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► **To cite this version:**

Nicolas Césard. Life and death of the “white manna” along the Saône River. *Études rurales*, 2010, janvier-juin 2010 (185), pp.83-98. 10.4000/etudesrurales.9068 . halshs-03498246

HAL Id: halshs-03498246

<https://shs.hal.science/halshs-03498246>

Submitted on 4 Jan 2022

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Life and death of the “white manna” along the Saône River

Nicolas Césard

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Abstract

While allochthonous species of insects multiply and become invasive during hot spells, some traditionally prolific invertebrates associated with lowland rivers are now vanishing. Little is known about why. The fact that people come to watch and exploit mass mayfly emergences shows the level of interest in them: these swarms can be seen as spectacular, or aberrant and invasive. The insects' emergence from the water as a multitude of winged adults is called the “*manne blanche*,” or “white manna,” a phenomenon that fishers and locals who harvest the manna along the Greater Saône know well. Their sudden proliferation is expected but occurs at irregular intervals. When it does not occur, it forces people to raise questions about the development of the Saône River and the environmental impact of their actions.

Keywords: Ephemeroptera, collection, Saône River (France), “white manna”, emergence, trade, ecology

Translated and edited by Cadenza Academic Translations

Translator: Zac Heyman, Editor: Matt Burden, Senior editor: Mark Mellor

When snow falls thickest, and in the largest flakes, the air is never so completely filled with them as that which surrounded us was with mayflies. Réaumur, *Histoire des insectes* (2001 [1742], 340).

INSECTS in large numbers provoke feelings of fear and are often seen as uncontrollable pests.¹ While heat may directly influence the behavior of some species (those that need humidity to hatch or those looking for plant material to consume), the most bothersome insects, those that bite or that are attracted to light, are mostly a nuisance for human beings. Higher temperatures are beneficial to more prolific insect species (cockchafers, potato beetles, scale insects, and wood-eating insects), whose voracious appetites can even threaten harvests and forests.

Researchers from the INRA have shown that global warming will lead to more biological invasions as species' geographic distributions expand and they are introduced into new areas.² The heat of summer, in particular, contributes to “tropical” insects migrating to more temperate latitudes. Examples include the

¹ This study was undertaken with support from the “Ressources des terroirs” (Local Resources) branch of the Eco-anthropology research unit of the MNHN and the CNRS. It benefited from a grant from the Société des amis du MNHN et du Jardin des Plantes.

² “Ravageurs et maladies dans un contexte de réchauffement climatique : résultats de recherche.” See http://www.inra.fr/la_sciences_et_vous/.

pine processionary moth (*Thaumetopoea pityocampa*) and the Italian locust (*Calliptamus italicus*). In Brittany, the former are known for defoliating trees, for their urticating hairs, and for their intense swarming behavior³; meanwhile, the latter have recently received media attention focusing on the meteorological conditions that have facilitated the rise in locusts coming from the south.⁴

Beyond their spectacular impact, animal invasions are rarely seen as happy events for those who observe or endure them. And yet, abundant swarms of mayflies have been popularly described as “manna,”⁵ after the miraculous food mentioned in the Bible (Exodus 16:13–16). Mayflies, however, are not the only insect that, in great numbers, can go from being a “nuisance” to being “useful.”

Some species that are harmful to humans and their activities can, during periods of emergence, also be eaten. Such is the case, in Africa, for certain pest locusts, a very small portion of which are eaten by the people living in areas where they swarm. The nutritional value of the most prolific insects has been known for a long time (5,000 years): the remains of around 5 million locusts that had been eaten were found in a cave in Utah (United States). In the Americas, Africa, and Asia, swarms of ants and winged termites are often awaited with anticipation. In Mexico and Colombia, flaming torches are placed over *Atta* nests to draw out the females, which are rich in protein. Mayflies were also harvested for food in Thailand, Vietnam, and Laos, and, in massive quantities, in China (Bergier 1941). In China, they were fried or crushed to a paste in mortars before being mixed with honey and stored in “little porcelain jars.”⁶

The proliferation of insects can mean both nuisance and prosperity for humans. When faced with ravaging plant-eating pests whose population can boom when their host plant is cultivated on a large scale, farmers turn to auxiliary insects, either predators (ground beetles, rove beetles, ladybugs) or parasites, which are often just as numerous as the pests they are combating. But then again, is it not only through their large numbers that bees are able to produce the honey we so desire as they go about their pollinating activities?

