)	–	–	ND	ND	Ar, Gr, Re
Porcellio scaber (A)	–	–	ND	ND	By
Chilopoda (centipedes)					
Lithobius forficatus (A)	–	–	ND	ND	Gr
Diplopoda (millipedes)					
Chicobolus sp. (J)	+	+	M	No	Dü
Mestosoma hylaeicum (A)	–	–	No	No	Ma
Orthoporus sp. (J)	+	+	F+C	No	Ma
Pycnotropis acuticollis (A)	+	+	ND	ND	Ma
Rhapidostreptus virgator (A)	+	+	F+C	No	Gi
Unident. A (J)	+	+	F	No	Am
Unident. B (J)	+	+	F	No	Dü
Unident. D (J)	+	+	F+C	No	Dü
Unident. K (J)	+	+	F+(C)	No	Co
Glomeris sp.* (A)	+	–	No	Pou	Re
Julus sp.* (A)	–	–	No	No	Re
Polydesmus sp.* (A)	–	–	No	No	Re
*Tachypodojulus niger** (A)	–	–	ND	ND	St
Thysanura (bristletails)					
Lepisma saccharina (A)	–	–	ND	ND	By
Collembola (springtails)					
Folsomia candida (J, A)	–	–	No	No	By
Acrididae (short-horned grasshoppers)					
Locusta migratoria (A)	–	–	No	No	Ny, Dü
Schistocerca gregaria (A)	–	–	No	No	Dü
Unident.* (A)	–	–	No	No	Wy
Gryllidae (crickets)					
Acheata domesticus (A)	–	–	No	Brush	Ny, Dü
Decticus sp.* (A)	–	–	ND	ND	Re
Gryllus bimaculatus (A)	–	–	No	Brush	Ny, Dü
Ventralla quadrata (A)	–	–	ND	ND	Am
Phasmidae (stick and leaf insects)					
Eurycantha calcarata (A)	–	–	ND	ND	Dü
Pharnacia acanthopus (A)	–	–	ND	ND	Dü
Sipyloidea sipylus (A)	–	–	ND	ND	Dü
Mantidae (mantids)					
Hierodula membranacea (A)	–	–	ND	ND	Dü
Blattidae (cockroaches)					
Blaberus cranifer (A)	+	+	F+C	Brist	Ha, Co
Blaberus fuscus (L, A)	–	+	F+C	Brist	Dü, By, Bo
Blaberus giganteus (L)	+	+	F+C	Brist	Am
Blatta orientalis (A)	+	+	F	Brist	By
Blattella germanica (A)	+	+	F	Brist	Co, Fr
Blattella germanica (A)	+	–	No	Brist	Dü, Mg
Ectobius sp.* (A)	–	–	No	—	Gb
Gromphodorrhina portentosa (L, A)	+	+	F+C	Brist	Am, By, Co, Dü
Leucophaea sp. (A)	+	+	F	Brist	By, Dü
Panchlora nivea (A)	–	–	No	—	Am
Periplaneta americana (L, A)	–	+	F+C	Brist	Am, By, Dü, Ny
Periplaneta australasia (L, A)	+	+	F+(C)	Brist	Ar, Dü, Ha
Pycnoscelus surinamensis (L, A)	+	+	F+C	Brist	Ar, Dü
Supella supellectilium (L, A)	–	+	F+M	Brist	By
Isoptera (termites)					
Cryptotermes brevis (A)	–	+	ND	ND	Kr
Heterotermes indicola (A)	–	+	F+M	Pou	Kr
Mastotermes darwiniensis (A)	–	+	F+M	Pou	Kr
Reticulotermes santonensis (A)	–	+	F+M	Pou	Kr
Dermaptera (earwigs)					
*Forficula auricularia** (A)	–	–	ND	ND	Gr
Heteroptera (bugs)					
Dysdercus intermedius (L, A)	+	–	No	Pou	Co
Oncopeltus fasciatus (L, A)	–	–	ND	ND	Dü
Platymerus bigutiata (A)	–	–	ND	ND	Am
Pyrrhocoris apterus (L, A)	–	–	ND	ND	Co
Cicadoidea (cicadas)					
Nephotettix cincticeps (A)	–	–	ND	ND	By
Aphididae (aphids)					
Aphis fabae (L, A)	–	–	ND	ND	By
Apidae (bees)					
Apis mellifera (A)	–	–	No	No	Gr

Species	H_2	CH_4	Met	Hgut	Source
Carabidae (ground beetles)					
Carabus sp.* (A)	–	–	ND	ND	Re
*Pterostichus niger** (A)	–	–	ND	ND	Gr
Silphidae (carrion beetles)					
*Necrophorus vespillo** (A)	–	–	ND	ND	Gr
Dermestidae (Dermestid beetles)					
Dermestes frischi (A)	–	–	ND	ND	Ma
Tenebrionidae (darkling beetles)					
Oryzaephilus sp. (L, A)	–	–	ND	ND	Kr
Scarus tristis (L)	–	–	ND	ND	Dü
Tenebrio sp. (L)	–	–	ND	ND	Ny
Tribolium confusum (L, A)	–	–	ND	ND	By, Ny
Zophobas morio (L, A)	–	–	No	No	Ma
Cryptophagidae (silken fungus beetles)					
Alphitobius diapecurius (L, A)	–	–	ND	ND	By
Bostrychidae (branch and twig borers)					
Acanthocelides panaceae (L, A)	–	–	ND	ND	By
Rhizopertha dominica (L, A)	–	–	ND	ND	By
Sitophilus graminarius (L, A)	–	–	ND	ND	By
Anobiidea (death-watch beetles)					
Anobium punctatum (L)	–	–	ND	ND	Kr
Oligomerus ptilinoides (L)	–	–	ND	ND	Kr
Ptilinus pectinicorni (L)	–	–	ND	ND	Kr
Stegobium panaceum (A)	–	–	ND	ND	By
Xestobium rufovillosum (L)	–	–	ND	ND	Kr
Lyctidae (powder-post beetles)					
Lyctus africanus (L)	–	–	ND	ND	Kr
Lyctus brunneus (L)	–	–	ND	ND	Kr
Minthea rugicollis (L)	–	–	ND	ND	Kr
Dynastinae (rhinocers beetles)					
Dynastes hercules (L)	+	+	F+M	Brush	Dü
Cetoniidae (rose chafers)					
Cetonia aurata (L)	+	+	F+M	Brush	Am
Dicronorrhina micans (L)	+	+	F+M	Brush	Am
Eudicella gralli (L, A)	+	+	F+M	Brush	Ha
Eudicella smitii (L)	+	+	F+M	Brush	Am
Pachnoda bhutana (L, A)	+	+	F+M	Brush	Co, Ha
Pachnoda ephippuata (L)	+	+	F+M	Brush	Am
Pachnoda marginata (L)	–	+	F+M	Brush	Dü
Pachnoda nachtigalli (L, A)	–	+	F+M	Brush	Dü
Pachndoa savignyi (L, A)	–	+	F+M	Brush	Dü
Potassia cuprea (L, A)	+	+	F+M	Brush	Ha
*Phyllopertha horticola** (A)	–	–	No	Pou	Gr
Geotrupinae (dung beetles)					
Geotrupes sp.* (A)	+	–	ND	ND	Re
Geotrupes sp.* (A)	–	–	ND	ND	Gr
Cerambycidae (longhorn beetles)					
Hylotrupes bajulus (L)	–	–	No	No	Kr
Chrysomelidae (leaf beetles)					
*Crioceris asparag** (A)	–	–	ND	ND	Gr
Diabrotica baltea (A)	–	–	ND	ND	By
Leptinotarsa decemlineata (A)	+	–	ND	ND	Gr
Phaedon cochleariae (L, A)	+	–	ND	ND	By
Curculionidae (weevils)					
Otiorrhynchus sulcatus (A)	+	–	ND	ND	By
Lepidoptera (butterflies and moths)					
*Aphomia sociella** (L)	+	–	No	No	Un
Bombyx mori (L)	–	–	ND	ND	Ny
Caligo memnon (L)	–	–	ND	ND	Dü
Danaus plexippus (L)	+	–	ND	ND	Co
Ephestia kühniella (L)	–	–	ND	ND	Co
*Galleria mellonella** (L, A)	–	–	No	No	Gr
Heliotis virescens (L)	–	–	ND	ND	By
*Pieris brassicae** (L)	–	–	ND	ND	Gr
Plutella xylostella (L)	–	–	ND	ND	By
Spodoptera frugiperda (L)	–	–	ND	ND	By
Trabala vishnou (L)	–	–	ND	ND	Dü
Diptera (flies)					
Hylemyia antiqua (L)	–	–	No	No	By
Musca domestica (P, A)	–	–	No	No	By
Tipula sp.* (L)	+	–	No	Pou	Gr
Siphonaptera (fleas)					
Ctenocephalides felis (L)	–	–	ND	ND	By

