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Prevalence of intestinal nematodes of dogs in the Warsaw area, Poland

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Summary

The prevalence of infection with intestinal nematodes of dogs in the Warsaw area was determined by coprological examination. Faecal samples of 2659 adult dogs kept under different conditions (dogs from shelters, rural area, pension) and 1115 samples of dog faecal deposits were examined by Fülleborn's method. In dog faeces collected in the Warsaw area the eggs of *Toxocara canis*, *Toxascaris leonina*, *Trichuris vulpis* and *Ancylostomatidae* were found. Parasite eggs were recovered in 71.2 % dog faeces from shelter 1; 56.5 % in shelter 2; 80.9 % in shelter 3; in 34.2 % of country dog and in 3.3 % of dog faecal deposits collected in Warsaw area. The results of the presented studies suggest that environmental factors influence the health conditions of dogs.

Key words: dog; intestinal parasites; faeces; epidemiology; Poland

Introduction

The first report presenting studies on the prevalence of intestinal parasites infections in dogs in Poland was published in 1935 (Łukasiak, 1935). But the articles were published after the II World War (Kozłowska, 1954; Stankiewicz *et al*,. 1958; Ramisz & Martynowicz, 1963; Kozakiewicz, 1983; Okulewicz *et al.*, 1994).
It is not suprising to find that many of the factors of the natural environment are changing and this influences parasites and their host, which causes the necessity of undertaking still new studies and estimating the prevalence of parasitic infections in dogs.
The most frequent intestinal parasites of dogs are nematodes. Nematodes like: *Toxocara canis*, *Toxascaris leonina*, *Uncinaria stenocephala* and *Ancylostoma caninum* are common parasites of the alimentary tracts of carnivorous animals. Some of them such as *T. canis* and *A. caninum* can infect humans (Beaver *et al.*, 1952; Woodruff, 1970; Prociv & Croese, 1990; Yoshikawa *et al.*, 1989; Sharkey & McKay, 1993). An infection with *T. canis* evokes toxocarosis in humans. Researchers distinguish three forms of toxocarosis: visceral toxocarosis (visceral larva migrans-VLM) with fever, coughing, allergic reactions, attacks of bronchial asthma, hepatomegaly, anemia, hypersomnia, vomitting, diarrhoea, loss of body weight, anorexia, persistent eosinophilia, leucocytosis, hypergammaglobulinaemy and elevated anti-A and anti-B isohemaglutinins (Beaver *et al.*, 1952); ocular toxocarosis (ocular larva migrans-OLM), when larvae are localized in the eyes, they evoke eye pain, retinal abnormalities, uveitis, endophthalmitis, retinal granuloma and blindness (Wilder, 1950; Taylor, 2001); and covert toxocarosis, when during routine examination physicians find eosinophilia in blood and a high level of anti-*Toxocara* spp. antibodies. However, during human infections with *A. caninum* an idiopathic eosinophilic gastroenteritis was observed (Loukas *et al.*, 1992).
Parasites of dogs with their own pathological effect can negatively influence the health of their host. Toxocarosis is very frequent among pups, which do not have a very effective immune system. Glickman *et al.* (1979) has wrote about „immunity connected with an age".
The aim of the present study was to report the prevalence of intestinal nematodes infections of dogs in the Warsaw area, by coprological examinations.

Material and Methods

In 1998 – 2001 2659 faecal samples were collected from dogs kept in different conditions (dogs from shelters, rural area, pension). There were faecal samples from adult dogs aged between 1 and 10 years. In the same time 1115 samples of dog faecal deposits were collected from urban areas of Warsaw.
Faecal samples were examined usually on the day of collection, but not later than the following day. All the samples were examined microscopically. For detecting parasite infection, flotation with a saline solution was applied using

the Fülleborn's method with Willis' modification (Stefański & Żarnowski, 1971). Parasite eggs were identified according to their morphological features, as described by Mehlhorn *et al.* (1986), and percentages of positive samples were calculated.

