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Better to stay downtown or in the countryside? Raptors wintering in urban and rural Protected Areas of Rome (Central Italy)

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Abstract – Urbanization is one of the main permanent landscape changes we are witnessing. Some raptor species are increasing their urban population sizes but others are facing local extinctions due to new settlements. To investigate the composition of raptor community and abundance, we counted wintering raptors in five Protected Areas, three located inside an urban environment and two situated in a large part of the countryside around the city. The most abundant species were the Eurasian Kestrel *Falco tinnunculus* and the Common Buzzard *Buteo buteo*. The first species was distributed across both landscape types whereas the second required woodland to overwinter. Both species actively selected undisturbed open areas with natural vegetation and tended to avoid artificial surfaces. The results suggest that larger rural areas better support wintering raptor communities than urban contexts, in particular when rural areas are located along the coastline.

Key-words: wintering raptors, urbanization, Eurasian Kestrel, Common Buzzard, Protected Areas.

INTRODUCTION

For hundreds of years, urban environments have attracted scavenging raptors, especially in areas where garbage was not systematically removed from the streets and private backyards. This was common practice in many European cities of the XVI century and nowadays occurs throughout some large cities in Asia and Africa (Bildstein & Therrien 2018). In recent years we are witnessing an increase of some raptor species populations which displays a level of behavioural plasticity to interact and survive in urban environments (Sol *et al*. 2013). This is the case of some *Accipiter* species of North America (Boal & Dykstra 2018, McCabe *et al*. 2018), but also of the Peregrine Falcon *Falco peregrinus* which is colonizing several cities across Europe and Africa. For instance, in Rome (Central Italy) the latter species started to breed in 2005 and the population grew up to 15 pairs in 2017 (Manzia & Dell'Omo 2017). As in Western United States, Peregrine Falcon breeding in European towns may benefit from a higher abundance of birds relative to non-urban areas (Gahbauer *et al*. 2015) but also in finding nest sites in buildings and infrastructures. Green areas inside cities represent a relevant opportunity for recovering predator populations such as the case of recent colonization of Goshawk *Accipiter gentilis* in Hamburg, Germany. This species benefited by afforestation and forest maturation in urban green spaces (Rutz 2008). In some cases there are raptor species that overwinter in cities and return to natural environments to breed such as the case of the Orange-Breasted Falcon *Falco deiroleucus* in Argentina (Grande *et al*. 2018).

The influence of urbanization on animals and on ecological processes likely varies among geographic regions and with the magnitude of development. Scientific evidence suggests that there are species that have declined as a direct result of landscape modification due to urbanization (Palomino & Carrascal 2007, Ferrer-Sanchez & Rodriguez-Estrella 2015). As a general pattern, urbanization causes the simplification of natural habitats, resulting in animal communities characterized by invasive alien species with few top predators. To verify the presence of raptors, their community composition and abundance, we carried out field research inside and in the surrounding countryside of Rome where we counted raptors wintering in ur-

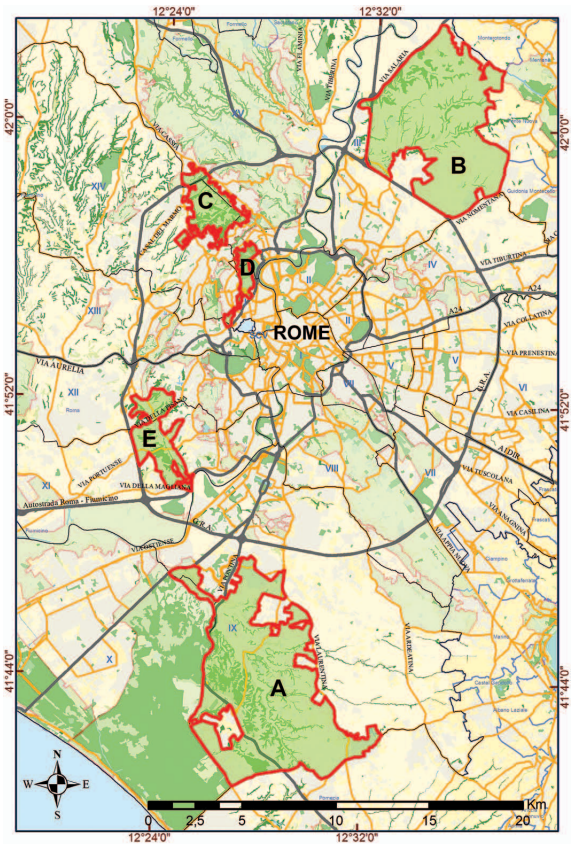

Figure 1. The five monitored Protected Areas and Rome: A) Decima-Malafede; B) Marcigliana; C) Insugherata; D) Mount Mario; E) Massimi's estate. Transects and point counts are indicated in the maps in violet. In red the border of the Protected Areas.

