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THE MIRE IN NORTHEAST OF CHINA

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ABSTRACT: The northeast region is one of the principal mire distribution regions in China. According to the process of peat formation and accumulation , middle geomorphology type controlling water source supplement and the plant cover, 2 types, 10 subtypes and 27 mire bodies are divided. The mire area decreases gradually from north to south. There is more peat mire in the mountain and there is mainly gley mire without peat in the plain. The paper also explains the mire types in the principal mire distribution region and the utilization of mire in the fields of agriculture, forest, animal husbandry. The mire is a wetland ecosystem. It can reserve a lot of water, adjust rivers, humidify air. Thereby , attention must be paid to protecting ecological balance in the process of reclaiming mire and the mire protection.

KEY WORDS: mire distribution, utilization and protection of mire, mire types, northeast of China

The northeast region is one of the principal mire distribution regions in China. The mire area is nearly 3,332,000 ha, accounting for 2.7% of the area of the northeast region or 30.3% of the total area of mire in the whole country(Fig.1).

I. THE MIRE TYPES AND DISTRIBUTION LAW

1.The Mire Types

The natural conditions in the northeast region are complicated and there are many mire types. The comprehensive factor classification method is based on the principle of interrelation and interaction of natural factors. The method is carried out by comprehensively considering moisture-thermal condition of mire formation, the characteristics of geology and geomorphology, the plant types and the peat horizon and soil properties, and paying more attention to the dominant factors of restricting the mire genesis and

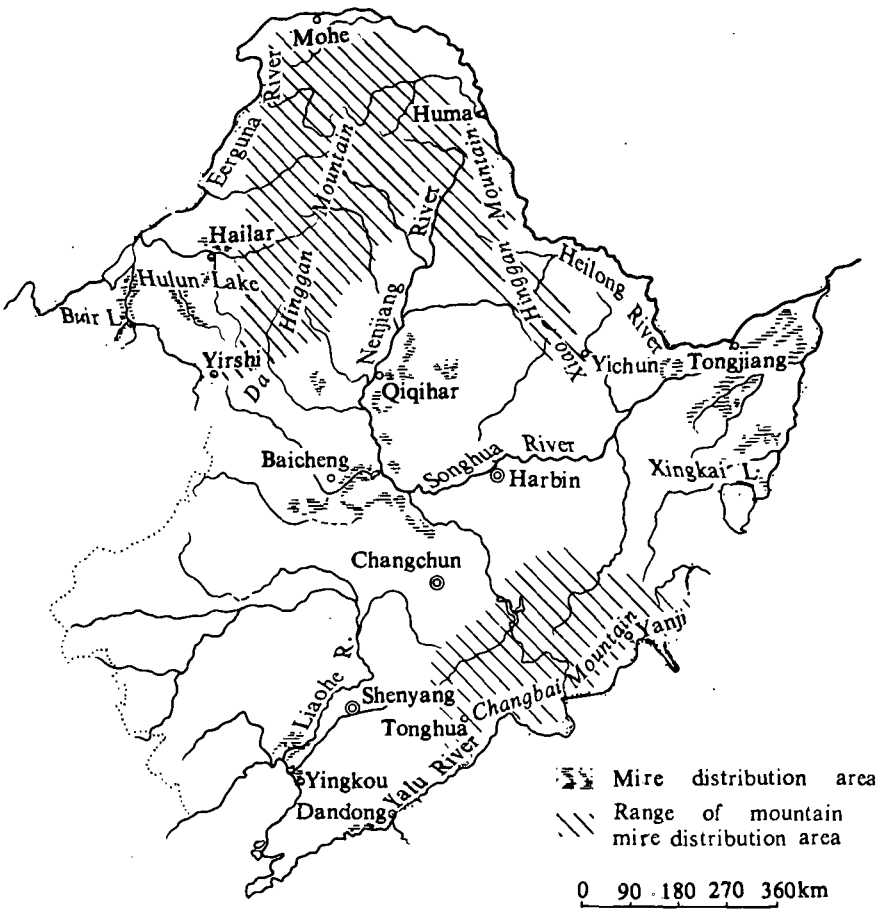

Fig 1. The mire types and distribution in northeast of China

growth. The comprehensive factor classification method is better than the other methods because it can reflect mire attribution and property.