Results

The eggs of intestinal nematodes of dogs was examined by the coprological method. The results of this study were divided into four groups: the prevalence of infections in stray dogs (from three shelters), in domestic pets (from a pension), in rural dogs (from small villages) and the percentage of positive dog faecal deposits collected in Warsaw. Parasite eggs were recovered in 71.2 % dog faeces from shelter 1; 56.5 % in shelter 2 and 80.9 % in shelter 3 (Table 1). The number of parasites species which occurred in the stray dogs was 1 to 3. The eggs of nematodes from the *Ancylostomatidae* family and *T. canis*, *T. leonina* and *T. vulpis* species were found in many samples. The most frequent parasites were nematodes from the *Ancylostomatidae* family, they were present in 70.6 % (shelter 1), 55.5 % (shelter 2) and 50 % (shelter 3) of dogs faeces, respectively. From the stray dogs 14.2 % (shelter 1); 0.3 % (shelter 2) and 15.8 % (shelter 3) were infected with *T. leonina*. However, the infection of homeless dogs with *T. vulpis* was on a level of 11.6 % (shelter 1); 2.9 % (shelter 2) and 14.6 % (shelter 3). Among the all examined dogs only one (from shelter 1) was infected with *T. canis*.

Comparing the results obtained in stray dogs, it was evident that the differences between shelter 1 and shelter 3 were not significant. There was a similar percentage of dogs infected with nematodes (71.2 % and 80.9 %), especially the percentage of animals infected with *T. leonina* and *T. vulpis*. A different situation occured in shelter 2. There were 56.5 % infected animals and 55.5 % of them were infected with *Ancylostomatidae*.

From the country dogs (n = 38) 34.2 % was infected with intestinal parasites (Table 1). Eggs of nematodes from the *Ancylostomatidae* family were the most frequent (34.2 %) in the country animals, and 13.2 % of faecal samples were positive for *T. canis* and *T. vulpis*.

310 dog faeces from household dogs kept indoor in the pet hotel were collected. Only 3.2 % of animals from this group were infected with intestinal nematodes (Table 1). After coprological examinations in 2.9 % of domestic pets, nematodes from the *Ancylostomatidae* family were found. 0.3 % of pet dogs were infected with *T. canis* and *T. vulpis*.

In the same years 1115 dog faecal deposits were collected from 17 different areas of Warsaw. In 3.3 % of the samples eggs of intestinal nematodes were detected (Table 2). The most frequent eggs were from the *Ancylostomatidae* family (3.1 %). The eggs of *T. canis* were found in 0.3 % of the faecal deposits and 0.2 % of the examined samples contained *T. leonina* eggs.

Table 1. Prevalence of infection with intestinal parasites in adult dogs

Localisation	Examined animals	*Toxocara Canis*		*Toxascaris leonina*		*Trichuris vulpis*		*Ancylostomatidae*		Total number of infected animals	Prevalence of infection
	n	No.	%	No.	%	No.	%	No.	%	No.	%
shelter 1	1574	1	0.1	224	14.2	182	11.6	1111	70.6	1121	71.2
shelter 2	375	0	0	1	0.3	11	2.9	208	55.5	212	56.5
shelter 3	362	0	0	57	15.8	53	14.6	181	50.0	293	80.9
country	38	5	13.2	0	0	5	13.2	13	34.2	13	34.2
pension	310	1	0.3	0	0	1	0.3	9	2.9	10	3.2

n – the number of the examined animals; No – the number of the infected animals

Table 2. Presence of parasite eggs in dog faecal deposits collected from Warsaw area

Total examined samples	*Toxocara canis*		*Toxascaris leonina*		*Ancylostomatidae*		Total number of positive samples	Percent of positive samples
n	No.	%	No.	%	No.	%	No.	%
1115	3	0.3	2	0.2	34	3.1	37	3.3

n – the number of the examined animals; No – the number of the positive samples

Discussion

Our results indicated that parasitic nematodes from the *Ancylostomatidae* family as well as *T. canis*, *T. leonina* and *T. vulpis* species were common parasites of dogs from the Warsaw area, but their prevalence of infection was different among dogs originating from different enviroments.

The prevalence of infection with parasitic nematodes in adult dogs from shelters (71.2 % – shelter 1; 56.5 % – shelter 2; 80.9 % – shelter 3) was considerably higher than in country dogs (34.2 %) and in household dogs (3.2 %). The lower rate of detected eggs of certain nematode species in shelter 2 was induced by a improved hygienic situation,

e.g. concrete bases in animal boxes, washing bases of boxes with running water, presence irration in boxes, lower animal concentration, systematic health control by veterinarians and deworming. Shelters 1 and 3 had soil bases in animal boxes, where eggs of parasites, scraps or rain water were accumulated, and in these two places high animal concentrations were attended.