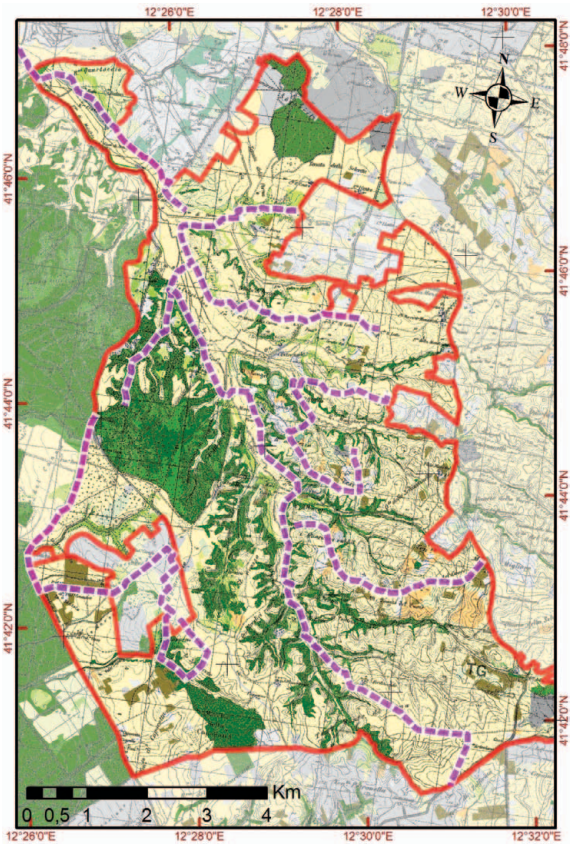

Figure 1A. Decima-Malafede.

ban and rural Protected Areas. We selected winter as suitable study period because raptor presence is not limited by nest site availability and territorial constraints. During this season birds can easily move in areas with good foraging opportunity (Newton 1979). Our hypothesis is that some species are more adapted than others to the urban environment and we expected higher frequencies than in rural areas. Moreover we expected a homogenous distribution of raptors inside areas of the two investigated categories (urban, rural areas) without a given preference for a particular habitat.

MATERIALS AND METHODS

The fieldwork was carried out in five Protected Areas located inside an urban environment and in the surrounding countryside outside of Rome (Fig. 1), Central Italy, all areas are managed by RomaNatura regional authority:

1. Decima Malafede (6145 ha)
2. Marcigliana (4680 ha)
3. Massimi's Estate (868 ha)
4. Insugherata (771 ha)
5. Monte Mario (238 ha)

The first two areas are located outside the great ring road of Rome and represent a relevant portion of the Roman Landscape where raptors have been monitored in the past. Decima-Malafede is located south-west of the city and is the closest study point from the sea at approximately five kilometers (Panuccio 2009, 2018). Marcigliana is on the opposite side of the city and is located further away from the sea at a distance of approximately 30 kilometers. The other smaller Protected Areas are located inside the urban fabric and are completely surrounded by buildings and settlements. The fieldwork was conducted between the 9th of December 2013 and the 26th of February 2014. Due to differences in study site size, to count wintering raptors we used road counts along roads in the two largest areas and point counts for the three smallest study areas