A, adult; J, juvenile; L, larva; P, pupa; Met, methanogens; F, free methanogenic bacteria in the hindgut; C, ciliates with intracellular methanogens; M, mastigotes, with or without intracellular methanogens; ( ), small numbers of protists; Hgut, hindgut differentiations; Pou, pouch, dilated hindgut; bristles (Brist) and brushes (Brush) include the presence of a pouch (cf. Fig. 1); ND, not determined; No, absent; +, gas emission; –, no gas emission. Am, Artis, Amsterdam, The Netherlands; Ar, Burgers Zoo, Arnhem, The Netherlands; Bo, Zoology Dept., Bochum, Germany; By, Bayer AG, Monhein, Germany; Co, Zoology Dept. or Zoo, Cologne, Germany; DS, Dar-es-Salaam, Tanzania, kept at Nijmegen, The Netherlands; Dü, Löbbecke Museum, Düsseldorf, Germany; Fr, France, kept at By; Gb, Griether Busch, Zoology Inst., Griether Busch, Germany; Gi, Zoology Dept., Giessen, Germany; Gr, Groesbeek, The Netherlands; Ha, Hortus, Haren, The Netherlands; Kr, Desowag AG, Krefeld, Germany; Ma, Zoology Dept., Marburg, Germany; Mg, Mönchengladbach, Germany; Ny, Zoology Dept., Nijmegen, The Netherlands; Re, Reichswald, Germany; St, Zoology Dept., Stuttgart, Germany; Un, Unna, Germany; Wy, Wyler, Germany.
*Endemic European species from the field.

Table 11: Different cockroach species and methane emission

(from Hackstein and Stumm, 1994)

	Mean	SD	Max	*n*	S	Protists
Blaberus sp.*	49	27	109	9	6	Ciliates
Blatta orientalis	22	9	36	5	1	No
Blattella germanica (Co)†	31	—	—	1	1	No
Gromphodorrhina portentosa	49	27	107	8	4	Ciliates
Leucophea sp.	18	9	28	2	1	No
Periplaneta americana	85	67	255	11	5	Ciliates
Periplaneta australasia	31	18	49	6	3	(Ciliates)/ no‡
Pycnoscelus surinamensis	80	71	268	13	2	Ciliates
Supella supellectilium	49	31	80	2	1	Mastigotes

Mean, mean of methane production rates (nmol per g fresh weight per hr); SD, standard deviation; Max, maximum value of methane production measured in the course of our experiments; *n*, number of independent measurements; S, number of different strains (see Table 1); Protists, predominant protists with intracellular methanogens.
**Blaberus* sp. indicates pooled data from *Blaberus cranifer* and *Blaberus fuscus* (likely to be the same species) and from *Blaberus giganteus* that is very similar to the other species.
†Strain Cologne.
‡Two strains harbored only small numbers of ciliates; one did not host any.

Some species of methane emitting taxa do not emit methane though, as can be seen with diplopods, cockroaches, and termites (it is suggested that they deal with a secondary loss of the methanogens). Besides this, millipedes, rose chafers, and cockroaches occurring in temperate European climates also lack emission due to the sensitivity of methanogens for low temperatures (see e.g. the cockroach *Ectobius* sp.). Therefore, those methanogens are also lacking from the hindgut.
Table 12 reveals the contribution of the four methane emitting taxa and these taxa contribute significantly to atmospheric methane.

Table 12: Estimated emissions of methane

(from Hackstein and Stumm, 1994)

	Annual production, $ml \cdot g^{-1} \cdot year^{-1}$	Bio-mass, $g \cdot m^{-2}$	Tropical forests,* Tg/year	Humid tropics/ subtropics Tg/year†
Diplopoda	Mean 11.4	1	0.15	0.61
		20	3.0	12.1
	Max 81.5	1	1.1	4.3
		20	21.4	86.9
Blattidae	Mean 9.6	1	0.12	0.51
		10	1.3	5.1
	Max 52.6	1	0.7	2.8
		10	6.9	28.0
Isoptera	Mean 74.5	1	0.98	5.6
		6	5.9	23
	Max 158.6	1	2.1	8.5
		6	12.3	50.7
Scarabaeidae	Mean 49.9	1	0.66	2.7
		20	13.1	53.1
	Max 145.4	1	1.9	7.7
		20	38.2	154.9
Sum	Mean	1	1.9	9.4
		>1	23.3	93.3
	Max	1	5.8	23.3
		>1	78.8	320.4

Annual production is based on laboratory measurements shown in Table 3. Mean is based on average production rates; Max is based on maximum production rates measured in the laboratory; these values are lower than most of the values given in the literature. For biomass, low and high data were used; they were derived from refs. 21–30.
*Tropical forests occupy an area of 18.5×10^{12} m^2 (20).
†Humid tropics and humid subtropics occupy 75×10^{12} m^2 (20).

At least several species of the methane emitting taxa are edible and are in fact being eaten (e.g. *Blatta orientalis*).
The selection of edible insects for breeding can be made according to methane emission: due to the specificity of methanogens there are more edible insects not emitting methane than those that do emit (e.g. *Locusta migratoria*, *Schistocerca gregaria*, *Bombyx mori*, and *Apis mellifera*, see table 10).

Ammonia Ammonia is a minor excretory product in many insects (Bursell, 1967). If present in the excreta of terrestrial arthropods, it is in small amounts (Kuzhivelil and Mohamed, 1986). While many arthropods do not emit ammonia, a substantial portion of the nitrogenous waste (uric acid, urea, ammonia) of at least some aquatic larvae (Staddon, 1955; from Bursell, 1967), certain dipteran larvae (Brown, 1938; from Bursell, 1967), cockroaches (Cochran, 1985) and termites is made up of ammonia. Termites contribute significantly to ammonia fluxes in tropical ecosystems. The mounds of soil-feeding termites and their guts contain large amounts. The emitted ammonia does not leach into the atmosphere though, due to adsorption of the nest soil. The ammonia is then available to plants (Rong and Brune, 2006).
The proportion of nitrogenous waste in the faeces of insects varies enormously and depends mainly on feeding habits. Variation within a species is depending on developmental stage. The edible adult form of *Schistocerca gregaria (Orthoptera)* does excrete ammonia – but unknown in what quantities – while the edible adult form of *Locusta migratoria (Orthoptera)* does not (Bursell, 1967). Also the larvae of the edible *Bombyx mori (Lepidoptera)* does excrete ammonia, even in an enormous quantity (Pramila and Krishnamoorthy, 1977; from Kuzhivelil and Mohamed, 1986).
Further research is needed on the emission of ammonia by (edible) insects, although the prospect is a positive one: several edible species do not emit ammonia at all. Selection of edible insects for breeding can be made according to these emissions so that a production system with zero animal ammonia emission can be applied.

Food conversion efficiency

Authors such as Lindroth (1993) and Nakagaki and DeFoliart (1991) have underlined the suitability of edible insects as alternative food for the future by postulating an important feature that makes (edible) insects an environmentally sound food: the efficiency of converting ingested food to biomass (food conversion efficiency – ECI). This efficiency varies among species (e.g. because of different feeding guilds: foliage- versus wood-feeders, herbivores versus carnivores) and within species (e.g. homeostatic adjustments, sex (Slansky, 1985), developmental stage) (Lindroth, 1993).
Nakagaki and DeFoliart (1991) have found the house cricket (*Acheta domesticus* L.; fresh cricket eighth instar nymphs) to contain a crude protein level similar to that of vertebrate livestock. The quality of the proteins is lower for the crickets in comparison to vertebrates and high quality protein

sources such as egg (e.g. Ozimek et al, 1985; from Nakagaki and DeFoliart, 1991). These quality measurements were conducted through NPU (net protein utilization), PER (protein efficiency ratio), and analysis of amino acid content in egg protein. The lower quality of the cricket protein can be explained by its relative low digestibility. The integument of insects contains chitin (which consists of nitrogenous components) and monogastric animals do not have the necessary chitinase to digest it. But the protein quality can be improved. Ozimek et al (1985) have shown that by removing chitin followed by alkali extraction, the protein digestibility, NPU, and PER are increased of whole dried honey bees (*Apis mellifera* L.).

