

An Initial Investigation on the Distribution, Living Conditions and Traits of the Hazel in Great Xing'an Ridge Region

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ABSTRACT

To take full advantage of the natural hazel resources and improve its yield and quality in Great Xing'an Ridge region, we carried out an initial investigation. The result showed that: there are two species in this area: *Corylus heterophylla* and *Corylus mandshurica*. They mainly distribute from south of Xinlin town, Huma county, Heilongjiang province to south boundary of Great Xing'an Ridge in mountain and hilly areas. Most of hazel in this area was under the state of natural growth with no scientific man-management. Soil where *Corylus heterophylla* grew was about 40 cm to 50 cm and *Corylus mandshurica* was 30 cm to 45 cm. The main plant disease was powdery mildew and insect pest were *Curculio dieckmani*, *Zeuzera sp.* and *Faust Cockchafer*. 100-seed weight of *Corylus heterophylla* was more than twice of *Corylus mandshurica*. However, *Corylus mandshurica* was plumper, had much more kernel and much less empty shell than *Corylus heterophylla*, and what's more, shell sickness of it turned to be significantly thinner than *Corylus heterophylla*, all of which showed great cultivation value and economic commodity value.

Keywords: *Corylus Heterophylla*, *Corylus Mandshurica*, Distribution, Quality, Condition

1. Introduction

Hazel which originated in China and rich in fat, protein, carbohydrates, together with many kinds of vitamins and minerals is a kind of precious woody grain and oil resources, containing a high economic value. According to the analysis, hazel contains 57.5% - 69.8% fat, 14.1% - 18.0% protein, 6.5% - 9.3% carbohydrate, only 4.1% - 5.8% water and a variety of vitamins (Vc, Ve, Vb) and minerals (Ca, K, P, Fe etc.) [1]. What is more, unsaturated fatty acid content reaches up to 90% in hazel oil, far higher than conventional vegetable oils. Among the oil oleic acid is the most (74.1% - 82.1%) and linoleum acid come to the second (12.7%). It contains much less

iodine and is clear orange with mellow taste, so turns out to be a high quality oil [2]. Hazel is one of the world's four nuts and is well received by consumers due to its rich nutritious and unique flavor. Hazelnut oil can soften blood vessel, which could help the elderly prevent cardiovascular disease and promote longevity [3]. Distribution of hazel root is deep and wide, which could reach 1.5 m deep and 1 - 2 m wide respectively. Meanwhile, they are easy to form continuous hazel forest because their roots could stretch in the surface soil and sprout tillers [4]. As a result, it becomes very helpful for soil, water conservation and for woodland soil improvement due to its well-developed root system.

Hazel belongs to *Corylaceae*, *Corylus L.* in plant taxonomy and there are about 20 species around the world. They mainly distribute in the Northern Hemisphere from Cold Temperature Zone to Subtropical Climate Zone [5]. 10 of the 20 species originated in China and scattered in 22 provinces (regions), among which *Corylus heterophylla*, *C. mandshurica*, *C. kweichowensis* Hu, *C. chinensis* Franch, *C. fargesii* Schneid, *C. yunnanensis* A. Camus, *C. ferox* Wall, *C. wangii* Hu were 8 original species

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and *Corylus heterophylla* × *corylus avellana* and *C. avellana* L. are 2 cultivars [6].

Corylus heterophylla and *Corylus mandshurica* are two species containing high economic value in the north of China. *Corylus heterophylla*, a small deciduous tree or shrub and alias hazel or hazelnut, mainly distribute in mountains or hilly regions at an altitude of 200 - 800 m. It is divided into 7 types according to different shapes, and they respectively are round hazel, cone hazel, oblate hazel, long round hazel, flat hazel, sharp hazel and flat-topped hazel [7]. *Corylus mandshurica*, alias fire hazel or *Corylus mandshurica maxim*, is a 2 - 4 m tall shrub. They distribute in forest or mountains in Temperate Zone or Warm Temperate Zone, and often grow among birch, aspen, Mongolian oak, oak or on the edge of other summer green broad-leaved forest.

