

Endoparasitoses of the Eurasian collared dove (*Streptopelia decaocto*) on the northern Black Sea coast of Ukraine

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One of the main tasks of ecological parasitology at the present stage is to determine patterns of spread of invasive diseases of poultry in the environment through a thorough epidemiological examination, as well as to determine the main directions and factors of spread of parasites in Ukraine. Some pigeon health problems can affect their populations, but parasitic infections play an important role. Our research found that 83.3% of Eurasian collared doves examined (*Streptopelia decaocto*) were affected by endoparasites. The commonest helminths were *Raillietina* spp. with the average invasion intensity of 4.9 ± 1.3 specimens/ind., *Baruscapillaria* spp. and *Ascaridia columbae* with an invasion intensity of 4.6 ± 1.5 and 3.7 ± 2.1 specimens/ind., respectively. The commonest cestodes were *Raillietina* spp. with the extent of invasion of 52.2% and *Davainea proglottina* – 6.7%. The *Amoebotaenia cuneata* cestodes were recorded in 3 (3.3%) doves, and *Echinolepis carioeca* – only in 2 (2.2%) doves. Six doves (6.7%) were infected with the nematode *Ascaridia columbae* and 5 (5.6%) – *Baruscapillaria* spp. Eimerian oocysts were found in 9 (10%) collared doves, and *Trichomonas gallinae* was recorded in 15 (16.7%) birds. According to the results of helminthological autopsy and identification of the isolated pathogens, 8 varieties of mixinvasions were identified. In association with the Rayetins, there were the protozoa *Eimeria* spp. and *Trichomonas gallinae* and the nematode *Ascaridia columbae*. Two-component invasions were registered in 78.6% of doves, three-component infestations in 14.3% and four-component infestations in 7.1% of birds. Mixed infection with *Raillietina* spp. + *Ascaridia columbae* was found in the small intestine of *Streptopelia decaocto*, which was also pathomorphologically observed to have catarrhal-hemorrhagic enteritis, which was accompanied by the formation of a large number of spotted hemorrhages on the mucous membrane, and in the places of attachment of cestodes - necrotic-caseous areas. Temperature and other weather conditions such as humidity, precipitation, etc. of the northern Black Sea coast affect the population size of intermediate host cestodes. Continuous monitoring of invasive diseases of pigeons of different species will help to take the necessary preventive measures against endoparasitoses of birds.

Keywords: pigeons; cestodes; nematodes; eimeriosis; trichomonosis; distribution; epidemiology.

Introduction

Pigeons of the genus Columbiformes are birds that can be found almost all over the world. Those who observe these birds cannot even imagine how harmful their disorderly reproduction can be and how many risks they are exposed to. They are the main source of a number of infections and pathogens (Bled et al., 2011; Orlova & Orlov, 2019). The Eurasian collared dove *Streptopelia decaocto* Frivaldszky (1838) (Columbiformes: Columbidae) is a common resident bird in many countries, mainly in villages and cities (Dinevich et al., 2003; Scheidt & Hurlbert, 2014; Bagi et al., 2018). Cities and suburbs are home to a large number of pigeons of various breeds, including wild pigeons, which are permanent residents of parks, playgrounds, markets and other facilities and can serve as distributors of the commonest intestinal nematodes (Vaz et al., 2017; El-Dakhly et al., 2019). *Streptopelia decaocto*, since the 1930s, has spread from West Asia and the Balkans to all of Europe and Central Asia, and continues to expand its range. The first birds in Ukraine appeared in Uzhgorod in 1944. Three years later it was already nesting in Mukachevo and Chop. Soon it flew through the Carpathian Mountains to Lviv region. Then it gradually inhabited Volyn, Rivne, Zhytomyr. In 1955, this species was first observed in Kyiv, in 1960 – in Sumy. Then there was the settlement of Southern Ukraine. Currently, the Eurasian collared dove is a common species in Ukraine. It lives exclusively in settlements – both in small villages and large cities. It inhabits areas with well-developed woody vegetation. It nests more often in old parks, cemeteries, areas of old