The moisture condition is the dominant factor of the formation of mire and peat. It also affects plant growth and restricts soil formation process. Both moisture and thermalconditions can determine mire types and direction of mire development and succession. The mire in the northeast can be divided into three grades according to three principles as follows:

1.1 Whether the process of peat formation and accumulation exists

The northeast is an integral physical geography unit. Because of the differences in distribution of geographic position , regional distribution of geomorphology characteristics, and moisture-thermal condition, there exist many models of the decomposition and accumulation of mire plant residue. In some places, the accumulation of dead plant residues exceeding decomposition, the peat horizon with different thickness accumulates and peat mire forms. In other places, the decomposition of dead plant residues exceeding accumulation,

the peat can't grow in the mire, so the gley mire with humus horizon forms instead. The characteristics in hydrology and soil profile between peat mire and gley mire are distinct, so their directions of utilization and reformation are different.

1.2 Middle geomorphology type controlling water source supplement

The concentration of the mire water mainly depends on geomorphology condition. Middle geomorphology type has an effect on mire water supplement, hydrological state, nutrient property, and further effect on the characteristics and process of mire growth. According to middle geomorphology type and the state of principal mire water supplement or reformation means, the mire can be further divided into a number of subtypes.[1]

1.3 Plant cover—comprehensive symbol reflecting environment condition

The micro-change of surface pattern and material composition will certainly restrict water state in different section and affect further mire plant community, therefore, the plant can correctly reflect environmental micro-variety. In addition the ecological condition reflected by plant community and plant composition element can be used to judge land natural productive force and can provide the foundation for utilization and reformation of various mire types. So the mire body, as basic unit of the mire, can be classified according to dominant species of plant community. The types of mire are shown in Table 1.

2. The Law of Mire Distribution

The mire distribution in geographical space depends mainly on moisture-thermal condition of the mire formation. The moisture-thermal condition is not only controlled by latitude zonality factor, but also affected by a zonality factor of geology and geomorphology. The mire as a natural complex, therefore, has latitude characteristics in distribution as same as climate zone. On the other hand latitude zonality is often destroyed by the factor of a zonality, so that the mire type and distribution show some regional characteristics.

2.1 The mire area decreas gradually from north to south

The region extends across frigid temperate zone, temperate zone and warm temperate zone , the administrative division includes Heilongjiang Province, and eastern part of the Inner Mongolia Autonomous Region . As everyone knows, the most extensive distribution zone of the mire in the world is frigid temperate zone. The cold and humid climate there is suitable for the mire development. The peat mire is distributed most widely. The thickness of peat layer there is maximum, and it becomes thinner from the region to north or south. Heilongjiang Province is located in the northemmost of China. It is the most frigid province in our country, especially the north section of the Da Hinggan Mountains belongs to frigid temperate zone. Because the rainfall exceeds the evaporation, the peat mire is distributed widely. According to initial statistics, only in Heilongjiang Province the area of the mire is more than 2.70 million ha. The mire in Liaoning Province is distributed in river mouths along the coast mainly and east mountains. The total area is nearly 134,000 ha. In Jilin

Table 1 Mire types in northeast of China

Type	Subtype	Mire body
Peat mire	Watershed peat mire	*Larix gmelini*–*Ledum* sp. –*Sphagnum* sp.mire body
	Lava platform peat mire	*Larix olgensis*–*Ledum* sp. –*Sphagnum* sp. mire body
		Larix olgensis–*Carix* sp.–*Sphagnum* sp. mire body
	Slope peat mire	*Larix gmelini*–*Ledum* sp. –*Sphagnum* sp. mire body
		Betula fruticosa–*Carix* sp. mire body
		Sphagnum sp. mire body
		Betula fruticosa–*Vaccinium uligilosum* –*Sphagnum* sp. mire body
	Valley peat mire	*Larix gmelini*–*Ledum* sp. –*Sphagnum* sp. mire body
		Larix olgensis–*Ledum* sp. –*Sphagnum* sp. mire body
		Betula fruticosa–*Carix* sp. mire body
		Carex meyeriana–*Carex appendiculata* mire body
	Terrace peat mire	*Carex meyeriana*–*Sphagnum* sp. mire body
		Carex meyeriana–*Carex appendiculata* mire body
		Carex lasiocarpa mire body
	Flood plain peat mire	*Betula fruticosa*–*Carex* sp. mire body
		Carex meyeriana–*Carex appendiculata* mire body
		Craex pseudo–*curaica* mire body
Gley mire	Valley gley mire	*Carex meyeriana*–*Carex appendiculata* mire body
	Terrace gley mire	*Carex lasiocarpa* mire body
		Carex meyeriana–*Carex appendiculata* mire body
		Carex sp. –*Deyeuxia angustifolia* mire body
	Flood plain gley mire	*Phragmites communis* mire body
		Carex pseudo–*curaica* mire body
		Carex meyeriana–*Carex appendiculata* mire body
		Carex lasiocarpa mire body
		Carex sp. –*Deyeuxia angustifolia* mire body
	Shore gley mire	*Phragmites communis* mire body

