MORPHOLOGICAL ANOMALIES IN URBAN AMPHIBIANS

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Data are presented on the frequency of various morphological anomalies among amphibians inhabiting urban areas. There is a marked tendency toward increased frequency of aberrations with increasing urbanization. Possible causes of the observed deformities are discussed.

Morphological anomalies are more frequent among all systematic groups of amphibians compared with other terrestrial vertebrates. One cause is the possibility of regeneration of lost body parts, typical to varying degrees for tailed and tailless amphibians. Amphibians and their larvae have high sensitivity to changes in the chemical background of the environment. In tailed amphibians, this may be expressed in the appearance of cutaneous neoplasms (Pliss and Khudolei, 1979; Rose and Harshberger, 1977), and anomalous regeneration of lost limbs (Zavanella et al., 1984). In tailless amphibians, a series of anomalies (curvature of the spine and deformation of limbs) may form when larvae develop under unstable environmental conditions (temperature and chemical stress, fungal damage; Cooke, 1981; Hazelwood, 1970). The appearance of morphological anomalies is known in the Siberian angle-tooth where eggs have been exposed to prolonged action of cold (Obukhova, 1984).

A series of irregularities constitute genetically caused anomalies: symmetric cases of clinodactylism, ectrodactylism, poly- and ectromelism (Dubois, 1979; Roberts and Verrel, 1984), absence of pigmentation in the iris (Rostand and Darre, 1970), presence of unusual pigmentation (Dubois and Vachard, 1971), and metamorphic edema of the abdominal cavity with lethal result (Wittouck, 1980; Gollmann et al., 1984). Using the example of discussion of causes for such an anomaly as polymelism (the presence of additional limbs) in *Hyla regilla*,

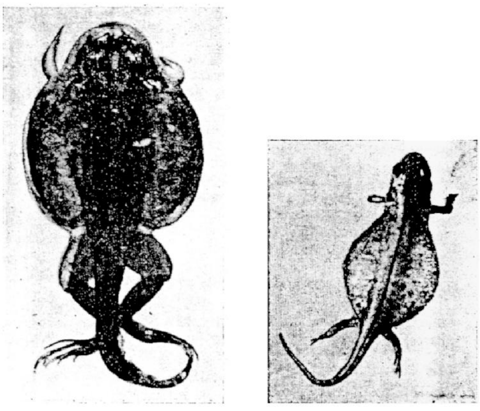

Fig. 1. Metamorphic edema in lake frog and common newt.

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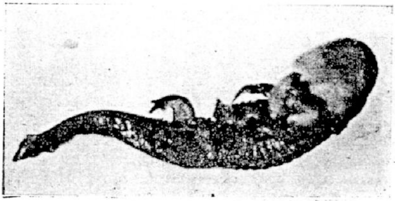

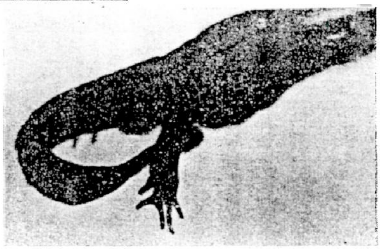

Fig. 2. Polydactylism in first-year sharp nose frog, ectrodactylism in first-year Siberian angle-tooth, and clinodactylism in female common newt.

it was shown persuasively (Van Vallen, 1974) that there exists a whole series of factors that may induce it. These include genetic breakdowns, viruses, parasites, radiation, pH, temperature, and desiccation. Thus, searches for causes of the appearance of only one of the possible deviations do not yield an unequivocal answer to the question of which factor caused the defect. For example, in the aforementioned H. regilla, polymelism is encountered in three isolated populations located away from the main range. Under such conditions, the probability of inbreeding grows, and many genetic defects enter the homozygotic state and appear phenotypically, leading to growth in the frequency of aberrant individuals.