Before the presented studies, two Polish teams of researchers found a high prevalence of infection with parasitic nematodes in stray dogs from shelters in Warsaw and Cracow (Górski *et al.*, 1996; Kornaś *et al.*, 2002). Also in other European countries, a high level of infection with parasites was detected in stray dogs (Kulisić *et al.*, 1998).

In this investigation, the most frequent parasite eggs in all groups of dogs were from the *Ancylostomatidae*. From shelter 1 70.6 % of the dogs, from shelter 2 55.5 %, from shelter 3 50 %, from the country 34.2 % and from private houses 2.9 % were infected with these parasites.

Two species: *A. caninum* and *U. stenocephala* belong to the *Ancylostomatidae*.

The epidemiology of *A. caninum* infections in dogs in Poland was studied by many Polish researchers. In shelters 4.2 % of dogs in Wrocław and 3 – 15 % of dogs in Cracow were infected with this nematode (Okulewicz *et al.*, 1994; Kornaś *et al.*, 2002). Similar results were obtained in pet dogs in Poznań (2 %) and Wrocław (10 %) (Luty & Mizgajska, 1999; Okulewicz *et al.*, 1994). In other countries in Europe the infection with *A. caninum* was not very often in dogs. 2.8 % of stray dogs in Lithuania and 0.1 % of household dogs in the Czech Republic were infected with this nematode species (Bajoriniene & Balkjawiczius, 1988; Vokoun & Slezáková, 1977).

In Poland cases of infection with *U. stenocephala* were very frequent. This species was found in 5 % and 10.1 – 47.1 % of stray dogs in Wrocław and Warsaw respectively; 75 % of country dogs around Wrocław; and 2.9 %, and 10 % of pet dogs in Poznań and Wrocław respectively (Okulewicz *et al.*, 1994; Górski *et al.*, 1996; Mizgajska & Luty, 1998). In Lithuania Bajoriniene & Balkjawiczius (1988) detected this parasite in 11.3 % of stray dogs and in Greece Haralabidis *et al.* (1988) found it in 3 % of household dogs.

In the presented studies only 0.1 % of dogs from shelter 1, 13.2 % of country dogs and 0.3 % of pet dogs were found to be infected with *T. canis*. This roundworm lives in the intestines of almost all newborn puppies, because older dogs develop a strong natural immunity to the worms. All examined dogs were older, over one year of age, for this reason prevalence of infection with *T. canis* is low.

In the last years a few Polish researchers detected this parasite in 12.2 % of stray dogs, 6.4 % of dogs in villages and 2.7 % of household dogs (Kornaś *et al.*, 2002; Mizgajska & Luty, 1998). Prevalence of infection with *T. canis* in stray dogs has been documented to be 8.1 – 9.5 % in the Czech Republic (Vokoun & Slezáková, 1977; Borkovcová, 2003); 21 % in Holland (Overgaauw & Boersema, 1998); 18 % in Belgium (Vanparijs & Thienpont, 1973) and 25 % in Ireland (O'Lorcain, 1994). Besides, Habluetzel *et al.* (2003) found nearly half of the dogs (48.4 %) living in rural areas of Italy to be *T. canis* positive.

The results of the presented studies showed infection with *T. leonina* only in homeless dogs kept in shelters. This parasite was diagnosed in 14.2 % of dogs in shelter 1, in 0.3 % of dogs in shelter 2 and in 15.8 % of dogs in shelter 3. Other authors found this nematode in 0.9 % of pet dogs in Poznań (western Poland), in 1 % of household dogs in Olsztyn (northern Poland), and in 5 % of pet dogs in Wrocław (southern Poland) (Luty & Mizgajska, 1999; Gaca *et al.*, 1998; Okulewicz *et al.*, 1994).