Province situated in the middle part of the northeast region, the mire area is more than 300,000 ha. Three sides of the northeast region are surrounded by mountains and the middle part of the region is an open enormous plain facing to sea, the relief is suitable to form mountain mire. But the general tendency of the mire distribution is still controlled by climate which is caused by latitude change. The tendency of the mire area reducing from north to south is right reflection of the law of latitude zonality.

2.2 There is more peat mire in the mountains and gley mire in the plain

The type of the mire in the mountains differ from that in the plain because the relief affects climate and the landform restricts the distribution and movement of surface runoff and underground runoff. In mountains, the conditions, which are the high relief, the low temperature, more precipitation, steady water supplement, permanent over-wet soil, anaerobic condition in soil and uneasy decomposition of plant residues, are suitable for peat accumulation. The thickness of peat horizon is 50-100 cm generally, even more than 300 cm. Due to the variance of regional moisture and thermal condition, the mires in the mountains are also different in their type distribution. Eutrophic mire taking herb as dominant is distributed mainly in valley, flood plain and depression in terrace. The wood-moss mire grow in lava platform, glacis, even watershed. The change of water supplement and the mire surface pattern show that some mires have been become oligotrophic peat and transitional peat mire.

The mire in extensive plain forms at the conditions which are low and flat earth surface, poor drainage of surface runoff, and the water concentration in negative relief. The peat in those mires accumulates difficultly because the mire stagnant water is unstable in dry season, aerobic decomposition appears and the plant residue decomposes accelarately. Under the alternate effect of anaerobic and aerobic microbe, the humus forms. So the mire profile from top to bottom is divided into root horizon, humus horizon and gley horizon. Only in local depressions which are supplied by underground water and stable water source, the peat mire can form.

II. PRINCIPAL MIRE REGIONS

1. The Sanjiang Plain Mire Region

The Sanjiang Plain is an alluvial low plain which was deposited by the Heilong River, the Songhua River, the Wusuli River and Xingkai Lake. The plain covers the northeast part of Heilongjiang Province. The mire in the plain is distributed very widely, with an area of about 1,140,000 ha. Genesis and growth process of the mire take meadow mire process as dominant. There are main types in the region as follows:

1) *Carex lasiocarpa* mire is distributed in flood plain and depression of terrace. It is the widest distribution type in the plain. There is stagnant water of 20 cm deep in the mire surface in normal years. Because stagnant water of the mire isn't steady and often evanesces in dry season, the peat can't accumulate. The humus horizon grows in soil profile.

2) *Carex* sp. - *Deyeuxia angustifolia* mire is distributed in some flat and shallow depressions in the edge of *Carex lasiocarpa* mire. The stagnant water is only 5-10 cm deep. Sometimes the stagnant water disappears, meadow mire grows. The high content of organic matter and rich nutrition are contained in meadow mire soil, so that the mire is the most suitable type for being reclaimed.

3) *Carex psudo-curaica* mire is distributed in the edge of channel and oxbow lakes. The cover degree of *Carex psudo-curaica* is 70%-80%. There is peat accumulation in part of the mire. The peat mire soil and peat soil grow. Because of deepstagnant water the root horizon floats and is called "floated blanket".

