

Environmental and cultural history of the Death's head Hawkmoth – “Europe's most infamous insect ...”

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Fearsome creatures of the night have since times immemorial been creeping, crawling, fluttering, prowling through our world and our minds, leaving a track of deep impressions in our human cultural memory. Often they carry an intangible, yet heavy freight of most sinister meaning. Human fear and fantasy makes them into an evil omen, a harbinger of death, a visitation from a netherworld. That frightful, fruitful, memorable moment of encounter is cast into the dramaturgy of wild, weird and wonderful stories. The encounter with the uncanny is vividly reflected in folk lore and further in literature and the arts.

Nature in the wealth of forms and behaviors of its living creatures is not only the physical basis of human economies, but also the prime origin of the imagery we use to culturally reflect the world we live in. Environmental change with resultant alterations in ecological phenomena, such as shifts in population sizes, thus also induces cultural changes. Processes of extirpation and extinction as well as patterns of biological globalization that encourage the homogenization of global fauna and flora have tended to reduce possibilities for encounters and experiences with certain species, leading, in turn, to their gradual cultural impoverishment. Sometimes, however, anthropogenic environmental changes have given rise to new ecological phenomena that served both to increase the visibility of particular species and to engender their cultural presence. The dynamic nature of this relationship between the material and the imaginative is particularly intriguing when examined in the context of colonizing species that have been charged with ominous and malevolent meanings: an identification of some portent that makes them particularly trackable in the cultural record.

The epitome of such a creature in central and northern Europe is *Acherontia atropos*, the Death's head hawkmoth. The hawkmoths (Sphingidae) are a family of moths comprising well over a thousand species, mostly native to the tropics and subtropics some being long-distance migrants that advance well into the temperate or even boreal zones¹. The name of the family is derived from “Sphinx” for the body posture the caterpillar adopts when threatened – a term first introduced by Reaumur, then referring to privet hawk moth *Sphinx ligustri*².

Acherontia atropos – in earlier literature also referred to as *Sphinx atropos*³ - is an extraordinarily large afrotropical and Near-East hawkmoth species that appears in warm summers as a vagrant visitor in North-West and central Europe, with some specimens even having been found as far north as Iceland⁴. Only in the warmest and longest of summers they have sufficient time to complete a generation north of the Alps. The offspring of migrants that fly in in June or August typically can be encountered as imago in northern regions from August to October⁵.

In any stage of its life it is a highly conspicuous animal. With both wingspan and larval length reaching up to 13 cm it is one of the very largest lepidopteran species known to occur in Europe⁶. The imago further displays on its abdomen a striking aposematic coloration, in ochre-yellow and black with a touch of blue. The pattern of stripes earned the species early on the name of “tiger hawkmoth”⁷. In addition it carries dorsally on its thorax that yellowish or whitish maculation that, contrasting with its bone black background, in a pareidolia-effect tricks human eyes and brains to see

the eponymic image of a human skull, that most obvious, unambiguous and universal symbol of death.

Many authors who found themselves vis-a-vis to the creature in gloaming light commented on its 'shining' reflective eyes^{8,9}. Some saw them as glowing in the dark¹⁰, or observed that "...when the rays of a candle fall upon the eyes, they glow as if lighted from within by some hidden fire¹¹". Those visual features are olfactorily complemented, with a perfume that has mostly been perceived as reminiscent of musk¹², that peculiar, most ambiguous redolence that is characterized in the language of perfumers as "warm, with depth and a dark animalic aroma"¹³.

The insect delivers an acoustic accompaniment with its outstanding "voice" created by a stream of air blown through the proboscis and thus rather different from the humming and buzzing caused by wing motion in other species¹⁴. The imago's vocal utterances are to some people akin to a mouse's squeak^{15,16} - an observation that made its way into fiction for example by the hand of writer and entomologist Vladimir Nabokov (1899-1977)¹⁷. Some authors hear it as a plaintive¹⁸, mournful whimpering and wailing¹⁹ or choose allied expressions for a most upsetting noise that evokes dismaying, painful sentiments. "As if a human is groaning" it says in a 1962 radio play by German writer Georg von der Vring (1889 -1968), and indeed the acoustic effect used in the recording is resembling a man moaning in agony²⁰.

One naturalist who hatched some pupae solely to kill the imagines for preservation described their death cry in a similarly disturbing manner²¹. It is a sound that wraithlike and spectral that Italian poet Guido Gozzano (1883-1916) reports his dog in the presence of the moth to tremble like a leaf and "rifiutarsi d'entrare nella stanza / dov'era l'*Acherontia lamentosa*", 'to refuse to enter the room, where *Acherontia* was lamenting'²². One may however speculate, that the animal was actually responding not so much to the insect's sound, but rather to his master's subconscious fears.