Amphibian groups under urban habitat conditions are isolated to a significant degree, with a small number of animals. In isolated populations with low abundance, we often observe an effect known by the name of "inbreeding depression" (Simberloff, 1983), where under conditions of closely related hybrids, there appear recessive mutations, which "generally should be adverse" (Gershenzon, 1985) and in several cases produce various morphological defects. The quantity of animals with morphological aberrations likewise increases due to unstable conditions in urban habitats of adult and juvenile animals; sharp temperature fluctuations and changes in the chemical background and pH may lead to anomalous regeneration of lost body parts, and the appearance of neoplasms or morphological defects forming during the process of larval development. Consequently, it can be expected that the frequency of various kinds of morphological anomalies in amphibian groups close to the central part of a city will be higher, which we observed (Vershinin, 1982). Earlier (Vershinin, 1982, 1983) we cited combined data on the frequency of morphological aberrations, giving aggregate percentages of illnesses and traumas (including limb amputations, etc.) and aggregate percentages for morphological anomalies, where we included pigmentation irregularities, neoplasms, absence of iris pigmentation, absence of eyelids, and defects associated with the number of limbs and digits on them, and deformations in them.

In this work, we group anomalies according to a scheme presented below (after eliminating cases of traumatic loss of limbs and other body parts, bacterial and fungal injury to skin covers, parasitic infections, etc.)*:

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*Photo by S. V. Krinitsyn.

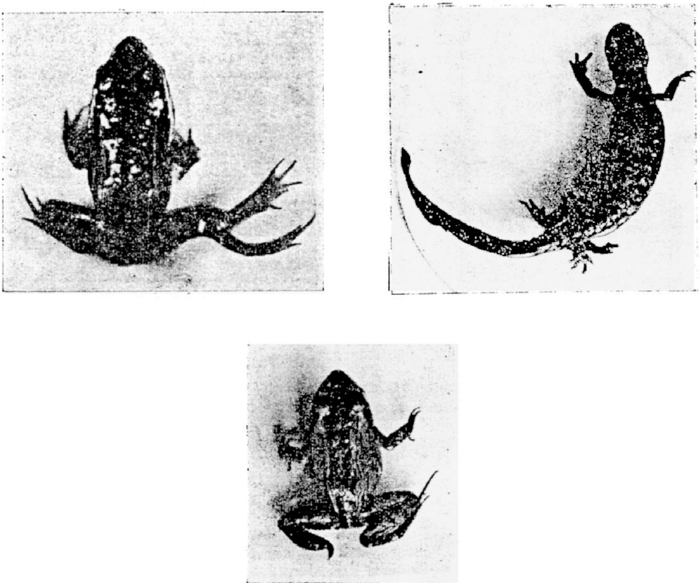

Fig. 3. Polymelism in first-year grass frog and male Siberian angle-tooth, and ectromelism in first-year sharp-nose frog.

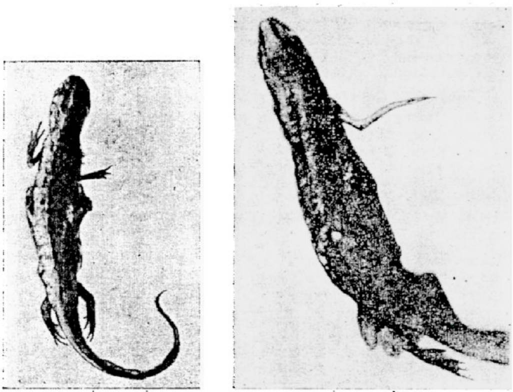

Fig. 4. Bulging ovary in female and lung in male common newt.

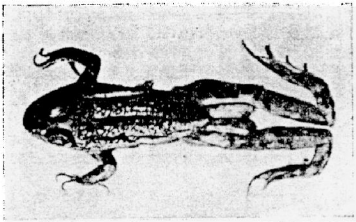

Fig. 5

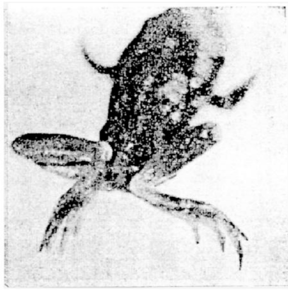

Fig. 6 Fig. 7

Fig. 5. Rigid rear limbs in first-year lake frog.

Fig. 6. Absence of eyelids in first-year grass frog.

Fig. 7. Symmetrical ectrodactylism in first-year lake trog.