residential buildings with courtyards, street avenues. In summer and autumn, it occurs in agricultural lands (Talposh, 2019). On the territory of Kharkiv, absolute surveys of the Eurasian collared dove with mapping elements in squares with an area of 0.25 km² were conducted (40 squares were surveyed). Then the number of collared doves in the following habitats was determined by extrapolation: multi-storey buildings, private buildings, industrial zone, forest zone, park zone, wastelands (including undeveloped areas, etc.). The average nesting density of the species within the city of Kharkiv was 6 pairs/km² in the zone of private development, 4.6 pairs/km² – in areas with multi-storey buildings, 3 pairs/km² – in the industrial zone, 2 pairs/km² – in the park zone, 0.4 pairs/km² – in wastelands and other undeveloped areas. The estimate of the size of the nesting population of the collared dove, taking into account the areas of these habitats within the city, was slightly more than 850 pairs (Brezgunova et al., 2017).

The Eurasian collared dove is considered a pest of crops, as it usually feeds on large flocks, grains, fruits and can spoil them. It also feeds on beetles and butterflies (Olimpi et al., 2020). This species hosts a large number of endoparasites, such as cestodes, nematodes and unicellular protozoa (Mushi et al., 2000; Senlik et al., 2005).

One of the main tasks of ecological parasitology at the present stage is to establish patterns of spread of invasive diseases of poultry in the environment through careful epizootological examination, as well as to determine the main directions and factors of parasitism in Ukraine (Nakao et al., 2019; Paliy et al., 2020). Researchers believe that intestinal parasito-

sis is primarily a sanitary problem, and its prevention should be based on sanitary-parasitological monitoring (Harlin & Wade, 2009; Ahmed et al., 2017). Some health problems of doves can affect their populations, but parasitic infections play an important role (Mohammed et al., 2019).

However, there are no data on the prevalence of *S. decaocto* parasites on the northern Black Sea coast of Ukraine. The population of wild pigeons is growing every year. They infect private poultry, thus spreading the invasion to synanthropic and domestic pigeons. Therefore, finding out the spread of parasitic diseases will help prevent the infection of the population of domestic and wild pigeons in the region.

Materials and methods

The research was conducted in the period from August to November 2019 and 2021 on the northern Black Sea coast of Ukraine (Odessa, Mykolaiv, Kherson regions). A total of 90 *S. decaocto* individuals seized during sport hunting were studied: 30 in Berezivsky, Odessa and Belgorod-Dnistrovsky districts of Odessa region, 30 in Bashtansky and Mykolayiv districts of Mykolayiv region, 30 in Skadovsk and Kherson districts of Kherson region. The experiments performed on the animals did not contradict the current legislation of Ukraine (Article 26 of the Law of Ukraine 5456-VI of 16.10.2012 “On protection of animals from cruel treatment”), adopted by the First National Congress of Bioethics (Kyiv, 2001) and international bioethical standards (materials of the IV European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Purposes, Strasbourg, 1985) (Simmonds, 2018; Kabene & Baadel, 2019). The research program was reviewed and approved by the Bioethics Commission of the National Research Center the Institute of Experimental and Clinical Veterinary Medicine.

To diagnose trichomonosis of pigeons, fresh wet smears were taken from the mucous membrane of the oral cavity and throats of the birds, which were examined in the laboratory of epizootology and parasitology of the Odessa research station NSC “IEKVM” by staining according to the method of Romanowsky-Giemsa using light microscope $\times 400$ (Anderson et al., 2009). *Trichomonas* was identified by signs of mobility and the presence of flagella (Dovc et al., 2004).

Species of helminths were identified morphologically – nematodes were identified after clearing in lactic acid with glycerin, and cestodes – after staining with lactic acid carmine. Differentiation of cestode oncospheres (raietin, davenii) was performed by staining eggs with diamond green in the dilution of 1:10,000 and then the capsules were examined in Petri dishes. Oncospheres of *Davainea proglottina* were stained with light green in 3–5 minutes, and oncospheres of *Raillietina* spp. during this time were not stained (Ukrainian patent for utility model No. 78451).

To diagnose eimeriosis, pigeon feces were examined by the standardized Fuleborn method. Microscopic examinations were performed at low magnification of the microscope (8×10) with subsequent determination of the average rates of invasion extent (EI, %) and invasion intensity (II, the number of oocysts in 1 g of feces) (Bakulin, 2006).