	Before chitin removal	After chitin removal
Protein digestibility	71,5%	94,3%
NPU	1,50	2,47
PER	42,5	62

While protein quality is similar to that of vertebrate animals, insects seem to "be an excellent source of protein compared with most plant sources" (Nakagaki and DeFoliart, 1991). Finke et al (1989) found in their experiments better results for growing rats when fed insect proteins (Mormon cricket meal and house cricket meal) than when fed soy protein (tofu is made of soy protein!).
Nakagaki and DeFoliart (1991) have measured the ECI of the house cricket and compared this with the ECIs of vertebrate livestock measured by Meyer and Nelson (1963). *Acheta domesticus* appeared to be far more efficient in converting food to biomass (measured in wet-weight): more than twice as efficient than poultry, about three times more efficient than pigs, five times more efficient than sheep, and almost six times more efficient than cattle. Lovell found in 1979 ECIs for vertebrates that differed little from Meyer and Nelson (1963), but the ECI of crickets was still higher (Lovell, 1979, did not include sheep). This efficiency of crickets over conventional livestock implies less need for input as livestock requires a large input: one kilogram of meat derived protein requires 3 to 10 kilogram plant protein (depending on animal species and circumstances) (www.profetas.nl, seen on 27/10/2007). A restriction is made here by mentioning only wet weight measurements because these crickets are usually marketed fresh. Other insects such as the mopane worm are often sold in dried form. When house crickets are dried, ECIs are reduced (but ECI remains higher than for vertebrate livestock in the case of *A. domesticus*). The efficiency is also temperature sensitive: optimal ECI is found at optimal rearing temperatures for the insect species (about 30°C for the house cricket).
Slansky (1985) has reviewed literature on ECIs of insects in dry weight which can be consulted to compare other insect species with vertebrate livestock. The extensive list covers many different larval stages and some adult forms of which most have higher ECI (e.g. the edible *Bombyx mori* (L.)) when compared to ECI of livestock in Nakagaki and DeFoliart (1991).

For a more complete picture of the advantage of crickets over vertebrate livestock, the additional factors dressing percentage and carcass refuse should be taken into account. The combination of these two factors reduce the edible portion of the four vertebrate livestock classes by approximately 50% (of whole body weight). When legs are removed and the indigestible integument is taken into account of nymphal crickets (the integument is usually not removed), the loss is approximately only 20% (of whole body weight).
Last but not least, the fecundity of both insects and vertebrate livestock should be considered. A female house cricket, after reaching the adult stage, lays on average 1,200 – 1,500 eggs over 3 – 4 weeks (Patton, 1978; from Nakagaki and DeFoliart, 1991). This high fecundity adds an extra advantage in comparison to sheep, cattle, and pigs. The advantage is less when compared to poultry.

3.3. Conclusion

Conventional livestock production has major effects on global warming, acidification, eutrophication, and energy use. The environmental impacts are severe and need to be cut down to avoid an increase of damage. Some of the main influential processes are: feed crop production and transport (of which e.g. deforestation, pesticide and fertilizer use, and food miles form part), fermentation of ruminants, animal waste and animal waste treatment, and animal management. These processes increase the emissions of greenhouse gasses (and therefore increase global warming), increase acid rain and acidification of ecosystems, and cause water pollution (eutrophication). Consequentially, biodiversity is affected (Steinfeld et al, 2006). Although organic farming decreases these impacts (except for pig production), stronger solutions are needed since organic farming is not necessarily ecologic. Steinfeld et al (2006) and Ogino et al, (2007) suggest some measure within the current conventional livestock production that can be taken to cut down the effects.
A suggestion that is made here, in which acknowledged authors such as Gene R. DeFoliart (e.g. 1999) and Julieta Ramos-Elorduy (e.g. 2005) are followed, focuses on a different livestock. Although only limited researched can be referred to, (edible) insects have some ecological advantages in comparison to conventional livestock. The results found, suggest that most of the insects in the world do neither emit methane (except for termites, rose chafers, millipedes, and cockroaches) nor ammonia (except for some aquatic larvae, some dipteran larvae, cockroaches, and termites). Methane emitting insects are suspected to make a significant contribution to atmospheric methane. There are more edible insects not emitting methane than those that do emit, and the number of ammonia emitting insect species seems to be relatively little. From these results follows that selection of edible insects for breeding can be made according to these emissions so that a production system with zero to nearly zero animal methane and ammonia emissions can be applied. This selection can be further influenced by the insect species specific efficiency of converting food into biomass (ECI). The ECI is an important feature in the

choice of environmental sound food alternatives for the future. Many insect species have proven to have a higher efficiency of conversion in comparison to cattle, sheep, pig, and poultry.
The discussed results suggest that edible insects can be regarded as an environmentally sound food alternative. These results should trigger further in depth research in these ecological advantages.

5. Ethical Desirability

In this chapter, the focus further deals with the question: should entomophagy be part of Western food habits? The answer to this question is not straightforward and has to be dealt with care. Therefore, an important sub-question is being answered first: with what right can we ask the attention of the West to consider edible insects as food?
This thesis presents entomophagy as *a* solution to environmental problems related to conventional livestock. As often, solutions to a problem introduce new problems related to that solution: entomophagy in the West is loaded with ethical dilemmas of which five of them are briefly explained. A second important sub-question is then: how to deal with these dilemmas?
The answers to both of these questions can be found in the deliberative approach explained by Prof. Michiel Korthals (2004). This approach is a useful tool in assessing whether entomophagy *should* be part of Western food habits from an ethical point of view and it gives clues on the position consumers and government should take.

Section 1 : Entomophagy: Food Styles and Dilemmas

1.1. An evil in food country: lack of pluralism

1.1.1. Food styles

Before elaborating on the question: with what right can we ask the attention of the West to consider edible insects as food, we have to take into account existing food preferences and food practises. The concept of 'food styles' can be helpful to analyze these. This concept is a key concept in explanations on ethics of food. A food style can be seen as:

> ". . . a food regime that is part of a life style, and it covers a certain type of information on food, type of shopping, preparing, cooking, eating out or at home, together, and form of fulfilment" (Korthals, unpublished).

It is also ". . . a way of disciplining yourself and others, whereby health can be important (. . .), or hedonistically enjoying" (Korthals, unpublished). Food styles are closely related to life styles according to these descriptions. The strong relationship of food with culture and subcultures through life styles is then realized. This aspect has been dealt with in section 1 of chapter 2.

1.1.2. Connecting entomophagy to existing food styles

Some lifestyles can be distinguished with their matching food styles. Korthals (2004) follows Schulze (1993) who defines three general categories of late-modern lifestyles in which five of those can finally be distinguished with their respective food styles. Fitting entomophagy in the given lifestyles (food styles) means making a choice between: (1) integration lifestyle, (2) harmony lifestyle, (3) upper level lifestyle, (4) self-realization lifestyle, and (5) amusement life style. These life styles can be generalized as concentrating on respectively traditional (regional or national) food, health food, natural (organic) food, international (cosmopolitan) food, and fast food (Korthals, unpublished). The motivations of consumers to choose a certain food style can be different. Vegetarians can have ethical concerns (e.g. animal welfare) but on the other hand might just not like the taste and smell of meat (anymore). Also, consumers do not refrain themselves to stick to one category: many overlap is existing.
It is not straightforward to make a choice between these five food styles in relation to entomophagy. Natural food is the category in which entomophagy can most easily fit (insects are natural food). But to restrict the view of entomophagy to this category is insufficient. The aspect of *ecological eating* – meaning to choose food with respect to sustainability and such – is/can be an important feature of entomophagy (see chapter 4). It does not seem that natural foods covers ecological eating (organic meat is not necessarily ecological food!) and it is not present in the others. This ecological aspect is of interest. The essence of this thesis is not: edible insects as biological food. Then, attention would be asked for organic food. The essence though, lays in the ecological sound possibilities of entomophagy. But a food style which can be called ecological is lacking. An ecological life style is also lacking in Korthals (2004) and Schulze (1993).
Entomophagy then could be fitted in a (not distinguished) ecological life style. It seems that an ecological life style has not had much attention yet (although during the process of writing this thesis former US vice-president Al Gore Jr. and the United Nations Intergovernmental Panel on Climate Change (IPCC) received the Nobel prize for peace, and Belgian TV made a series on the ecological footprint of the Belgians stressing bottlenecks such as food and energy); one can recognize it in the public though: companies applying ‘green roofs’ for better isolation (less use of fossil fuels), private persons putting solar panels on their roof tops, energy companies offering ‘green’ energy, private persons buying energy saving light bulbs, etc. Consequently, this thesis regards entomophagy as part of the category: ecologically sound food.