Hazel is a major nut tree in China. It distributes in Heilongjiang, Jilin, Liaoning, Inner Mongolia, Hebei, Shaanxi and Shanxi province. In China, this ancient fruit tree is always in the original wild state and research on it has not begun until the 1970s. After thirty years research, hazelnut was finally included within cultivation fruit tree. Consequently, Hazel, the new fruit tree who has long been known but with so short history of artificial cultivation has attracted more and more attention with the implementation of the conversion of cropland to forest program and development of economic forest industry [8].

Nowadays, the current development and utilization and other aspects of the research of hazel focused on the biology and ecology in China from the economic forest's development status. As oleiferous tree species, hazelnut could bring tremendous economic and ecological benefits through scientific management, and meanwhile promote local economic development together with people's income increase.

Because hazel has always been in the original wild state in China, it led to smaller nuts, low kernel rate and poor commodity traits. What's more, serious insect fruit result in yield and quality significantly decreased. In recent years, not only no hazel was exported from China, but a large number of large fruit-European hazelnut was imported as hazelnut decline in the quality in China, which has a serious impact on our hazel industry [9]. In summary, detailed investigation and scientific management on wild hazel resource in China is imminent.

Most of hazel in Great Xing'an Ridge region is similarly under pure wild growth at this stage with no scientific artificial management. In addition, development of hazel product in this area is still in primitive stage and the major sales are primary original products. Given the status of local hazelnut resources, we conducted this preliminary investigation and study in order to make full use of this wild hazel, to improve its yield and quality. And

the last purpose of the present study is to provide a theoretical basis for rational exploitation and utilization.

2. Materials and Methods

2.1. Sampling Site and Background

Great Xing'an Ridge is an important mountain in the northeast of China and it stretches from 43° - 53°30'N latitude to 117°20' - 126°E longitude. Altitude of mountains range from 600 - 1000 meters, and some peaks are close to 1400 meters. This area has large temperature difference between day and night. The annual average temperature is -1.2°C - 5°C, and the lowest temperature is -52.3°C. July average temperatures is 16°C - 20°C. The annual accumulated temperature reaches 1100°C - 1700°C. Its frost-free period is about 90 - 110 days, and average annual precipitation achieves 400 - 600 mm. What is more, Great Xing'an Ridge is covered with vast expanse of forest. Its forest area is 6,463,600 hectares, and forest coverage rate reaches up to 75.16%.

Great Xing'an Ridge in northeast of China own the richest hazel resource. The area of hazel in Great Xing'an Ridge came up to 670,000 hm² [10]. They mainly distribute in sunny, fertile, deep, well drained mountain soil in southeast of Great Xing'an Ridge. The hazel here is often contiguous and focused and large hazel forest range from one hectare to hundreds hectare. Hazel shrubs can be divided into shrub layer and herb layer, and the cover degree of shrub layer could come up to 78% - 80% which composed mainly by hazel with 80 000 - 150,000 hazel trees per hectare in average [11]. Although there were so much hazel resource in Great Xing'an Ridge, they had always been in the state of natural wild growth and had never really got exploration.

For a long time, production structure of forest area was single and exploration, utilization and protection of hazel had not been paid enough attention. Consequently, greens nuts were always picked by local people in every harvest reason with deforestation, thus, resulting in nut yield and quality declining and increasing proportion of empty seeds, shriveled kernels and serious insect nuts.

So, we randomly chose several sampling sites for survey orderly from Jiagedaqi County, Nenjiang County and Huma County to make an initial investigation and research to provide a theoretical basis for rational exploitation and utilization.

The following considerations were used to select sampling sites: 1) the area should be wide and easily identifiable in GIS images, and 2) the area should not be destroyed by farmland or highways and could represent the local hazel growth conditions. Therefore, based on the aforementioned considerations a total of 11 samples were collected in the present study, at each sampling site, ha-

zel was collected from a 2.5 m × 2.5 m area. The geographic coordinates of sampling site are listed in **Table 1** and locations of the study area are showed in **Figure 1**.