The prevalence of infection with *T. leonina* in stray dogs was about 10.1 % in Belgium (Vanparijs *et al.*, 1991); 1.3 % in Greece (Haralabidis *et al.*, 1988); 1.1 % in Spain (Vazquez Valdes *et al.*, 1989) and 9 % in Italy (Tassi & Widenhorn, 1977). Furthermore, 0.5 % of pet dogs in the Czech Republic and 0.4 % of household animals in Holland were infected with this parasite (Vokoun & Slezáková, 1977; Overgaauw, 1997).

In this survey a relatively high level of infection with *T. vulpis* was detected, especially in dogs from two shelters (shelter 1 11.6 %, shelter 3 14.6 %) and in dogs from villages (13.2 %). But only one pet dog from the 310 dogs kept in the hotel for pets was *T. vulpis* positive. Polish authors detected this species in stray dogs kept in shelters in Warsaw (5 – 21 %) and in Wrocław (18.3 %) (Górski *et al.*, 1996; Okulewicz *et al.*, 1994). Dogs of Polish private owners were infected with this nematode in the Warsaw area – central Poland (0.5 – 1 %), in the Olsztyn area – northern Poland (1 %), in the Wrocław area – southern Poland (2 %) and in the Poznań area – western Poland (3.2 %) (Górski *et al.*, 1996; Gaca *et al.*, 1998; Okulewicz *et. al.*, 1994; Luty & Mizgajska, 1999). Okulewicz *et al.* (1994) diagnosed *T. vulpis* infections in about 40 % of country dogs from the Wrocław area. This nematode was detected in homeless dogs in all European countries, e.g. in Yugoslavia (18.1 %), in Belgium (7 %), in Italy (10 %), in Spain (8.2 %) (Kulišic *et al.*, 1998; Vanparijs *et al.*, 1991; Tassi & Widenhorn, 1977; Vazques Valdes *et al.*, 1989). The prevalence of infection with *T. vulpis* was lower in the pet dogs in the Czech Republic (0.9 %) and in Holland (0.7 %) (Vokoun & Slezáková, 1977; Overgaauw, 1997).

Finally, the results of the presented studies suggest that factors of the natural environment influence on the health conditions of dogs. Private owners of dogs pay attention to professional veterinary care, proper nourishment, the sanitation of lodging and other factors. Stray dogs kept in kennels have worse living conditions. For this reason it is necessary to improve the keeping conditions in shelters, e.g. change the hygienic condition of boxes – to introduce concrete bases in animal boxes into practice to render impossible direct contacts between healthy and ill dogs, to reduce animal concentration, to carry out systematic health controls.

The second part of the studies was the estimation of the presence of parasite eggs in dog faecal deposits collected in the Warsaw area. In the examined 1115 samples the eggs of *T. canis* (0.3 %), *T. leonina* (0.2 %) and *Ancylosto-*

matidae (3.1 %) were detected (Table 2). There are not many published reports presenting the results of studies conducted on dog faecal deposits collected in public places. Until now in Poland the presence of these parasite eggs was detected in two places – in the Olsztyn area (northern Poland) and in the Poznań area (western Poland). In the first area, 11.8 % of the faecal deposits contained the eggs of *Toxocara* spp., 1.8 % – the eggs of *T. leonina*, 2.7 % – the eggs of *Ancylostomatidae* family, 1.3 % – the eggs of *T. vulpis*. Different results where obtained in the second area, where in only 0.9 % of the samples *Toxocara* spp. and *T. leonina* eggs were found, and in 1.8 % of the faecal samples the eggs of *T. vulpis* were present.

In European countries this kind of studies is not very popular. Valkounová (1982) detected the eggs of *T. canis*. (4.2 %), *T. leonina* (2.6 %), *U. stenocephala* (1.4 %) and *T. vulpis* (2.2 %) in collected dog faecal deposits in Prague (Czech Republic). The studies carried out by Fok *et al.* (2001) in eastern and northern regions of Hungary resulted as follows: *T. canis* eggs were observed in 24.3 – 30.1 % of the samples, *T. leonina* eggs – 2.1 %, *T. vulpis* eggs- 20.4 – 23.3 % and *Ancylostomatidae* eggs in 8.1 – 13.1 % of the faeces.

Results obtained in the Warsaw area gave evidence that a greater part of the dog population in our city consists of household dogs, because in collected faeces samples parasites eggs were detected rarely. Systematic anthelmintic treatment of pet dogs influences the small number of parasites in the alimentary tract and the small number of their eggs in faeces.

