in vivo (degradation, trapping, relocalization, etc.; Fig. 2). Several cases in which such small, functionalized protein binders have been used in *Drosophila* will be discussed, and a look into the promising future of research with *Drosophila* will end the presentation.

Disclosure of interest The author declares that he has no competing interest.

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3

Insects as interactants in artists' minds: Symbols and anti-symbols

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Insects, as small animals of frequent and easy access to humans, at least under their non-flying larval stages, have always been of interest to our species. The interest has probably been nutritional, but also naturalistic and symbolic. Many aspects of insects' biology are of high symbolic potential, among which biodiversity, metamorphosis or flight. These three creative attributes of the insect orders, over the mammalian order at least–the *self* or reference class of human life–, probably induced early interests in human societies. This interest is indicated by folk classification of insects in some indigene cultures of northern America or central Africa [1]. Representation of insects in paleolithic art is scarce but existing; one of the earliest attested records could be that of "the buprestid" of Arcy-sur-Cure, revised as a ground beetle–carabid–(Magdalenian III, ≈ 15000 years BP), or that of "the grasshopper" of Enlène [2]. The first is sculpted in lignite and could have served as a shamanic representation, while the latter is more obviously naturalistic in nature, and carved on bone. The more recently discovered Chauvet cave might contain insect representations (a "butterfly" or a many-legged animal), but no attested insects yet. Similarly, no insect mention come yet from Sulawesi caves (late Mousterian, < 30,000 years BP).

Neolithic representations are much more numerous, as exemplified by bee hunting and bee rearing in Iberic or Egyptian parietal and monumental arts. This trend culminated in Egyptian jewellery and its quasi-industrial representations of scarab or dung beetles. Noteworthy, most prehistoric representation of insects lie on coleoptera and Hymenoptera, and associated with symbolic features linked to colour, strength (beetles), metamorphosis (all) or social and utility behaviours (bees, ants). Aristotle himself did not clearly recognize aphids as a group, as the ancient Greek word ψυλλι΄ δα did not differentiate aphids and psyllids. Many mentions however, on the reproduction of such insects, for example, show that he was talking of aphids.

In line with these historical roots, insects have been associated with far eastern or Christian society arts [3]— in contrast, Islamic and Jewish imaging or alimentary taboos having banned them from visible representations in middle eastern societies. A previous review on the subject gives an excellent outline of our matter, restricted to European painting [4]. I will here sketch a variant perspective, trying to uncover a hitherto hidden monument of cultural entomology, with the case study of the representation of aphids (Hemiptera: Aphididae) in various arts and all periods of history. Our purpose is to draw a reflexive perspective on what such invisible insects, through their invisibility, tell us of their representation in artists' minds, and more generally in any human mind (being he a reader, a writer, a watcher, an actor, or in any position of the artistic universe).

The first and archetypal position to be quoted in my survey of invisible insects is the *detail aphid*. This position of a subject, the detail, have been analysed thoroughly in the history of arts [5]. It reflects both scientific and artistic mastery end precision (it is painted because *it exists*), and a position of power of the painter who is freely choosing low signification or even forbidden or non-codified subjects due to the act of freedom of the artist (and art factories, often specialized in such very specific matters); I paint it because *I want/know* it. This is characteristic of the Flemish and Dutch renaissance, as visible in the *Bouquet of flowers in a vase* by Jan *velvet* Brueghel the Elder (Fig. 1). In contrast to many of its fellow insects, cricket, coleoptera, syrphid, the aphid is extremely difficult to localize (Fig. 1A), and needs an intensive focus on its lily host-plant to be seen (Fig. 1B). However, in spite of its minute size, it is precisely depicted, and the *crescent-marked lily aphid* was recognized by expert aphidologists (Colin Favret, *pers. comm.*). A non-expert comparison between object and subject (Fig. 1B,C,D), be it living (1 C) or mounted (1D) is edifying and informs us on the naturalistic and observational abilities of the painter(s).

As one may imagine, such identification of aphids in European classical painting is extremely difficult and has been only found on three occasions and with the help of the G-art Gigapixel project, apart from Fig. 1: in another still life by velvet Brueghel, *Flowers in a Vase* displaying at the Antwerp museum of fine arts, and in a third *Chat renversant un vase de fleurs* by Abraham Mignon, Museum of Fine Arts, Lyon.

Fig. 1 *Bouquet of flowers in a vase*, by Jan Brueghel the Elder (1608, oil on copper 65 × 45 cm); original (A) in the Pinacoteca Ambrosiana (Milan, Italy), © with permission. Detail with an aphid on a lily leaf (B) situated at the bottom-left corner of the bouquet. Inferred species, with the help of Dr C. Favret: *Neomyzus circumflexus*, quoted from Encyclop'aphid (C) with its typical darkish crescent on the back (D).

All Dutch painters.

One easy case of *naturalistic aphid* lie in the paintings of Maria Sibylla Meriam, a painter and entomologist of the seventieth century who has painted aphids in numerous works, and both entitled some of her paintings with the word, and depicted the whole aphid ecosystem including all trophic levels in the global picture (*Rode akelei met bladwesp en bladluis*, 1684).

