Analysis of the *Insectifera* 2019 article on *Colias ponteni*

Image 1: A preserved specimen (male) of ***Colias ponteni***, described in 1860 by Wallengren. The species has an orange-yellow ground color with dark marginal bands and is now considered extinct. The origin and collection location of this butterfly have long been debated, but new research (including isotope analyses) points to Hawaii as the likely home.

Background and main findings in the article

Colias ponteni was originally described from butterflies collected during Sweden's first circumnavigation of the world in 1851–1853 with the frigate *Eugenie*. Wallengren states in his description that Dr. J. A. Kinberg and Samuel Pontén caught the species near **Honolulu on the island of Oahu** during June–July 1852. Despite this, doubts arose early on whether Hawaii was truly the place of origin – on biogeographical grounds it was considered unlikely that a Colias butterfly would be found in Hawaii (where no other *Colias* are found). British entomologist A. G. Butler described the same butterfly in 1871 under the name *Colias imperialis* and gave the locality as "Port Famine" at the Strait of Magellan (southern Chile). This probably happened after three specimens ended up in the British Museum (Natural History) in London (BMNH) – possibly via material collected by Captain P. P. King in Patagonia – which led Butler to assume a Patagonian origin. For almost 150 years it was uncertain whether ***C. ponteni*** originated in Hawaii or the Strait of Magellan. The article in Insectifera (2019) by Göran Sjöberg, Museo Avellonia in Gävle, Sweden, reports on 47 years of research into this mystery, and presents several key findings:

• **Isotope analysis of the specimens:** Using IRMS (Isotope Ratio Mass Spectrometry), stable isotopes in Pontén's original butterflies were analyzed. These values were compared with butterflies collected both on **Oahu, Hawaii** and in the area of the **Strait of Magellan**. The results showed that the Colias ponteni specimens had isotope profiles that were strongly consistent with butterflies from Hawaii, while the correlation with butterflies from the Strait of Magellan (e.g. *Colias vauthierii cunninghamii*) was **significantly lower**. This suggests a tropical, oceanic climate rather than the cool, southern Patagonian one. According to the author, "everything indicates that **Oahu** and the areas just outside Honolulu are the place where the butterfly once existed".

• **Museum evidence (BMNH specimens)**: Two historical specimens of *C. ponteni* were found in the BMNH collections. The article shows that these are **very likely Pontén's own butterflies** from the Eugenie expedition that later ended up in London. A strong indication is the labels on these specimens – the handwriting on the labels and species names **matches Wallengren's handwriting**. Wallengren himself therefore marked specimens (in addition to the type specimen) that Pontén brought with him. The author has carefully examined these specimens at BMNH to trace their provenance. It is reasonable that Pontén or Wallengren kept at least two more of their own specimens of this spectacular butterfly, which may explain how these two eventually ended up at BMNH (through exchange or sale and later donation many years after the expedition). The article also reports the discovery of a **butterfly pupa** associated with Pontén's material – a pupal shell that shows that the pupa had been parasitized when the parasitized fly or stinger broke out of the pupa and left remains in the pupal shell. So it is not a fully formed butterfly that has left the chrysalis. Göran Sjöberg, who found this pupal shell, has left it untouched as he himself lacked the knowledge to investigate

in more detail which parasitic fly or parasitic wasp had parasitized the butterfly larva or pupa. This was to enable a DNA analysis of the remains of the parasite later. The presence of this pupa together with Pontén's specimen confirms that the butterfly's life cycle was observed on site (i.e. that a pupa was found on the host plant).

• **Connection to Hawaiian flora (Sesbania tomentosa):** The article also discusses the butterfly's possible **host plant** in Hawaii. No direct field observation of larvae was documented in 1852, but based on the expedition's botanical collections and the local flora, it was later concluded, i.e. after Göran Sjöberg published his article in 2019, that a likely host plant was the endemic pea plant *Sesbania tomentosa* (Hawaiian name *'ōhai*). This pea bush used to be abundant in dry coastal areas on Oahu, including the areas around Honolulu, which is consistent with Pontén's collection site. *Sesbania tomentosa* belongs to the *Fabaceae* (pea plants) family and has large orange-red flowers. Since many ***Colias*** species are linked to pea plants as food for the larvae, it is logical that the ōhai bush may have been a host plant for *C. ponteni*. Later photographs of *Sesbania tomentosa* have shown its natural habitat in Hawaii (dry sandy beaches and low-lying scrublands). This suggests that the butterfly's habitat was likely the very environments where *ōhai* grew, before these lands were reclaimed for agriculture. The connection is thus implicit: by showing the plant and its distribution, the reader understands that the butterfly was likely ecologically bound to it, which strengthens the case for Hawaii.

