Inokentii Horobtsov,
PhD student, speciality 101 «Ecology»
Department of Ecology
National Aviation University,
inimyo7@gmail.com

ANALYSIS OF AVIFAUNA EXAPTATION CAPACITIES TO POPULATE URBAN ENVIRONMENTS (KYIV STUDY)

With rapidly increasing rates of urbanization and expansion of natural territories grabbing by humans, the wildlife is forced either to flee away from underneath the wheels of progress, or to accept the newly established neighborhood (or, rather, the takeover of habitats by new hosts). Yet, questions like what reasons predetermine such choice and why cannot all animal species live in their previously occupied areas (if the obvious lack of space and direct threat from humans are not accounted) are still standing.

The classic, well known and established in scientific community answer lies in the notion of environmental (ecological, phenotypic) plasticity of the species. This is the inherent ability of species to withstand certain environmental changes, which greatly vary among organisms, communities and populations, and can be extremely wide, as in the case of ubiquist organisms, or vulnerably narrow, putting such creatures to the group of stenobionts. Nevertheless, while this concept explains why it is impossible for some organisms to exist in urban habitats, it still provides little clarification regarding the mechanisms enabling the opposing group to make this transition, and sometimes even thrive beside human.

Some theories have already attempted to address the issue. It has been speculated (Gould & Vrba, 1982), that the mechanism known as exaptation (previously – preadaptation) is responsible for the ability of species to adapt to newly established unfamiliar conditions. Basically, this is an opportunistic mechanism or a by-product of evolutional process that allows organisms to utilize previously developed traits and adaptations (which are active, or dormant, or not quite explained by the classical evolution and natural selection principles) in dramatically changed environments or in case of forced community or population relocation to a new, previously unexplored, habitat. In other words – change or expansion of the function of the traits. Another interpretation of the concept is that it may be an intermediate stage of adaptation development, which helps organisms survive the first waves of ecosystem change. Further those exaptations develop into the full adaptation best suited to new conditions or the new secondary adaptation arises for the most efficient use of initially imperfect expatation. In that sense, species' evolutionary progress works as a cycle presented on the Figure 1.

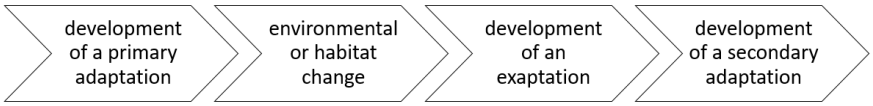

Fig. 1. Adaptation-exaptation cycle

We found no generalization or classification of exaptation types. Yet, studies show, that researchers tend to use the same approach as to the classification of the adaptations. Therefore, the following types can be distinguished: (1) morphological (body structure, form etc.), (2) physiological (related to the metabolic or chemical processes within organisms), (3) ethological (also called behavioristic, habitual or simply lifestyle). Naturally, as with the adaptation types, those exaptation forms are intertwined and act all at the same time: morphological manifestations must be related to some peculiarities of physiological processes and outcome in particular lifestyle, habits and behavior, aimed at the fulfillment of some specific needs.

Debates over the viability and correctness of the exaptation concept are still ongoing. Some scientists argue, that the proofs are circumstantial, others speculate on highly creationistic and teleological nature of the theory (due to confusions in previous notion of «preadaptation», which suggested existence of evolutionary developed traits prior to their natural selection). At any rate, taking into account the «blind spots» in the explanation of evolution of particular traits, as well as the absence of a commonly agreed theory, any concept trying to clarify those points should be considered in depth to confirm or debunk it and move on to the further topics.

Analysis of adaptation capacities and evolution of traits of separate communities, let alone a species, is a very complicated task. It requires a deep understanding of both biology and ecology, as well as views of both of them on evolutionary theory. Moreover, the evolutionary path of each species is different and there is no possibility to draw a universal formula, which will predict highly stochastic processes behind it. And with exaptations, so highly dependent on environmental conditions, it becomes even more difficult, as the scale of their manifestation is often attributed to separate populations and communities. As such, there is a necessity to establish a focus with clear spatial and species boundaries in any research on the topic of exaptations. Given that our analysis has rather a review character and therefore is limited in depth and width, we decided to take into account several species. We picked four most represented synanthropic (most adapted to urban conditions) bird species of Kyiv city, presented on the Figure 2 (Shupova, 2014). At some point all of those species were completely wild and lived under very different conditions, thus it is interesting to follow their path to the city.