1.1.3. Lack of pluralism

The problem that should be recognized in general concerning food is: lack of pluralism and misrepresentation of food styles and choices. When one food style is dominant, there is an indication

of misrepresentation. Different food styles focus on different concerns. Concerns of the environment, animals, and landscape (to name a few) are suppressed. Although, for instance, biological products are becoming more and more available in supermarkets, fair representation is lacking. This means that some people who identify themselves with a certain food style are better served by the food sector than others. In other words: the right on food choice of certain groups of individuals is not respected. Objections to the bio-industry have resulted in an increase of biological meat in supermarkets, and as a result the availability of biological vegetables and fruit has increased. Still, fair representation is not yet achieved which is according to Korthals (not published) an evil in food country.
Fair representation of food styles implies that:

- products belonging to a certain food style are available
- food production processes are structured in such a way that products of a certain food style are in fact produced
- all products must be affordable: price may not exceed the price of similar food stuffs too much
- people cannot be condemned for their choice in food: people must be able to enjoy an own choice

When these fundamentals are not present in food country, then a matter of disrespect is abound. A food style may be dominant in a culture (e.g. fast food in the West), other food styles (in other words: the preferences of certain groups of consumers) may not suffer under this dominance. One's own food choice must be a fundamental because of respect for the individual. Anyhow, it seems that in Europe pluralism (fair representation) is increasing (Korthals, unpublished).
In the explanations on the deliberative approach, the demand for pluralism, and therefore attention for entomophagy, will be defended. Namely, that by following the principles of the deliberative approach entomophagy as ecological food deserves a place in food country.

1.2. Ethical dilemmas of entomophagy

Especially due to chapter 4, one might consider this thesis to reveal a question of morality: the unconventional food of edible insects is presented as a solution to environmental problems related to and therefore as an alternative for conventional livestock. However, the moral choice for entomophagy is not that simple, because entomophagy also raises new moral dilemmas. In questions of morality, norms are in fact at stake. When a matter of morality reveals at least two norms that clash, a dilemma is born. Characteristic for a dilemma is that the clashing norms can not be respected fully at the same time (Korthals, 2004). Clashing norms can be found within entomophagy – as an unconventional food for the West. The dilemmas that are distinguished here are:

- deep rooted aversion vs. respect for emotional reaction
- fair trade vs. Western based production

- ‘cultural cows’ vs. ethnic product
- low vs. high number of animal killings
- “restore” nature vs. ‘domestication’ of new animal species

We will elaborate on them in section 2.2., after we have discussed the deliberative approach.

Section 2 : The Deliberative Approach

2.1. The essentials of the deliberative approach

There are many ethical approaches, but I will confine myself to the deliberative approach because this approach promises to have an open eye for pluralism and for dilemmas.
The liberal perspective (e.g. Locke, 1689/1727) considers the state as a neutral organ that does not take into account the differences between its citizens and their view on the good life. The deliberative perspective (e.g. Habermas, e.g. 1992, 1996, 1998) on the other hand, pays attention to “values as respect for the individual as a member of communities and the pluralism of lifestyles” (Korthals, 2004) (and accordingly to food styles). Because of the latter (pluralism of lifestyles), there was a need to connect entomophagy to lifestyles and food styles as this is a key element in this chapter. The deliberative approach is then a valuable tool for answering the questions stated in the introduction of this chapter.
The following points of view play a role in ethics of food (deliberative principle) and are being appealed on (Korthals, 2004):

- *autonomy* of the consumers
  whether or not governments act neutral (*justice*)
  → combined in one: the principle of autonomy and justice
- cultural dependant values (*identity*)
  → referred to as the principle of the ‘good life’ (a.k.a. comprehensive doctrine of the good)

Why autonomy and justice?
This point of view focuses on the vulnerability of individuals and their need for protection. To make it possible that (vulnerable) people can live together, arrangements in the form of rights are formulated and put into practise. These rights appeal on common goods such as the possibility of survival, health and so on.
Three important aspects are part of this point of view of the deliberative perspective.

The principle of *autonomy*

This principle implies that every individual has a choice of him- or herself in choosing autonomously aspects of his or her life like job, religion, etc. An important aspect is the right of *'exit'*, meaning that without further consequences, a person can alter the choice made in job and religion. Closely attached, is the *right on information* which aids a person in considered choosing.

By following (accepting) this principle, Western people have the right to choose entomophagy as part of a food style (ecological eating as a food style, ecological living as a life style) without any consequences. But as said above, entomophagy can be part of the food style natural foods as well since there can be overlap between food styles. The right to say 'no' remains present, as is the right to say 'no' after having participated ('exit'). Information on entomophagy is indispensable. People today not knowing about entomophagy must be and can be informed to be able to make a considered choice. Not only do consumers have the right to be informed, also academics have the right to inform people on something as new and unconventional as edible insects. The principle of autonomy also expects that considered choices are being made. In fact, considered choosing reflects one's autonomy. The autonomous and considered choice to either participate or to not participate is essential in which the stressing lays on *autonomous*, *considered* and *choice*.

The principle of *'voice'*

The principle of voice refers to the right of people to take part in discussions concerning the rights of autonomously choosing and justice in choice (Hirschman, 1970; from Korthals, 2004).

Since the motivations of people to eat according to a certain food style differ, these people have the right to ask for an application of entomophagy into their food style. In this way, entomophagy is not restricted to one food style – ecological eating. Applying a sustainable food to other food styles must be possible. Eating a sustainable ecological food but maintaining one's 'principle' food style is implied by the right of voice. In this way a combination can exist between entomophagy and the distinguished food styles of Schulze (1993, from Korthals, 2004). The preference for fast food can be maintained by adjusting edible insects in such a way that for instance grasshopper hamburgers in fast food chains can be sold or microwave meals are available in supermarkets. To meet the requirements of natural food, it must then be assured that for instance no pesticides are used in the feed production of marketed edible insects. The principle of voice then means that people having a preference for one certain food style should not refrain from participating in features of another food style: entomophagy can be applied to other food styles and this must be made possible.

The principle of *access*

Citizens/consumers have a right on products and services of which they feel are essential for them to live the 'good life'. A large group of people asking for a certain product or service should be heard and satisfied. Scientists and producers have to answer the call.

When reflecting on entomophagy, it can be seen that while some people prefer natural foods, to eat food stuffs that are ecologically sound might be important to some as well. Aspects of an ecological life style are being applied (e.g. 'green' energy), while the gate to an ecological food style might be open. These kinds of awareness of life (and food) is part of some people's idea of living the 'good life'. These days, effort to answer the demand for biological food is being seen in shops.

But biological meat does not mean ecological eating. Since eating is an essential part of many people's life, eating ecologically is a part of ecologically living. Therefore, the ability to eat ecologically should be present. Entomophagy as ecological eating must be made possible by science (academics) and food companies.

Why comprehensive doctrine of the good?

This view (focussed on living the 'good life') holds the individual as member of a certain community (or (sub)culture) central. To maintain one's identity is what is at stake here. As for people to be able to live *their* 'good life', here restricted to food, their demands and "needs" must be made available/must be assured according to the deliberative perspective in an optimal way.

Biological eaters, ecological eaters and people concerned with animal welfare can be satisfied by the practise of entomophagy. These individuals as part of a certain group can be helped to achieve their view on the 'good life'.