By looking more closely at mayflies and their ecology, we will try to understand how families living on the banks of the Saône River became interested in this short-lived yet abundant insect. And, now that mayfly numbers have fallen, we will also try to learn from their stories about the different changes in the recent history of the river.

Mayflies as manna

There are three species of mayfly in France⁷ that are referred to, either regionally or more broadly, as “manna.” There is one species in particular that goes by this name: *Ephoron virgo* (*Ephemeroptera: Polymitarcyidae*, previously known as *Polymitarcys virgo*), which is also called “virgin mayfly” or “white manna” depending on the region.⁸

Generally associated with big lowland rivers, *Ephoron virgo* is known for mass emergences of adults over a short period, usually in the evenings of just a few days during the summer (in either July or August depending on the region). The females lay their eggs after mating, and the adults die very shortly after completing their biological cycle, covering the water’s surface with a layer of insects that can be several

³ The variety of damages that insects cause to the plants they feed on increases as the temperature goes up (Currano et al. 2008).

⁴ See “Sud Aveyron. Vorace criquet italien,” *La Dépêche du Midi*, July 21, 2005. See also, “En France, le climat a favorisé la pullulation des criquets italiens,” *Le Monde*, August 4, 2006. The increase in Italian locust numbers can be explained not only by milder winters, but also by pastureland being left fallow, which favors the reproduction of certain locusts. See also Mark A. Quinn and D.D. Walgenbach (1990).

⁵ The Biblical manna (from the Hebrew “*man*”) is generally thought to refer to the sweet sap excreted by the stems of sugar-containing trees. This “heavenly” food is produced after the tree is fed upon by a scale insect (*Coccus manniparus*). There are several plant excretions that take their name from the holy book. The manna ash (*Fraxinus ornus*), which produces what was called Calabrian manna, and later Sicilian manna, was harvested and sold for its laxative properties (Ponzio 2002). In France, Briançon manna, which “fell” onto the leaves of larches (*Pinus larix*) on August nights, was called “air honey” or “celestial dew” (Marchenay 1988; Rivière-Sestier 2000).

⁶ Émile Bergier (1941, 105) cites Sir Henry Berthoud: “Fried mayflies bring to mind the slightly tart taste of apple fritters. When mashed to a paste, you might think they were an excellent redcurrant jam” (1860). **Translator’s note:** Unless otherwise stated, all translations of cited foreign-language material in this article are our own.

⁷ There are 149 species of mayfly in France, divided into 37 genera (Thomas and Masselot 1996).

⁸ See also Alain Thomas and Gérard Masselot (1996) for the distribution of *Ephoron virgo* in France.

centimeters thick. Every body of water inhabited by this species experiences a mass emergence each year, followed by a rapid decline in the following days. Attentive observers may notice fluctuations in emergence densities from year to year (Réaumur 2001 [1742], 363–64). Another species that goes by the name of “manna” is *Oligoneuriella rhenana*, a mayfly that prefers large constantly flowing rivers (Tarn, Dordogne, the Gaves of the Pyrenees). Its emergence on fine summer evenings between June and July is similar to that of *Ephoron virgo*, but it is often less spectacular.

Finally, in regions where the two previously mentioned species are rare or absent, it is only fishers who use the name “manna” to describe species of the genus *Ephemera*, primarily the *Ephemera danica* (or “green drake”), whose emergences from May to September can be quite massive, depending on the year. While for entomologists *Ephemera danica* is the true “mayfly,” fishers often apply this name to around ten different species (Brulin 2008, 16), including *Ephemera vulgata* (de Boisset 1942, 20). All of the mayflies referred to as manna are among the largest French mayflies, making them more visible to various predators. Emergences are moments of joy for fish and for the fly fishers who come to catch them. Every ripple is observed with great attention (Brulin 2008). In the evenings, after gorging themselves on manna, the fish will only rise for insects that disturb the surface of the water. It is this barely perceptible trembling of insect wings against the water that fly fishers attempt to imitate with artificial flies during their famous “*coup du soir*” evening outings (de Boisset 1942, 145). Outside of mass emergences, fishers use lures that imitate insects or fish larvae. The art of preparing “dry” flies, a “true science” according to M. Ryvez (1927), draws inspiration from the different growth stages from nymph to full adult.⁹

