HYDROCHEMISTRY OF BOGS AND RIVERS IN SWAMPED MASSIFS OF THE LOWER AMUR

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Bogs and swamped massifs are expanded in vast areas of the Amur Basin. Only in the Middle-Amur Plain they cover the area of 36 000 km^2. Studies of bog water chemical composition started in 1976 in the Evoron Lake Basin. They revealed certain regularities in the formation of bog water chemical composition and their dependence on biogeocenotic specifics of the bogs (Ivanov et al., 1979).

Further studies in the Middle Amur region, carried in 1987 – 2002, produced new data on the formation of bog water chemical composition, observations of seasonal dynamics of biogenic and organic substance content, identification of various factors that effect these substance concentrations in water (Ivanov, 1989; Ivanov, Shesterkin, 1989).

In spring, when snow starts to melt, the lowest values of mineralization and pH (up to 15 mg/dm^3 and 4.4 respectively) and the lowest levels of biogenic element concentrations are observed in bog water. At this time of the year iron concentrations in water do not exceed 0.3 mg/dm^3, ammonium ion concentrations – 0.20 mg/dm^3, phosphate ion concentrations – 0.02 mg/dm^3, organic matter (COD_{MN}) – 30 mg O/dm^3. Only water colority is increasing (> 100^o). Higher concentrations of these elements are observed only in bog areas damaged by fire. In the Kiinsky bog massif phosphate ion concentrations reached 1.78 mg/dm^3, iron concentrations – 0.39 mg/dm^3 and organic matter– 22.7 mg O/dm^3. Water colority in fire-burnt areas was 150^o and pH was 5.49.

Melting of the peat deposits at the beginning of summer causes the increase of organic matter and biogenic substance concentrations in bog water. Thus, in the bog massif near the Slavyanka village water colority at this time reaches 625^o, organic matter concentrations (COD_{MN}) are about 90.6 mg O/dm^3 and iron content is 2.68 mg/dm^3. With water temperature rising (> 29^o) biochemical processes in the peat deposits and leaf debris are accelerated and biogenic and organic substance concentrations in bog water increase significantly.

Observations, undertaken in the bog massif near the Slavyanka village in June – July 1990, revealed noticeable fluctuations of dissolved substance concentrations in waters there. The smallest concentrations were registered in the rainy period when bogs were rather full of water. Ammonium ion concentrations in water at that time changed within the range 1.08 – 2.29 mg/dm^3 and organic matter (COD_{MN}) varied within 31 – 77 mg O/dm^3.

Chloride and sulphate ion concentrations in water were little different from their concentrations in the atmospheric precipitation in Priamurje. Slavyanka massif data did not differ much from the data received during the field works in the bog massifs of the Evonon Lake Basin, implemented in 1977-1978. The data, collected in the Evoron Basin, showed pH values as low as 4.35 and increased levels of concentrations of organic matter (COD_{MN}) to 148 mg O/dm^3, ammonium ions –

to 4.5 mg/dm^3 and ion compounds to 25 mg/dm^3 (Ivanov et al, 1989; Shesterkina Ivanov, 1981). Following O.A. Alekin's (1970) classification according to their chemical composition bog waters in the Evoron Lake Basin are of the calcium group, the first class. Among the main ion group sulphate ion showed the lowest concentrations or was not detected.

In the dry period biogenic and organic substance concentrations were summer time maximal. Value of pH changed within 4.10 – 4.35, ammonium ion concentrations varied within 1.7 – 8.9 mg/dm^3, iron changed from 0.86 to 3.44 mg/dm^3, organic substance (COD_{MN} and COD_{CR}) values were within 118 – 156 mg O/dm^3 and 118 – 177 mg O/dm^3 respectively.

Studies, undertaken in autumn 1987 in a big bog massif between the rivers Manoma and Anui, also revealed marked differences in biogenic element distribution in waters of this massif (Shesterkin et al., 1989). Although pH (5.35 – 5.60) and mineralization (16 – 23 mg/dm^3) did not vary much, significant fluctuations were observed in iron concentrations (1.15 -7.64 mg/dm^3), ammonium ion concentrations (1.46 – 2.44 mg/dm^3) and organic matter (COD_{MN}) (41.1 – 70.6 mg O/dm^3). Similar concentration levels were registered before water freezing and in the bog massif near Slavyanka (Ivanov, Shesterkin, 1989).

In winter peat deposit freezing causes significant dissolved matter increase due to cryogenic concentration processes. Thus, in the Slavyanka bog massif iron concentrations reached 5.1 mg/dm^3 and organic substance content (COD_{MN}) increased to 199 mg O/dm^3 (Ivanov, Shesterkin, 1989). Water pressing out from the peat in some cases may cause even higher increase of dissolved substance concentrations, including iron. Water colority in the streams was up to 675^o and iron concentrations were about 29.4 mg/dm^3.