2.2. Test Method

Check out the hazel forest location by GPS and note their detailed latitude, longitude, altitude and record the habitat of the hazel forest according to actual situation.

Note the plant diseases and pests on leaves, branches and shoots of the hazel forest on experimental points. Compare the types and severity of diseases, pests and check out which is the most harmful.

Excavate the soil where hazel forest grow and record the thickness of it.

Have a preliminary understanding of hazel in this area by investigating the hazel forest, local markets, and information provided by experts in local forestry bureau. 10 robust *Corylus heterophylla* trees with no plant diseases or insect pest together with 10 *Corylus mandshurica* trees were selected for the experiment. Nuts of the two

species were selectively picked and brought to the laboratory for air dry. 90 *Corylus heterophylla* nuts and 90 *Corylus mandshurica* nuts were randomly selected for the test and each 30 nuts as duplication 30 days later.

The weight of nuts were weight by 1/10,000 electronic balance, and fruit size, shell thickness and other related economic indicators were measured by vernier caliper.

The indicators are as follows: traverse diameter (x_1), longitudinal diameter (x_2), side diameter (x_3), shell thickness (x_4), 100-seed weight (x_5), plumpness (x_6), kernel-rate (x_7) and empty shell rate (x_8). And schematic diagram of whole survey procedure is showed in **Figure 2**.

The experimental data were analyzed by average method and variance analysis, applying mean square error test method by spss17.0 statistical software.

3. Result and Discussion

3.1. Distribution of Hazel Forest

The results indicate that there are two hazel species in Great Xing'an Ridge region and they respectively are *Corylus heterophylla*, *Corylus mandshurica*. The minimum altitude that hazel forest distributes was 312 m and the highest was 461 m. They mainly grow in mountains or hills from south of Xinlin Town, Huma County, Heilongjiang Province to south boundary of Great Xing'an Ridge. Distribution of *Corylus Heterophylla* was significantly wider than that of *Corylus Mandshurica*.

Most of *Corylus heterophylla* grew in the sunny forest edge or shrub south of the hillside. *Corylus heterophylla*'s requirements on soil was very high, so zones where they grew in were fertile, moist, rich in humus and had deep soil. As a result, much area where hazel forest grew had changed into farmland, leading to nearly exhausted resource.

Corylus mandshurica's requirement on sun was not so high that most of them grew in shrub north of the hillside or broad-leaved forest and mixed coniferous forest, and sometimes mixed with *Corylus heterophylla*. They preferred to soil which were moist, rich in humus, slightly acidic, but tolerates dry, infertile soil. *Corylus mandshurica* was even found grow in the local limestone rock. However, due to the high requirements on moisture and shade, although their distribution was wide, production turned out to be lower than *Corylus heterophylla*.

3.2. Plant Disease and Insect Pest of the Hazel Forest

Most of hazel forest that distributed in eastern mountains of Heilongjiang Province was under pure wild state with no scientific artificial management, resulting in low yield. Especially for the pest factors, close to 30% - 40% of hazel suffered from pests each year, causing enormous

Table1. Geographic coordinates of sampling site.

Samling site	Geographic coordinates	
	North latitude	East longitude
1	51°21'32"	124°28'14"
2	50°20'23"	124°41'43"
3	50°33'42"	125°75'41"
4	50°33'21"	125°22'12"
5	50°37'09"	125°53'24"
6	50°56'20"	126°04'43"
7	51°04'30"	126°17'54"
8	51°09'03"	126°35'53"
9	51°09'02"	126°08'14"
10	51°20'17"	124°06'12"
11	50°17'52"	124°07'20"