To explain the phenomenon of the manna and its ecology, we must understand the life cycle of the mayfly, from aquatic larva (or nymph) to winged adult (subimago: pre-adult and imago: adult). First, let’s talk about nymphs. Burrowing larvae, such as those of *Ephoron virgo*, come in various sizes. All of them have mandibles whose long anterior extension meets or goes beyond the front of the body, a small but wide head, and a powerful and robust first set of legs (Verrier 1956, 153). Their cylindrical bodies and gills that curve back on their abdomen allow them to make their way through the sediment (Brulin 2008).

Individual species can be found in various habitats: the “typical” burrowing forms, which dig tunnels in clay soils, can appear abundantly on substrates of sand or fine gravel, or even under stones in more energetic streams (Verrier 1956). In lowland rivers like the Saône, they can live both in the center of the river or near its banks and around islands, feeding on organic plant debris and silt particles. The insect’s behavior in its nymph stage is conditioned by each individual’s physiological state as it approaches its transformation into a subimago, and by environmental factors (dissolved oxygen and other physiochemical factors, as well as light density, according to Marie-Louise Verrier [1956]).

The larval cycle of the genus *Ephoron* is univoltine, lasting one year, with rapid growth in the spring. After molting several times, the insect enters the subimago (pre-adult) stage: the nymph rises to the surface of the water and molts once more, becoming a winged pre-adult.¹⁰ Emergences are quick. Male mayflies emerge first, before night falls, followed by the females after sunset, or sometimes later (Denis, Paris, and Pillon 1936). While quite similar to the full adult, the subimago is unable to reproduce, and it soon leaves the surface of the water. Once it finds vegetation to rest on by the riverbank, or sometimes even in flight, it undergoes a second molt and becomes a sexually mature imago.

Observers often note a correlation between emergences and low barometric pressure (warm weather with cloud cover, no rain or wind). Mating takes place soon after emergence. The male imagos swarm together (the “gray” manna or “feathers” according to those who live by the Saône) and fly off down the river, looking for females. The nuptial flight takes place over the water, and copulation is over quickly. The males then fall into the water and die (*ibid.*).

⁹ M. Ryvez (1927, 28) cites the example of an amateur who had designed six models for the same species (male and female subimago, imago, and end of life). Some of the flies used are also “wet” flies, which imitate larvae or older nymphs, although “toc” fishers will also use the nymphs of caddisflies, stone flies, and mayflies (“*la petite bête*,” or “critters”) as live bait when fishing in the currents.

¹⁰ This transformation makes the insects very vulnerable to predators. The nymphs are hunted by fish not only when they rise to the surface, but also during their transformation to become subimagos, when they hang immobile in the water.

The eggs are then laid in a spectacular fashion, with fertilized females laying two long cylinders of eggs on the surface of the water,¹¹ their abdomen opening wide, or sometimes even bursting. While locals describe the phototropic females as “rising toward the moon” at night, whole swarms of females that have not yet laid their eggs (the “manna” or “white manna” due to the milky color of their wings) are attracted both to the lights of houses along the embankment and to the lamps placed by manna collectors to draw them away from the river. The insects’ activity gradually tapers off, ending around midnight.

Clouds of butterflies become a storm

Ephemeroptera were the first animals to achieve flight, around 280 to 350 million years ago, and today they are still Earth’s oldest winged animals. Early observers spoke of the briefness of their adult life, before describing their primary morphological characteristics. Because the main activity of the adult mayfly is reproduction, its lifespan after mating may last only minutes, or up to 1 or 2 days, depending on the species. This short earthly existence gave rise to various names that all share a similar etymology.