Parasite eggs present in faeces can be transmitted to the soil and are a potential source of humans infection. Toxocarosis and other zoonosis are an accidental human infection acquired by swallowing eggs of parasites. Children are at the highest risk of infection because of pica, geophagia, and playing on grounds contaminated with animal faeces (Glickman *et al.*, 1979).

However, in Poland increasing attention should be paid to proper hygienic habits of dog owners to prevent environmental contamination and community education programmes should promote the concept of responsible pet ownership.

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References

BAJORINIENE, D., BALKJAWICZIUS, B. (1988): The problem of toxocarosis in Lithuania. *Wiad. Parazyt.*, 34: 234 – 238

BEAVER, P. C., SNYDER, C. H., CARRERA, G. M., DENT, J. H., LAFFERTY, J. W. (1952): Chronic eosinophilia due to visceral larva migrans. *Pediatrics*, 9: 7 – 19

BORKOVCOVÁ, M. (2003): Prevalence of intestinal parasites of dogs in rural areas of Sounth Moravia (Czech Republic). *Helminthologia*, 40: 141 – 146

FOK, É., SZATMÁRI, V., BUSÁK, K., ROZGONYI, F. (2001): Prevalence of intestinal parasites in dogs in some urban and rural areas of Hungary. *Vet. Quart.*, 23: 96 – 98

GACA, K., MICHALSKI, M., SZELĄGIEWICZ, M., SOKÓŁ, R., SIEMIONEK, J. (1998): Infections with nematodes in dog- patient of veterinary clinics. *Med. Wet.*, 54: 407 – 408

GLICKMAN, T., SCHANTZ, P. M., CYPESS, R. M. (1979): Canine and human toxocariasis: review of transmission, pathogenesis, and clinical disease. *J. Am. vet. med. Ass.,* 175: 1265 – 1269

GÓRSKI, P., BADOWSKA, M., WĘDRYCHOWICZ, H. (1996): Distribution of nematode *Uncinaria stenocephala* in dogs from Warsaw region. *Wiad. Parazyt.*, 42: 221 – 227

HABLUETZEL, A., TRALDI, G., RUGGIERI, S., ATTILI, A. R., SCUPPA, P., MARCHETTI, R., MENGHINI, G., ESPOSITO, F. (2003). An estimation of *Toxocara canis* prevalence in dogs, environmental egg contamination and risk of human infection in the Marche region of Italy. *Vet. Parasit.*, 113: 243 – 252

HARALABIDIS, S. T., PAPAZACHARIADOU, M. G., KOUTINAS, A. F., RALLIS, T. S. (1988): A survey on the prevalence of gastrointestinal parasites of dogs in the area of Thessaloniki, Greece. *J. Helminth.*, 62: 45 – 49

KORNAŚ, S., NOWOSAD, B., SKALSKA, M. (2002): Hookworm infection in dogs in stray animals shelters. *Med. Wet.*, 58: 291 – 294

KOZAKIEWICZ, B. (1983): Extensiveness of *Toxocara* invasion in dogs and epidemiological aspects of this invasion in urban aglomerations. *Med. Wet.*, 39: 660 – 664

KOZŁOWSKA, J. (1954): The helminth of the dogs in the city of Łódź. *Acta Parasit. Pol.*, 17: 403 – 407

KULIŠIĆ, Z., PAVLOVIĆ, I., MILUTINOVIĆ, M., ALEKSIĆ-BAKRAĆ, N. (1998). Internal parasites of dogs nd role of dogs in epidemiology of larva migrans in the Belgrade area. *Helminthologia,* 35: 79 – 82

LOUKAS, A., CROESE, J., OPDEBEECK, J., PROCIV, P. (1992): Detection of antibodies to secretions of *Ancylostoma caninum* eosinophilic enteritis. *Trans. R. Soc. trop. Med. Hyg.*, 86: 650 – 653

LUTY, T., MIZGAJSKA, H. (1999): Prevalence of *Toxocara* spp. and other intestinal parasites in dogs and cats. *Med. Wet.*, 55: 759 – 761

ŁUKASIAK, J. (1935): A parasitic worms and their localization in a dogs in the Warsaw area. *Wiad. Wet.*, 183: 477 – 487