The literal demand for *ecological* food only seems to occur in a minimal way. Whether or not there is an actual demand for ecological food is only relevant to some extent. Awareness of environmental problems is spreading and more and more effort is being done, even by individuals, to care for the environment (to some extent). For instance, people buying energy saving light bulbs or putting solar panels on their rooftops. The demand to live a (more or less) ecological lifestyle is being answered: it is made possible (the Belgian government subsides private persons in buying solar panels). The demand for ecological *food* might not or hardly be present, when informed about the possibility people might want to join in. Entomophagy is in this way an extension of possibilities: people wanting to live an ecological lifestyle can further extend their life style to the food domain. It can then be regarded as a better chance in the fulfilment of the good life (recall that biological food not necessarily means ecological food!).

Moreover, it could be argued that in days of ecological problems all around the globe, living a (to some extent) ecological life should count for every person. Entomophagy stands strong in this case (chapter 4). Living such a life can only be advised though through the deliberative perspective and not

commanded. Whether people actually should be *persuaded* to eat ecologically or eat insects is a deliberation worth an entire thesis. Here, a first step toward an ethically argued deliberation to put edible insects as food under the attention of the West is made in which this thesis limits itself to defining a *right for attention*.

When the ecological food style is accepted as a food style, it becomes a *second order desire* (a choice between different food styles). Since the deliberative perspective demands pluralism of life styles and accordingly food styles, the ecological food (edible insects) should be brought under attention. Edible insects are a *first order desire* within the category of ecological foods (a specific choice within a food style). Regarding entomophagy as part of natural foods, it is also a *first order desire*. Although *first order desires* are of less importance than *second order desires* (Korthals, 2004), edible insects deserve attention because of the limited choice for ecological food.

2.2. Dealing with ethical dilemmas

The deliberative approach is also a useful tool in dealing with dilemmas. Mepham (1999 and Mepham et al, 1996; from Korthals, 2004) has developed an ethical approach on dealing with ethical dilemmas in which four principles form the centre (based on Beauchamp and Childress (1994)): (1) autonomy, (2) justice, (3) do not inflict harm, and (4) well-doing. The objections made by Korthals (2000; from Korthals, 2004) show that this approach is inadequate because it focuses only on the principles[9]. Then according to Korthals (2004), dealing with an ethical dilemma is a process with – among other things – *compromises* in which *not only principles*, but also *values*, *preferences*, and *ideals* play a part. Korthals (2004) calls this *applicationism* and focuses – as the name suggests – on application of principles instead of only justifying principles and identifying / analysing the ethical problem (see also Korthals, 1994). Ethical problems are present in socio-cultural contexts and therefore these contexts are being focussed on. This implies that the deliberative ethical approach is not an approach of forbidding and setting up rules, it acts to advise and put up guide-lines. As individuals can't have knowledge and insight on all possible solutions, experts are an aid to them. This means that principles as autonomy have a practical border. But there needs to be trust between consumers, producers, and experts.

It should also be recognized that there is a huge gap between consumers and producers. Korthals (2004) is aware of the need of good communication to restore the trust between consumers and producers and so principles that have a practical border can still be followed. He insists on active roles of all stakeholders through ethical commissions in different parts of the food chain. The idea behind this, is that principles are followed in respect of the socio-cultural context. To make this work, at least

[9] It is not the point to explain the objections made to this approach, see Korthals (2000, from Korthals, 2004).

two forms of communication and consultation are needed at *every level* in food country: forming of an opinion and decision-making (with implementation).
The forming of an opinion should be conducted by as many people as possible. Therefore, the focus is not on specific food styles but on the general public as a whole. The goal is to reach as many people as possible with the topic (the sustainable food of insects) and to let them form an opinion, which results in many opinions. Decision-making on the other hand, should lead to consensus. A clear end product or goal ought to be defined and worked toward it. Both of these forms of communication have two tasks: identifying and analysing the ethical problem and bringing up constructive solutions. The forming of an opinion process will lead to different analysis' and several solutions to the problem while the decision-making process will develop one clear and complete analysis of the problem and brings up the best solution to it.
Basically, the central point of discussion (ethical problem) is the conventional food production. At the two levels (forming of an opinion and decision-making) this ethical problem should then be identified and analyzed (see also chapter 4) after which then solutions should be thought of. In the case of this thesis though, another situation is at stake. A solution is being brought up already; entomophagy is considered as a possible solution. The point now is that this solution can be an ethical problem in itself which deserves identification and analysis to which then a solution is to be made (compromise).

2.2.1. Solving a dilemma

Two important aspects to the solution of an ethical problem should be bared in mind: (1) the type of solution, and (2) the status of ethical instructions (Korthals, 2004). The first one implies making effort to find and try out a solution which is most probably an imperfect one as the perfect solution is an ideal in itself, whereas the second refers to the place ethical reasoning and recommendations should take at finding and trying out those solutions.

The type of solution

Entomophagy is being seen as *a* solution to the broad ethical problem of the ecological problems related to (production of) conventional livestock, not as *the* solution but as a possible part. A solution is often *second best* and therefore not perfect. But by putting careful attention to the implementation of and the reasoning behind a solution, it is valuable to try a solution although its imperfectness is realized.
As stated above though, this solution can be seen as an ethical dilemma itself because of lack of knowledge, and, its unconventional features. For instance, lack of knowledge on animal welfare considering insects and the cultural aversion to the topic are problematic. Solutions to this last problem are stated in section 5 of chapter 2. Further research is needed to expand knowledge on these

suggestions and on animal welfare and such. These solutions on their turn (especially on aversions) can not be perfect. But also here, careful attention at implementation can lead to reduced imperfection.

The status of ethical instructions

To what extent should ethical indications and recommendations as entomophagy be prohibitive? This is the central question in this part on solutions of an ethical dilemma. Food country is a complex world in constant change with new developments and insights. Besides this, globalisation and pluralism play a major role. It is therefore not realistic to focus on principles that lead easier to strict rules. In a constant changing field, these rules would then also have to be constantly adapted. By focussing on ideals, preferences and nuances there is room to work up to considered compromises with principles as guide-lines. It is then, hopefully, possible for people to shape their own (food) world and not be restricted to principles.

The suggestions made on tackling aversion are ethical indications, but they are not principles that have to be followed! But since pluralism is at stake, the suggestions of section 5 can be helpful in achieving this pluralism.

2.2.2. Ethical dilemmas of Western entomophagy

An attempt is made to distinguish different clashing norms not in the broad central point of discussion (ecological problems in production of conventional livestock), but specific in the solution (entomophagy). A revision of the solution is needed: identifying and analysing the ethical problem(s) concerned with entomophagy itself and a constructive solution (if possible) to the ethical problem(s) involved by as many people as possible.

As for the following ethical dilemmas, no recommendations are made. Some ethical dilemmas are being pointed out but a detailed elaboration on them can unfortunately not be achieved in this thesis. These dilemmas – clashing norms! – can be heavy drawbacks for people to participate in entomophagy (besides emotions of course). It is due to these personal drawbacks in connection with people's autonomy and view on the good life that entomophagy is a right, not a command. Dilemmas as these play a role in the outcome of the eventual compromise, but they need to be researched upon which opinions and decisions have to follow.

Deep rooted aversion vs. respect for emotional reactions

At first hand, the overall deep rooted aversion toward insects does not seem to be a norm as such. With a lot of twisting and turning one may find features of a norm in this behavioural reaction.

The opposite – an enthusiastic reaction to insects on the plate – is an unexpected behaviour. The *more or less expected* behaviour/reaction to insects as food in the Western world is aversion and could

therefore be argued to have features of a norm in the Western world. Although within an ethical dilemma there is a clash between norms, it does not seem to be necessary to hold on to this characterisation in a strict way; it is more or less what you call it.
There is a matter of a dilemma and that is what is at stake here: the solution that is being brought up in this thesis strikes with the Western consideration (cultural rule) of what is edible and what not. The aversion toward insects is problematic for the success of implementation of the solution. Is the solution therefore reasonable?
The aversion is problematic to the solution, but the aversion can in itself be considered problematic. The matter of irrationality of emotions has been mentioned but not elaborated on into detail (section 3.7. of chapter 2). It was also stated that the deliberative approach implies that no judgement can be made on personal emotions. The dilemma is then clearly that the solution to the global environmental problems concerning the conventional meat production – entomophagy – does not have to be applied by the stakeholders due to its unconventional features and therefore due to respect for the individual emotions. The aversion can be dealt with, but to what extent? Solutions to this dilemma have been suggested in section 5 of chapter 2. These solutions (education, exposure, . . .) are quite straightforward. Their implementation is not problematic and are therefore not unreasonable because they do not collide with principles such as respect for autonomy.