4) *Phragmite communis* fen is distributed in flood plain of the lower Dulu River, the middle Qixing River and around Xiao Xingkai Lake. Due to the distinction of water conditions, the reed growth is also different in various areas. The best place of reed growth is the northeast to Xiao Xingkai Lake near spill way. The yield of the reed has reached 7,500 kg/ ha, in other places, due to deep stagnant water or no drainage system the reed yield is lower and reed growth is worse.

5) *Carex meyeriana-Sphagnum* sp. mire is distributed in spill belt of under ground water and the area along the lower Abuqin River and the lower Qihulin River. The herb mound is formed by *Carex meyeriana* and *Carex schmidtii*. There is a horizon of *Sphagnum* sp. in the soil between Dahu Ridge and Taiyang Ridge. So peat accumulates in the mire profile, with a thickness of 20-50 cm generally.

2. Hinggan Mountains Mire Region

The region covers the north and northwest parts of Heilongjiang Province and the northeast part of Inner Mongolia. The cold and wet climate, the existing permanent frozen soil and island permanent frozen soil are suitable for the growth of peat mire. The peat mire is divided into five types:

1)*Larix gmelini-Ledum* sp.- *Sphagnum* sp. swamp is distributed in wide valley and glacis where the *Larix gmilini* grows badly. The mire is supplied by rainfall and slop water and the herb mound forms.

2) *Sphagnum* sp. bog is distributed barely in wide valley, oxbow lake and glacis of Gulian and Mangui forest bureaus in the extreme north of the Da Hinggan Mountain. The *Larix gmelini* in the moss grows much worse than in other mires. The thickness of *Sphagnum* sp. residues is more than 50 cm and the permafrost is under the *Sphagnum* horizon.

3) *Betula fruticosa-Carex* sp. swamp is distributed in glacis and flood plain. The peat horizon is less than 50 cm thick.

4) *Betula fruticosa-Vaccinium uligilosum-Sphagnum* sp. swamp is distributed in glacis. The peat bog is supplied by rainfall and slope water. The peat soil and peat bog soil grow.

5) *Carex* sp.-*Deyeuxia angustifolia* mire is distributed in flood plain in the south section of the Hinggan Mountains. The most of the mire have not peat accumulation process and the meadow swamp soil grows.

3. The Changbai Mountain Mire Region

The Changbai Mountain is the highest mountain in the northeast region. Because of the frequent volcanic activity in geologic period, the lava platform which is higher than 800 m formed around the Changbai Mountain. The conditions of high relief, low temperature, more rainfall and weak evaporation is suitable for the mire growth, so many types of mire have formed. Due to different landform positions and different moisture thermal states, various mires are distributed regularly in space. The *Larix olginsis–Carex* sp.–*Sphagnum* sp. swamp is distributed in Menjiang and other places in the southwest slope of the Changbai Mountain. The dome has occurred and peat mound of one meter high has formed in swamp surface. The water source of the swamp is precipitation. The thickness of the peat horizon is more than 2 m in the central area. Under the influence of the runoff of slop and the spill over underground water of slop wash, the water source is very rich in low mountain and hill, especially, the catchment pit of flater source and frontal friging of diluvial fen. The *Carex meyeriana–Carex appendiculata* fen forms usually. There is herb mound in fen. The herb mound is 20–30 cm high, its diameter is 30 cm and its density is about 30%. The *Carex* sp. –*Deyenxia angustifolia* fen often forms in flat and shallow depression and the *Carex lasiocarpa* mire often forms in oxbow and between the natural levees.

4. Shore Reed Swamp Region

The shore reed swamp region is situated in the north bank of Liaodong Bay, coastal plain of Liaodong Peninsula. It belongs to alluvial and fluvial low plain formed by various rivers into the se . As the ground surface is low and flat, the drainage is difficult, in addition, the water in the sea is against river flowing seasonally, the reed fen forms. Because of reclaiming, the area of the reed swamp is reduced to only 70,000 ha now. *Carex* sp. marsh also grows in local depression far away from sea with permanent stagnant water.

The reed swamp is the main landscape in the region. The condition with irrigation and drainage, 6.5–9.0 pH value and fertile mud mire soil are the most optimum environment for reed growth. Most of reed swamp in the region haven't peat accumulation.

5. Songnen Plain Marsh Region

This region is located in the center of the northeast region. The marsh area is about 2,000,000 ha. The Songnen Plain has been descended in large extent since the Quaternary. Owing to overflow of the Wuyuer River, the Shuangyang River and the Huolin River, reed swamp forms widely in the Plain.

