ANOMALOUS AMPHIBIAN EGG DEPOSITS IN AREA OF URBAN AGGLOMERATION

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A description of and data on frequency of anomalous egg deposits in amphibians in an urban setting are given. Possible causes for the appearance of such deposits are discussed.

Since reproduction and development of amphibians occurs in small and often temporary water bodies, their egg deposits are the most vulnerable part of the amphibian life cycle. Often a large quantity of eggs die from rapid dessication of water bodies (Ishchenko, 1978). Spring-time returns of freezes also may lead to death of some of the eggs. Under urban conditions, mortality of deposits occurs for the most diverse reasons: Children destroy them (Cooke, 1975a), and amateur collectors gather them (Cooke, 1985). Changes in the chemical composition of the medium affect them indirectly, through a drop in resistance to injury to the eggs by the fungus Saprolegnia (Cooke, 1975b; Leuven et al., 1986). High acidity, synthetic cleaning compounds, and other forms of chemical pollution disrupt the process of normal fertilization of eggs and embryonic development (Ilosvay, 1977; Freda and Dunson, 1985; Gunter and Plotner, 1986; Pierce, 1985). In some cases, egg mortality occurs before the amphibians complete breeding (Beshkov, 1979). In the zone affected by industrial discharges, embryonal mortality in the deposits of anuran amphibians amounts to 42-76% (Bobylev and Bulakhov, 1982). Female lake frogs wintering over in sites where polluted waters are discharged display disintegration and injury of the ovaries (Kosareva and Vasyukov, 1976). Use of chemicals induces asynchronous maturation of sex cells in male and female lake frogs (Zhukova and Kubantsev, 1980). In the zone of industrial pollution, amphibians display a change in protein and lipid exchange (Misyura, 1982), leading to disruption of normal development of sexual products (Misyura, 1985). The action of chemicals leads to changes in the protein composition of the egg membranes, which consequently prevents normal swelling of the deposits and development of embryos (Hazelwood, 1970).

This work examines anomalous amphibian deposits observed in an area of urban agglomeration from 1978 to 1986. The unusual egg deposits were found in the Siberian angle-tooth salamander (Salamandrella keyserlingii), and the sharpnose and grass frogs Rana arvalis and R.

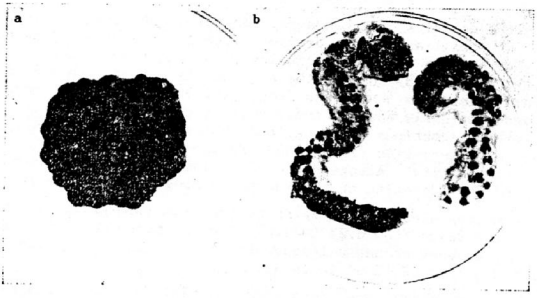

Fig. 1

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Fig. 2

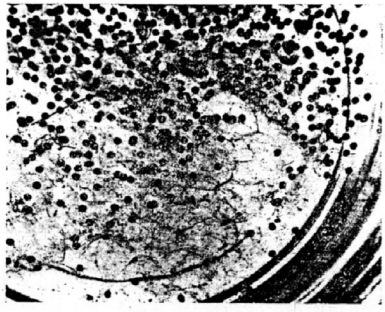

Fig. 3

Fig. 4

temporaria). Among the deposits of urban amphibians are found the following types of anomalies: 1) deposits do not swell and do not develop (Siberian angletooth, sharpnose frog; Fig. 1); 2) the quantity of eggs in the deposit is low (0-6 eggs), and diameter of string is 3-5 mm (Siberina angletooth; Fig. 2); 3) some of the eggs in the deposit contain no eggs, having only its internal membrane (sharpnose and grass frog; Fig. 3); and 4) eggs in the deposit are arranged in strings and apparently have no individual external membranes; the eggs are located very close to each other, sometimes touching, and no development occurs (grass frog; Fig. 4). Throughout the years of observation (1977-1986), no anomalous deposits were identified in the control section beyond the city. Altogether 4327 strings of the angletooth, 1791 deposits of the grass frog, and 3664 deposits of the sharpnose frog were examined.*

The share of anomalous deposits int he sharpnose frog from groups inhabiting the urban area fluctuates over the years from 0.23 to 3.8%. An exception was 1978, with 44.6%. Groups of grass frogs had a frequency of unusual deposits fluctuating from 0.7 to 12.5%, and of Siberian angletooths from 0.4 to 1.6% (3.9% in 1978).