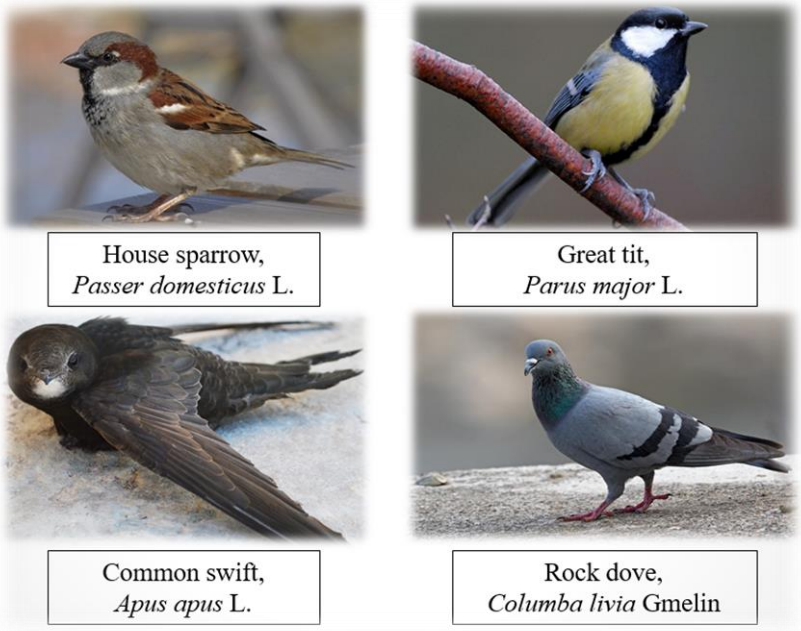

Fig. 2. The most represented bird species of Kyiv city

Most scientists attribute the success in populating urban areas (as they do with the majority of urbanized species) to the morpho-ethological complex of foraging organs and habits, as well as plasticity in terms of nesting behavior (Rakhimov & Rakhimov, 2011). For example, the beaks of house sparrows (*Passer domesticus* L.) are highly adapted to the grains and cereals consumption, thus their spreading across the cities of the world is well-correlated with the spread of agriculture and widening of foraging possibilities. Yet, cities of today often do not resemble agricultural sites. Fortunately, the beaks of sparrows (and all other species under consideration) are also suitable for capturing food from any solid substrate (although swifts prefer insects) – and as such, an exaptation arises. Digestive system and foraging habits also allow certain ambiguity, leading to high foraging and adaptation success.

As for the nesting, such factors as body size, weight, and preferred locations play the decisive role in the choise of settlement. This is well observed on the example of rock-preferring species such as rock dove (*Columba livia* Gmelin), and common swift (*Apus apus* L.). Those species nest under the rooftops of buildings, on pipes, in cavities and hollows of various kinds. Yet, as in previous case, the high degree of plasticity in nesting preferences is always welcomed. This also extends to the choice of nesting materials, as often natural materials are scarce in urban environments, and birds are forced to use man-made ones.

We would also add, that the following factors play certain role in exaptation in case of birds' synathropization in Kyiv:

- plumage, that allows them to remain highly unnoticed in motley urban landscapes;
- brain structure and trainability, that are responsible for higher, quicker and smoother reactions to a very dynamic and unstable urban environments, as well as ability to tolerate the surges and swings of light or noise modes, adjust their biological and circadian rhythms etc.;
- wing structure and flying patterns (especially relevant in case of swifts) that enable birds to navigate through the intricate and sometimes shifting spaces;
- social habits and organization, songs and voice signals, usually short and high-pitched, quickly sent and received and understood, matching the pace of life in the city;
- compact and simplified body structure, mostly excluding too long or curiously shaped and structured necks, legs, tails, etc.

Obviously, the knowledge on the exaptation mechanisms are yet in development, thus the list presented above is incomplete and factors and traits, potential as an exaptations, highly vary from one urban location to another, and need further research. For example, although the great tit (*Parus major* L.) has many minor adaptations for city life, it has no signature features that would explain its fitness for it; another example is how mallards and ducks, widely represented in so many cities as synanthropes, in turn are inexplicably underrepresented in Kyiv. Probably, the major drivers of the settlement process are of purely environmental character and depend on availability and quality of habitats.