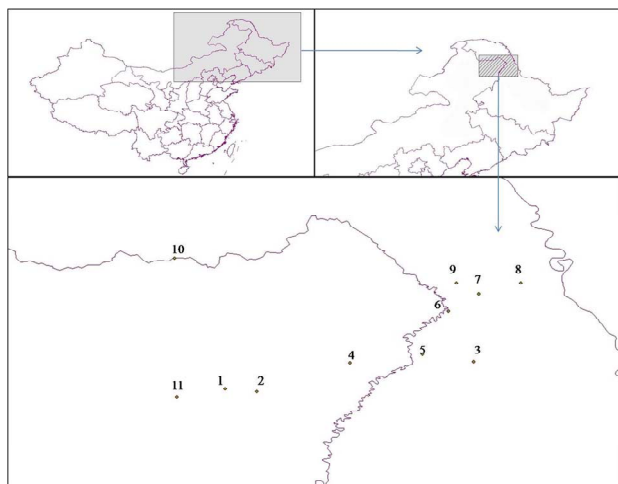


Figure 1. Location of the study area. *: In the image sampling sites are represented by points.

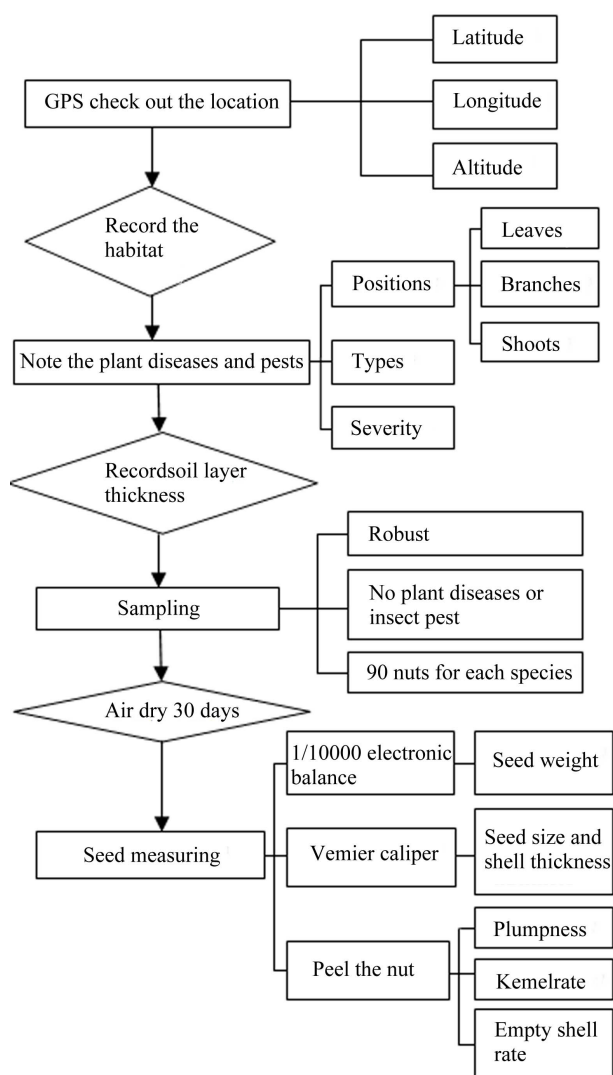


Figure 2. Schematic diagram for survey procedure.

loss [12].

We checked out the main plant disease and insect pest harmful to local wild hazel forest during their growth phase by survey on random samples. The result showed that the main plant disease was powdery mildew, and main insect pest were *Curculio dieckmani*, *Zeuzera sp. Faust Cockchafer*, among which *Curculio dieckmani* turned to be the most harmful.

As for powdery mildew, diseased branches and leaves should be removed in time as soon as diseased plants are found. And for too dense shrub, cutting down the excess branches and thinning could help them improve ventilation, light conditions, which can enhance the tree's resistance to disease. In addition, spraying pesticide from early May to early June is also available for resistance.

As for *Faust Cockchafer* and the most serious *Curculio dieckmani*, we can make use of their suspended ani-

mation and phototaxis of adult pest to capture them artificially or kill them by black light. What's more, to protect and attract a variety of biological natural enemies can effectively control pests.