Notably sounds can be perceived from the imago even before it hatches from the pupa²³, and also the larvae can make themselves heard, uttering something that is sometimes compared to a series of electric sparks²⁴. Naturalist Giovanni Scopoli (1723-1788) feels reminded of the stridulation of the great capricorn beetle (*Cerambyx cerdo*) - „irritata stridet ut *cerambyx*“²⁵. Another early text pictures the caterpillars caged in a box as hissing at - and even biting - each other, when coming into too close a proximity of another²⁶, and to one author the war cries of two battling "catty" caterpillars sound "as if a human is grinding his teeth"²⁷.

Meeting what has been called "Europe's most infamous insect"²⁸ comes along with "wailing and gnashing of teeth" and thus would have undoubtedly provided a highly memorable, sometimes haunting encounter and ample of fuel for the development of a plethora of superstitions linked to that animal^{29,30}.

Emergence as a cultural icon

In our time the fascination and surprise is reflected in numerous news pieces that, in warm summers, and often coinciding with the "silly season", relate incidences of the unusual animal being found³¹. They hardly ever do so without a reference to its cultural significance, mentioning the Thomas Harris novel³² and horror movie³³ 'The Silence of the Lambs'³⁴ (notwithstanding that the novel mentions the related Asian species *Acherontia styx*, and the role in the movie is played by tobacco hornworms in disguise³⁵). This is a relatively recent example, which, as far as box office success is concerned, may have marked a culmination in the moth's career in the arts and media. Some slightly more in-depth articles devoted to such visits refer to the animal's altogether ominous symbolicness, sometimes pointing to cultural reflection of *A. atropos* that allegedly dates back to the Middle Ages³⁶. This claim however

needs to be treated with great caution. It certainly holds true, that the species was known to the cultures of the Mediterranean antiquity. Classicist Otto Keller (1838-1927) suggests it to be depicted in a stylized form in Mycenaean jewelry³⁷. This however is not really convincing, as the pieces referred to may as well be interpreted to represent a honeybee. It is however unmistakably painted on an ancient Greek honey pot, a picture thought to be Europe's oldest depiction of a lepidopteran³⁸. North of the Alps in contrast the oldest graphic depiction that the author could identify is a drawing of the caterpillar by Flemish artist Joris Hoefnagel (1542-1600)³⁹, which survives in an engraving done by his son Jacob (1575 - c. 1630). Joris Hoefnagel spent some time in Spain⁴⁰, and may have encountered the species there. Though he stayed in Seville and, being an artist, surely marveled at then uncommon animals and plants imported from overseas, the fact that he depicts the caterpillar rather than the imago suggests that this was indeed a 'local' encounter.

The imago appears only much later in the pictorial record in an insect still-life by Flemish painter Jan van Kessel the Elder (1626-1679), who, like Hoefnagel was based in Antwerp. Given that the Low Countries were the hub of Europe's overseas trade then, the artist may have purchased a dead specimen imported from foreign lands, perhaps from a Dutch posts in Africa. In fact, it even cannot be excluded that the artist's model was in fact *Acherontia styx* from South-East Asia.

As to depictions in literature we may find an early, faint trace in Mediterranean antiquity. Terms for insects in Latin and classical Greek are notoriously unspecific though, and often do not allow the attribution of a certain name to a species according to our modern taxonomic understanding. Keller, somewhat speculatively, supposes that "the unearthly croaking death's head hawkmoth" was attracted to offerings of honey on graves, adding to the idea of moths and butterflies as soul birds⁴¹. For North-Western and central Europe however no vestige of the species in literature in a non-scientific context that would predate the earlier eighteenth century could be found⁴². In the northern part of Europe it is by all accounts culturally absent – until the 18th and 19th century, when writers and other artists within a rather short time seemingly became truly infatuated with *Acherontia*. Naturalists used a more poetic and more imaginative language then, which was rather accommodating for further artistic inspiration. The scientific name is in fact a piece of art in itself. It was coined by Austrian Ferdinand Ochsenheimer (1767-1822), who, being not only an entomologist, but also an actor⁴³, clearly had a sense for the dramatic. He changed the already "fateful" older name "*Sphinx atropos*" given by Linné⁴⁴, into a truly dark line of poetry by naming the genus after underworld river Acheron⁴⁵.

