Ectoparasite hypothesis – what is the true purpose of zebra stripes: a review

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Currently, as much as 18 different theories have been proposed for striping in zebras. Functional hypotheses fall into four broad categories: 1) camouflage against predators through aposematic colouration, leading to confusion; 2) thermoregulation; 3) having social functions; and 4) avoidance of ectoparasite attacks – the ectoparasite hypothesis (Connock, 2020), (Tombak et al., 2022), (Pan, 2020).

Zebras, like most ungulates, are harassed by tabanids, glossinids, stomoxys and other biting muscoids, which can inflict significant blood loss, transmit disease, and weaken the host's immune system (Hopla et al. 1994). Many detailed video analyses show that in comparison to horses proportionally more tabanids simply touch rather than land on zebra pelage (Fig. 1) (Caro, 2020), (Caro et al., 2023). Regular patterns could become misregistered when viewed by the fly while in motion producing false motion magnitudes and directions. An example of which is the wagon-wheel effect for a human observer (Fig. 2).

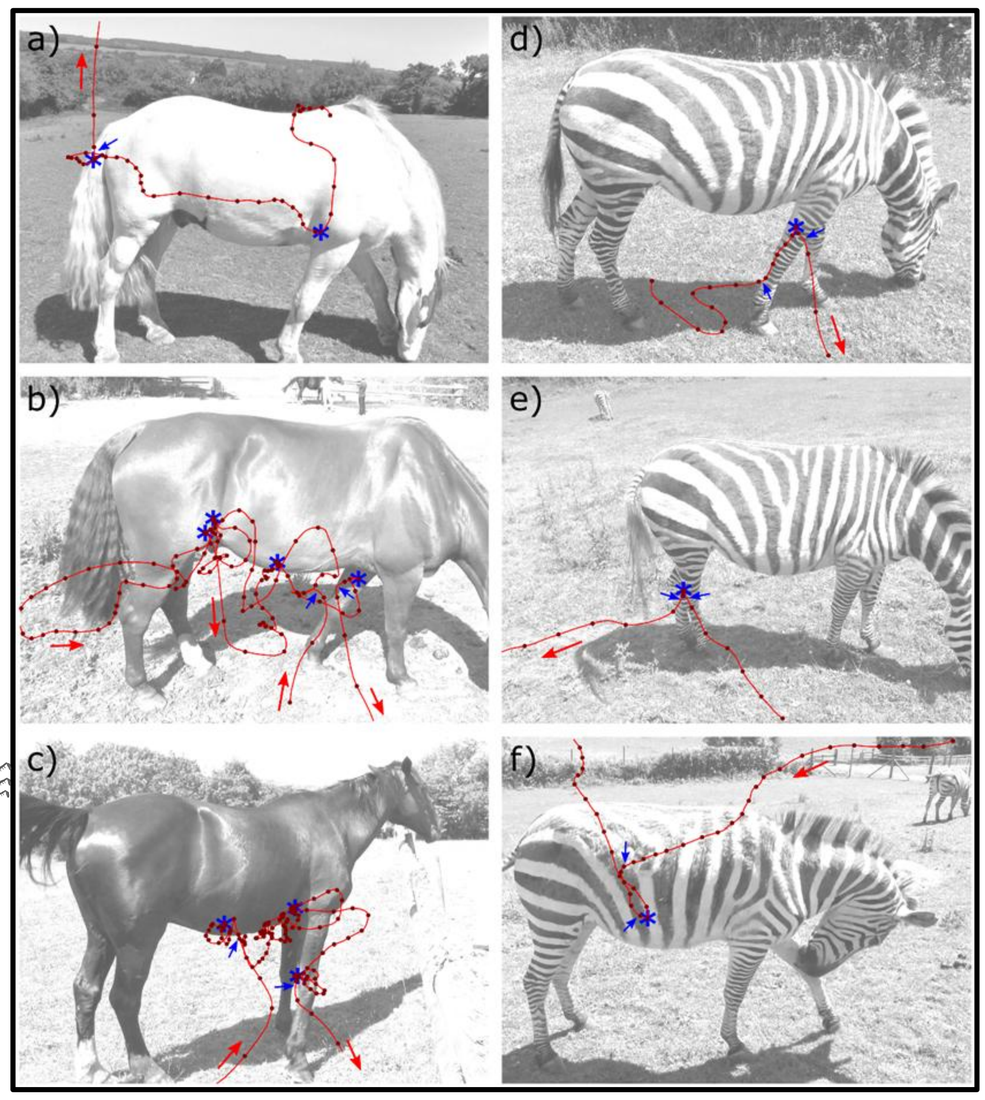

Fig. 1. Examples of horsefly flight paths around domestic horses and captive plains zebra. The red arrows indicate the direction of flight. The blue stars indicate the points of contact or landings on the equid. (Caro et al., 2019).

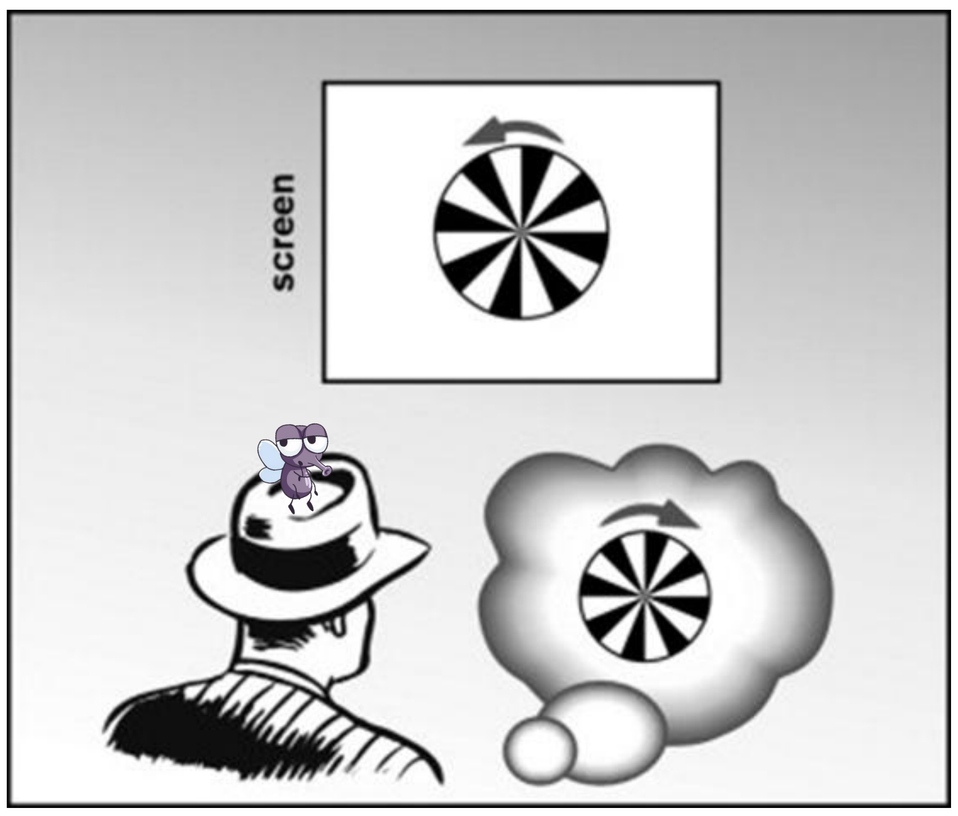

Fig. 2. The continuous Wagon Wheel Illusion. A perioding moving stimulus (e.g., a rotating wheel) might be misperceived even under continuous illumination (sunlight) (VanRullen, 2007).

Many assays speculate that black stripes, by nature of being thin, serve to minimize the size of local features on an equid target that are attractive to biting flies. The body location of the widest stripes varies among zebra species. The widest stripes are commonly on the flank, the neck or the rump of the zebra. The thinnest stripes for all zebra species are consistently on the forelimbs. Stripes may also be found on the legs of other species of the same genus (e.g., *Equus africanus)* (Fig. 3) (Waage, 1981).