• **More supporting findings**: In addition to the above, the article reports a number of other pieces of evidence. Among other things, it is mentioned that the *Eugenie* expedition's logbooks and Kinberg's diaries do not mention any *Colias* butterflies at the Strait of Magellan, even though they documented most of the natural finds there in detail. On the other hand, the stay in Honolulu was less well reported in the diaries, which left room for individual butterfly finds there to not be mentioned beyond the formal description. It is also pointed out that if the species had been found in Patagonia, **further finds** should have been made there over the years – the region's butterfly fauna is relatively well known, and a large *Colias* would hardly have remained unseen by later entomologists. No such thing has happened, which speaks against a southern distribution. On the contrary, *C. ponteni* remained unknown to science until its description in 1860 and was never seen again after the early 1850s, which rather suggests a small local endemic population that was wiped out shortly thereafter (more like a Hawaiian scenario than a Patagonian one). The article also notes with Göran Sjöberg´s very clear and unique images that the butterfly has certain **primitive features** (e.g. unique androconia and antennae structure) that may indicate an isolated evolutionary lineage. Such features would be consistent with a relict population in Hawaii that had long been geographically isolated, rather than a species in the midst of the diversified *Colias* complex in South America.

Interpretation: Place of origin and fate of the species

The accumulated evidence points unequivocally to Hawaii (Oahu) as the origin of *Colias pontenis*. Isotope data support climatic and environmental conditions corresponding to Honolulu rather than Patagonia. The history of the *Eugenie* expedition also confirms that the ship visited both locations, but **only on Oahu** were Kinberg and Pontén reported to have collected this particular species. The **most likely explanation** is that *Colias ponteni* was endemic to Oahu (possibly also surrounding islands) and lived in the dry coastal biotopes where *Sesbania tomentosa* flourished. The **disappearance** of the butterfly can be linked to the rapid environmental changes that affected Oahu in the 1850s. After the mid-19th century, extensive sugarcane cultivation and other agriculture began on the Honolulu Plain, and grazing animals were introduced. These interventions destroyed the native dryland landscape and greatly reduced the abundance of the ōhai bush. Thus, *C. ponteni* likely lost both its habitat and its host plant within a few years of its discovery. Göran Sjöberg argues in the 2019 article that this likely caused the species to become **extinct** already during the second half of the 1850s. The fact that no later expeditions (e.g. R.C.L. Perkins' studies of Hawaiian insects in the 1890s)

found any *Colias* there supports that the species was already gone shortly after Pontén's discovery of the species in 1852.

To clarify the comparison between the two proposed areas of origin, the evidence can be summarized as follows:

Evidence	**Hawaii (Oahu)**	**Strait of Magellan (Patagonia)**
Historical data	Collected at Honolulu, Oahu, June–July 1852.	Butler (1871) gave Port Famine as the locality, based on misinterpreted old museum specimens.
Isotope analysis (IRMS)	Isotope values match tropical climate (Oahu).	Differs from Patagonian butterflies (low correlation).
Museum labels & Writing	Wallengren's probable handwriting on the BMNH specimens not originating from Butler's find in 1871 (origin Pontén)	No unique markings on the specimens Butler wrongly linked to Kings Patagonia collection.
Other fauna & flora	Unique butterfly, isolated lineage; host plant *(Sesbania)* was found locally.	Similar *Colias* species are found in Patagonia (e.g. *C. vauthierii*), but *ponteni* has not been found there.
Habitat change	Rapid and extensive (agriculture on Oahu ~1850s) – likely explanation for extinction.	No corresponding habitat loss in southernmost Chile the mid -19th century; the species should have survived in that case.