An early example of the species appearing in non-scientific, non-naturalist literature dates to 1804, when an individual of the species visited German butterfly-collecting writer Johann Peter Hebel (1760-1826) in a dream⁴⁶ and settled in his writings. From the mid-19th century onwards the moth appears in fiction and poems, short stories, paintings, drama, and popular culture, sometimes in a leading role, sometimes as a cameo. It plays its part for example in an 1846 short story by Edgar Allen Poe (1809-1849)⁴⁷ and (of course) in Bram Stoker's (1847-1912) *Dracula*⁴⁸. It is met with in novels by William Makepeace Thackeray⁴⁹ (1811-1863), George Sand⁵⁰ (1804-1876) or Thomas Hardy⁵¹ (1840-1928). It is discussed in an essay by August Strindberg⁵² (1849-1912) and in the writings of H.G. Wells⁵³ (1866-1946), Paul Claudel⁵⁴ (1868-1955) or Franz Werfel⁵⁵ (1890-1945). Literature Nobel Laureates Gerhart Hauptmann (1862-1946)⁵⁶, Maurice Maeterlink⁵⁷ (1862-1949) and Eugenio Montales⁵⁸ (1896-1981) conjured it up. Their contemporary Richard Le Gallienne⁵⁹ (1866-1947) may

have first created in his novella *The Worshipper of the Image* the picture of the moth on the lips of a young woman, a motif echoed in recent decades by the *Silence of the Lambs* movie poster⁶⁰. The moth seems to be a particular inspiration to poets. It is mentioned in Keats' (1795-1821) *Ode to Melancholy*⁶¹ and scares the villagers in Gérard de Nerval's (1808–1855) *Les papillons*⁶². It flutters through the verses of Gerard Manely Hopkins⁶³ (1844-1889), Guido Gozzano⁶⁴ (1883-1916), Gottfried Benn⁶⁵ (1886-1956) or Robert Byron (1905—1941)⁶⁶. It is, though much rarer, also found in the works of some contemporary authors such as Danish poet Inger Christensen⁶⁷ (1935-2009), Brazilian novelist Osman Lins (1924-1978) – who explicitly refers to the insect's smell⁶⁸ – or Portuguese literature Nobel Laureate José Saramago (1922-2010)⁶⁹.

In the fine arts it is, for example, central to William Holman Hunt's (1827-1910) painting *The hireling Shepherd*⁷⁰. It stars in movies ranging from Buñuel's *Un chien andalou* (1929)⁷¹ to the *Silence of the Lambs* (1991)⁷². That listing of examples of Acherontia being featured in art or entertainment of any genre could be continued on end⁷³. It is remarkable that the examples date predominantly from “the long nineteenth century”. In literature and arts the species features hardly ever before and it seems to become gradually rarer as a motif after.

One simple explanation for the rather sudden emergence of the species in the cultural record is that in earlier times the species was either completely absent from this cultural space, or may have been seen too rarely, to induce a significant cultural reflection.

This hypothesis can be tested by a study in early scientific – or naturalist – literature, reports on sightings of the species, and a comparison of the dates of emergence of the image in non-scientific literature.

Rare encounters

For an animal to become a fixture in the arts and popular culture, and to manifest itself in cultural memory, it may be supposed that the encounter with the observing human has to happen at sufficient frequency and further has to be sufficiently impressive and memorable.

As for nocturnal creatures that may carry the air of the sinister and preternatural with them, bats and owls can be seen in North-Western and central Europe into our times, and regionally wolves were at least historically common. Even if not seen face-to-face, a species may become culturally memorable if it is heard, as is the case with either owls or howling wolves. The Golden Jackal (*Canis aureus*) may have earned itself its modest role in folk lore of the Mediterranean by eerie howling. The Eurasian lynx (*Lynx lynx*), for comparison, an almost invisible animal that does not announce its presence acoustically, is hardly at all culturally reflected⁷⁴.

Among arthropods there is the example of the deathwatch beetles⁷⁵, a collective term for a number of species including *Anobium pertinax*, *Xestobium rufovillosum* and the Psocopteran *Trogium pulsatorium* (once called *Atropos pulsatorium*)⁷⁶, known as the “Lesser Death-watch”, Hardly ever seen, their acoustic signal stirred fears in humans, as illustrated in Edgar Allen Poe's *The Tell-Tale Heart*⁷⁷ or Strindberg's *Ghost Sonata*⁷⁸. The majority of the entomofauna of human houses however remains silent, and is reflected only in terms of pest management.

An indication that the frequency of actual, direct encounter, be it visually or acoustically, has an effect on the degree to which it is reflected may be found in the example of spectacular, but rarely-seen avian species. Snowy owls (*Nyctea scandiaca*) or flamingoes (*Phoenicopterus roseus*) for instance, which for their conspicuousness would lend themselves as objects of tales and artistic depictions, do show up at times

as out-of-range vagrants in central or northern Europe, and it can be supposed that they did so historically as well. The former occurred for example in the snow-rich winter of 1858/1859 in various places in Germany⁷⁹. The latter were seen in flocks in 1728 or in the hot summer of 1811 in the Rhineland⁸⁰. This however happened extremely rarely, and thus no lasting image in these regions' culture could arise.

The sudden emergence of the "picture" of a species as imposing as *Acherontia atropos* therefore either suggests an altered quality of perception, or an enhanced frequency of encounter due to the species being at some point more numerous north of the Alps, or possibly both.