Results

Both helminths of the classes of cestodes and nematodes, and protozoa, were recorded in the intestinal canal of the collared dove. It was found that 83.3% of the examined collared doves *S. decaocto* were infected by endoparasites. The commonest of the cestodes were *Raillietina* spp. (Molin, 1858; Megnin, 1880) with the invasion extent of 52.2% and *Davainea proglottina* (Davainea, 1860) – 6.7%. The cestode *Amoebotaenia cuneata* (von Linstow, 1872) was recorded in 3 doves with the invasion extent of 3.3%, and *Echinolepis carioca* (Magalhaes, 1898) in only 2 (2.2%) doves. According to the results of research, 6 doves (6.7%) were infected with the nematode *Ascaridia columbae* (Gmelin, 1979) and 5 (5.6%) doves – *Baruscapillaria* spp. (Madsen, 1945; Moravec, 1982). Eimeriosis oocysts of *Eimeria columbarum* (Nieschulz, 1935), *E. labbeana* (Labbe, 1896; Pinto, 1928), *E. columba* (Mitra and Das Gupta, 1937) were found in 9 (10%) doves, and *Trichomonas gallinae* (Rivolta, 1878) was recorded in 15 (16.7%).

The commonest helminths of *Raillietina* spp. were detected by pathological autopsy in the intestines of birds, with the average invasion intensi-

ty of 4.9 ± 1.3 specimens/ind., *Baruscapillaria* spp. and *Ascaridia columbae* with the invasion intensity of 4.6 ± 1.5 specimens/ind. and 3.7 ± 2.1 specimens/ind., respectively (Table 1).

Table 1

Intensity of infection with endoparasites of the collared dove *Streptopelia decaocto* ($x \pm SE$, $n = 90$)

Parasite	Helminthes detected, specimens	Invasion intensity, specimens / ind.	Min-max
<i>Raillietina</i> spp.	234	4.9 ± 1.3	1–5
<i>Davainea proglottina</i>	18	3.0 ± 0.9	1–3
<i>Echinolepis carioca</i>	3	1.5 ± 0.2	1–2
<i>Amoebotaenia cuneata</i>	17	5.7 ± 0.2	2–4
<i>Ascaridia columbae</i>	22	3.7 ± 2.1	1–4
<i>Baruscapillaria</i> spp.	23	4.6 ± 1.5	3–6
<i>Eimeria</i> spp.	–	$227.5 \pm 22.1^*$	175–281
<i>Trichomonas gallina</i>	–	$12.6 \pm 0.2^{**}$	9–16

Note: * – oocysts in 1 g of feces; ** – trichomonosis in the field of view of the microscope.

The pathological changes of eimeriosis in the doves were characterized by slightly disheveled dull feathers, and the back of the body around the cloaca was contaminated with fecal masses. The goiter was half-empty, and the muscular stomach contained the residuals of a small amount of fodder. The intestine retained its characteristic tubular shape, the walls of the duodenum and jejunum were thickened in places, the lumen of the intestine was uneven, narrowed in some areas, without feed content (empty). The cecum had a normal shape and volume, greyish on the outside, the relief of their mucous membrane was partially smoothed. The rectum was balloon-like dilated, with much thinner walls, contained semi-liquid watery, poorly formed fecal masses in the lumen. The intensity of lesions was from 175 to 281 oocysts in 1 g of feces (Fig. 1).

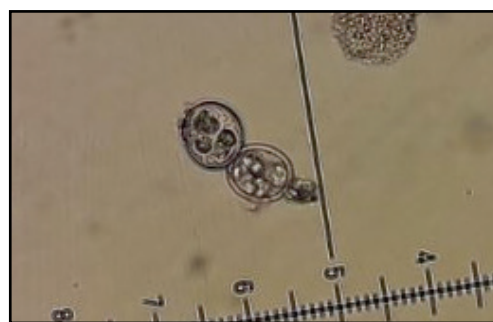


Fig. 1. Oocysts *Eimeria* spp. in *S. decaocto*

In the fecal masses of infested collared doves in the field of view of the microscope single eggs of *Baruscapillaria* spp. were recorded, although the intensity of the invasion was high (Fig. 2).