Fair trade vs. Western based production

More and more attention is being paid to fair trade: supermarkets, advertisement on TV and in the street (with for instance famous Belgians), and even specific fair trade shops. All kinds of products are sold with a ‘fair trade’ sticker on them or even from the brand ‘Fair Trade Original’: e.g. bananas, coffee, and wine. This is being supported by many consumers. It could be stated that fair trade (to some extent) is valuable for some consumers and part of living the good life. The same discussion can be held as above: it is not specifically a norm, but the aspect of willingness to buy fair trade products may have features of a norm (it is not valuable for many people, while it is for many others).
The dilemma at stake focuses on breeding edible insects (a minimal occurring resource in the West). Price-wise it would probably be more interesting to import a ‘handful’ of edible insects and start a Western based mass breeding program (an affordable price will increase the availability to many people, see section 1.2.). The question that could be stated here, is: what price does the West pay for a ‘handful’ of insects (ethnic product!) that will eventually lead to masses of insects? Bear in mind though that insects are already being bred in the West as animal feed for e.g. reptile and snake pets. But due to the widespread attention to fair trade on the one hand and the solution to the environmental problematic of conventional livestock being a (mainly) non-Western product on the other hand, it could be advised to only import (deep-freeze / canned / dried / . . .) edible insects. This would provide job opportunities in the countries of origin which may result in, also due to a fair price, more

economical stability. Of course this depends on the success of edible insects in the West! On the other hand, fair trade products being more expensive than other products, many Western people do not buy these products because of the price.

'Cultural cows' vs. ethnic product

Although conventional livestock has ecological disadvantages (environmental damage), grazing cows and sheep in meadows are part of Western culture and this is celebrated for its aesthetic character. Eating the meat (and drinking the milk) of these animals is firmly established in Western food habits (cultural rule). Judging this firmly established food is already perceived as problematic. Offering a solution so distant from most Western people's perception of what is edible and what is not, reveals a clash between retaining Western culture and opening up to and accepting an ethnic food as (partly) replacement of a part of that culture. To what extent can insect breeding replace cows and sheep on the meadows?

Low vs. high number animal killings

Objections to the killing of animals for food are made by e.g. vegetarians. Killing for food is needed for survival (although thus vegetarians may refute this) and it is a natural thing. The killing of one cow can provide a meal for many people. Insects on the other hand are small. To reach the same amount of 'meat' (or animal protein), there is a consequential need of a high number of individual animals being killed for human consumption. To give in to the objections of e.g. vegetarians would imply that killing a cow is preferred over killing edible insects. This is a clear dilemma and research to counteract this dilemma is needed in the fields of environmental loads of both the animal production systems, animal conscience and welfare, and others. These fields should be taken into account for a correct judgment on whether it is ethically seen more right to kill one cow or to kill many grasshoppers considering the provision of animal protein. Referring only to the number of animals being killed is insufficient for a correct judgement.

"Restore" nature vs. 'domestication' of new animal species

Many questions are asked on the relationship of humans with nature and whether or not humans should reconnect with it and respect it more. The effects humans have on biodiversity result in loss of biodiversity and endangered species. Efforts are made to reintroduce species in the wild through special breeding programs in order to restore wild populations and also endangered species in the wild are protected and aided in their survival. Another objection to the relationship of humans with wildlife is being made: domestication is regarded as a danger that would destroy nature and *wild*life as it should be. The dilemma in entomophagy is then clearly that it implies breeding programs of 'wild' animals, especially when it concerns the West. Careful collection in the wild only is out of the

question since it is being suggested that breeding programs are necessary in insect eating regions themselves due to large amounts of harvest (Yhoung-Aree and Viwatpanich, 2005). But true domestication, as with human dependent cows, is not meant here by domestication. DeFoliart (1999) mentions ". . . the failure to domesticate edible insects on any significant scale (except as a byproduct of silk and honey production . . .". This means that insects will never be under human control. DeFoliart calls it a "calamity", due to the food conversion efficiency, but this impossibility may please many people. Domestication implies here "imprisonment" of encountered wild individuals for food. The dilemma is then recognized as the clash between preserving and restoring nature and wildlife on the one hand and using "new" wild animals in breeding programs for human food.

Section 3 : The Role of Government, Academics, and Consumers in Stimulating Entomophagy

A non-neutral government with respect to entomophagy

Implication of the deliberative approach asks for and results in a non-neutral government. When a certain goal (tackling the central point of discussion) is agreed upon, it is taken up at national level in laws and regulations. This agreement is collective because of the involvement of experts, the public arena, and higher political institutions. The history of the discourses at those three levels reflects the end attitude of governmental and juridical institutions: moral (focussed on respect for the individual), ethical (focussed on respect for individuals as part of a community), and pragmatic (expert) discourses are involved (Habermas, 1992; from Korthals, 2004) . The processes of forming of an opinion and decision making as described in section 2.2. come in to play. The ethical reasons forming the end product are a temporary compromise and are therefore changeable due to e.g. the changeable socio-cultural context and the different life styles with their differing respective values. Also change occurs in preferences or ideas of the general public, by new insights from experts, etc. This compromise also implies that the dominant lifestyle (food style) can have major effect on the future of the compromise. This could mean that edible insects, as a proposed solution to the central point of discussion, will not reach popularity and then might not be produced anymore due to lack of sales. The ethical arguments may not be neglected by governmental institutions though. Therefore, first of all, lack of misrepresentation and lack pluralism of lifestyles (and accordingly food styles) must be avoided by it based on the principles of autonomy, access, exit, voice, and the comprehensive doctrine of the good. The ethical concerns involved in the ecological problems (as in: caring for/of the environment) should also have power in dealing with these problems as are ethical concerns about the solution (dilemmas of entomophagy); once more because of the socio-cultural context and their effect on a community as a whole. The outcome of the discourses (held at all three levels) on these issues influences the kind of compromise. It can for instance easily be seen that emotions will play a major role on the discourses conducted by the general public when it concerns edible insects. The ethical arguments should not be

the sole arguments listened too though. Neither moral, nor pragmatic arguments alone may lead the government in drawing conclusions either: all treated aspects of and views on the problem and solution must be dealt with. Which then clearly implies the important role of experts' views, as well as the public arena's needs and wishes, and of the higher political institutions. A collective agreement is a necessity in the deliberative approach and for reaching an acceptable compromise in which a government acts in a regulating way.

Impartial government

The non-neutral government is also impartial when it concerns different food styles and personal choices. This is essential in the deliberative democratic political model regarding the essentials of the deliberative perspective. The most probable outcome of compromise (fair coexistence) is respected and the different lifestyles (food styles) are expected to respect each other.

Every philosophy of life, with the requirement that it does not inflict harm to other people, should be acknowledged on the basis of the right of equal respect. This implies that the unconventional idea of entomophagy can not be condemned. "Me eat insects? No, if they want to, let them, they have to know". This reaction has been found in Costa-Neto and Magalhães (2007; see section 3.1. of chapter 2) and Amar (2002-2003). Although some situational differences can be distinguished between these two recordings on the similar reaction, this reaction is a positive one according to the deliberative approach. Entomophagy does not inflict harm to others[10] and the reaction does neither condemn entomophagy nor makes it impossible for others to eat insects. The ecological food style then also must respect other food styles on the same principles of mutual respect and the right on 'exit', 'voice', and access. For some people namely, entomophagy is not an option due to personal reasons. It is due to the fact that the emotions involved in entomophagy, resulting in aversion, are deep rooted emotions and due to the principle of respecting an individual (personality), that respect for this aversion has to be shown: it should be accepted that some people do not want to participate because of their 'gut feelings'.