It is not only about the number of encounters over time, and the strength of the impression left with the human observer that have a species emerge as a cultural icon. Without doubt it is equally important that the experience is reported, the "story" is told on and distributed to a sufficiently large number of recipients, who then in turn use the image and thus secure its "survival" in common lore, even though the animal itself may not be seen for a while.

In some cases it can be speculated that the occurrence of a striking species in large numbers coinciding with other momentous events synergistically made for a significance in folk lore. This is likely to be the case for example in the gaudily colored Bohemian waxwing (*Bombycilla garrulus*), a passerine bird which, migrating into Europe from the North-East ahead of cold spells. It thus became associated with hard winters, and received an ill fame as a harbinger of pestilence and the name "Pestvogel"⁸¹ – the "Plague bird". A somewhat comparable entomological case is delivered by a striking migratory butterfly, the Red admiral *Vanessa atalanta*. It was observed in unusually large numbers in Russia in 1881, the year Czar Alexander II. was assassinated. In the wing's underside markings some people pareidolically read the palindromic numerals "1881"⁸².

Myth and Natural history

Natural history itself is likely to have added considerably to the emergence of myths and mysticism surrounding *Acherontia atropos*. As a result of the advance of knowledge on the moth's biology and the growth of a body of naturalist publications, more and more formidable features and behaviors of the species became known to wider circles of readers. In times when a well-educated and well-read person was conversant in humanities as well as natural history, publications such as Réaumur's⁸³ would have widely inspired writers and artists. Many creative minds would become familiar with the image of the moth without ever having seen it alive. Edgar Allen Poe, though having lived at a young age from 1815-1820 in Britain⁸⁴, where the species was certainly found at that time, most likely only knew it from hearsay before casting it into the central role in his short story *The Sphinx*⁸⁵. As Nabokov puts it: "Not only did he not visualize the death's-head moth, but he was also under the completely erroneous impression that it occurs in America"⁸⁶.

Sometimes misconceptions arise from poor biological background knowledge. French historian, and occasional dabbler in natural history, Jules Michelet (1798-1874) gives an intriguing, though historically and biogeographically false, account: "C'était vers le temps de la Révolution américaine, peu avant la Révolution française. On vit apparaître et se répandre un être inconnu à notre Europe, d'une figure effrayante, un grand et fort papillon de nuit, marqué assez nettement en gris fauve d'une vilaine tête de mort. Cet être sinistre, qu'on n'avait vu jamais, alarma les campagnes et parut l'augure des plus grands malheurs"⁸⁷. His dating of the moth's coming on the scene ignores early observations such as the seventeen thirties events reported by Réaumur⁸⁸. That the creature was never seen before in Europe is

obviously false. It however is likely to have been a very rare sight to the majority of the population of North-Western and Central Europe.

The first instances of western scholarship taking note of the Deaths' Head Hawkmoth can be found in the works of 16th and 17th century authors, who either were Italian or had travelled Italy, such as English naturalist Thomas Moffet⁸⁹ (1553-1604), who went to Italy to study silkworms. He mentions a caterpillar that lives on nightshade, and also refers to the work of Italian Hieronymus Cardanus (1501-1576) who had seen that species too. Ulisse Aldrovandi (1522-1605) in his work "De Insectis" also shows a caterpillar⁹⁰ that may be *A. Atropos*. The depiction of the imago is, depending on the edition more⁹¹ or less⁹² clearly recognizable, but at least one of Aldrovandi's figures unmistakable portraits the Death's Head Hawkmoth⁹³. One very early - if not the earliest - description and depiction of a Death's Head Hawkmoth found north of the Alps, in this case in *Schneeberg in the Erzgebirge* region, dates to September 27th, 1688. Local doctor Johann Christian Mack (1634-1701)⁹⁴ observed the animal in the evening circling around a lamp and almost mistook the animal for its size for a bat. Dr. Mack discovered it again the next day sitting on a wall. He caught it, kept it in a box for a few days, and then sent the specimen to his Breslau colleague doctor Johann Burg (1652-1690)⁹⁵. An article published the same year by L. Schröck reports this insect having made in its box noises similar to a nibbling mouse when eating. It also delivers a precise description of the insect's morphology which was studied microscopically, and also mentions „dorsum intermedium est citrinum, maculis duabus nigris conspicuum"⁹⁶ – that "the middle back is yellow, with two conspicuous black spots". No comparison to the shape to a skull is made then. This picture apparently was to emerge only later.

In 1719 one individual was found in the town of Gotha, flying into a room. This instance is possibly the first example of the moth's role as a harbinger of death was documented in writing. The appearance of the moth in the bedroom of a town council member was interpreted as announcing the impending death of the Mayor of Gotha, Johann Philipp Wallich, who indeed passed away that year⁹⁷. A description of the specimen, which was kept in the princely collection in Gotha, was published in 1744, complete with a picture that, though not too naturalistically, undoubtedly shows the Death's Head⁹⁸.