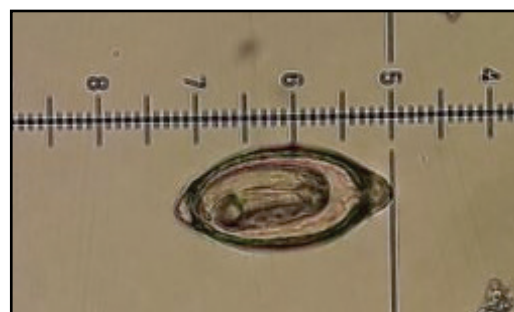


Fig. 2. Egg *Baruscapillaria* spp. in *S. decaocto*

One dove from Skadovsk district of Kherson region and another from Belgorod-Dniester district of Odessa region had a high degree of intensity of *Raillietina* spp. and *Ascaridia columbae* (Figs. 3, 4). According to the results of helminthological autopsies of the doves, it was found that monoinvasion was more often recorded in the collared dove (EI – 67.8%; 81.3% – from sick doves). Mixed invasions were less frequently recorded (EI – 15.6%; 18.7% – of infected doves).

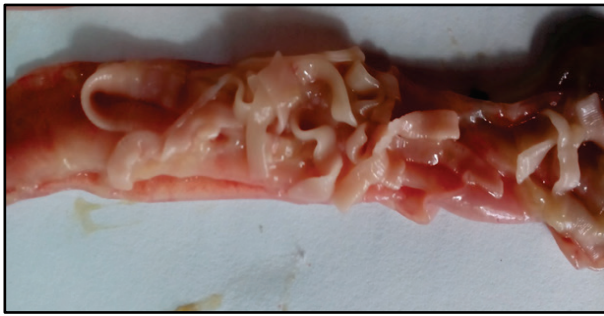


Fig. 3. High intensity of invasion of *Raillietina* spp. in *S. decacocto*



Fig. 4. High intensity of invasion of *Ascaridia columbae* in *S. decacocto*

Two-component parasitocenoses (EI – 12.2%; 78.6% – of examined doves with mixed infections) were recorded mostly, where raietins were the main component of the parasite association. A smaller percentage of mixed infestations was seen, which consisted of three components (EI – 2.2%; 14.3% – of examined doves with mixed infections) and four (EI – 1.1%; 7.1% – of examined doves with mixed infections).

In the collared dove in the northern Black Sea region, 8 combinations of pathogens of mixed invasions were found, in which the main co-member was raietins (Table 2).

Table 2

Distribution of mono- and mixed invasion in the collared dove *Streptopelia decacocto* in the northern Black Sea region

Type of invasion	Association of parasites	Helminths detected, specimens	EI, % (n=90)
One-components	<i>Raillietina</i> spp.	33	67.8
	<i>Davainea proglottina</i>	4	
	<i>Echinolepis carioca</i>	1	
	<i>Amoebotaenia cuneata</i>	3	
	<i>Ascaridia columbae</i>	3	
	<i>Baruscapillaria</i> spp.	3	
	<i>Eimeria</i> spp. (oocysts)	5	
	<i>Trichomonas gallinae</i> (protozoan)	9	
	Total	61	
Two-components	<i>Raillietina</i> spp. + <i>Davainea proglottina</i>	1	12.2
	<i>Raillietina</i> spp. + <i>Ascaridia columbae</i>	2	
	<i>Raillietina</i> spp. + <i>Baruscapillaria</i> spp.	1	
	<i>Raillietina</i> spp. + <i>Eimeria</i> spp.	3	
	<i>Raillietina</i> spp. + <i>Trichomonas gallinae</i>	4	
Total	11		
Three-components	<i>Raillietina</i> spp. + <i>Echinolepis carioca</i> + <i>Trichomonas gallinae</i>	1	2.2
	<i>Raillietina</i> spp. + <i>Ascaridia columbae</i> + <i>Eimeria</i> spp.	1	
	Total	2	
Four-components	<i>Raillietina</i> spp. + <i>Davainea proglottina</i> + <i>Baruscapillaria</i> spp. + <i>Trichomonas gallinae</i>	1	1.1
	Total	1	
Total parasitocenoses		75	83.3

Raillietina spp. (EI – 44%) and *Trichomonas gallinae* (EI – 12%) were most often recorded as monoinvasion. *Eimeria* spp. was diagnosed in 6.7% of infected doves, and *Davainea proglottina* in 5.4% of birds.