3.3. Soil Layer Thickness of Hazel Forest

Corylus heterophylla's requirement on soil is very high, so most areas they grow in were fertile, moist sunny hill-sides which were rich in humus and had deep soil. The survey showed that thickness of soil layer where *Corylus heterophylla* grew and hadn't been destroyed proved to be not less than 50 cm; soil at foot of the mountains, beside the highways and those had even been destroyed by farmland can still come up to 40 cm thick; and no growth signs of *Corylus heterophylla* was found in those areas thickness of soil layer was less than 30 cm. It indicates that *Corylus heterophylla's* requirement on soil is not less than 40 cm, so fertile, moist soil rich in humus is necessary for their growth.

Most of *Corylus mandshuri* grew in shrub north of the hillside or broad-leaved forest and mixed coniferous forest. Soil which was moist, rich in humus, slightly acidic was their most suitable survival place. In addition, they can tolerate dry, infertile soil. Thickness of soil layer where the hazel forest grew and hadn't been destroyed was not less than 45 cm; and most of the soil layer they grow in ranged from 30 cm to 45 cm. For their strong ability to endure dry, infertile soil, some were truly found in the local limestone rock at 51°20'17"N latitude, 124°06'12"E longitude.

The requirement of hazel on soil is very high, so fertile soil and good drainage is indispensable for high yield. The growth and development will be greatly affected if bred in the heavy clay or sandy soil which is barren, dry or stands too much water. In addition, hazel requires 40 cm thick soil and some soil should be replaced if they are less than 40 cm [14]. So, our result quantitatively supports the conclusion that reported by Zhanhui Liu and other experts, which proved that hazel forest need enough fertile soil not less than 40 cm for normal growth and for development in the process of artificial breeding. This provides a realistic basis for artificial cultivation of hazel resources and lays a theoretical base for improving their yield and quality.

3.4. Wild Hazel Resource Utilization

Most of hazel in this area was under the state of natural growth at this stage with no scientific artificial management, combined with destruction from farmland occupation. As a result, production became very unstable. What's more, the strong germination ability of hazel led to too large density of the wood, so ventilation and light became insufficient. Consequently, yield and quality was

affected seriously, which confirmed the earlier conclusion reported by Minghua Che and other experts. They pointed out that the main natural reasons resulting in low production of hazel were as follows: scarce sunlight for being distributed under the arbores; poor fruiting ability due to too old age; intense competition among individuals because of too large density; arid climate and pest insect [13].

In addition, as local people's value cognition of hazel deepened gradually, greens nuts were always picked by them, resulting in much reduction. Hazel product development was still in primitive stage. There were no processed products, and only primary products were sold on local market.

Hazel has high economic value. To protect and make full use of the wild resource can not only improve its yield and quality, but also safeguard the environment and ensure the sustainable use of wild resources. Given the status of local hazelnut resources, artificial rearing and scientific management are imminent. So, "Artificial and wild hazelnut garden" is necessary on the base of its natural environment, growth and development law. Only to guide it to achieve stable, high yield, and thus the formation of industrial-scale, can it meet the economic development needs of local area.

3.5. 100-Seed Weight Comparison between *Corylus heterophylla* and *Corylus mandshurica*

As we can see in **Table 2** that 100-seed weight of *Corylus heterophylla* was more than twice that of *Corylus mandshurica*.

3.6. Nut Size and Shell Thickness Comparison between *Corylus heterophylla* and *Corylus mandshurica*

Traverse diameter, longitudinal diameter, side diameter and shell thickness of 90 *Corylus heterophylla* nuts and 90 *Corylus mandshurica* nuts were respectively measured by venier calipers and the result is as followed.

As we can see in **Figure 3**, traverse diameter and longitudinal diameter of *Corylus heterophylla* were both significantly higher than that of *Corylus mandshurica*, respectively higher by 33.07% and 25.96%. While side diameters of both were not so different for *Corylus heterophylla* was only 6.67% higher than *Corylus mandshurica* in this factor. However, shell thickness of *Corylus heterophylla* was particularly higher than *Corylus mandshurica* by 83.67%, almost twice of it. The results present here show that size of wild *Corylus heterophylla* was evidently bigger than wild *Corylus mandshurica* with clearly thicker shell.

