Adaptations to climate change

In Paris as elsewhere, cherry trees are adapting to current climate change by flowering earlier

In response to global climate warming, two main types of adaptation are expected and observed, in both animals and plants [1], which can be seen as two dimensions, ecological and geographical (or spatial), of species adaptation:

- **Phenotypic adjustment** and/or **genetic adaptation** of the ecological niche of individuals and populations to new local conditions. That is to say: partial adjustment of the life cycle (phenology) and other biological characteristics (morphology, physiology) of individuals and populations confronted with new local climatic and ecological conditions (seasonal cycle, nycthemeral cycle), exploration and use of local micro-habitats and micro-climates, exploitation of new local preys, confrontation and defences against new predators and competitors, etc.
- **Shift of the distribution area** of populations towards more favourable climatic conditions, i.e. mainly towards the poles or at higher altitudes, with a variable speed.

Figure 1. Lemon butterfly and bee on a sweet pea. [Source: © Anne Teyssèdre]

Biodiversity monitoring over the last twenty years has largely documented these two main types of response, both from species and communities. Locally, most plants flower and fruit earlier in spring in temperate and boreal regions, with a general **phase shift** in the "greening" of plant communities observed by satellite, at the scale of habitats, landscapes and regions [2].

Insects respond to this phase shift by progressively adjusting their life cycle, via their 'r' strategy and/or their behavioural plasticity, to that of the plants they feed on. This adjustment is easier for generalist species such as lemon butterflies (*Gonepteryx rhamni*) and bees (Figure 1)... as long as the plants are not sprayed with pesticides! In addition, the wing colour of butterflies, dragonflies and other insects in Europe is **gradually lightening** on a regional scale in response to increasing summer temperatures [3]. Natural selection in favour of a paler livery, absorbing less solar radiation, indeed applies for all dark insect species exposed to hyperthermia in a warmer climate. Thus, the populations of dark species are becoming scarcer in southern Europe, but they are also evolving (paler) through the selection and reproduction of the palest individuals.

Mammals, birds and reptiles adapt locally more or less well, according to their behavioural plasticity and their demogenetic strategy, to the new life cycles of their preys and other ecological partners: shifting of migration or hibernation dates, of the reproduction calendar, use of new resources, etc

Figure 2. Cirl bunting on a rock (Valencia, Spain). A lover of open, sunny habitats, the Cirl bunting (Emberiza cirlus) is expanding in Europe, probably due to global warming. [Source: Cirl_bunting.jpg: Paco Gómez from Castellón, Spainderivative work: Bogbumper, CC BY-SA 2.0, via Wikimedia Commons]

As for movements, at the European scale, plant, butterfly and bird communities monitored for more than 20 years have been expanding their range northwards, at varying rates depending on the groups and countries considered [4].

However, these responses to climate change can only be **partially adaptive** [5], [6], [7]. In particular, they seem **insufficient** to reverse the decline of 'K' type specialists (*i.e.* long-lived and not very fecund species), which are more sensitive to the massive transformation and fragmentation of their habitats, for several reasons:

- **the lack of synchronization between species**, especially according to their trophic level, partially disorganizes the ecological net especially to the detriment of specialist, long-lived and low fertility species (type 'K');
- given the shape of the biosphere, the continents and the relief, the surface area of habitats with a potentially favourable climate de **towards the poles and at altitude**, limiting the number of 'climatic refugee' species (type 'r' or 'K') that will be able to establish t there; moreover, **the accessibility** of these habitats is not guaranteed, especially for the large specialist 'K' species that will have to unfavourable and/or anthropised habitats;

Figure 3. 2013 Stanislaus National Forest fire, California. This fire favored by the heat wave destroyed more than 1000 Km^2 of fo August 2013, causing numerous animal and plant victims. [Source: U.S. Department of Agriculture, Public domain, via Wikimedia Commons]

all these responses cannot protect populations of 'K' species from the **devastating effects of extreme climatic events** such as pro droughts, forest fires, storms and floods (even typhoons and tsunamis, in tropical regions), the **frequency** of which is currently **in** with the intensity of climate change.

Notes and references

Cover image. Cherry trees in bloom. [Source: Koudkeu, CC BY-SA 4.0, via Wikimedia Commons]

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