Only in three pigeons (4%) did we record *Amoebotaenia cuneata*, *Ascaridia columbae* and *Baruscapillaria* spp. and one collared dove (1.3%) was found to have the cestode *Echinolepis carioca*.

Of the two-component mixed invasions, *Raillietina* spp. + *Trichomonas gallinae* (EI – 5.4%), *Raillietina* spp. + eimeriosis (EI – 4.0%), *Raillietina* spp. + *Ascaridia columbae* (EI – 2.7%) were diagnosed most often. Less common were *Raillietina* spp. + *Davainea proglottina* and *Raillietina* spp. + *Baruscapillaria* spp. (EI – 1.3%).

Of the three-component and four-component, *Raillietina* spp. + *Echinolepis carioca* + *Trichomonas gallinae*, *Raillietina* spp. + *Ascaridia columbae* + *Eimeria* spp. and *Raillietina* spp. + *Davainea proglottina* + *Baruscapillaria* spp. + *Trichomonas gallinae* were recorded (EI – 1.3%).

Raillietina spp. was registered at pathological autopsy of *S. decacocto* (Fig. 5). Pathological changes were characterized by serous-catarrhal enteritis, the signs of which were most pronounced in the places of fixation of cestodes. The mucous membrane of the small intestine was covered with numerous small erosions and spot hemorrhages.

Pathomorphologically, in mixed invasion of *Raillietina* spp. + *Ascaridia columbae* in the small intestine of *S. decacocto*, we observed catarrhal-hemorrhagic enteritis, which was accompanied by the formation of a large number of spotted hemorrhages on the mucous membrane, and necrotic-caseous areas in the places of attachment of cestodes (Fig. 6).



Fig. 5. *Raillietina* spp. in the small intestine of *S. decacocto*



Fig. 6. *Raillietina* spp. + *Ascaridia columbae* in the small intestine of *S. decacocto*

Discussion

According to the results of our research, it is necessary to conduct additional research on the northern Black Sea coast of Ukraine on pigeons of different species and especially the collared dove, which makes dispersive movements and at the same time settles near towns and villages and comes into contact with other poultry species – chickens, turkeys and domestic pigeons.

The operation of agricultural enterprises is accompanied by feeding of wild birds, a large number of which can lead to significant economic losses and pose epizootiological threats (Chaplygina et al., 2019; Ferenczi et al., 2021; Velkers et al., 2021). The commonest of these bird species are pigeons (Ellakany et al., 2019; Giunchi et al., 2020). For any effective program to control endo- and ectoparasitoses of poultry, the collared dove should be prevented from approaching poultry houses, as they can share watering and feeding sites and be carriers of various diseases (Lucas et al., 2008; Mugale et al., 2015).

Almost all birds are infested with various types of endoparasites, both in the form of mono- and mixed invasion. The endoparasites recorded in our studies are of great veterinary importance and therefore require de-

tailed study (Al-Quraishy et al., 2021). The high prevalence of monoinvasion in doves, compared to double and triple infections, leads to competition in which nutrients are shared by endoparasites and leads to the development of mono- or mixed invasions. This may also indicate an innate systemic strategy of endoparasites to avoid competition (Santos et al., 2020).

The prevalence of pigeon endoparasites was studied in the Canary Islands, where eimeria oocysts were recorded in 50%, cestodes of the species *Raillietina micracantha* (Fuhmann, 1909) López Neyra, 1947 – in 44% and *Ascaridia columbae* – in 40% of cases (Foronda et al., 2004). In the state of Minas Gerais in Southeastern Brazil, a study of wild feral pigeons (*C. livia domestica*) showed that all pigeons were infected with *Eimeria* spp. The causative agent of *A. columbae* was detected in 4.9% of pigeons, and in 3.2% – a mixed invasion caused by *A. columbae* and *Raillietina* spp. (Oliverra et al., 2000). In the Zaria region of northern Nigeria, pigeon infestation caused by a single pathogen was more common (37.5%) than double (10.0%) and triple (0.8%) (Adang et al., 2008). According to a number of researchers, in Central Ethiopia, a higher number of infected pigeons – 27% had a monoinvasion, compared with those who had a mixed invasion – 1% caused by *R. echinobothrida* + *R. cesticillus* and 1% *R. echinobothrida* + *R. tetragona* in absence of triple infection (Ashenafi & Eshetu, 2004).

