DISTRIBUTION OF LAKE FROG IN CITY OF SVERDLOVSK

V. L. Vershinin

UDC 591:597.6

Examined here are distribution in an urban area in 1977-1986 and certain population specifics of *Rana ridibunda* Pall., a species introduced into the city of Sverdlovsk.

The expanded range of the lake frog resulting from human activity is known from an entire series of works (Belimov and Sedalishchev, 1980; Toporkova, 1977, 1978; Toporkova et al., 1979). The northern border of this species in the Urals falls substantially to the south of the city of Sverdlovsk (Toporkova, 1973). The spread of the lake frog beyond the limit of its natural range was made possible by human industrial activity and its attendant thermal pollution of the environment. Serving as the source of introduction in such cases are medical-biological establishments or fisheries complexes (Toporkova, 1978).

Material was collected in 1977-1988 in the city of Sverdlovsk.

The lake frog was first noted here in 1977 (Vershinin, 1981; Vershinin and Toporkova, 1981). Information about green frogs in the Ekaterinburg Urals dated 1874 (Sabaneev, 1874) apparently was erroneous (Toporkova, 1973). In 1978, two permanent groups of lake frogs were found in the central part of Sverdlovsk: The first group numbered 15-20 specimens along Belinskii Ave.), and the other included around 100 specimens along Krylov Ave.). Since 1978, isolated specimens have repeatedly been found in several urban water bodies (see Fig. 1), but no breeding has been observed anywhere.

In 1980 for the first time within the city, breeding of the lake frog was noted in isolated water bodies on the shores of the Iset' River (along Krylov Ave.). In September 1980, tagging data indicated that 946 yearlings went through metamorphosis. Spawning was recorded in mid-June 1981 on the same water body, with 38-208 eggs per batch (averaging 132.8 ± 13.5). According to tagging results, the 1981 generation abundance amounted to 2000 individuals. From 1983 to 1985, breeding was not observed, apparently in connection with the lowered water level in the reservoirs, which usually serve as breeding and developing grounds. In 1986, breeding of the lake frog was again observed (along Krylov Ave.), but tadpoles reaching the 47-46 stages (Dabagyan and Sleptsova, 1975) did not manage to complete metamorphosis by the onset of the frosts. According to tagging data, the larval abundance by the onset of hibernation totaled 96 specimens, with average body mass of 2925 mg ($n = 6$). During the same year, a new group of lake frogs, also undergoing breeding, was found in a previously unstudied area (Kuibyshev Ave.). The output of yearlings was insignificant (50 individuals) because of the arrival of cooler weather and the beginning of hibernation by tadpoles. According to tagging data, the larval abundance up to the onset of hibernation totaled 1650 specimens, with body mass of animals reaching the 49th stage averaging 3788 mg ($n = 25$). In 1988, the abundance of metamorphosed yearlings reached 296 specimens, but they were smaller, apparently because of the severe dessication of the water body and significantly increased larval density. The average body mass of tadpoles in 1980 and 1981 were, respectively, 4050 mg ($n = 102$) and 4294 mg ($n = 18$).

The emergence of adult animals from hibernation is observed early in the last 10 days of May, spawning in mid-June; the emergence of larvae from eggs occurs in the last third of June, the onset of metamorphosis early in the first third of August and the first third of September, and hibernation begins in the second and last thirds of September.

The major indices for yearlings are presented in Table 1. High values for the liver index (Hep ‰; $p = 0.01$) are observed in yearlings from the Kuibyshev Ave. group, which may be associated with the significant pollution and transformations of their habitat. The water body is located nearly in the center of the city on waste land long occupied by a dump for garbage and various wastes, near one of the busy highways. Content of sulfates in the water here is 153.7 mg/liter; of oil: 6.67 mg/liter; and of superficially active substances: 0.678 mg/liter, against 94.1, 3.0, and 0.486 mg/liter, respectively, on Krylov Ave.

Yearlings (except in 1988) reached relatively large linear sizes, which may be associated both with the populational specifics, and with the increased body sizes of lake frog yearlings under conditions of anthropogenic

Institute of Plant and Animal Ecology, Urals Branch, Academy of Sciences of the USSR. Translated from Ékologiya, No. 2, pp. 67-71, March-April, 1990. Original article submitted May 12, 1989.

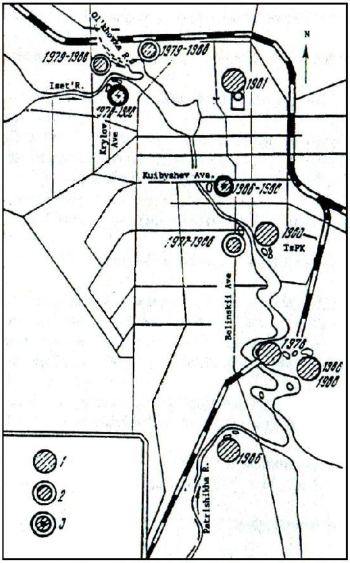

Fig. 1. Distribution of lake frog within city of Sverdlovsk: 1) sites where isolated specimens are found; 2) permanent groups; 3) groups where breeding was observed.

influence (Vinnichenko et al., 1985; Bobylev, 1985). Body sizes for yearlings from the area of Verkhnye Tagil averaged 25.7-26.3 mm (Toporkova, 1978); in southern Kazakhstan the metamorphosed animals have a body length of 18-23 mm (Iskakova, 1954).