Most of reed swamp in the region haven't peat accumulation. The humus mire soil, mud mire soil and saline meadow mire soil have developed. In addition, *Carex* sp.–*Typha angustifolia* grows in depressions, log with deep surface water and belt of spillover of underground water.

III. UTILIZATION AND PROTECTION

1.Utilization

Mire is a kind of land resources. It plays an important role as other land resources in the fields of agriculture, forestry, animal husbandry and so on.[2]

1.1 Transferring mire into cropland

To transfer mire into cropland must be merely limited to some light mire, for example, the *Carex* sp.–*Deyexia angustifolian* mire in the Sanjiang Plain. The following means can be taken before and after reclaiming mire land.

1) Establishing drainage system. In order to improve fundamental productive conditions, the surface water and superfluous water in the soil must be removed before reclaiming mire land. Establishing drainage system should suit measures to local conditions.

2) Accelerating mire soil ripeness. Because the mire land has been saturated by water for a long period, the soil lacks oxygen, Organic matter decomposes slowly, nutrient element can't be absorbed by crop. The soil should be turned up so as to add the soil evaporation, enhance the soil temperature, reduce the moisture, accelerate organic matter decomposition and release mineral nutrient which can be absorbed by crop.

3) Constructing shelter forest for cropland. Before reclaiming mire belongs to a wet ecosystem, erosion appears. The cropland shelter forest can prevent wind and humidify environment. Constructing cropland shelter forest make mire land which has be reclaimed reestablish new ecological balance.

1.2 Transforming mire and tending wood

In some places, a numb

area of the Hinggan Mountains and Changbai Mountain. In other places, because the forest suffered from mire, the woods grow worse than the normal. In order to enlarge forest area, rejuvenate woods and increase forest reserve amount, the drainage must be carried on first.

The methods of planting woods and rejuvenating forest are: 1) building a low bank of earth in field, 2) building high bed or building raised field, 3) draining the mire, transforming mire into pasture.

In late spring and early summer, *Deyeuxia angustifolia* contains high nutritive elements whose protein content is 10%–14% and cellulose content is about 26%–35%. So the *Deyeuxia angustifolia* is a natural fodder for cow and sheep. Meanwhile, perennial herbage may be planted in a planned way after animal husbandry actively is also one of the fashion methods of transforming mire.

2. Protection

2.1 Protecting ecosystem of mire region

Mire is a natural complex. It is also a wetland ecosystem. The mire can reserve a lot of water, adjust rivers, humidify the air and have definite influence on surrounding ecosystem. Thereby, attention must be paid to protect ecological balance in the process of reclaiming mire.

2.2 Protecting reed swamp and developing reed production

Reed is a very good raw material of paper making and artificial fibre industry. It accounts for 50%–60% of total materials of paper-making, wood accounts for only 30% at present.

Each ton of paper can be produced by using 2.5 t reed or 5 m^3 wood, therefor, protecting reed swamp and developing reed production can save a large amount of wood for our country. But there are some problems in the reed production, for instance, nobody manages in a large area of reed swamp; the reed severely degenerates in some sections because of lack of water; the reed land has been reclaimed. Thereby, developing reed production must protect reed swamp and resolve the above-mentioned serious problems.

2.3 Protecting and synthetically utilizing peat resources

Rich peat exists in the mire. The peat is a valuable natural resource. It has been used extensively in the fields of agriculture, industry, medicine , etc. The peat, including a lot of humus and nitrogen, is an important material for making fertilizer and is also suitable for making compound fertilizer and hormone for crop growth. It has obvious effects to apply them for crops, vegetables, fruits and other economic crops.

The peat can be used to produce active arbon and ion exchange resin in recent years. Applying it can deal with waste water with heavy metals. It can play an important role for protecting environment and preventing pollution.

2.4 Establishing mire protection district

Theory problems about the principle, eco-structure, eco-function of mire should be explored further. Therefor, we may select typical and representative mire land as research base. In addition, the mire has special landscape property. Many countries have protected certain area mire as tourist district. Establishing mire protection district has important significance not only in production but also in theory for advancing study of mire.

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