One important item in our quest is the topos of the *female aphid* (and eventually *superfemale aphid*). It probably did not start with Charles Bonnet, but at least has fully expanded after him. This talented Swiss student of Réaumur discovered, described, and demonstrated parthenogenesis in what could be called one of the first modern scientific papers in biology, its *Traité d'entomologie* (1745). This signed a series of quasi-quotes all over the following centuries, exemplifying the importance of this reproductive trait in biology, as well as the importance of aphids as a model for this trait: this started by a pejorative citation of Eugène Delacroix in a letter to a friend in 1830 (*"What a pity that such brilliant mind and man has lost his time and eyes for understanding the venial sin of such hideous animals"*), followed by a real tribute to parthenogenesis in the masterpiece of Simone de Beauvoir, *Le deuxième sexe* (Volume 1, Chapter 1, "The data of Biology"). One may also quote in this very context the interesting parallel, made by the contemporary art blog Quadrivia, between parthenogenesis and the codified representation of *"Sainte Anne trinitaire"* in the European religious sculpture of the late Middle Ages (https://quadriv.wordpress.com/2011/06/10/jesus-aphids-and-parthenogenesis/). The sculptural code of Ste Anne consisted in a triptychal representation of Virgin Mary, her mother Anne, and child Jesus in a strange character proportionality of adult (Anne), child-adult (Mary) and child-child (Jesus). This invasion of the female-only character over the Holy Trinity was increasingly popular in central Europe from the fortieth to the sixtieth century (https://fr.wikipedia.org/wiki/Sainte_Anne_trinitaire), and was only stopped by a specific canonical law codifying the Marial cult, or hyperdulia, within the Council of Trento (1542–1563). Although no aphid is represented in such topoi, of course, the parallel between parthenogenesis *and* viviparity, somehow unique to aphids, and the mystery of immaculate conception ought to be underlined.

Already exemplified by Eugene Delacroix, cited above, the recurrent and frequent topos of the *evil aphid* has been used many times in French literature. Victor Hugo listed the vile aphid among a list of biological fearsome fellows (*Les Contemplations*, T3 L6 26, p. 467 as appears in the Frantext database). However, the complimentary figure of the *humble aphid* is also present in post-ninetieth-century occurrences, typically shown in Maurice Carême's poem entitled Le Puceron.

Coming to modern art, the appearance of aphids tends to explode, and I will only quote two examples. One is what could be called the *surrealistic oulipian aphid* by Boris Vian (Fig. 2), the other being the *situationist aphid* of the musical theme of the Polish artist Duy Gebord in the well-named *Mildew* album (https://duygebord.bandcamp.com/album/mildew). The former merits a short outline, as it is emblematic of the mosaic Carollian style of Boris Vian (*Les Fourmis*, Fig. 2A). The prose starts as a very standard description of a explicitly boring subject, to fall out into the final black-hole of Oulipian fantasy (which translates as "The rearing of the Tyrolian 'gnatlet'or the milking of woolly aphids"). The induced image explicitly (again) looks as Fig. 2A, driving the reader in a universe of gentle and poetic madness typical of Vian's prose. It should be noted that the French mouchetis tyrolien (translated as Tyrolian gnatlet) does not refer, as it seems through subtle juxtaposition, to an insect: instead it refers to an industrial painting technique, also typical of the universe of *engineer* Boris Vian, who started as *fonctionnaire* of the French normalization agency AFNOR (as did Albert Einstein with the Swiss patent agency)...

We hope that our short survey of a hitherto boring subject has driven the reader on the wild side of the history of arts and sciences, and that the final references will allow him to escape even more, at night, from its truly exciting daytime highways

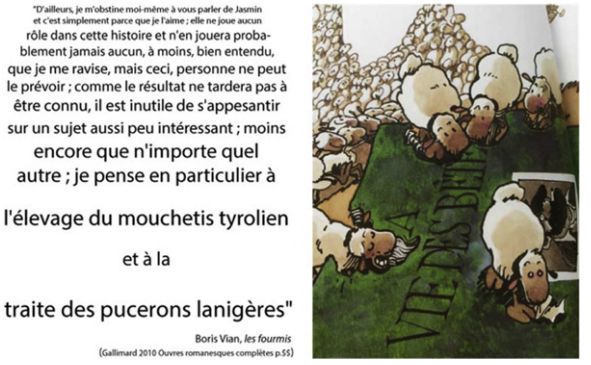

Fig. 2 The milking of woolly aphids, as cited by Boris Vian in *Les Fourmis* (Gallimard, La Pléiade) and reported on the left, with a possible representation on the right: *Le Génie des alpages*, F'Murr, Casterman.

of insect science. This compendium and conference is part of an ongoing project, involving the aphid BAPOA community for data collection, and partially published by Encyclopaphid [6]. The full corpus contains more than 100 entries and the present outline is thus only the hidden part of the iceberg, to be fully published soon.

This conference is quoted in the CNRS repository HAL as: https://hal.archives-ouvertes.fr/hal-02069668.

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4

The shining world of beetles

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Twisted liquid-crystalline organizations are ubiquitous in living matter [1,2]. Many insects own a tessellated carapace with bumps, pits, indentations, stripes or spots (Fig. 1). These geometric variation often exhibit iridescent colors, which are the consequence of a complex twist of chitin macromolecules. Such optical information with vivid structural colors might be of paramount importance in the life and the evolution of most day-living insects. Many biological functions are yet debated. They are related to conspecific or intra-species communication, thermoregulation, camouflage, survival or navigation [1,3].

For example, the cuticle of the scarab beetle *Chrysina gloriosa* exhibits two bands (Fig. 2). The green band serves as a wavelength-selective (green) diffuser due to the set of polygons