The first anomalous deposits were identified in 1978. Their appearance apparently is related to a sharp change in the environmental chemistry in one of the water bodies, since the deposits of Siberina angletooth and sharpnose frog did not swell and did not develop starting at the moment when the deposits are 13 and 24 days old, respectively. No injury by fungus was noted. Unfortunately, we did not have the opportunity to conduct analysis of the water. The low water level in the basins apparently promoted an increased concentration of pollutants,

*Photo by S. V. Krinitsyn.

TABLE 1. Frequency of Anomalous Deposits in Amphibians from Urban Setting

Indices	Sharpnose frog						
	1978	1982		1984		1985	1986
Zone* . . .	IV	IV	II	IV	II	IV	IV
Total quantity	83	169	53	128	332	409	165
Quantity of anomalies (in parentheses: % of anomalies)	37 (44,6)	3 (1,8)	2 (3,8)	1 (0,8)	1 (0,3)	1 (0,23)	3 (1,8)

Indices	Siberian angletooth					Grass frog	
	1978	1981	1984	1985	1986	1984	1986
Zone* . . .	IV	IV	IV	IV	IV	II	II
Total quantity	356	664	222	508	293	24	155
Quantity of anomalies (in parentheses: % of anomalies)	14 (3,9)	2 (0,3)	2 (0,9)	1 (0,2)	1 (0,34)	3 (12,5)	1 (0,65)

*II: zone of multistory buildings; IV: forest park.

as indicated indirectly by the high percentage of skin neoplasms in the Siberian angletooths (4.9%; n = 122) reproducing in this water body. The sensitivity of skin in caudates may be used as a test for indicating certain pollutants (Pliss and Khudolei, 1979; Rose and Harshberger, 1977).

The unusually low quantity of eggs in the strings of Siberian angletooth might have been explained by age peculiarities of the females participating in reproduction: They are very young or very old animals. But then, similar deposits would have been found in the control groups outside the urban setting. According to our observations, such strings were observed only in the angletooth from the Shartash Forest Part (the only exception being the Kalinov Forest Park). The Siberian angletooth is a typical forest species and normally reproduces only in the forest. Since 1978, the Shartash population has displayed a drop in average number of eggs in a string (Vershinin, 1982) from 102 ± 5.8 (n = 11) to 56.0 ± 4.8 (n = 26) with similar body sizes of reproducing specimens. The quantity of lipids and the total caloric content of breeders is known to increase in amphibians with age, which directly dictates the increased number of eggs laid (Bobylev, 1980). Like-aged amphibians usually are larger in urban groups than in natural populations (Ushakov et al., 1982; Vershinin, 1983; Gogoleva, 1985). However, despite the higher growth rates in amphibians in polluted water bodies, a drop in absolute and relative fertility is observed (Bobylev, 1985), which is related to changes in the lipid exchange in the animals (Misyura, 1982). With low level of fat in gonads and glycogen in the liver, and low total caloric content, maturation in females is delayed by a year (Abramova et al., 1977). Moderate or weak feeding induces a reliable increase in the number of atretic oocytes and a reduction in ovary mass (Saidapur and Prasadmurthy, 1988). A drop in fertility of the Siberian angletooth under conditions of urbanization probably reflects a reduction in the reserves of nutrient substances in the breeders. Deposits with anomalously low numbers of eggs first were noted in 1981 and are the exteme expression of this tendency.

Starting in 1982, deposits of sharpnose and grass frog whose eggs are missing embryos have been observed in the urban area. The share of anomalous eggs may reach 1/3-1/4 of the total number of eggs in the deposit. From experimetnal investigations we know that action by chemical substances leads to a decrease in the quantity of vitellus and cells of granulesa in follicles of R. tigrina (Pramoda and Saidapur, 1986). Hydrochemical analyses are evidence of significant changes in the environmental chemical composition of the studied water bodies (Vershinin, 1985), which may lead to disturbances in functions of the reproductive apparatus in females (Hazelwood, 1970).

The case of unusual arrangement of eggs in a deposit of grass frog apparently also is associated with deviations in the process of deposit formation. No development of eggs occurred, since they did not have a normal external membrane, and were located in a common protein string, often touching each other. The absence of individual membranes is probably associated with disruptions in normal functioning of the lower sections of the oviducts responsible for formation of protein membranes of the eggs.

In the majority of cases, the share of anomalous deposits in the populations of urban amphibians is small, and cannot have a substantial impact on the reproductive potential of the group as a whole. On the other hand, their appearance is evidence that in breeders in urban amphibian populations there are negative tendencies, which may lead to the appearance of externally normal eggs with reduced viability. Healthy deposits are known to be less sensitive to low pH than deposits with a large number of dead eggs (Beebee, 1986).

Thus, anomalous deposits represent the extreme expression of these processes, and promote their appearance.

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