Aristotle, Pliny, and Aelian referred to these insects as *Ephemeron*, *Hemerobion*, and *Monomeros*, terms that modern naturalists adapted to name the genus “Ephemera” (from the Greek “*ephēmeros*”: “lasting for one day”). In the Bosphorus, Aristotle observed an “insect [that] lives and flies about until the evening, but as the sun goes down it pines away, and dies at sunset,” but he mistook their number of legs, claiming they only have four (*History of Animals*, Book 5, Chapter 19). A Czech researcher recently discovered that mayflies had been mentioned by the Sumerians, who called them “water locusts” (Soldán 1997).

The most highlighted feature of mayflies is their fragility, both because of their short lifespans and because of their aerial adult form. Their teguments are not very robust, and it is in fact their eggs that give these flying insects their appearance and weight. In big swarms, it is also these eggs that give them their ecological and commercial value. While they are mediocre fliers, in large numbers their flight becomes a spectacular, even wondrous, natural phenomenon:

Each individual traces out a sort of spiral [...] [Their flight is] so fast that they look like ribbons of individuals (Denis et al. 1936, 102).

Some authors have fallen deep into their contemplation of mayfly emergences, comparing them to “fairy dances” (de Boisset 1942, 138). One thing in particular that has sparked the imagination is the “pendular” flight characteristic of certain species, whereby the swarm maintains a stationary position relative to some point in the landscape. The fisher and naturalist Léonce de Boisset compared it to a ballet,¹² of which the most grateful spectators are the fish (*ibid.* 139). Mass emergences of millions of individual insects rising to the surface of rivers and ponds were reported by naturalists such as Jan Swammerdam in the Netherlands (1681) and Réaumur in France (2001 [1742]). Probably surprised by the swarm of insects, the former wrote of a “fly” that lives for only five hours. While his description is less specific than Réaumur’s, he does record some emergences lasting several days (Swammerdam 1681, 41). With a fisherman as his guide along the banks of the Marne, Réaumur provides a detailed report in his 1742 book of an emergence of *Ephoron virgo* that he observed on August 19 and 20, 1738.

When they are particularly massive, emergences can overwhelm the usual predators and become invasive for humans. While some refer to Ephemeroptera as “flies,” their silky appearance, their attraction to light, and their clumsy flight lead them to be more often associated with “butterflies.”¹³ This is what the locals living along the banks of the Saône call them, even those who know their scientific name. The unpredictability of emergences and the sheer volume of insects nevertheless make these events an expected kind of nuisance.

Réaumur observed that the insects began to appear gradually in the early evening, then more and more

¹¹ The eggs sink and stick to the substrate. They hatch a few weeks after they are laid.

¹² The emergences of *Palingenia longicauda* on the river Tisza have given rise to the name “water flower” in Serbian. For more information, see the article by L. József Szentpéteri in the May 2003 US edition of *National Geographic* (203, no. 5, 72–85).

¹³ “They are very pretty flies, who should be classified among the Papilionoidae, since those who have not examined the insects closely [...] often mistake mayflies for butterflies when they see them for the first time” (Réaumur 2001 [1742], 335).

quickly, filling the air with flying insects “as thickly as a heavy snowfall” (2001 [1742], 344). This whirl of millions of milky-winged “butterflies”—“a veritable downpour of small white insects” according to A.-L. Letacq (1898, 88)—has reminded many of a snowstorm. On the banks of the river, the insects are more of a nuisance to locals,¹⁴ who try to protect themselves by fleeing from the swarm, turning out lights, or moving away from the water.¹⁵ While the phototropism of *Ephoron virgo* females is exploited by manna collectors, it is also the principal source of nuisance for those living along the banks of the river. Réaumur noted that it was remarkable that an animal that only lives and flies for one night could have “such a love for light” (2001 [1742], 341).

After considering the observations of naturalists, we should also take the more pragmatic concerns of locals into account. When there is no wind to push the manna inland (Verrier 1943), the illuminated houses and embankments along the river bear the brunt of the swarm. Streetlights attract great numbers of females. They circle the light, then fall exhausted to the ground, laying their egg sacs and forming a quivering pile before expiring.