1. Edemas of the abdominal cavity with lethal effect during metamorphosis, resulting from kidney illness or mutation. Animals cannot move or eat, and die (Fig. 1).

2. Anomalous regeneration of limbs and their parts under conditions of changing environmental chemical profile. Quite often noted in tailed amphibians, particularly in common newt. Includes cases of asymmetrical polydactylism, ectrodactylism, clinodactylism, polymelism, and ectromelism (Figs. 2 and 3).

3. Anomalies of development, induced by stressful changes in environmental conditions: cold, chemical pollution, etc. These obviously can include deformations of the skeleton, bulging of the abdominal wall, and rigid rear limbs, both symmetrical and asymmetrical cases (Figs. 4 and 5).

4. Anomalies of genetic origin (in the opinion of Dubois, 1979, many of them are symmetrical): cases of unusual pigmentation of skin coverings, absence of eyelids and pigmentation of iris (uni- and bilateral), and symmetrical poly- and ectrodactylism (Figs. 6 and 7).

5. Neoplasms (observed only in tailed amphibians).

The bulk of the material was collected in 1980-1981 in the area of a large urban agglomeration of all species of amphibians encountered there. Part of the collections relate to 1977, 1978, 1982, and 1983. Examination involved 266 adults and 313 first-year Siberian angletooths; 275 adult and 28 first-year common newts; 9 adult and 518 first-year lake frogs; 194 adult and 1784 first-year sharp-nose frogs; and 100 adult and 495 first-year grass frogs.

TABLE 1. Frequency of Morphological Anomalies in Amphibians, %

Year	Type of anomalies	*R. a.* juv.				*R. t.* juv.		*R. r.* juv.	*T. v.* ad.			*S. k.* ad.			*R. t.* ad.	*R. a.* ad.	*R. r.* ad.	*S. k.* juv.	*T. v.* juv.	
		II	III	IV	K	II	III	II	II	III	IV	III	IV	K	III	III	II	IV	II	III
1980	1	—	—	—	—	—	—	0,8	—	—	—	—	—	—	—	—	—	—	8,3	—
	2	—	—	—	—	—	0,4	—	—	—	—	—	4,2	—	1,6	—	—	1,8	—	—
	3	—	—	0,3	—	—	—	—	2,7	4,2	—	—	—	—	—	—	—	—	—	—
	4	1,5	15	1,0	—	4,0	1,8	1,6	—	—	—	—	—	16,6	—	—	—	—	—	—
	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Total	1,5	15	1,3	0	4,0	2,2	2,5	2,7	4,2	—	—	4,2	16,6	1,6	—	—	1,8	8,3	—
	n	65	20	302	90	50	226	122	73	24	—	—	24	6	61	—	—	170	12	—
1981	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	2	—	—	0,48	1,1	2,6	—	—	9,8	6,9	5,0	20	12,8	2,9	—	9,1	—	0,77	—	—
	3	—	—	0,48	—	—	0,68	4,7	1,2	3,4	—	—	—	2,9	—	—	—	—	—	5
	4	1,9	2,3	0,48	1,1	—	—	0,6	—	—	—	—	2,1	2,9	3,6	9,1	14,3	—	—	—
	5	—	—	—	—	—	—	—	3,7	—	—	—	—	2,9	—	—	—	—	—	—
	Total	1,9	2,3	1,5	2,2	2,6	0,68	5,3	14,6	10,3	5,0	20	14,9	11,8	3,6	18,2	14,3	0,77	—	5,0
	n	103	43	206	190	39	147	169	82	29	20	5	47	34	28	11	7	130	—	20

Note. 1) Edema of abdominal cavity with lethal result; 2) anomalous regeneration; 3) pathology of development; 4) hereditary defects; 5) neoplasms; R.a.) sharp-nose frog; R.t.) grass frog; R.r.) lake frog; T.v.) common newt; S.k.) Siberian angle-tooth; juv.) first-year; ad.) adult; II) multistory development; III) developments with limited stories; IV) wooded park; K) suburban area.

