A Shortage of Agar: the Sustainability of a Common Conservation Material

On a recent visit to Nora Lockshin, senior conservator at the Smithsonian Institution Archive, she brought to our attention the current shortage of agar. During our conversation on the subject of options for aqueous gel systems for localised stain removal, I was made aware that working properties, material stability, and toxicity should not be the only factors that inform the choice of conservation materials. A greater understanding of the degree of exploitation of a natural resource and its potential environmental impact should also come into the equation.

This news also came as a surprise to me on a more personal level, as I was brought up in the area where agar was traditionally found in such abundance: Japan's Izu peninsula. The area is known as the largest harvester of the seaweed *Gelidium*, the raw material for agar. One of my earliest memories is of my grandmother wandering to the seashore, and returning home with handful of the seaweed to make jelly for me each day.

Agar, or *agar-agar*, is derived from polysaccharide extracted from certain types of seaweed such as *Gelidium*, *Pterocladia,* and *Gracilaria*. The resulting jelly-like substance is widely used in the food industry as a gelling and thickening agent, as well as in microbiology as a growth medium for micro-organisms in petri dishes.

In conservation, it has been used as a very effective aqueous rigid gel for surface cleaning and stain removal. Its effective property of capillary action, combined with its availability, ease of preparation, PH neutrality, and lack of toxicity has made it a highly promising and desirable material. However, how this material is sourced is scarcely discussed within our community. even if the impact of the shortage has become a cause for concern among other sectors. The raw material is largely harvested in its natural, rather than cultivated, habitat, using labour intensive methods with little automation, but the industry's steadily declining yields demand our attention.

In October 2015 it was reported that Thermo Fisher Scientific had suspended its sales of several agar products used for culturing bacteria and fungi. The company cited low yields, more restrictive quotas for trade and the varying qualities of harvested raw material as the reason for their action (MacDonald, 2015). According to an article from *Nature* on the subject, Millipore Sigma is another lab materials supplier who suspended their supply of agar, attributing the cause of the global shortage to over-harvesting and the increased use of the material in the food industry.

The rationing and rising price of this important reagent naturally raised concerns regarding the future availability of the material, which will no doubt impact on such fields as medical and micro-biological research. The article also suggested that, on top of the global decline of harvests, trade restrictions imposed after the decline of yields in Morocco, the world's major harvester of the seaweed, has crucially affected the situation. The world's agar supply appears very reliant on this specific region. This means that the yields from other regions, whose seaweed harvests are also in decline, could not meet the increasing demand worldwide (Callaway, 2015).

Historically there have been attempts to cultivate and farm the *Gelidium*. Although it is not impossible to cultivate in a controlled environment, past experiments indicated that it is not economically viable (McHugh, 2003). *Gracilaria*, conversely, has been successfully cultivated in countries such as Chile. However, because of the difference in its properties from *Gelidium*, *Gracilaria* cannot be used for bacteriological agar. Moreover, the industrial-scale farming of *Gracilaria* requires a significant modification to sea beds which may affect other natural habitats (Santelices, 2014).

Inspired to investigate the issue further, I recently visited the Izu Branch of the Shizuoka Prefectural Research Institute of Fishery to speak to Masatoshi Hasegawa, research manager, and Koji Takagi, senior researcher, who conduct the annual population studies of the *Gelidium* seaweed and assess the production of agar in the region. The institute was originally founded in 1957 with a specific research focus on *Gelidium* habitats in the region.

In the Izu peninsula, the situation of the declining seaweed population presents a slightly different picture, not merely attributable to over-harvesting or trade restriction. There the problem is understood as a wider issue, both socio-economic as well as environmental, about how humans engage and sustainably maintain the natural resources.

Since the mid-1960s, following the economic boom in post-war Japan, the region found a flourishing new market in tourism, exploiting its natural resources, such as the volcanic hot springs, beaches and plentiful fresh fish. Many of the local population who had worked in the fisheries, including those harvesting and processing *Gelidium* and *Pterocladia*, collectively called tengusa in Japanese, switched their occupations to the more lucrative hospitality and tourism.