By the early morning, “of the previous night’s dance, only cadavers remain, accumulating on the roads and in doorways, which the locals do their best to sweep away” (Letacq 1898, 88), although, sometimes, they have to use snow shovels.¹⁶ They must act quickly. Besides the fishy odor of the decomposing insects, some people with asthma or allergies can be sensitive to the airborne particles released from their bodies.

In some regions, emergences have complex consequences. In the United States, massive swarms off of Lake Erie have been responsible for power outages and for spreading fires (Jones, Fager, and Stone 2007). Along the Greater Saône, the mayflies often arrive around the feast of Saint Philibert, and the local authorities in Tournus will turn off the lights along the river and close the fair rides early when the mayflies are in abundance. In some towns, the roads, sidewalks, and bridges end up covered in insects, as they are attracted by the streetlights, car headlights, and reflective road surfaces.¹⁷ They can be so abundant that the road becomes slippery, often causing traffic issues (Verrier 1956, 57).

Some particularly spectacular emergences make the headlines in regional papers¹⁸ and leave a lasting impression on the public memory, such as when the fire brigade had to briefly close the Tournus bridge in the 1960s. Several authors have been intrigued by this laying of eggs, sometimes described as “aberrant” (De Boisset 1942), on roads and the roofs of cars near areas where mayflies have emerged. Léonce de Boisset noted that road surfaces become traps for the insects when it rains (*ibid.*, 38). Based on several observations, Marie-Louise Verrier claimed that the insects are attracted by the glistening surface, as well as by the heat coming off the asphalt (1943, 171), although this last hypothesis was not confirmed in a more recent study (Kriska, Horváth, and Andrikovics 1998).

Mass emergences are not a nuisance for everyone: some are able to adapt to the sudden profusion and turn it to their advantage. Mayflies are an important food source for fish (trout, grayling, etc.), but also for birds, amphibians, and other insects. The boundary between harmful and useful is rather blurred. Even though emergences on Lake Erie can dampen tourism for a few weeks, the nuisance is temporary and soon outweighed by the resulting benefits for commercial and sport fishing. Mayfly emergences can be exploited either periodically or systematically: some of the people living near the lake collect the insects and compost them with plant material for use as fertilizer in their gardens (Jones et al. 2007).

¹⁴ Harvesters recall the feeling of insect wings beating under their shirt, the cold and damp feeling of their touch, and how the eggs would stick to their skin.

¹⁵ “Several times I was forced to move [...], since I could no longer stand the rain of mayflies, which did not fall as vertically as ordinary rain, or with any constant direction, striking every part of my face without interruption and in a most inconvenient manner. Mayflies flew into my eyes, my mouth, and my nose” (Réaumur 2001 [1742], 341).

¹⁶ See in particular “Swarms of Mayflies on Wing over Lake Erie,” *Pittsburgh Post-Gazette*, July 26, 1999.

¹⁷ In impacted areas, sodium-vapor lamps are used more and more as streetlights. Their yellowish light provides good visibility for motorists, while attracting fewer mayflies.

¹⁸ According to Émile Bergier, “on August 19, 1938, the press reported that in Ratisbon [on the Danube in Bavaria], mayflies of exceptional size fell in such abundance on the roads of the city and its surroundings that traffic ground to a halt” (1941, 104).

Economic exploitation of the swarm

While for most of those who live near big rivers emergences were, until recently, seen as unwelcome intrusions into everyday life, several families along the Greater Saône have long made seasonal use of the abundance of fallen mayflies. In Saint-Jean-de-Losne, for example, fishers would light paper torches out in the swarm, causing the insects to fall in the water and act as bait (Denis et al. 1936). Fishers in the region still collect the prized manna, dry it, and use it as bait for white fish (roach, bream, etc.). Others have turned the insects' attraction to light to their economic advantage. Originally started by local traders, this use of the manna became a "full-fledged small industry" (*ibid.* 102) between the 1930s and the 1980s along the banks of the Saône. The manna, made up mostly of mayfly eggs, was processed and packaged as feed for insectivorous domestic fowl.

