Advances in Amphibian Research in the Former
Soviet Union, vol. 5: 227-232, 2000

On the Influence of Extreme Weather Conditions on Some Amphibian Species of the Primorye Region

IRINA V. MASLOVA

Kedrovya Pad Nature Reserve, St. Primorskaya, Khasanskii District, Primorye Region 692710 Russia

Accepted 24 April 1999

РЕЗЮМЕ: О влиянии экстремальных погодных условий на некоторые виды земноводных Приморского края. И.В. Маслова. Приводятся данные о влиянии необычно жаркого и засушливого весенне-летнего сезона 1998 г. на дальневосточную жерлянку (*Bombina orientalis*), дальневосточную квакшу (*Hyla japonica*), сибирскую (*Rana amurensis*) и дальневосточную (*R. dybowskii*) лягушек на юге Приморья. Помимо прямого влияния, засуха вызвала повышенную гибель дальневосточной лягушки на зимовках в результате резкого падения уровня воды в реках и вымерзания зимовок.

ABSTRACT: Data on the influence of an unusually hot and dry spring and summer in 1998 on *Bombina orientalis*, *Hyla japonica*, *Rana amurensis* and *R. dybowskii* are presented. In addition to a direct influence, the drought increased mortality of R. dybowskii in hibernacula because of a sharp fall in water level in rivers and subsequent freezing of hibernating groups of frogs.

INTRODUCTION

Research on amphibians in the south of the Primorye Region, Russian Far East, were aimed towards the study of their systematics, biology and some aspects of their ecology. The influence of weather conditions on amphibians was studied only superficially. Korotkov (1974) pointed out the death of 75.2 % of *Rana dybowskii* hibernating along some parts of the river, resulting from a significant fall of water levels and a subsequently freezing of the river to its bottom. Belova (1973) mentioned the influence of rain on changes of the frogs activity and on their behaviour. Kostenko and Belova (1972) used dead frogs *Rana dybowskii* from hibernacula when describing the structure of the hibernating groups.

Some data on the phenology of amphibians are contained in "Annals of the Hature" of nature reserves of the Primorye Region. These data provide the material for a more complete understanding of the problem of fluctuations in the number of populations of amphibians.

MATERIALS AND METHODS

I conducted field research on the territory of several administrative districts of the south of the Primorye Region. It is possible to distinguish three main types of habitats in the study area:

1. Wet meadows and bogs near Khanka Lake within the Khankaiskii Nature Reserve (Spasskii District, Khankaiskii District and Kirovskii District). In 1997–98, I studied 38 ponds with a total area of about 2850 sq. m. These included both permanent and temporary pools, the shore of Khanka Lake, rest of sand-pit, storage pond, road ditches, fresh open pit and abandoned swamped rice fields.

2. Mixed coniferous-broad-leaved forests in the southern Sikhote-Alin Mountains within the Ussuriiskii Nature Reserve (Ussuriiskii and Shkotovskii districts). In 1997–98, I studied forest puddles, ditches and bogs with a total area 800 sq. m; as well as stretches of mountain river totalling 7 km in length.

3. Wet meadows and bogs, broad-leaved forests near the Japanese Sea (Khasanskii District). In 1998, I studied completely dried out permanent and temporary ponds on meadows near Khasan Village; pools, ditches and a big sand-pit near the Tumannaya River; forest ponds and regions of mountain rivers totalling 2.6km in length in the Kedrovaja Pad Nature Reserve.

I observed the following species of amphibians: Far Eastern Fire-Bellied Toad (*Bombina orientalis*); Dybovsky's Frog (*Rana dybowskii*), Siberian Wood Frog (*Rana amurensis*) and Japanese Tree Frog (*Hyla japonica*). I conducted censuses of egg clutches of amphibians, observed hibernacula (30 holes in a river), and censused numbers of dead amphibians.

RESULTS

In 1997 and spring 1998, the warm seasons were unusual due to the low amount of precipitation in the southern part of the Primorye Region. In 1997, late spring and summer fires were noted during a drought in the Southern Primorye. I obtained comparative data on the average monthly amount of precipitation, ground and air temperatures near the Ussuriiskii Nature Reserve (Table 1).