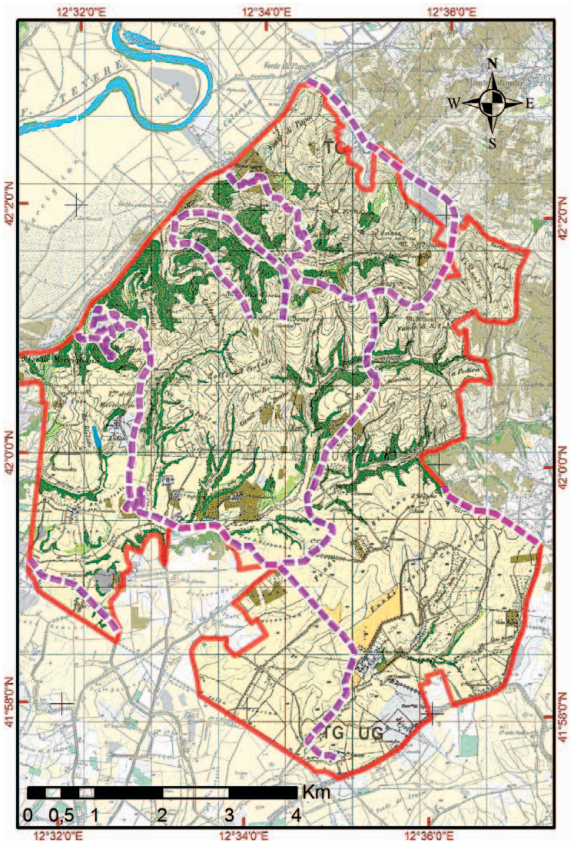

Figure 1B. Marcigliana.

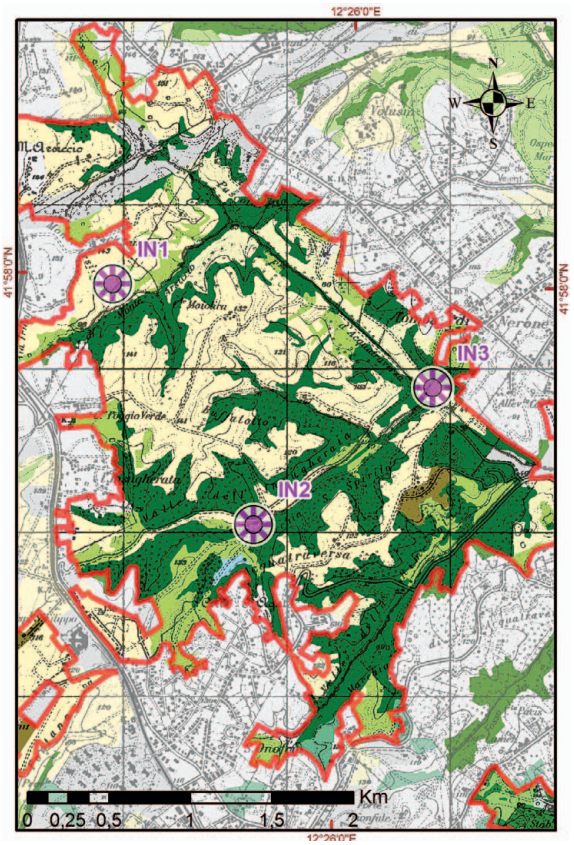

Figure 1C. Insugherata.

(Bibby *et al*. 2000, Sutherland *et al*. 2004). In the Natural Reserve of Decima Malafede we used a total of 45 km of transects (repeated 7 times during the field season). In the Natural Reserve of Marcigliana we used a total length of 36 km of road transects (repeated 5 times). In the smallest areas we used nine watchpoints, three for each area (repeated 8 times during the season) where we recorded every raptor observed during a 10-minute period (Sutherland *et al*. 2004). Road transects were performed by driving a car along fixed paths at a speed between 20 and 35 km/h, fieldwork was not conducted on days with fog and/or rain (Bibby *et al*. 2000). For every detected individual, we collected data including: date, time, species, number of individuals, and the habitat where the bird was observed. Habitat categories were selected according to Corine Land Cover (Büttner & Kosztra 2007), grouping them into 5 categories:

1. Artificial surfaces (human infrastructures such as houses and buildings),
2. Permanent crops (olive tree groves, vineyards) and complex cultivation patterns,
3. Pastures/arable land,
4. Forests
5. Scrublands and uncultivated lands