Body length of adult animals in Sverdlovsk averages 82.1 ± 1.4 mm in males (80.0-85.0 mm; n = 4), and 70.9 ± 11.2 in females (50.0-115.5; n = 6). Body length in adult animals from the V. Tagil region varies within the range of 60-110 mm (Toporkova, 1978), i.e., the maximal sizes of adult frogs from existing Urals populations approaches the limit (115.7 mm) for female lake frogs from the central belt of the USSR (Aleksandrovskaya, 1981).

The share of *morpha striata* specimens among yearlings in the Krylov Ave. group totaled 43.4% and 56.6% in 1980 and 1981, respectively, and 25.0 and 11.3% in the Kuibyshev Ave. group in 1986 and 1988, respectively, which is evidence of the substantial ($p > 0.001$) differences in genetic structure of the compared groups. In addition to differences in frequency of *morpha striata*, the yearlings from the Kuibyshev Ave. group had a very thin dorsal stripe: 0.3-0.5 mm (1.0-2.0 in yearlings from other groups), apparently resulting from the existing differences in brood stock groups.

During all the years of observation, not a single stripeless specimen was found among the adult animals captured in the urban area (n = 76). In the V. Tagil lake frog population, which also resulted from introduction, the frequency of this morph totalled 19% among yearlings, and 60% among adults (Toporkova, 1978). Comparing frequencies of this morph among yearlings and adult animals in the urban area overall showed reliable differences at the 0.001 level of significance.

It is likely that *morpha striata* animals possess selective advantages in lake frog populations of the technogenic zone. It is quite possible that in species of a single genus this trait is inherited in a similar way. It has been established for the sharpnose frog that *morpha striata* results from the action of one diallelic autosomal gene (Shchupak, 1977) with complete dominance by one of the alleles (dominance by the allele that dictates the presence of the stripe). A series of species of exchange processes has been established for this morph in the sharpnose frog (Dobrinskii and Malafeev,

TABLE 1. Major Indices for Lake Frog Yearlings

Indices	Location of sighting			
	Krylov Ave.		Kuibyshev Ave.	
	1980	1981	1986	1988
Average body length, mm	26,7±0,1 n=122	27,5±0,3 n=169	27,3±0,4 n=17	21,4±3,8 n=20
Heat index, ‰	2,1±0,7 n=20	2,2±0,1 n=46	2,4±0,1 n=17	3,2±0,2 n=20
Liver index, ‰	37,9±1,3 n=20	40,1±1,7 n=46	55,3±2,5 n=17	67,4±1,8 n=20
Anomalies, %	1,6 n=122	1,52 n=369	16,0 n=25	3,3 n=151
Morpha striata, %	43,4 n=122	56,6 n=369	25,0 n=25	11,3 n=151

1974), specifics that may dictate the adaptive value of *striata* under conditions of pollution and urbanization. Apparently, these are the causes for the high frequency of this morph in adult lake frogs in urbanized areas.

In terms of feeding of yearlings from the city of Sverdlovsk, the share of aquatic forms accounted for 2% of the frequency in the group from Krylov Ave. and 21.4% in the group from Kuibyshev Ave.; these groups accounted for 0.85 and 14.2%, respectively, in terms of quantity of objects.

The share of specimens with morphological anomalies among yearlings from the Krylov Ave. group was 1.6% in 1980 (n = 122) and 1.52% in 1981 (n = 396). Among yearlings from the Kuibyshev Ave. group, the frequency of anomalous specimens in 1986 and 1988 was 16% (n = 25) and 3.3% (n = 151), respectively. Overall, the frequency of anomalies in yearlings from the Kuibyshev Ave. Group is higher than in Krylov Ave. (5.38% against 1.54%; p = 0.01), which may be the result of greater environmental pollution in the case of the former. The frequency of morphological aberrations is known to grow with increasing anthropogenic influence (Cooke, 1981). Phenotypical specifics of the examined groups apparently arose during the process of their formation under specific environmental conditions, and also due to the genotypical constitution of the founders.

According to our observations, not a single brown frog tadpole survived until metamorphosis in the largest of the permanent lake frog groups (Krylov Ave.) from 1981 to 1987, despite the abundance of spring egg deposits. In 1986, *R. ridibunda* abundance dropped here due to unfavorable habitat changes (a sharp drop in water level, strong overgrowth), and for the first time in seven years emergence of grass and sharpnose frogs was noted. The lake frog, which better handles anthropogenic influence, under certain conditions probably can exert a negative influence on the reproductive level of local amphibian species. The introduction of *R. catesbeiana* in the USA under conditions of the destruction of natural habitat sites also leads to a decrease in the abundance of aboriginal amphibian species (Moyle, 1973).

The presence of thermal pollution in cities creates potential opportunity for the appearance of local lake frog populations beyond the limits of its natural range; in 1981, *R. ridbunda* was noted in the city of Chelyabinsk (Vershinin, 1983). During the years of observation, the lake frog was found in several water bodies in the city of Sverdlovsk located in the immediate vicinity of the Iset' River. As a result of its introduction (possibly repeated), it now is constantly found in five sections of the city, and in two of these is observed breeding, which does not occur every year, as is the case at the northern limit of this species distribution (Shvarts, 1980). The periods for breeding and development are close to those noted in the northern part of the lake frog range. The phenotypic appearance of groups is determined both by the hereditary specifics of the brood stock, and the characteristics of the new environment of the habitat. The appearance of introduced species following a change in the urban profile is one of the aspects of anthropogenic transformation of ecosystems.

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