MEHLHORN, H., DÜWEL, D., RAETHER, W. (1986): (Eds.): *Diagnose und Therapie der parasiten von Haus-, Nutz- und Heimtieren*. Gustav Fisher Verlag, New York

MIZGAJSKA, H., LUTY, T. (1998): Toxocarosis in dogs and contamination of soil with Toxocara spp. eggs in Poznań region. *Przeg. Epid.*, 54: 441 – 446

O'LORCAIN, P. (1994): Epidemiology of *Toxocara* spp. in stray dogs and cats in Dublin, Ireland. *J. Helminth.*, 68: 331 – 336

OKULEWICZ, A., ZŁOTORZYCKA, J., CZUŁOWSKA, A. (1994): The influence of environmental conditions on pa-

rasitic infection of dogs. *Wiad. Parazyt.*, 40: 293 – 298
OVERGAAUW, P. (1997): Prevalence of intestinal nematodes of dogs and cats in the Netherlands. *Vet. Quart.*, 19: 14 – 17
OVERGAAUW, P. A., BOERSEMA, J. H. (1998): Nematode infections in dog breeding kennels in the Netherlands, with special reference to *Toxocara*. *Vet. Quart.,* 20: 5 – 12
PROCIV, P., CROESE, J. (1990): Human eosinophilic enteritis caused by dog hookworm *Ancylostoma caninum*. *Lancet*, 335: 1302 – 1306
RAMISZ, A., MARTYNOWICZ, T. (1963): Parasitofauna of the alimentary tract of dogs and cats of the Wrocław town and its surroundings with particular reference to nematodes of the Ancylostomidae family. *Wiad. Parazyt.*, 9: 15 – 127
SHARKEY, J. A., MCKAY, P. S. (1993): Ocular toxocariasis in a patient with repeatedly negative ELISA titre to *Toxocara canis*. *Br. J. Ophthal.*, 77: 253 – 254
STANKIEWICZ, W., MARKIEWICZ, Z., PIETRASZEK, A. (1958): Intestinal Helminthiases in clinically healthy and sick dogs from the Warsaw area. *Wiad. Parazyt.*, 4: 577 – 579
STEFAŃSKI, W., ŻARNOWSKI, E. (1971): Detection parasitic infection of animals. Państwowe Wydawnictwo Rolne i Leśne, Warsaw
TASSI, P., WIDENHORN, O. (1977): Research on intestinal parasitic deseases in dogs of the city of Rome. *Parassitologia*, 19: 43 – 57
TAYLOR, M. R. H. (2001): The epidemiology of ocular toxocariasis. *J. Helminth.*, 75: 109 – 118
VALKOUNOVÁ, J. (1982): Parasitological investigation of childrens sandboxes and dog faeces from public areas in old housing district of Prague. *Folia Parasit.*, 29: 25 – 32
VANPARIJS, O., THIENPONT, D. C. (1973): Canine and feline helminth and protozoan infections in Belgium. *J. Parasit.*, 59: 327 – 330
VANPARIJS, O., HERMANS, L., VAN DER FLAES, L. (1991): Helminth and protozoan parasites in dogs and cats in Belgium. *Vet. Parasit.*, 38: 67 – 73
VAZQUEZ VALDES, F., GONZALES LOPES, A., GUTIERREZ GONZALEZ, M. J., FERNANDEZ MARTINEZ, A., LLANEZA LLANEZA, J. .J. (1989): Intestinal parasitosis of canine population in the principale of Asturias. *Revta Sanid. Hig. publ.*, 63: 49 – 61
VOKOUN, P., SLEZÁKOVÁ, J. (1977): Parasites of the digestive tract of city dogs and cats. *Vet. Med.*, 22: 367 – 375
WILDER, H. C. (1950): Nematode endophthalmitis. *Trans. Am. Acad. Ophthal. Oto-lar.*, 55: 99 – 109
WOODRUFF, A. W. (1970): Toxocariasis. *Br. Med. J.*, 3: 663 – 669
YOSHIKAWA, H., YAMADA, M., MATSUMOTO, Y., YOSHIDA, Y. (1989): Variations in eggs size of *Trichuris trichiura*. *Parasit. Res.*, 75: 649 – 654

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