Consequently this reduced activity had an adverse effect on the rocky beds where the seaweed was harvested. If not regularly maintained their habitat can be easily overtaken by other types of seaweed that are more competitive than tengusa in the ecological system. Traditional harvesting of the seaweed left the roots to encourage the growth of new shoots and undesirable seaweeds were weeded out , to prevent *Gelidium* and *Pterocladia* from being overtaken (Tengusa Fishery in Izu Compilation Committee, 1998, pp.72-74, 85-87).

The shift in the area's local economy resulted in the decline of *tengusa* harvesters and processors, and thereby the maintenance of the habitats. Currently the Research Institute is attempting to encourage and recover the *tengusa* population. The habitat has been regularly monitored and growth has been encouraged by weeding other species from rock sea beds by divers. However, they have found that it is a challenge to restore the same degree of seaweed population once it has been taken over.

Similarly, restoring the number of harvesters and processors has posed a challenge in the region. The harvesting and processing of the seaweed remains a labour intensive process, few stages of which have been mechanised or automated to date. Because of the nature of the environment that *Gelidium* and *Pterocladia* prefer to inhabit, harvesting is largely carried out by divers picking them up from the surface of the rocks by hand. It is also common to collect those beached ashore naturally, albeit these yields are perhaps even lower. Historically in Izu, female free-divers, or *Ama*, have taken a major role in this.

After sun-bleaching the seaweed, there is another arduous, non-mechanised stage of painstakingly removing the non-*tengusa* seaweed as well as other impurities, such as barnacles, from the entangled bunches of *tengusa* seaweed. The sheer intensity of this labour, coupled with its small monetary return, make the agar industry economically unsustainable and hence unattractive to the younger generation. Consequently, people who engage with the agar industry in the region are ageing and increasingly scarce (Tengusa Fishery in Izu Compilation Committee, 1998, p.75-76).

In conclusion, the conservation community is becoming more aware of the environmental impact of our practice and of what we can do as a profession to encourage its sustainability. However, investigation into the current agar shortage has made me realise that we are probably not talking enough about how our materials are produced and what the environmental and human costs are.

Studies and experiments into the use of agar rigid gel in conservation have been very promising and I am one of many conservators who would like to pursue these techniques further. Indeed, it is tempting, because of its ease of preparation and use, to make agar gel one's go-to material for many things aqueous, from stain removal to poulticing. Nevertheless, it is important to be aware of other options in instances where the desired effect can be achieved using less environmentally problematic materials than agar.

Good, and sustainable, conservation practice benefits from a good understanding not only of conservation materials' specific properties, but also of the environmental and economic contexts in which they are sourced, processed and eventually arrive in the lab.

Misa Tamura is the Research Conservator for the *Situating Pacific Barkcloth Production in Time and Place* project at the Centre for Textile Conservation and Technical Art History, University of Glasgow

Acknowledgements

I would like to thank Masatoshi Hasegawa and Koji Takagi at Shizuoka Prefectural Research Institute of Fishery Izu Branch for offering a fascinating insight into the subject. My thanks also go to Nora Lockshin, senior conservator at the Smithsonian Institution Archives and Michele Austin-Dennehy, conservator at Smithsonian National Museum for Natural History for the discussion which inspired me to pursue the topic further.

References

Callaway, E. 2015. *Lab staple agar hit by seaweed shortage* [Online] [15/05/2016] Available from: www.nature.com/news/lab-staple-agar-hit-by-seaweed-shortage-1.18970

MacDonald, G. 2015. *Seaweed shortage prompts Thermo to suspend sale of two lab agars* [Online] [15/05/2016] Available from: www.in-pharmatechnologist.com/Regulatory-Safety/Seaweed-shortage-prompts-Thermo-to-suspend-sale-of-two-lab-agars

McHugh, J.D. 2003. A guide to the seaweed industry. *FAO Fisheries Technical Paper*. [Online] 441. [15/05/2016] Available from: www.fao.org/docrep/006/y4765e/y4765e00.htm

Santelices, B. 2014. Cultured Aquatic Species Information Programme. Gracilaria spp. Cultured Aquatic Species Information Programme. *FAO Fisheries and Aquaculture Department* [Online] [15/05/2016] Available from: www.fao.org/fishery/culturedspecies/Gracilaria_spp/en

Tengusa Fishery in Izu Compilation Committee (Izu no Tengusa Gyogyo) ed. 1998. *Tengusa Fishery in Izu*. Tokyo: Seizando Shoten.

Reprinted with permission from the September 2016 issue of ICON News.