In other regions I have studied these data are absent, but the drought was observed in all places. Changes in the weather resulted in the displacement of breeding dates in many species of amphibians. In the territory of Ussuriiskii Nature Reserve I noted that

Table 1. Precipitation, air temperature and ground temperatute near the Ussuriiskii Nature Reserve

Month	Precipitation, mm		Air temperature		Ground temperature	
	Several years: average montly	1997: average montly	Several years average montly	1997: average montly	Several years: average montly	1997: average montly
April	61	19.7	5.3	9.1	5.7	15
May	54	43.9	12.0	11.1	16.8	15
June	81	77.2	15.6	16.2	21.0	22
July	95	10.4	19.6	22.4	26.3	30
August	151	150.3	19.7	20.6	25.3	24
September	146	34.6	13.1	12.9	16.6	17
October	53	41.5	4.4	5.9	7.1	2

such "summer-breeding" species, *as H. japonica* and *B. orientalis*, had already finished breeding by the middle of July (last egg clutches were found 15-17 July), whereas reproduction usually continues until the first third of August (Belova, 1972; Korotkova, 1978; Filipchuk, 1992b). In the valley of Sungacha River and the east bank of Khanka Lake I observed newly metamorphosed froglets of *R. amurensis* by the beginning of the middle third of June, though this does not usually occur until the end of June (Belova and Ragoina, 1976; Filipchuk, 1992a). The metamorphosis dates of *H. japonica* and *B. orientalis* also shifted by almost a month. The first froglets of these species were caught on 24 June 1997, while the usual dates fall in the final third of July (Belova, 1972; Korotkova, 1978; Korotkov, 1979, Filipchuk, 1992b).

In July, when the maximum air temperature reached 34.5° and conditions were very dry, the mountain rivers of the Ussuriiskii Nature Reserve and its environs became very shallow. The upper reaches of some rivers dried out completely, for example, the tributaries of the Komarovka River and the Salnikov Stream. The water temperature in rivers was 4–5° degrees higher than usual and reached 20–21°C. These conditions prompted the mass migration of amphibians in search of more favourable habitat. For example, on the shady and pebbly banks of the Barsukovka River aggregations of young frogs (*Rana dybowskii* and *B. orientalis*) reached 8-12 individuals per 1 sq. m. In these places froglets remained for 3 weeks, and they dispersed into the adjacent forest after the rains in the beginning of August. At the same time, I observed aggregations of adult *R. dybowskii* and *B. orientalis* by Salnikov Stream. There, on 20 July 1997, I censused 32 *Rana* and 8 *Bombina* along a river-bed transect 1 km long and 4 m wide.

From August to November 1997, there were only a few rains, and through winter the level of water in ponds was lower than usual. In spring 1998, when the ice began to thaw on the rivers, I discovered masses of dead frogs and fish in hibernation holes in some districts of the southern Primorye Region. On the Barsukovka River I made an attempt to determine the sex and age structure of groups of dead amphibians (n = 88) in two hibernacula (holes in the river bottom; April 1998). I counted 14 females, 15 males, 21 subadult frogs and 34 froglets. I did not determine the sex of 4 adult frogs, because they had been partly eaten by fish. In other rivers such observations were not conducted because the water level was raised after snow thawing in the mountains during April, and dead frogs were therefore at a depth of two metres. I counted the relative number of dead frogs in six mountain rivers. In the largest dead frog concentrations, in a few areas, I counted the number of amphibians per 1 sq. m and extrapolated these data to cover the total area of hibernation (Table 2).

Unusual rates of mortality of amphibians were noted on the eastern coast of Khanka Lake. In spring 1998, the water level in the lake was below the average of several years, by approximately 1 m, due to the drought. The water's edge was more than 100 m from its usual location. Swamps and small lakes around Khanka Lake dried up and grew shallow very quickly. Inspectors of Khankaiski Nature Reserve and Dr. Yu. N. Glushchenko observed several hundred dead *R. amurensis* near the Pospelov Lakes.

Table 2. Censuses of dead *Rana dybowskii* in underwater hibernacula (holes in the river bottom) in the south of Primorye Region after the winter 1997–1998.

Hibernacula	District	Lenght of route, km	Number of investigated holes	Number of dead frogs	
				total	in one hole, min – max
Artemovka River	Shkotovskii	0.5	3	620	20 – 500
Molokanka River	Ussuriiskii	0.1	1	150	150
Barsukovka River	Ussuriiskii	2.0	4	330	20 – 200
Komarovka River	Ussuriiskii	3.0	19	1800	10 – 500
Sukhoi Stream	Khasanskii	0.3	2	720	20 – 700
Russkaya Ima Stream	Khasanskii	0.3	1	more 3000	more 3000

All amphibians were "dried up" outside the ponds. It is possible that they had died during migration from hibernacula (Yu.N. Glushchenko, pers. comm.). Instances of mummified amphibians were also noted on the western coast of Khanka Lake in the environs of Novonikolaevka Village, Khankaiski District. On the sand beach near Khanka Lake I observed 4 dried individuals of *R. amurensis* without any visible injuries. I have also found two dried and uninjured *H. japonica*, which sat on the land in a natural position on a swamped meadow (environs of Khasan Settlement, Khasanskii District, April 1998). It may be that these animals also died during migration.