We calculated a Kilometric Index of Abundance (KIA) of each species for each road transect, dividing the number of observed individuals by the distance (km) covered by the transect. In the case of point counts, species abundance was expressed by the Punctual Abundance Index (PAI), which is a ratio between the total number of individual contacts of each species by total number of samples used in each area of the study (Bibby *et al*. 2000). The largest number of raptors were recorded in the Natural Reserve of Decima-Malafede (see below). The sample size for this study site allowed us to calculate habitat preferences using Jacobs indexes for each of the five habitat types (Jacobs 1974), calculated on the habitat used in proportion to habitat availability. The used formula is: $D = (r - p) / (r + p - 2rp)$, where r is the proportion of raptors observed in each habitat in relation to the total number of observed individuals and p is the proportion of each habitat in relation

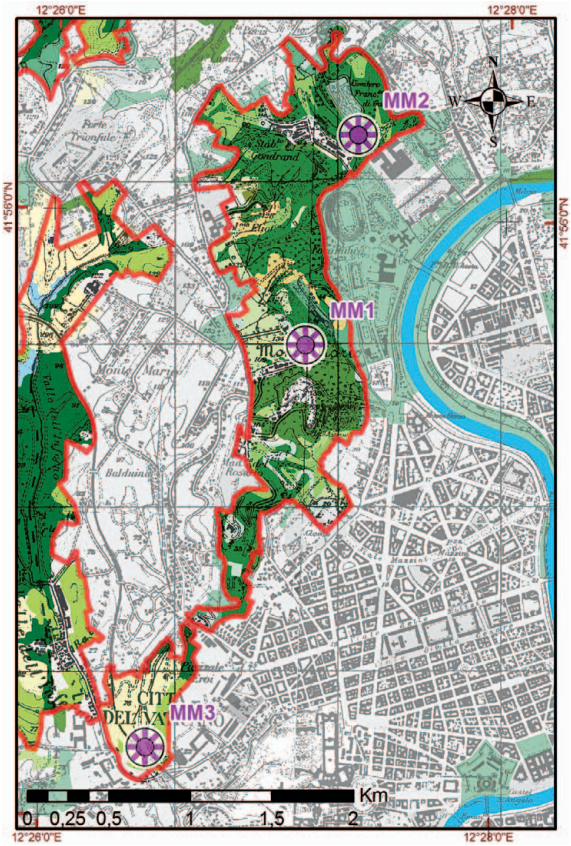

Figure 1D. Mount Mario.

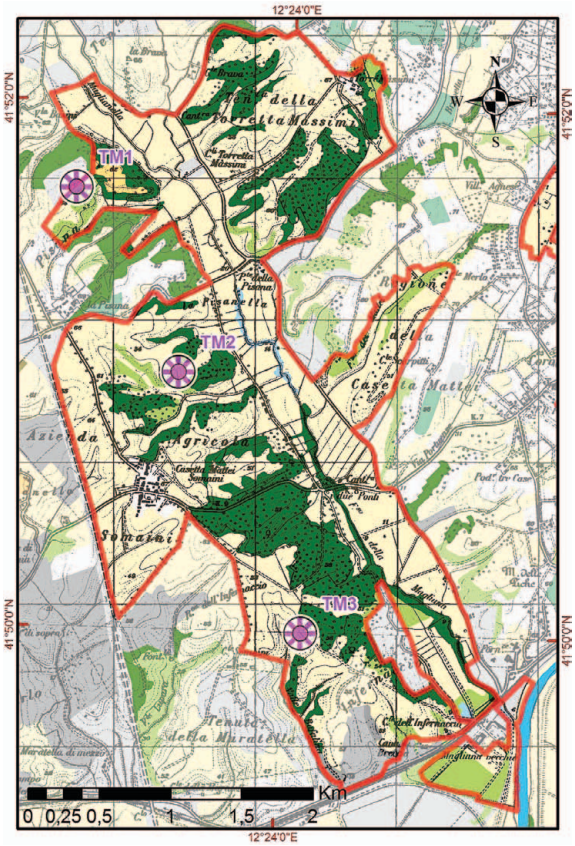

Figure 1E. Massimi's estate.

to the study area (the surface of Decima Malafede Natural Reserve). The surface covered by each considered category was calculated using Corine Land Cover (Büttner & Kosztra 2007). The D index is comprised between 1 and -1, whereby negative values represent when the species tends to underuse the considered category. To compare observed numbers in the different areas we used contingency tables (Fowler & Cohen 1992).These data showed that the two most common species were the Eurasian Kestrel and the Common Buzzard, we focused the analysis and discussion on these two species.