The pattern of frequency in 1980-1981 of anomalies among urban and suburban amphibians differs in the tailed and tailless animals, as well as in first-year and adult animals (see Table 1). In tailed animals, the anomalies were more widely encountered among adults than among first-year animals. The major share consists of cases of anomalies of regeneration and partly pathology of development and neoplasm, which is explained by the particular sensitivity of tailed amphibians to chemical pollution and its capability, retained through life, for regeneration. Low frequency of hereditary anomalies apparently is associated with the fact that tailed amphibians are not widely distributed in urban areas, and do not form small isolates in the zone of multistory urban development, as has been noted for tailless amphibian groups.

The small dimensions of terrestrial territories of isolates and low abundance of animals in groups of sharp-nose frog and other tailless amphibians dictates the significant increase in probability of closely related hybrids, which leads to the appearance of a series of genet: defects, some of which are expressed externally.

The majority of anomalies in tailless amphibian individuals are encountered among first-year animals, and probably diminish with age, while in tailed amphibians it is primarily the older animals in which anomalies form during the process of development and over the entire course of subsequent life (anomalous regeneration, neoplasms).

The frequency of all major types of anomalies depends also on the degree of anthropogenic influence in animal habitats. Among first-year sharp-nose frogs from habitats located in regions with multi- and limited-story developments, the overall frequency of anomalies is 1.5-15.0%, while in wooded park and suburban groups it is 0-2.2%. In first-year grass frogs, the frequency of morphological aberrations differs in groups from the zone of multistory (2.6-4.0%) and limited-story (0.68-2.2%) developments. An analogous tendency was characteristic (according to 1981 data) for adult specimens of common newt: 14.6% in the multistory development zone, 10.3% in the limited-story zone, and 5% in wooded park.

Thus, various morphological anomalies are noted in virtually all amphibian groups, dictated by the biological specifics of that group of vertebrates. However, even independent of causes for such irregularities, the aggregate percentage of frequency of morphological anomalies generally is higher in habitats with a high degree of anthropogenic influence. Thi should be linked with a whole set of causes, including changes in the environmental chemical profile (Vershinin, 1982, 1985), spatial boundaries, and isolation of several groups and the low abundance of the core of reproducers. Moreover, in each of the amphibian groups are certain differences in the frequency of various types of anomalies associated with specific biological characteristics of these species, but the tendency toward increased total percentage of morphological aberrations with increasing urbanization is preserved.

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SOME ZONAL CHARACTERISTICS OF THE STRUCTURE OF GROUPINGS OF ACRIDOIDEA

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A study of the grouping of Acridoidea in various zones over 20 years revealed a number of regularities in their structure, particularly in the character of dominant individual species. On a zonal profile it was found that semidominant grouping in southern latitudes changes to monodominant grouping in northern ones. The participation of dominant species in the groupings is analyzed in relation to their ecological characteristics in stable and changing conditions.

In the majority of studies made of analysis of the grouping structure in Orthoptera (Bei-Bienko, 1930; Chetyrkina, 1958; Stebaev, 1957; Vasil'ev, 1962; Stolyarov, 1965; Bykasova, 1973; Sergeev, 1981), observations are included on the species composition of Acridoidea and their ecological distribution. Orthopteroid grouping is dealt with in more detail in a study by Pravdin (1974). The beginning of an ecological-faunistic study was presented by Bei-Bienko (1930), in which ecological relations determined by acridoid grouping were studied for the first time in our country. In subsequent studies these investigations were developed further (Stebaev, 1957; Pravdin, 1978; Pravdin and Mishchenko, 1980).

The aim of the present work is to study multispecies groupings of Acridoidea in various zones and to elucidate regularities of their formation in relation to the character of dominance of main species in them.*

The material was collected in the Orenburg region (1962-1964, 1967, 1969, 1970) in the reserves "Askaniya-Nova," Central Chernozem (1965, 1973-1975), Naurzum (1971-1975), "Ramit"-Gissarskii Mts. (1976-1980), in the Zailiiskii Alatau (1977), the Moscow region (1981-1984), the interior Tyan-Shan (1983, 1984) and Lower Volga (Volgograd region — 1984-1985). The in-

*Over 20 years we studied the groupings of Acridoidea in various landscape zones under the leadership of Professor F. N. Pravdin, to whom we are deeply indebted.

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