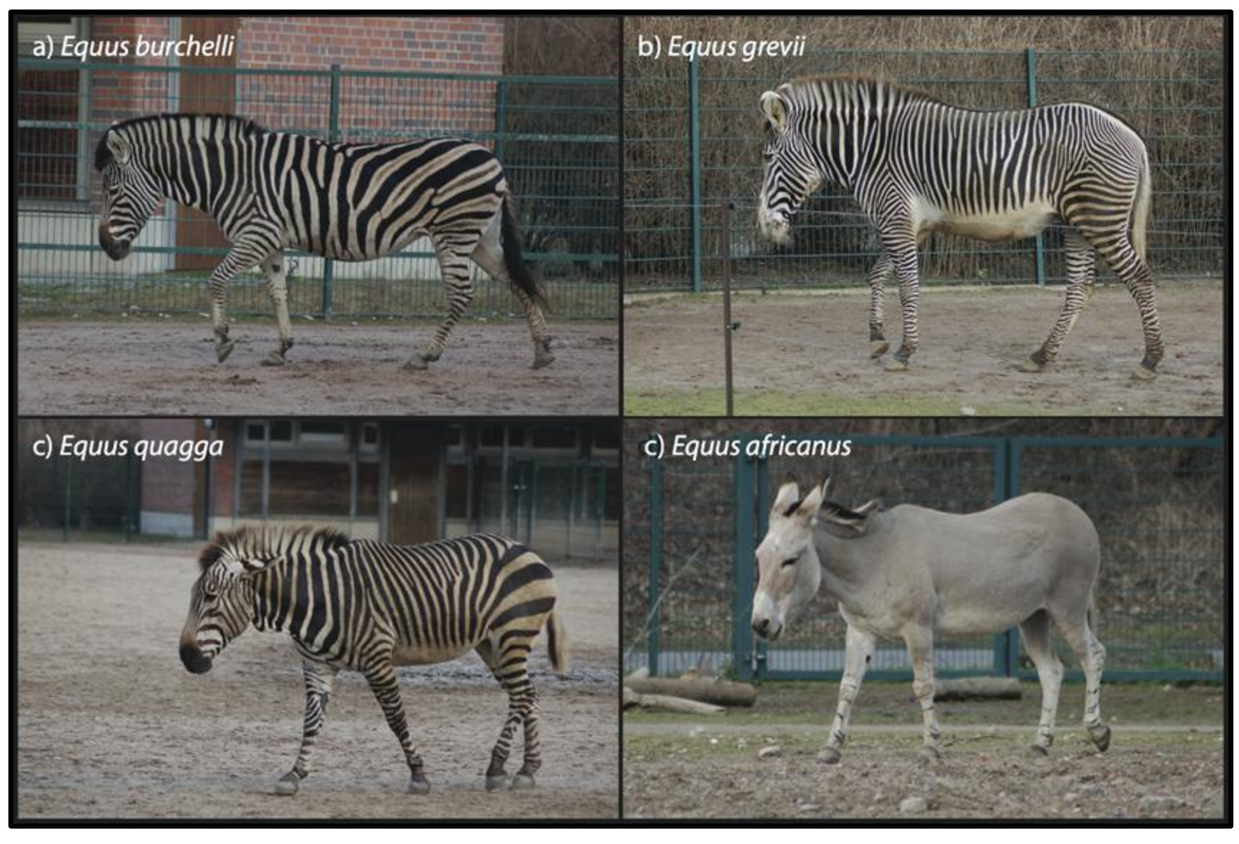

Fig. 3. Photographs of a (a) plains, (b) Grévy's (imperial), and (c) mountain zebra, and (d) African wild donkey (Melin et al., 2016).

CONCLUSION:

To elucidate the true functionality of striping in zebras needs much additional work. More realistic experimental studies are needed to investigate whether stripes function at close range creating optical illusions resulting in confusion and decreasing the likelihood of being predated or bitten, and whether they function at a distance to help zebra evade detection. The lack of parasite data in zebras may not be related to the characteristic of striping. While stripes obviously create confusion in the limited environment of the computer screen, the same phenomenon may not occur on a larger scale under normal conditions. Clearly, larger-scale experiments with live animals or a virtual system are needed. To investigate the potentional role of temperature more experiments must be conducted. Whether stripes function in thermoregulation, how environmental factors influence ectoparasites and likelihood of infection if bitten, all need to be studied.

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