An objection can be made, but carefully. The expectation regarding an unconventional idea as entomophagy is also that it is reasoned by the public. It should not be condemned based on intuition, because if it is, then two things are at stake: there is a lack of trust in experts and/or the 'gut feelings' influence people's judgement without reasoned arguments. Experts have to work on both of these dangers. Considering chapter 2, the second danger is quite realistic. Section 5 of chapter 2 has made some suggestions to fight this danger. It might very well be possible that by reducing the negative

[10] Although Rozin and Fallon (1987) and others have mentioned people feeling disgusted (harmed?) when witnessing a disgusted activity by another person, this does not necessarily account for entomophagy. Unfortunately, this was not discussed in chapter 2.

associations with insects and entomophagy (e.g. bug banquets), trust in experts dealing with these issues is increased. But, further research is needed on the emotions at stake (whether they are rational or irrational: Sripada and Stich, 2004, have made a strong and grounded appeal on regarding food related disgust as an irrational emotion). If this thesis would condemn the emotions negatively related to entomophagy, it does not continue on the path of the deliberative approach. Therefore, the 'gut feeling' is not condemned. Because, the deliberative approach implies that when a philosophy of life (food style) is considered *wrong* or *irrational* by others, only because of that reason the food style can not be forbidden. Then, according to the deliberative approach, it does not have to be made clear whether an emotion (and behaviour) is rational or irrational. Personal ideas can not be condemned: neither supporting entomophagy, nor rejecting it. But an important point made by Sripada and Stich (2004) on the other hand is that reasoning is influenced by (irrational) emotions and therefore the outcome of that reasoning can be irrational. When an appeal is made for reasoning (autonomy), the appeal is to rationality and excluding irrationality. The deliberative approach accepts the outcome of irrationality though. This aspect was briefly considered as a dilemma (section 2.2.2.). An irrational reaction to entomophagy may not be condemned (neither private nor publicly) but is allowed to be changed in a gentle way as in for instance bug banquets. The emotions at stake need not be unchangeable: time may reveal the changeability of emotions on edible insects.

Academics and entomophagy

But nevertheless, academics (experts) play a major role in solutions to an issue. In this way windmills were built and separate waste collection is regulated. Academics who have researched entomophagy in non-Western parts of the world, suggested that it might be an aid in fighting famine in several parts of the world. The world shortage of protein for instance, could be diminished by focussing more on entomophagy (e.g. Ramos-Elorduy, 2005). Several of these academics consider that it might now be time to ask the attention of the West for this food (e.g. DeFoliart, 1999; . . .) to be implemented there. Edible insect production is far more efficient and less polluting than conventional livestock (chapter 4). The pragmatic discussions concerning the use of insects as an alternative to conventional livestock is being put further under the attention. This is what this thesis is trying to do as well. At the same time, experts try to bring this topic (this solution) to the public arena by e.g. special events (Mignon, 2002), books (DeFoliart, 1999), and media (e.g. Prof. Arnold van Huis on 'de zevende dag' on Belgian TV channel VRT in November 2007). In this way, the topic is brought to the general public. Discussions on ethical concerns about the environment, ethical discourses, and moral discourses are also a goal of these experts and this thesis. An appeal to consider entomophagy is made to other experts in different fields (e.g. food scientists, environmental scientists, etc.), the public arena, and governmental institutions. It is realized though that the strength and influence of some food styles (fast

food) is overwhelming. In this way, the appeal made here is also a reaction to this dominance of these food styles.
The principle of autonomy implies the right on information to make considered choices (section 2.1.). Although consumers and producers have this right, they are unable to find and argue all information. Entomophagy even deals with a disadvantage. The lack of information partly due to an aversion on the topic and lack of information in general on entomophagy justifies the major role of academics in bringing it under attention and providing the information. Although there is no literal demand for edible insects, the interest to live an ecological sound life is present (ecological problems affect everyone) and it is the duty of experts to provide the information on the possibilities. Therefore an appeal is also made on the right of access. The public is most often dependent on these experts. Therefore, the expectation is that experts have the trust of the public to find solutions, like the one presented in this thesis. It may not be present though, this trust, considering many difficulties with for instance BSE and mad cow disease. To restore the trust and make sure that consumers can trust experts, the gap between these must diminish. This should not be purely based on information, but on transparency, openness, honesty, and accountability of the experts. They must hold responsibility (Korthals, 2004). Experts then must make sure that by participating in entomophagy, people in fact eat an ecological food.
The interest, views, and preferences of the public arena should clearly be investigated by experts, based on the appropriate information on possible solutions provided by experts (education).

Government position towards entomophagy: conclusion

Based on the former deliberations that a government should be impartial and non-neutral in a deliberative perspective, three main acts should then be highlighted on behalf of governments: “the promotion of a fruitful societal discussion in multifaceted debates, the establishment of contacts between the various views on nutrition that all have equal entitlement, and the availability of means to allow the development of new food styles (right to access)” (Korthals, 2004).
The possibility of edible insects in the West needs to be brought to the general public with the appropriate information of what it is in order for people to make a considered choice. Governments need to cover health and safety issues, environmental and animal welfare standards, availability and accessibility, and quality. New standards have to be investigated and set due to dealing with a virginal field of food production. These issues are indispensable in order to gain trust in the product and its proponents (producers and experts). They are of major importance in general in food production since they affect each and every consumer.
Further on, as the ecological food style is entitled to equal access to markets as other food styles (e.g. fast food), edible insects belonging to this food style – and moreover extending the possibilities of living an ecological life – deserve a place in food country. Further stimulation and facilitation of

scientific research is required. The ultimate goal for a government is to work up to peaceful coexistence of all food styles present in its community. Equal access to the market concerns mainly newcomers, products of a new food style. There may be no barriers to edible insects.
The dilemmas involved in the solution can be dealt with by basing on the principles of the deliberative approach. Insights into these dilemmas need to be developed and announced. Depending on the outcomes of discourses on these dilemmas (ethical, moral, and pragmatic), a temporary compromise can be found (once more due to e.g. changing preferences and ideas of the general public and new insights developed by experts).
Importantly, governments are allowed though to make recommendations in regard of health, sustainability, and such concerning food and food production. These recommendations do not collide with the deliberative approach as long as these recommendations are in favour of all citizens and consequently all food styles. Ecological problems originating from food world have to be tackled since they affect every person. As experts have pointed out the ecological advantages of entomophagy, a government should make possibilities for further research and propaganda in the field of edible insects in cooperation with experts: insect hamburgers (fast food), insect microwave meals (fast food), no use of pesticides (natural food), etc. But due to the principles of the deliberative perspective and the dilemmas concerned with entomophagy, forcing people to participate may not be done.

As a first step in creating possibilities for entomophagy in the West, governments ought to tackle barriers (chapter 2). Education was mentioned to be an important and crucial tool: create awareness of insects and tackle the overall generalisation that all insects are bad. Specifically ethno-entomological education could be taken up in school programs and school books with specific attention for entomophagy itself (what it is, where it occurs, etc.), ecological advantages of entomophagy, etc. Bug banquets have shown to be an excellent combination of education and creating awareness of the practise of entomophagy which could be applied in schools at all levels (primary, secondary, university). Indeed, learning is essential which will only be effective in a long period of time when edible insects are available. Production companies, supermarkets, restaurants, schools, events, etc. deserve equal attention and possibilities to reach children and adults of all social class as companies involved in candy, pasta, dairy, etc. To achieve true equality, efforts have to be made to keep prices comparable to those of similar foodstuffs.

Consumers position

Participation of consumers – being part of a community – in discourses on food related issues is a necessity, as should be clear from the above deliberations. Consumers should be aware of food production processes and not only the end product that is eaten because of the fact that food is part of every consumer's daily life, it is taken up in oneself, it is a matter of identity (Korthals, 2004).

Having/gaining this awareness requires openness instead of today's often encountered passiveness. Consumers play a major role in shaping the food world. When acting passive, they become somehow 'slaves' of e.g. food companies and let others than themselves determine their food. By expressing the here defended 'principle of voice', the consumers are actively taking part in food world. Consumers should participate in the discourses in order to create awareness, but also very importantly to express their needs and wants.

Openness toward expert information is another expectation that consumes should fulfil. While this openness can create awareness, it also gives possibilities which is the case in edible insects. Restoring/gaining the trust in experts can not only be an expert task, as consumers should also be open to expert suggestions. Consumers' autonomy then implies of making a considered choice. The suggestion made by experts and this thesis to introduce edible insects in Western cuisine and supermarkets should at least be considered with reason. Insights in the topic (e.g. on animal consciousness) can be developed by experts. For a compromise to be acceptable, these insights (which should be translated to the general public) should be reasoned by the general public with trust in the experts.