Image 1: Collecting fallen mayflies (Port d'Ormes 1965) Leduc Family Collection © Yves Debraine

Image 2 Fallen mayflies in Bujaraloz (Spain) © Isidro Martinez 2009

While it may be difficult today to reconstruct the origins of this fairly discreet trade, it seems that the idea came from a seed merchant who, while passing through the village of Allerey, saw farmers winnowing the manna to feed their poultry. The first commercial collection was initiated by the Maison Duquesne, a specialist in bird feed (Girard 1984). In the 1930s, the manna was harvested up and down the Greater Saône, from Verdun-sur-le-Doubs to Lyon. At Port Guillot, south of Chalon-sur-Saône, more than 1,000 kilograms of dried manna were collected in 1935, and more than 10 tons were collected every year between Verdun and Chalon (Denis et al. 1936). Starting in the 1950s, various seed merchants extended the harvest southward by around fifty kilometers, in particular upstream of the town of Tournus and the surrounding area. The harvesting work itself, however, remained limited to those living closest to the river.

The exploitation of fallen mayfly in the Tournus-Cuisery region reached its peak in the early 1960s. Each year for decades, in the three weeks that followed the first emergences, onlookers along the banks of the Saône could watch local families catching insects with light traps in the evenings. Working in small groups, each a good distance from the other, the harvesters would set out tarps or sheets illuminated by lamps or car headlights. Over time, carbide lamps were gradually replaced with similarly bright round vehicle headlights (from Citroën Traction Avants or 2CVs). These lights were battery powered and mounted on wooden tripods.

Some lucky locals, in Ouroux and Gergy for example, could plug their equipment directly into their homes or to utility poles along the embankment. The powerful beams of the headlights would then be pointed from the bank toward the middle of the river, aiming to cover as large an area as possible. Attracted by the light, the manna would come up to the riverbank, then, redirected by less powerful bulbs, fall on the tarps laid down there. Many of the insects who were attracted by the lights but that fell into the water would lay their eggs on the bank before being swept back into the river by the wakes of passing boats.

In order to not be caught in the swarm, the harvesters would work outside of the light beams. While some recall collecting the manna in the wake of brightly lit tankers, others would go out in flat-bottomed boats to "chase the cloud," since emergences could happen in different places along the river. In Port d'Ormes, for example, one harvester, who had a boat fitted with a headlamp and white canvas reflectors, would head out into the swarm, then lure the insects toward his equipment on the riverbank.

Families would collect the manna as it fell onto the tarps. Because fallen mayflies continue to beat their wings for an hour or two, the harvesters would place the trembling mass into wicker baskets by scooping it up gently with their hands. The mass of insects would heat up quickly ("you couldn't keep your hands in there"), so the baskets for airing out and "cooling" the manna could not be kept too full. Around 11 o'clock, the gatherers would get ready to dry their harvest. Working until late at night, the fragile mass of insects would be taken out and spread out in layers only a few centimeters thick on meshed and canvas-covered wooden frames. Because too much handling would cause the manna to break down faster, it was often most convenient to process it in the homes of those living near the collection site.

In order to avoid fermentation, the manna needed good aeration and to be dried in the sun the following day. The harvesters would turn it over several times throughout the day, bringing it under cover if the sky turned cloudy and chasing off the many birds that would come to try and eat it. Once dried, the harvesters would delicately “rub” the manna to detach the wings, legs, and bodies, before passing it slowly through a ventilated winnower to remove any dust. At the end of this process, you were left with a yellowish heap of eggs. During the drying process, the manna lost four-fifths of its weight. The harvest, which would begin after haying season, around the feast of Saint John, would end a few weeks later, at the beginning of the agricultural harvest season.

The dried manna was then put into jute bags and sold to brokers or brought to seed merchants in the region. While some well-organized families could collect an exceptional 3 to 5 tons of dried manna in a good year, most collected between 500 kilograms and 1 ton. As the manna was sold at a high price¹⁹ to traders who specialized in exporting spray millet (proso millet), the harvesters stood to make a substantial profit. The seed merchants and their intermediaries were also very active. Paid by the kilo, brokers would go around each season placing orders with the harvesters. Once the eggs had been winnowed and brought to the seed merchants, they were packed and resold at a much higher price as “mayflies” or “manna” (Girard 1984). Primarily purchased by foreign manufacturers, mostly German and British, the manna was used as an additive in bird feed, often in small amounts.