Own position: Based on all the evidence, it appears highly likely that ***Colias ponteni*** **originated in Hawaii** (Oahu). The article builds a convincing overall picture where both modern scientific analysis and historical data together support this conclusion. The butterfly's sudden discovery and disappearance fits well with Hawaii's colonial history – a unique native species that became extinct shortly after contact with man's transformative environmental impact. The alternative hypothesis that the species originated in the Strait of Magellan, however, finds no robust support when critically examined in the light of isotopes, museum finds and the lack of later observations. Thus, everything points to **the Honolulu area being the home of *Colias ponteni***, and that the species likely became extinct when its habitat was destroyed a few decades into the 19th century by white colonizers from the United States and Europe who then began to cultivate the premises where the butterfly had previously found its habitat.

Criticism: Strengths and weaknesses of the argument

The article is **thoroughly and interdisciplinary** throughout, which is a great strength. The author uses a range of methods – from archival studies and handwriting analysis to modern isotope technology – to approach the problem from several angles. The fact that the results converge towards the same conclusion (Hawaii) gives increased credibility. **The isotope study** in particular provides objective, quantitative evidence that supports the historical hypothesis. Another strength is that the article identifies and explains previous mistakes: it explains how Butler's incorrect location arose and shows with concrete evidence (Wallengren-style labels, etc.) what the truth probably is. In addition, the findings are placed in an ecological context – the connection

to *Sesbania tomentosa* and habitat destruction on Oahu makes the story logical and brings to life the reasons behind the species' extinction. The argument is thus supported by both **scientific data** and **historical context**, which is convincing overall.

At the same time, there are some **weaknesses or uncertainties** to consider. The isotope analysis is based on a few old museum specimens, which can lead to statistical uncertainties – the sample size is small and it is assumed that the isotope values have not been affected by preservation or age (however, stable isotopes are normally reliable over time). Furthermore, the reasoning assumes, **after the article was presented** in *Insectifera* 2019, that there was only one possible host plant (ōhai) and that this disappeared completely. Although Sesbania is a strong candidate, it is not mentioned whether there were alternative host plants on Oahu that the butterfly could have used; if such existed, the rapid extinction of the species could be questioned. The likely host plant still exists on Oahu, but conditions were obviously completely changed after colonization in the 19th century. Another weakness is that much of the evidence is **indirect or circumstantial** – e.g. handwriting comparison and logical assumptions about why no more finds have been made. Such indications are reasonable but always leave a small degree of uncertainty. It can never be completely ruled out that the butterfly originates from some **third area** (the article briefly toyed with the idea of, for example, California or other stops during *Eugenie's* journey) – although no concrete evidence supports this. Finally, some of the arguments (e.g. why the species was not found) are based on the **assumption that all subsequent searchers would have discovered it if it existed**. This is certainly likely in this case, but it is still negative evidence (lack of finds) that supports the conclusion.

In conclusion, the article succeeds in an impressive overall analysis where the strengths of the argument clearly outweigh the weaknesses. By combining classic detective work in museum collections with modern scientific technology, the author has largely solved the mystery of the origin of *Colias pontenis*. Minor uncertainties remain, but the **main evidence** – isotopic data, historical documents and label analysis – forms a consistent story. In the final discussion, the author states that Oahu (Hawaii) is the most likely locality for the species, which is supported by essentially all available data. The scientific argument is thus judged to be **strong**, and the conclusion that *Colias ponteni* once flew among the ōhai bushes on the Hawaiian coast appears to be very well substantiated.

Conclusion: The Insectifera 2019 article delivers a well-structured and in-depth analysis that not only summarizes 150 years of speculation about *Colias ponteni*, but also provides new empirical evidence. The main findings are that the butterfly most likely originated from the coastal environment of Oahu (not the Strait of Magellan), that Pontén's own specimens have now been identified in the BMNH with Wallengren's labels, and that the species' extinction was probably caused by human habitat destruction in the 1850s. The argument is multifaceted and convincing, albeit based on relatively few physical specimens. Overall, the study is an excellent example of how scientific rigor and creativity can solve a long-unsolved biological mystery.

Sources: The article by Göran Sjöberg (2019) in Insectifera and referenced information above

museoavellonia.se serevistas.umce.clrevistas.umce.clen.wikipedia.orgctahr.hawaii.edu.