Consequently, a government and food production companies have to take consumers' needs and wants into account being it animal welfare, fair trade, fast food, or other. Consumers have more power then they may think. Besides this, as consumers differ in food styles while being part of the same community, members of one food style should respect members of other food styles which is implied by the principles of the deliberative approach (which in turn may have made one's own food style possible). Withholding one to change food habits ('exit') is therefore also not done.

Section 4 : Conclusion; Why the West Should Give Attention to Entomophagy and How

Due to lack of pluralism and misrepresentation of food styles, entomophagy deserves a place in food country. The sub-question stated in the beginning of this chapter – with what right can we ask the attention of the West to consider edible insects as food? – has been answered by using the principles of the deliberative approach. By these principles of autonomy, voice, access, and living the 'good life', entomophagy as part of an ecologically sound food style deserves more attention. More and more attention is being given to living ecologically by Western media, politics, etc. Even though edible insects are an unconventional food, the ecological potentials of entomophagy are vast. Therefore, the following principles of pluralism should be accomplished (Korthals, unpublished):

- making food insects available
- (possibly) production of food insect hamburgers, microwave meals, . . .
- making food insects affordable: price of edible insects may not exceed the price of similar foodstuffs too much

- people cannot be condemned for their choice in food: people must be able to enjoy an own choice

Solutions often lead to new problems. Entomophagy as a solution to environmental problems related to conventional livestock is loaded with several ethical dilemmas. The following ethical dilemmas have been distinguished:

- Although the deep rooted aversion to insects in general and entomophagy specifically are an overall reaction of Western people, this aversion can be argued to be irrational. On the other hand, the deliberative approach implies a respect for other people's emotions.
- When implementing entomophagy, edible insects could be bred in the West. A socio-economic dilemma is then: the clash between, the by many Western people supported, fair trade (production of the resource restricted to country of origin) and Western based production.
- Conventional livestock is part of Western culture. Cows and sheep in meadows are of aesthetic importance. Entomophagy is an alien food habit to Western culture. A clash is then existing between one's own culture and accepting an ethnic culture's food habit as solution to the problems of that culture.
- Many animals are being killed for human consumption already. Entomophagy implies, due to the size of insects, that higher numbers of individual animals need to be killed. This is also a clash in regard of many Western people's concern with animals.
- While, among others, Western efforts are done to "restore" nature by returning animals to the wild or developing breeding programs to restore wild populations of wild animals, entomophagy in the West will take wild animals for breeding as food ('domestication').

It is due to these dilemmas, which are for some people heavy drawbacks, that entomophagy should remain a *choice*. These dilemmas have to be dealt with which is according to Korthals (2004) a process with – among other things – *compromises* in which *not only principles*, but also *values*, *preferences*, and *ideals* play a part. Therefore, a compromise as outcome on a problem is temporary and changeable. In both presenting entomophagy as a solution to the environmental problems concerning conventional livestock and to the dilemmas concerning Western entomophagy the government acts in a regulatory way aiming for coexistence of food styles. Discourses should be held by experts, the general public, and higher political institutions that take into account moral (focussed on respect for the individual), ethical (focussed on respect for individuals as part of a community), and pragmatic (expert) aspects. Opinions should be formed and decisions made at all levels which are taken into account at governmental and juridical level. By this process, a true deliberation is held in which pluralism of food styles and fair coexistence of those food styles is to be achieved. Nevertheless, a government may make recommendations in regard of health, sustainability, and such. In short, in the field of food, a deliberative government is expected to:

- play a preventive role: a government deals with standards of safe food production and safe and healthy food, accessibility, availability, environmental issues, quality, and animal welfare related to edible insects;
- follow the principles of justice, autonomy, voice, access, and the comprehensive doctrine of the good and works toward coexistence by acting in a regulating way.

Consumers (citizens) on their turn are expected to:

- respect other people's choice, including 'exit';
- make attempts to create awareness and openness to food related issues, specifically edible insects;
- make a considered choice themselves (autonomy).

A government should further make the entrance of entomophagy as a 'science' part of educational programs in order to tackle the overall generalization that all insects are bad, support it to be taken up in schoolbooks of all levels, support events, marketing, cuisine, production, supermarkets, etc. Available, education, and learning are the key aspects that Western entomophagy needs and to which it is entitled to.

Entomophagy *should* then have at least these possibilities in order to become part of Western food habits.

6. Conclusion: An Unconventional Food for the West

While Western conventional livestock makes a major contribution to environmental problems, the – in Western point of view – unconventional food edible insects is an environmentally sound food alternative for the (near) future. This is the main background of this thesis. It has tried to be an aid in developing an approach in bringing entomophagy – eating insects – to the attention of the West. Three guideline questions were used to do so: (1) *why* does the Western culture *not* take part in it?, (2) *can* entomophagy become part of Western food habits?, and (3) *should* it become part of Western food habits?

Edible insects may become part of Western food habits

For achieving acceptance of this unconventional food, barriers to acceptance and possibilities to tackle those barriers have been explored. One of the most important barriers is the perception of insects in general of Western people. A negative attitude is present that makes a generalisation: all insects are bad. This attitude is loaded with emotions such as *disgust*. The other distinguished barriers follow from this negative attitude: aversion of insects as food and a food neophobic reaction. The emotion of disgust is present in the latter two as well. Insects are rejected mainly because of what they are, how they look like, and where they have been (ideational factors). While this disgust is very much culturally influenced, culture in itself may then be regarded as the barrier to entomophagy.

This negative attitude is neither innate nor universal. Positive change can be induced with little exposure (naturalistic change). Chances to learn to like and information are indispensable for success to which “bug banquets” can be a good aid: an educational talk that is followed by a possibility to try edible insects. Rather quick changes in attitude have been recorded.

This thesis carefully concludes that edible insects may become part of Western food habits. Barriers can be tackled and possibilities of acceptance are present. But to what extent? What are the chances of actual establishment? It is only clear that it will take time and effort. Making edible insects available, offering chances to learn to like edible insects (exposure), and information (education) are indispensable aspects.

Media coverage is one step to creating awareness on the topic of the general public: e.g. documentaries. The right information should then be distributed: e.g. tackling the idea that it tastes bad and ecological advantages. This coverage is also a means of exposure. Another means of exposure can be trough school programs at all levels (“bug banquets”) and having the topic taken up in school books of all levels. Events such as ‘City of Insects’ in Wageningen and the film festivals in Gembloux and Narbonne are excellent for education and possibilities to learn to like. As success is only achieved when edible insects are available for people to buy, help can be found in supermarkets selling them at reasonable price and distributing recipes (with familiarity).

Edible insects should at least have the possibilities to become part of Western food habits

When comparing performances of edible insect species on e.g. methane and ammonia emission and the efficiency of converting feed into biomass (meat) with that of conventional livestock – being cattle, sheep, pigs, and poultry – one can only conclude that edible insects are more environmentally sound than conventional livestock. Although, further research is required.

This thesis then describes the right with which the attention of the West can be asked to edible insects. Lack of pluralism is a current problem in food country. People who identify themselves with a certain food style are better served by the food sector than others. The right of food choice is then not fully respected for all consumers as consumers differ in their needs and wishes. An equal presence of all these preferences of consumers should be present. When it is not, a matter of disrespect is abound which is an evil in food country. One's own food choice must be a fundamental because of respect for the individual. As edible insects can be regarded ecological food, they are an extension of the possibilities for people wanting to live an ecological life and more specifically, eat ecologically. It follows from this fact and from respecting people's choice that edible insects deserve attention of the West. It has been further formulated using the ethical principles of the deliberative approach (autonomy, voice, access, and living 'the good life'), an approach that pays attentions to values such as respect for the individual as a member of communities – so it takes into account the changing socio-cultural context – and the pluralism of life styles. This approach is also a useful tool in solving ethical dilemmas. Examples of dilemmas concerning entomophagy in the West have been given.

Fair representation (equal presence) and fair coexistence of the different food styles is then the goal to be achieved. A government should in this regard then play a preventive role by giving aid in setting up food safety standards concerning edible insects and ensure availability, accessibility (price), quality, and such. As governments can make recommendations on health and environment toward consumers, it should therefore support events and scientific research in entomophagy because it can easily be fitted in these recommendations. Consumers on their behalf are expected to make a considered choice in regard of the recommendations made by a government and the information distributed by entomophagy academics.

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