RESULTS

A total of 268 raptor observations were made during the fieldwork. Most of them were made in the Natural Reserve of Decima Malafede (Tab. 1). The PAI values recorded in the three areas including inside the city showed that number of Eurasian kestrels were similar while Common Buzzards were recorded mostly in the Massimi's Estate Natural Reserve while it was completely absent from Mount Mario which was the smallest monitored Protected Area. IKA values collected in the two areas located outside the city show that density of raptors was differed largely, with higher numbers of raptors observed in the Natural Reserve of Decima Malafede. Looking at the habitat preferences of raptors in the three Protected Areas inside the city, Common Buzzards were frequently observed in forest patches while kestrels used all of the available habitats homogeneously (Tab. 2). In the Natural Reserve of Marcigliana raptors were observed in two macro-habitats: open areas and forests. Eurasian Kestrels were observed mostly on open areas (92.8%), whereas Common Buzzards preferred patches of forest (62.5%). At Decima Malafede Natural Reserve the Jacobs indexes (Fig. 2) showed that both species over-selected scrubland and uncultivated open areas (Eurasian Kestrel: D = 0.7; Common Buzzard: D = 0.5) while, surprisingly, pastures and arable lands were under-used by both Eurasian Kestrels (D = -0.7) and Common Buzzards (D = -0.74). Urbanized areas were strictly avoided by both species and in particular by Common

Table 1. Raptors observed during the present survey. IPA and IKA values are presented for two of the most common species. Total number of observed individuals displayed in brackets.

Protected Area	E. Kestrel	C. Buzzard	Hen Harrier	Sparrowhawk	Peregrine Falcon
Mount Mario (PAI)	0.2 (5)	0	0	0	0
Insugherata (PAI)	0.3 (6)	0.2 (3)	0	0	0
Massimi Estate (PAI)	0.3 (8)	0.6 (14)	0	0	0
Marcigliana (IKA)	0.1 (16)	0.04 (8)	(1)	0	0
Decima - Malafede (IKA)	0.4 (133)	0.2 (65)	0	(7)	(2)

Table 2. Percentages of observed raptors in the different considered habitats of the three Protected Areas inside the city.

Protected Area	Species	Arable land	Scrubland and uncultivated land	Forest
Mount Mario	E. Kestrel	-	60	40
Insugherata	E. Kestrel	50	33.4	16.7
	C. Buzzard	-	-	100
Massimi	E. Kestrel	28.6	42.8	28.6
	C. Buzzard	14.3	42.8	42.8

Buzzards as this species was never observed over artificial surfaces (Eurasian Kestrel: D = -0.6; Common Buzzard: D = 1). Eurasian Kestrels also avoided forest areas (D = -0.7) while Common Buzzards were more commonly observed over wooded areas (D = -0.03), this difference is significant ($\chi^2 = 78.1$, $P < 0.001$). In the Natural Reserve of Decima Malafede ecotonal fringes were widely used by Common Buzzards (31% of the observed individuals) and also by Eurasian Kestrels to a lesser extent (22.6%), this difference is significant ($\chi^2 = 4.1$, $P < 0.05$).

Not a single individual of any other raptor species was observed in the small protected areas inside the urban fabric, however, a Hen Harrier *Circus cyaneus* was observed once at Marcigliana while at Decima-Malafede Sparrowhawk *Accipiter nisus* and Peregrine Falcon were observed seven and two times respectively.