Another early descriptions of caterpillars that were discovered on jasmine in Silesia, and that were most likely *Acherontia atropos* date to 1720, with some indication herein being even to earlier findings in 1711⁹⁹. In 1726 the caterpillar is observed in Braunschweig¹⁰⁰, and the discoverer, curious to see the imago attempted to keep it in a glass jar.

Over the 18th century the records of both, larvae and imagoes become increasingly frequent. In March 1730 the species was documented in Brittany when the curate of the parish of S. Jaques de la Lande near Rennes found a large moth sitting on the churches' wall towards the cemetery. He unsuccessfully tried to keep the animal in a vessel and attempted to fed it with bread and herbs. Though it died after three days, the curious curate delivered a remarkable description that gives no room for doubt on its taxonomic identity, in particular given that is carried "la figure d'une tête de Mort de la largeur de l'ongle, imitant parfaitement celles qu'on represente sur les Ornemens noirs de l'Eglise" and uttered "des cris semblables à ceux des Chauvesouris" - shrieks similar to those of bats¹⁰¹. In 1733 it showed up in large numbers in that region, coinciding with an epidemic, which sure made for its ill fame¹⁰². Only a few years after the Breton mass-occurrence Réaumur reports „que le

peuple de Bretagne est allarme dans les annees où il voit de ces papillons, il les regarde comme les avant-coureurs de maladies epidemiques et pestilentielles"¹⁰³. Often quoted is an incident of the moth intruding into a convent, much to the consternation of the sisters¹⁰⁴. The true beauty of the beast – at least of the larva – was seen in 1746 by naturalist, entomologist and miniature artist August Johann Rösel von Rosenhof (1705-1759). He purchased a caterpillar that had been discovered by a Regensburg gardener on a jasmine bush¹⁰⁵, and soon later he obtained a second specimen from a nearby property. The local gardeners had in fact found a sizeable number of them, but trampled them to death as they had considered them for their enormous size to be the “most dangerous breeding mothers of all vermin”¹⁰⁶ – an indication that the fear of that creature, was at this point not too transcendental yet. They had not seen the imago’s skull-pattern yet, or heard its spooky moaning sound.

Potato pest and honey thief

Within the next decades more publications followed, e.g. in 1763 by Tyrolean naturalist Johann Anton Scopoli (1723-1788), who saw the species south of the Alps in Carniola¹⁰⁷, or in 1779 by Eugen Johann Christoph Esper¹⁰⁸ (1742-1810), who saw it in Germany. With the expanding and deepening occupation of naturalists with the moth also more and more astonishing detail of its behavior and ecology became known. Though jasmine was the first plant that the caterpillars were discovered on, and hence “*Jasminraupe*”¹⁰⁹ (jasmine caterpillar) was a name in use in the German-speaking world, alongside such names as „Stechapfelschwärmer“ (Datura Hawkmoth)¹¹⁰, it was already known in the later 18th century that potato plants were a favorite feed^{111, 112}. “Kartoffelraupe” – “potato caterpillar” was apparently an early synonym in parts of Germany¹¹³. The animal lived up to its name when in the years 1779-1781 the caterpillar emerged as a pest on potatoes in the area around the city of Halle in Saxony, It is reported to have been so numerous then that farmers collected them by the buckets^{114, 115}. In 1779¹¹⁶, 1783 and 1784^{117, 118} finds are also recorded in Thuringia, for example in Weimar which, from Halle, is a distance of 72 Kilometers, as the crow – or moth – flies. 1779 and 1780 they were further common in the County of Hanau, in today’s federal state of Hessen¹¹⁹, and in the following year they were known to occur frequent in nearby Offenbach¹²⁰.

With those large numbers being around, also one other behavior of the moth that is most intriguing, and has been fascinating writers and scientists since came to the attention of naturalists. Augsburg priest Gottlieb Tobias Wilhelm (1758-1811) relates that “One has made the experience that the death’s-head-bird goes after the bees, or rather their honey. In 1779 several clergymen in Thuringia who kept bees once noticed a tremendous commotion among their bees. They believed that one of the usual enemies of the bees had done an incursion, and saw that the bees were darting furiously onto an animal that, within the throng of bees that were crowding around it, could not be recognized, but whose anxious piping could be heard clearly. How much they were surprised when they discovered in those privateers pursued so ferociously Death’s-head-birds of rare beauty and size, whom the sweet scent of the honey had called in, though surely not looking for that barbaric treatment to which many succumbed...” (transl. M.R.)¹²¹. – The behavior of intruding into beehives must have been sufficiently well known by the later 18th century for the insect to be named at times “bee tiger” as in the writings of John Wallis (1714 –1793)¹²² or “bee tiger hawk moth”, as in the works of Moses Harris (1731-1785)¹²³.