The exploitation of manna was dependent on demand from seed merchants, on the availability of the resource, and on competition between harvesters. At the end of the 1960s, emergences along the Greater Saône had become less abundant. As harvests shrank, some harvesters became discouraged and gave up collecting the manna. The insects made a recovery in the 1970s, breathing new life into the trade. After another few years, however, the emergences went back to being irregular. Some harvesters continued to collect the manna, but the unpredictable harvests and the appearance of other, more accessible dried insects for bird husbandry and farming (Russian daphnia, *musca*: Mexican flies) made the trade less profitable for both the locals and the seed merchants (Girard 1984). Outside of a few exceptions, the practice of harvesting manna ended in the mid-1960s.

Explanations for this “disappearance”

Locals continue to question why this insect went from being “prolific” to “rare,” and if it had anything to do with the decline and end of the manna trade. Like all other natural phenomena, mayfly emergences have always been irregular from one year to the next, and it is difficult to predict when they will start.²⁰ While in Ouroux they always say that the mayflies will hatch around ten days after the bulrushes flower, there is no way to predict how abundant the manna will be. The number of insects at one site can also vary from one evening to the next, or even hour by hour. This unpredictability inherent to manna collecting meant that the harvesters could never take a day off. Thus, each year, a family’s participation in the harvest depended on the results of the previous year and on the abundance of the first emergences. Some families would take a year off, and then return to harvesting when the manna returned.

The proliferation of the past has given way to a “disappearance” of manna today. Locals cannot explain either of these phenomena. Just because mass emergences have ended, this does not mean that there are no more mayflies: the insects are there, they simply do not “rise” in the same way. Only long-time harvesters, who know how abundant the manna was in the past, question the transformations of former harvest sites and, more generally and more vaguely, the consequences of riverbed dredging projects on the surrounding environment.

In fact, each summer, families that live along the Saône observe fewer and fewer mayflies on their stretch of the river, which they blame on the visible degradation of the banks. Only the most observant fishers have made the connection between the decrease in the intensity of emergences, lower fish numbers, and various

¹⁹ The price varied from one broker to another. In Ouroux in the mid-1950s, the price of manna was about 150 francs per kilo. The Girard company bought it for between 18 and 20 francs per kilo in 1960, and for 22 francs per kilo in the early 1980s.

²⁰ “The laborers have as little of an idea of when the harvest will come as fishermen do of when the mayflies will appear on a certain river” (Réaumur 2001 [1742], 337).

forms of pollution.²¹ Generally speaking, few of the locals know about the insect's habitat and ecology during its larval stage. Emergences are eagerly anticipated, but opinions differ on where the "rise" actually occurs: Does the manna come from the banks or the channel?

While variations in emergences from one year to the next are not surprising, swarms have shrunk so much since their harvesting began that it is starting to cause serious concern. Based on empirical observations, several hypotheses have been proposed. Although it is understood that the manna appears later as you go further down the course of the Saône, emergences everywhere are now less intense and occur later than in the past. From Verdun-sur-le-Doubs to Tournus, when emergences do occur, they no longer begin in mid-July but in early August, and they no longer reach their peak at the end of July but in mid-August, sometimes even later.²²

According to the locals, the insects thrive in warmer water, so might this all be the result of a warming climate, as some have suggested? Or of the waters of the Saône warming up later in the season, as recent works have raised the low-water level to allow for navigation throughout the year? A sense of mystery continues to surround the conditions for the emergence of the manna and, in particular, its development in the river.