Waters of draining bogs, swamped areas and small rivers differ in chemical composition from bog waters. River waters in dry periods are characterized with high concentrations of ammonium ion (up to 12.6 mg/dm^3), iron (up to 4. 9 mg/dm^3) and organic matter (COD_{MN}) (up to 85 mg O/dm^3). Values of pH are not increased in these rivers.

Small rivers formed in areas of high swamping significantly effect chemical composition of big tributaries of the Amur River. Most noticeable is the bog impact in the Gorin River Basin. Hydrochemical research in this region was carried out in 1986-1987.

The Gorin River is one of the biggest tributaries in the Amur lower reaches. The river is 390 km long and the area of its basin is 22 400 km^2. When entering the Evoron-Chukchagirskaya Plain the Gorin River flows through a huge bog massif, formed by the Khurmulinskaya (500 km^2) and Kharpinskaya (866 km^2) maris. The rivers Khurmuli, Kharpin, Elgany and a big number of small streams, running right into the Gorin River, drain this bog massif. The area of bogs in the Evoron Plain is 2184 km^2, the water runoff is first directed into the Evoron Lake and further on through the Devyatka River reaches the Gorin River. The total share of bogs and swamped areas in the Gorin River Basin is 23%.

Many streams drain the Khurmulinskaya and Kharpinskaya maris. The biggest of them are the Kharpin and Khurmuly rivers with basin areas 2900 km^2 and 1940 km^2 respectively. Dissolved substance concentrations in these rivers do not differ much from the respective concentrations in bog waters (Table). The highest concentrations of biogenic substances are observed in Khurmuly water and in small streams without names. In the main ions group sulphate ion is not registered in these streams and chloride ion concentrations are low (less 0.5

mg/dm^3). Season specifics include maximal concentrations of biogenic elements and organic substance and minimal concentrations of mineral substances at the end of summer – beginning of autumn after the monsoon rains. At this time of the year organic substance discharge dominates the discharge of mineral substances. When the rainy period is long, chemical composition of water changes from hydrocarbonate-calcium to hydrocarbonate-magnesium and organic substance and iron concentrations decrease. Phosphate ions appear in water.

The flow of bog waters into the Gorin River causes significant changes of river water chemical composition. In the mountainous upper reaches of the river water is highly transparent and has low content of organic substances (4.6 mg O/dm^3). According to their chemical composition Gorin waters are classified as of the hydrocarbonate class, calcium group, I type [1]. In the main ion group chloride ion concentrations are low in this water and are similar to those in bog waters. Biogenic substance concentrations are also low. Ammonium ion and iron concentrations in this river passage do not exceed 0.33 and 0.36 mg/dm^3. After the Gorin River enters the Evoron-Chukchagirskaya plain and Devyatka River and other small streams, which drain the Khurmulinskaya and Kharpinskaya maris, add their waters to the Gorin, its water chemical composition sharply changes. Mineralization value drops from 40.4 to 33.1 mg/dm^3, ammonia nitrogen concentrations increase twice, ion increases 4.4 times and organic substance concentrations increase (COD_{MN}) 5.5 times.

Table.

Water Chemical Composition in Small Rivers of Swamped Massifs of the Gorin River Basin (in mg/dm^3 and mg O/dm^3).

Date	pH	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	NH_4^+	Fe	COD_{MN}	M
Kharpin River											
30.08.87	-	2.1	0.6	4.4	2.9	0.3	0.0	1.73	1.49	37.3	48.2
Khurmuly River											
5.07.87	6.78	2.1	0.4	4.2	2.5	0.4	0.0	0.85	1.56	17.6	43.4
30.08.87	-	1.3	0.5	3.3	2.2	0.3	0.0	1.56	0.95	42.3	40.1
Bezymyanny stream											
5.07.87	7.10	2.4	1.0	-	-	0.6	0.0	1.33	4.24	18.6	-
30.08.87	-	1.3	1.0	5.2	3.2	0.4	0.0	1.37	4.94	51.5	-
Elgany River											
30.08.87	-	2.8	0.8	3.8	1.5	0.4	0.0	0.87	0.96	44.8	26.8
Pukka river											
5.07.87	6.65	2.7	0.6	-	2.0	0.7	0.0	1.33	2.10	19.8	-
30.08..87	-	1.7	0.6	2.8	1.7	0.3	0.0	1.86	0.87	-	28.0

The biggest effect on Gorin water composition bog waters produce in winter, when, due to the decrease of dissolved oxygen in water, concentrations of ammonia nitrogen and iron, mostly oxide, increase.

Thus, bog waters in the Lower Amur are characterized with increased concentrations of biogenic elements and organic substances and with low concentrations of the main ions. Bog water inflow into the river net causes the increase of river water colority, concentrations of ammonia nitrogen, iron and organic substances.

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