It is now thought that the moth employs a kind of chemical mimicry¹²⁴, or acoustically^{125, 126} disguises itself for entry into the hive. Earlier observations in

combination with some authors' fertile imagination of may have led to such fanciful ideas as of the moth hypnotically humming the bees into sleep¹²⁷. This certainly was yet a further of the many fascinating stories about the species that triggered the interest of naturalists and collectors. The Halle farmers who, in the late seventeenth seventies and early eighteenth hundreds collected those staggering numbers, are reported to have brought their unusual harvest to town for sale^{128, 129}. While it is not documented for what purpose they were exactly sold for – as fishing bait, to fatten pig or for poultry feed? – it is likely that a fair number was purchased by amateur naturalists and entomologists, who expressed delight in the sudden availability of the much-sought caterpillar, and even more so, when the abundance in 1779, 1780 or 1783 made the price of the once rare and expensive specimens drop dramatically^{130, 131}. Soon naturalists also tried the obvious – to hatch the caterpillar and pupae to observe the metamorphosis and to obtain the imago^{132, 133, 134}, sometimes with the intention of a later profitable sale.

The Death's head and the expansion of a New World solanaceae

Jules Michelet not only got the historic timeline wrong, but quite like Poe he was 'under the completely erroneous impression' that *Acherontia atropos* occurs in America, stating that "*Il était venu en chenille avec sa plante natale, la pomme de terre américaine, le végétal à la mode.*"¹³⁵ – "It had come in the grub condition with its natal plant, the American potato,—the fashionable vegetable..."¹³⁶.

Acherontia atropos and *Solanum tuberosum* obviously live in their respective native habitats an ocean (at least) apart. The transition of the moth to the potato, a species closely related to some of its original larval host plants is a case that does not stand alone in environmental and entomological history. A fine, partly analogous, example is further found in the Colorado beetle (*Leptinotarsa decemlineata*), originally feeding on wild solanaceae of the Colorado plateau, only became accustomed to - and in consequence a major pest of - the potato through human activities¹³⁷.

As early as 1779 (the year after the Thuringian outbreak) entomologist Eugen Johann Christoph Esper (1742-1810) put forward the theory of the moth's increased frequency being due to the expansion of potato culture¹³⁸. In various parts of Esper's native Germany the novel crop was grown in house gardens as early at the Thirty Year's war. By 1720 the potato was planted in fields, for example in Saxony's Vogtland region, where an early introduction took place in 1647 and a second, and more successful one in 1708¹³⁹. In Thuringia potatoes were grown at least since 1739, when Duke Ernst August I of Sachsen-Weimar had introduced the plant on his estate, first to bait wild boar, then, after 1757 for human nutrition¹⁴⁰. 1746, when Rösel von Rosenhof received the caterpillar in Regensburg, was coincidentally also the very year King Frederick the Great (1712-1786) issued the first of his series of "potato decrees" („Kartoffelbefehle“), that aimed at increasing potato farming in the Kingdom of Prussia. In 1757 the King ordered his subjects to plant potatoes "near their houses and gardens, wherever there is a free spot"¹⁴¹ to solve a rapidly growing population's alimentary problems.

"It is a mistake to think you can solve any major problems just with potatoes" Douglas Adams¹⁴² declares. Neither did the potato alone feed Prussia, nor does it's expanding culture provide a sole and sufficient explanation for the emergence of *A. atropos* as an iconic creature. It is however most likely to be a key factor, woven into a complex network of causes and effects. This is illustrated for example by the fact that the moth's seventeenthcenturies "outbreaks" in Brittany, with notably only imagoes being documented, well predate the 1740 introduction¹⁴³ of potatoes in that area. An explanation for this is found in the moth's prowess as a long distance flyer. When

Brittany was still void of potato plants, *Solanum tuberosum* was already grown in the Old World on Spanish soil. In the Canary Islands potatoes were possibly present as early as 1562¹⁴⁴, and apparently were planted in mainland Spain as early as 1573¹⁴⁵. Favorable winds could easily have carried the moth across the Bay of Biscay into Brittany. That it flies well across the open sea is confirmed by a large number of landings on ships^{146, 147, 148}, sometimes several hundred¹⁴⁹, and or even over a thousand^{150, 151} miles off a possible coast of origin. Bram Stoker's "Dracula" sending the moth as a messenger across the sea¹⁵² may be inspired by such instances. Notably the introduction of the potato in Italy, where it was certainly well established since the early seventeenth century¹⁵³ and thus pre-dates even the earlier descriptions, may have made for a "staging area" for the moth crossing the Alps northwards.

Death's Heads in the heat of summer

Other than the presence of the host plant, and suitable wind conditions that would bring the imago even to areas in want of potatoes or other larval host plants, also the local climate has to be considered in the history of *Acherontia atropos*. The presence and abundance of the insect is certainly more than just a linear function of summer temperatures. First, the spread of the potato seems to overrule climatic limitations to some degree: there is, to the author's best knowledge no documentation, even of single individuals in the mediaeval warm period between 1000 and 1300, but plenty in the later part of the "Little ice age", when the potato was present in Europe. Attempts to correlate the cycles of sunspots with the appearance of unusual insects, including *A. atropos* are in the light of the current climate debate somewhat unconvincing¹⁵⁴. Also regular patterns of occurrence in general – as for example the suggested cycle of 50 years, at least with reference to Eastern Germany, were 1925 and 1975 having been such years - do generally not match the historical records over time¹⁵⁵.