The harvesters recall certain spots, both on land and in the water, where the manna used to be common, but that have been degraded over time. Over the last century or so, the morphology of the river has changed considerably. The river's historical natural state, with a shallow channel and low banks, has been significantly altered due to various infrastructure projects.²³

The natural exchange processes that used to take place within the river have now been limited by the disappearance of "*platis*" landscapes (shallow areas with a slow current, a soft substrate, and abundant plant and animal life). Most of these areas, which used to lie below the banks, have now disappeared due to landslides caused by dredging, or have become flooded or permanently drained (Astrade 1995, 155). At the same time, dense vegetation (trees and shrubs) on some sections of the river makes the banks less stable, causing erosion and creating new deposition zones. Locals have noticed the disappearance of bulrushes and the silting of the riverbanks. The banks of the river are no longer as clean as they once were: "the water is murky," "new algae have appeared," covering sandy banks that used to be good swimming spots with silt. Built up with man-made structures, the riverbanks themselves have become impermeable to the river's exchange processes (*ibid.*): damming has isolated and transformed the river's alluvial plain, that area around the river that used to be subject to regular flooding, and which was an important source of alluvium and silt.

Although it is common knowledge that "the manna comes from where it is clean,"²⁴ fishers and manna harvesters who used boats to reach the middle of the river have been reporting silting in the channel since the late 1980s, when dredging ended. As the river's gentle slope favors deposition, the main bed of the Greater Saône was exploited for gravel, an activity that is both economically important and essential for allowing navigation in the channel.

Locals' observations have also indirectly highlighted the importance of sandy substrates for emergences: since many harvesters chose to work near gravel pits, this showed that the most coveted spots for nocturnal harvesting were where the bottom had recently been dredged. While dredging may therefore have had some positive effects, it is possible that the disappearance of gravel banks and the excessive deepening of the riverbed disrupted the mayflies' primary habitat and deprived the river, now limited to a single channel, of essential biological exchange mechanisms. Add to this the suspension of different particles during

²¹ The risks arise mostly from soil improvement practices and the use of soluble substances (nitrates and pesticides) in agriculture. At the time of our study, a prefectural decree dated February 16, 2009, prohibited the consumption of certain "bottom-dwelling" fish from the Saône, due to their high levels of PCB contamination.

²² This phenomenon has been observed elsewhere, particularly in Aisne (Brulin, personal correspondence).

²³ As a useful navigation route, the Saône has been transformed into an important waterway to enable boat traffic during the summer months. The construction of groins (1835) was followed by dredging of the central channel and the construction of locks and dams (1870) (Astrade 1995, 155).

²⁴ Sensitive to changes in water quality and substrate conditions, potamophilic mayflies, much like other benthic macroinvertebrates, are very reliable indicators of aquatic habitat health.

exploitation and the clogging of the riverbanks caused by currents from boats traveling along the river made navigable, in its downstream portion, in accordance with the Freycinet and European gauges.

From local exploitation to local conservation

Thinking about the future of the white manna reveals the ambivalent place of insects in our society. Generally ignored, emergences can become real nuisances when they are massive and invasive. Yet, as long as it is regular and useful, the abundance of the very same species, even if the individuals are very small, may have some economic interest, which changes the perspective of those exploiting it. Highly localized, all of the activities surrounding the manna were dependent on the availability of that resource: they rose and fell with the insect's level of biological activity and ended when it did.

Locals were the first to observe a disruption as the once-prolific manna, which they had until recently seen as an inexhaustible resource, became much scarcer. As locals went from being exploiters of the river's resources to guardians of its future, a new figure emerged around halieutic species that had previously been very present locally. Along the Saône, insects have always acted as indicators: locals who were already aware of environmental discourse and of local changes began to worry and make an effort to understand these changes.

When they look back on the past, those who were involved in the exploitation of the manna see their harvests as markers of the passage of time. While they do not always agree with the scientists who refer to mayflies as a "sentinel" species, the intensity of each year's emergences gives them information about habitat degradation. While manna harvesters look to the most recent changes to explain ups and downs in the resource's availability and its exploitation, it seems that, lacking an overall understanding of the changes that are affecting the Saône, they tend to focus on past drains on the river's resources and on their own role in its ecology.

In current discourse, environmental changes and shifting lifestyles are often discussed together. While some idealize a natural environment that no longer exists, many look back with fondness on a time when they made their living from the river and speak with nostalgia about the summer evenings when multiple generations would come together to wait for the insects. While emergences used to spur local economic activity, as the manna and its trade have disappeared, a part of rural life has vanished too. For many, the activities around the manna already belong to another time.

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