Among pigeon nematodes, ascariasis is one of the most frequently reported infestations (Bahrami et al., 2013). Gupta et al. (2011) indicate that pigeons may play the role of intermediate host for certain helminth species. Despite the widespread population of *S. decaocto* in Iraq, only a few relatively recent articles have been published on their parasites. Al-Bakry (2009) reported the simplest *Trichomonas gallinae*. In the survey of 250 – *Columba oenas*, 200 – *C. livia* and 40 – *S. decaocto*, the prevalence was 22.0%, 17.5% and 10.0%, respectively. Mehmood et al. (2019) isolated cestodes: *Aporina delafondi*, *Cotugnia digonopora*, *Raillietina echinobothrida*, *R. serrata* and *R. tetragona*. The infestation of pigeons was 63% at the intensity of 5.3 specimens/bird.

In a study of wild pigeons in Santiago, Chile, *Trichomonas gallinae* was detected in 11% of cases without any clinical signs and pathological changes at autopsy. Seven species of nematodes were identified: *Tetrameres* spp. (14%), *Capillaria annulata* (1%), *C. columbae* (11%), *C. obsignata* (1%), *Ascaridia columbae* (5%), *Dispharynx spiralis* (2%) and *Gongylonema ingluvicola* (2%). The Cestoda class found in a single pigeon was represented by *Aporina delafondi* (Toro et al., 1999). Al-Rammahi et al. (2013) reported the spread of protozoa *Trichomonas* spp. in 13.3% of pigeons and three species of cestodes: *Raillietina* spp. (64.2%), *Aporina* spp. (18.6%) and *Cotugnia* spp. (17.1%). In a study of 63 Eurasian collared doves *S. decaocto* from Florida, nine species of helminths (5 nematodes, 2 cestodes and 2 trematodes) were identified. The most common were *Ascaridia columbae* (73.0%) and *Baruscapillaria obsignata* (11.1%) (Bean et al., 2005). The data from this study suggest that the environment in which doves live and the food search strategies of each host species are the driving force behind the helminth component communities.

In various studies, differences in the prevalence of endoparasitoses are predicted by many factors that influence the onset of the disease, such as host resistance to infestation, eating habits, climatic conditions, geographical differences, and living conditions. Adult birds can remain infected for a year or more and are a constant source of infection for their chicks (Radfar et al., 2012). Monitoring of invasive diseases of pigeons of different species will help the necessary preventive measures to be taken against endoparasitoses of birds (Boyko & Brygadyrenko, 2019). Along with parasitic diseases, pigeon lesions and bacterial microflora are noted (Teske et al., 2013; Han et al., 2021).

Pigeons, due to their close interaction with humans and other domestic and wild birds, serve as a potential reservoir of zoonotic parasites (Adang et al., 2008). Both domestic and wild pigeons are not harmless birds, they can serve as hidden potential reservoirs of too many human diseases, and can transmit parasitic diseases to animals and poultry (Piascecki, 2006). The authors report that wild pigeons and domestic pigeons are usually infected by internal and external parasites through a common food source (Ali et al., 2020). Both domestic and wild pigeons feed mainly on grain, but consume beetles, snails, earthworms, and ants, which can be carriers of invasive stages of helminths (Boyko et al., 2009; Bogach

et al., 2020). The prevalence and level of infestation of birds varies depending on the type of parasite, the physiological condition of the infested individual, as well as the geographical location of the natural and climatic zone (Oniye et al., 2000).

Conclusion

According to the results of helminthological dissections of the collared dove *S. decaocto*, raietinosis in the form of monoinvasion was recorded most often (44% of sick pigeons, EI – 36.7%). Raietinosis was also recorded in mixed invasions (18.7% of infected doves, EI – 15.6%) with pathogens *Trichomonas gallinae*, *Eimeria* spp., *Ascaridia columbae*, *Davainaea proglottina* and *Baruscapillaria* spp. Pathomorphological changes in the small intestine of *S. decaocto* were characterized by the development of catarrhal-hemorrhagic enteritis and dystrophic-necrotic changes in the liver, which occurred due to mechanical toxic and immunosuppressive action of cestodes.

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