However, there is *some* link between the average temperature of a year and likelihood of the insect being found, though it may not always be obvious. As early as 1779 Esper noted that "Experience teaches that they show themselves only in the hotter years in considerable quantity. Among these the 1747th and 1756th, when Rösels von Rosenhof discovered it, and the 1776th have distinguished themselves above all. In the latter it was also to no lesser degree found in our Franconia in almost all places"¹⁵⁶. Indeed, the later eighteenth century summers in most of Europe turned out warmer in comparison to previous decades¹⁵⁷. Also the summers of 1779 and 1780 when they were found frequently, were hot in Germany¹⁵⁸.

The 19th century in contrast was overall a century of cool summers with however a few warmer ones interspersed¹⁵⁹. In 1824 for example, which is recorded as "a particularly blessed year"¹⁶⁰ in Germany, the moth was common in eastern Germany and Poland¹⁶¹ and the following year saw it many times in Scotland^{162, 163}. Local variations are certainly considerable. 1825 for example was in some places very warm¹⁶⁴ - in fact, the heat is recorded to have been "*so intense that men and cattle died from sun strokes in various parts of England*"¹⁶⁵ - though it was not an exceptionally warm year overall in Europe (1826 was)¹⁶⁶. In 1846, which was a warm year¹⁶⁷, the moth was, coinciding with the Irish Potato Famine, abundant in Scotland¹⁶⁸ and many parts of England¹⁶⁹, as for example the Isle of Thanet (Kent), where they were in fact so common that farmers collected them for chicken feed¹⁷⁰. 1865 must have been another one of those moth-years, at least on the British Isles. *A. atropos* was recorded then as being „most plentiful“ near Belfast¹⁷¹, and abundant near Manchester¹⁷² and in Cornwall¹⁷³ and was collected in general in many places

along England's South Coast¹⁷⁴. In fact, it was so common in that year that the editor of the journal "*The Entomologist*" begged the readers "*Please do not send any more records of the occurrence of this species at present*"¹⁷⁵. 1865 however was apparently not one of the exceptionally warm years (1868 was)¹⁷⁶. Though in our times the moth is hardly known to ever be that frequent in northern latitudes, it still seems to be more common in the warm summers. 270 years after that Breton "Death's Head" year of 1733, in that notoriously hot summer of 2003, newspapers report again that "*African moths spread alarm across Brittany*"¹⁷⁷.

The animal's appearances being rather sporadic and irregular is already addressed in the earlier records of *Acherontia* in central Europe¹⁷⁸, and it remains into our time rather unpredictable. However, it may be presumed that with the presence of the potato in warm years the likelihood of the "northern generation", at least of caterpillars growing successfully, and being more numerous is higher. As early as 1784¹⁷⁹ one naturalist points out that a single female can lay a large number of eggs, and thus the arrival and survival of only few individuals can lead to a large number of offspring emerging. As always in biology chance is a factor that is not to be underrated.

Yet great caution has to be taken when drawing conclusions from the presence or absence in media such as daily newspapers. The insect world is very much a specialist niche topic, addressing the naturalist, or in our times, the environmentally aware and concerned readers. However, in contrast to the specialist, and often unpublished notes of early entomologists they are easier accessible to research and thus till our time at least throw some light onto potential effects of climate on the seasonal entomofauna.

The Moth and the flame

The development of the rare moth that occasionally drifted into northern Europe into an iconic species that accompanies in literature and the arts all that is eerie, uncanny and sinister is not only due to a change in our environment. It is also an effect of behaviors and habits on the side of humans.

It is remarkable how often literature has *Acherontia* flying into a house, into a lit room late at night. Quite a typical instance is that early record of 1688 with the moth circling the lamp at a safe distance for its own good, and to the advantage of the describing naturalist¹⁸⁰. In fiction it sometimes proves in its positively phototactic behavior an utterly suicidal penchant for flying right into a candle's flame,^{181,182} at times extinguishing it to dramatic effect with its body and wings^{183,184}. Occasionally also natural history reports such incidences, as for example one author in a *Science* paper tells of "an old lady made ill with fright because a death's-head (*Acherontia atropos*) had hit her candle and put it out"¹⁸⁵. Another record tells of the gruesome fate of one individual that flew into a gas-burner¹⁸⁶. The portentous flight into doom, or that ominous intrusion into the human sphere is further often staged in literary depictions with the moth unerringly finding the room where someone lies sick or dying. In contrast to our light polluted and artificially climatized world of today in the 19th century, a sick chamber may have been the only room in a house to be illuminated and heated, thus naturally attracting the moth, quite comparable to light traps and heat traps used by entomologists in our times. Such a scene just as any encounter with the animal would further have been more likely to occur in past centuries as the vast majority of people was living in the country and of the land. In addition, as mentioned above, potatoes were in the earlier times often planted in

house gardens¹⁸⁷, enhancing the likelihood of the insect coming into close proximity to the human living environment.