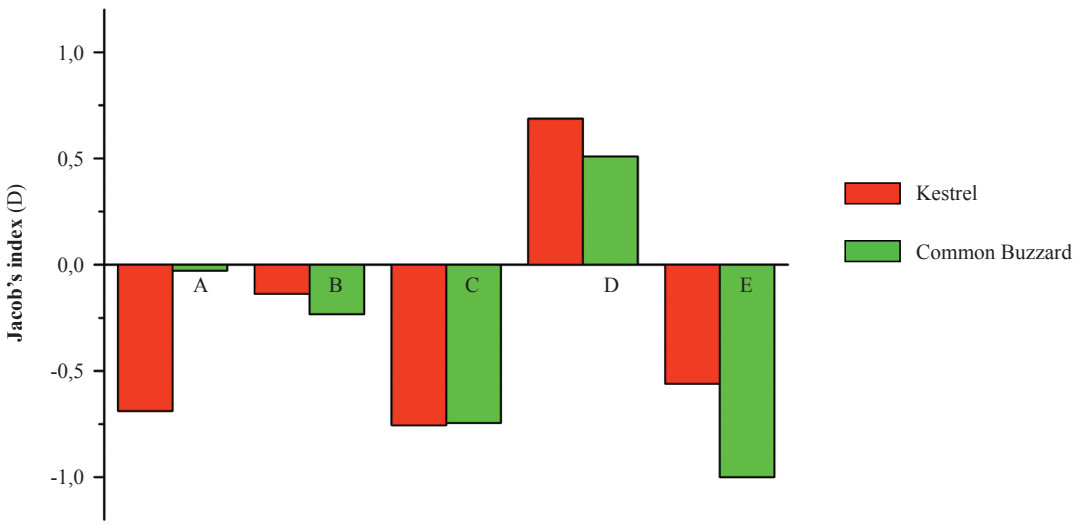

Figure 2. Jacobs indexes for Eurasian Kestrel (red) and Common Buzzard (green) wintering in Decima-Malafede Nature Reserve: a) wooded areas; b) permanent crops and complex cultivation patterns; c) pastures and arable land; d) scrublands and uncultivated areas; e) artificial surfaces.

DISCUSSION

The results of this survey do not support the starting hypotheses. We did not find any raptor species preferring urban areas more than rural areas. We expected to record Peregrine Falcons in urban Protected Areas as this species often uses urban environments to breed. However this was not observed in this study. Observations at Decima-Malafede showed that raptors actively avoid artificial surfaces. The Eurasian Kestrel was the only raptor species distributed across all the surveyed areas while the Common Buzzard clearly required wooded areas for wintering. There is evidence to suggest that urban raptors feed primarily on bird species allowing high survival rates and breeding performances while the opposite occurs for raptors feeding on mammals (Kettel *et al*. 2017, Grande *et al*. 2018). This difference may explain why of the two commonest wintering raptors only the Eurasian Kestrel was regularly observed inside the city. This species shows a high plasticity in its hunting habit, often feeding on birds (Costantini *et al*. 2005, Trotta *et al*. 2015). On the other hand, Common Buzzards mostly prey on small mammals (Wuczyński 2005, Rooney & Montgomery 2013, Tóth 2014, Dare 2015). The observations at Decima-Malafede indicate that raptors select open areas with natural vegetation rather than semi-natural vegetation. These relatively small patches of uncultivated and non-grazed open areas likely provide higher feeding opportunities for raptors. In intensively managed agricultural areas, the preservation of relict patches of other habitats is of paramount importance for bird conservation (Brambilla *et al*. 2015). The relevant difference in recorded IKA in the two monitored rural areas indicates that raptor distribution is not homogeneous across the countryside in the surrounding area of Rome. It is likely that the lower number of observed raptors at Marcigliana compared to Decima-Malafede is due to the differences in distance from the coastline (minimum distance from the coast: Marcigliana > 30 km, Decima Malafede < 5 km). Areas located along the coast support a higher productivity and might be preferred by wintering raptors.

In conclusion, the results of our research indicate that raptors require large green areas for wintering and avoidance of urban settlements confirming what has been observed in other Mediterranean areas (Aradis & Carpaneto 2001, Palomino & Carrascal 2007). The Common Buzzard is particularly sensitive to human disturbance and for this reason it selects large rural areas for wintering and for breeding (Zuberogoitia *et al*. 2006). Urbanization promotes irreversible landscape changes and although some raptor species are increasing as breeders in cities, most birds of prey are sensitive to changes in habitat structure and connectivity and have a high susceptibility to local extinctions as a consequence of urbanization (Savard *et al*. 2000, Chace & Walsh 2006). Therefore it is easy to predict that the undergoing urban sprawl in the surroundings of Rome will negatively affect the community of birds of prey now present in the Roman countryside. Moreover as an indication for wildlife management it is of crucial importance to maintain wooded areas as well as uncultivated and ungrazed patches of open areas for supporting raptor populations in the future (Palomino & Carrascal 2007, Brambilla *et al*. 2015).

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