Between 17 and 24 April 1998, I made censuses of egg clutches of *R. dybowskii* along a permanent route in the Ussuriiskii Nature Reserve. I noted a displacement of the breeding period in 1998 compared to earlier dates and an evidently understated swimming activity (Table 3). In the dry spring of 1998, I observed the mass drying out of temporary and permanent breeding ponds. The frogs *R. dybowskii* and *R. amurensis* were very mobile during their resulting search for new spawning sites. For example, on the eastern coast of Khanka Lake, *R. amurensis* moved to the bogs from the lake-bank and from the broad-leaved forest, where they bred actively in 1997 and where all ponds dried in 1998. In other districts (Ussuriiskii, Shkotovskii etc.), *R. dybowskii* spawned in

Table 3. Number of clutches of *Rana dybowskii* near the settlement of Kaimanovka, surroundings of Ussuriiskii Nature Reserve, during April 1995 – 1998.

Dates	1995		1996		1997		1998	
	total number	fresh (up 2 days)	total number	fresh (up 2 days)	total number	fresh (up 2 days)	total number	fresh (up 2 days)
14	–	–	1	–	119	26	–	–
17	10	–	36	35	226	107	148	40
18	64	54	61	25	–	–	–	–
19	79	15	–	–	–	–	227	79
21	325	246	121	60	328	102	271	44
24	368	43	307	186	–	–	287	16
25	456	88	–	–	–	–	–	–
27	501	45	–	–	–	–	–	–
28	–	–	464	157	365	37	–	–

Note: – means that censuses were not conducted on that day; "fresh" means newly deposited clutches.

Table 4. Number of clutches of *Rana dybowskii* in early flooded ponds in April 1998.

Ponds in river valleys	District	Date	Length of route, km	Water temperature	Number of clutches
Barsukovka River	Ussuriiskii	19	0.3	7.4	10
Komarovka River	Ussuriiskii	23	3.0	8.3	71
Kamenka River	Ussuriiskii	23	0.1	15.6	13
Artemovka River	Shkotovskii	22	0.5	8.2	2
Stream, flowed back in low bog	Shkotovskii	22	0.1	12.0	4
Low bog	Shkotovskii	22	350 sq.m	7.9	127
Sukhoi Stream	Khasanskii	30	0.3	6.0	14
Kedrovaya River	Khasanskii	30	2.0	8.4	27

ponds which they had previously not used. As a rule, these were running river channels and river branches with a low temperature and great depth (Table 4). In previous years I did not see such cases.

The extreme weather conditions of 1997–1998 influenced many aspects of amphibian ecology. I noted changes in breeding places, breeding dates, lowering of frog numbers and their egg clutches. Further observations will provide data on the influence of such weather anomalies on amphibian populations.

ACKNOWLEDGMENTS

I thank the administrations of the Khankaiskii Nature Reserve, Ussuriiskii Nature Reserve and Kedrovaya Pad Nature Reserves for their help in my work. I am grateful to S.L. Kuzmin, my supervisor of studies, who reviewed and improved this article. The work was supported by the Russian Foundation for Basic Research, project no. 98-4-48254.

REFERENCES

Belova, V.T. 1972. [Reproduction and development of Anura in the Suputinka River valley]. – Zoologichesky Zhurnal 51 (9): 1419-1422 (in Russian).

Belova,V.T. and Ragoina, V.A. 1976. [Materials on the breeding of Anura in the south of Primorye]. – In: Okhrana Prirody i Ratsionalnoe Ispolzovanie Prirodnykh Resursov. Khabarovsk: 56-57 (in Russian).

Filipchuk, N.V. 1992a. [On the ecology of *Rana amurensis* in the southern Primorye]: – In: Zhivotnyi i Rastitelnyi Mir Dalnego Vostoka. Ussuriisk: 78-82 (in Russian).

Filipchuk, N.V. 1992b. [Some data on the ecology of Far Eastern Anura in the south of Primorye]. – In: Zhivotnyi i Rastitelnyi Mir Dalnego Vostoka. Ussuriisk: 82-89 (in Russian).

Korotkov, Yu.M. 1979. [Some data on ecology *Hyla japonica* in Primorye Region]. – Ecologiya (3): 95 (in Russian).

Korotkova, E.B. 1978. [On the ecology of *Bombina orientalis* in Primorye Region]. – Ecologiya (4): 106-107 (in Russian).

Kostenko, V.A. and Belova, V.T. 1972. [Composition of hibernating populations of *Rana semiplicata* on the south of Primorye]. – Zoologichesky Zhurnal 51 (10): 1588-1590 (in Russian).

Letopis Prirody [Annals of the Nature] of Ussuriiskii Nature Reserve. 1995-1997.