Cambridge Zoological Museum holds two specimens of *Acherontia atropos* that were allegedly caught in King George's (1738-1820) bedroom 1801¹⁸⁸, possibly during the third phase of his mental illness. He resided in this time at Kew palace, surrounded by parks and gardens, and agricultural land cannot have been far. The exhibit has a label that says "*Taken in the bedroom of King George III by Dr. R. D. Willis.*" – which would identify the collector as Robert Darling Willis (1760-1821), who was one of the doctors attending to the royal patient¹⁸⁹. While two moths' route from the royal bedroom to the museum is unknown, it may be no coincidence that one of Dr. Willis' descendants, John Willis Clark (1833 – 1910), was the Museum's first superintendent from 1866 on. How tempting would it be however for a romantic mind to bring the moth into the story to adorn the sad scene with mystery and providing physical evidence by producing the moths themselves? Alternatively it may also have been a criminally creative or criminologically inventive mind, as it could be speculated whether the moth might have been placed on purpose for the monarch to see and to further destabilize his mental health¹⁹⁰. Even if the entire story is not true, it is beautifully made up, inspired by that plethora of stories woven around the species.

A closing window

In our times it appears to be found in lower abundance compared to earlier reports from "good" moth years. Finding 20 caterpillars on a single plant, as a collector did in Cambridge in that warm year 1846¹⁹¹, or even a total of 17 specimens in a single day, as one contributor to a learned magazine writes in 1784¹⁹² from Weimar would be rather sensational today. This might partially be due to the use of pesticides reducing the entomofauna in general¹⁹³.

A further hypothesis is as to a reduced number of occurrences may also pertain to the duration of the moth's development, passage of the seasons and the advances in potato breeding.

The earliest introductions of potatoes are believed to have been of inner tropical Andean origins, *i.e.* short-day ecotypes¹⁹⁴ that cannot flower or develop tubers over the height of European summer with its long days, but only in late summer when days are shortening. This is well in accordance with the observation that in the early decades of European potato culture harvest times seem to have been generally very late, stretching into November¹⁹⁵ and, at least in Spain and other southern European countries, even into December¹⁹⁶.

Many of the findings of the Death's head Hawkmoth reported north of the Alps date to October, sometimes even later. The development of eggs and caterpillars will need roughly two months, followed by about a month in the stage of the chrysalis¹⁹⁷, *i.e.* the caterpillar needs nutrition until September to be able to perform metamorphosis into an imago before the cold season begins.

The development of potato breeds towards "early maturing" characteristics by selection from earlier-flowering seed-grown plants was certainly a lengthy process, and it can be presumed, that late maturing potatoes were common for a long time in Europe¹⁹⁸. Potatoes in culture now in Europe are all carefully bred from crossings that involve ecotypes from Chile, native to areas outside the tropics and adapted to long-day conditions. This genetic heritage would have contributed to current breeds flowering and forming tubers earlier in the year. This agronomically desirable trait however can be expected to shorten the time in which development of *Acherontia atropos* larvae on potato plants is possible, reducing the time in which that local, northern generation could develop. Notably a hiatus in the finding of *A. atropos* of

stage of development between 1847 and the mid eighteenthies in the region of Mecklenburg, Northern Germany, has been attributed to a potato disease, leading to a wilting of the foliage by August, thus also shortening the growing period of the plant, depriving the larvae of its feed and terminating the development into the imago¹⁹⁹.

Perhaps the reduced number of encounters is also in another way an effect of human behavior, with less exposure to nature²⁰⁰, and a smaller number of people manually working in the fields where they may happen upon the animal in its larval stage. Those working in potato farming today often do so sitting encased in a glass cockpit on the back of a tractor with much reduced direct contact with the living crop plant, and all that lives on it. In addition in our times there is a much larger percentage of the population living in urban environments, into which the moth advances much less. A large number of people spend their lives in a sedentary rather than ambulatory, exploratory manner and have their field of vision limited to a computer or smartphone screen, and all acoustic cues from a living environment drowned out by their headphones. Also knowledge of the natural world appears to be generally fading in a large part of the European population, thus even those who may encounter the moth, may often times not know what they see.

The time between the mid-19th and mid-20th century in which most cultural reflections of the moth fall thus appears to have been due to a complex, synergetic combination of various factors a window of opportunity through which *Acherontia atropos* flew into the human sphere and human consciousness to emerge as a new icon of popular natural history and a symbolic animal in literature and the arts.

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