What's more, each standard deviation of *Corylus hetero-*

Table 2. 100-seed weight comparison between *Corylus heterophylla* and *Corylus mandshurica*.

variety	100-seed weight					mean
	1	2	3	4	5	
<i>Corylus mandshurica</i> (g)	48.345	49.212	51.561	50.708	47.244	49.41
<i>Corylus heterophylla</i> (g)	107.131	103.853	103.679	106.315	104.670	105.13

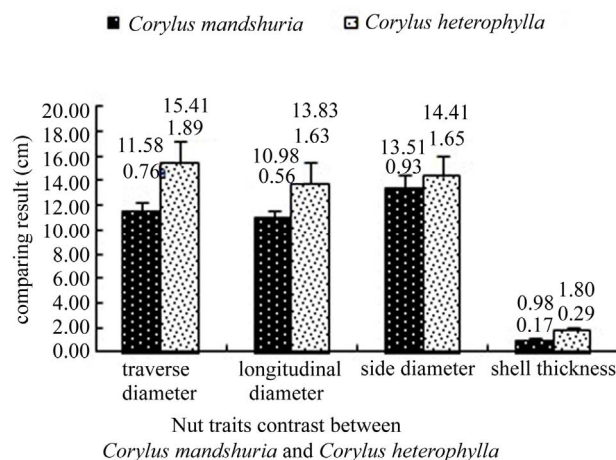


Figure 3. Nut size and shell thickness comparison between *Corylus heterophylla* and *Corylus mandshurica*. The data on top of the post were the record of the item; below them were their standard deviation.

phylla nut size was clearly bigger than *Corylus mandshurica*, which indicates both shape and size of wild *Corylus heterophylla* were not so homogeneous. However, *Corylus mandshurica* showed more stable situation in these factors and turned out to be very suitable for commercialization.

3.7. Plumpness, Kernel Rate and Empty Shell Rate Comparison between *Corylus heterophylla* and *Corylus mandshurica*

Figure 4 showed that plumpness of *Corylus mandshurica* was significantly higher than that of *Corylus heterophylla* by 17.51%. Kernel rate of *Corylus mandshurica* was almost twice of *Corylus heterophylla*. Empty shell rate of *Corylus mandshurica* was especially lower than that of *Corylus heterophylla*, only 1/4 of it. From **Figure 3** we can see that size of *Corylus mandshurica* was clearly smaller than *Corylus heterophylla*. However, the result present in **Figure 4** indicates that *Corylus mandshurica* was plumper, had much more kernel and much less empty shell than *Corylus heterophylla*, which showed great value of economic commodity.

That *Corylus heterophylla* was utilized much more

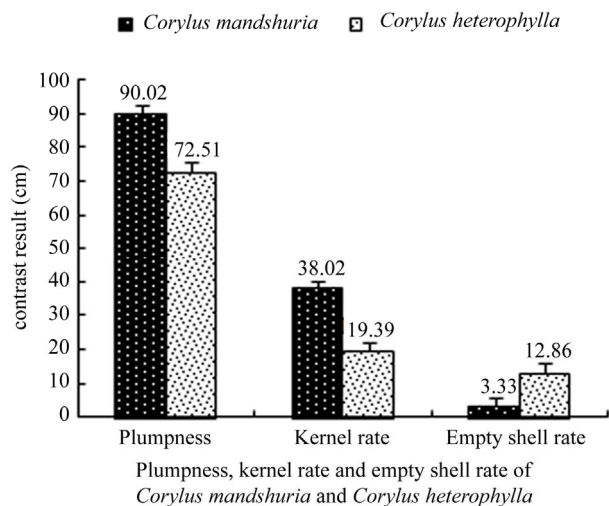


Figure 4. Plumpness, kernel rate and empty shell rate comparison between *Corylus heterophylla* and *Corylus mandshurica*.

than *Corylus mandshurica* was because of its better economic quality traits for it has wide adaptability, large nut yield, easily preserved pollen, high pollination rate and fruiting rate, great variation of cross-breeding offspring and better breeding shape controllability [15]. However, **Figure 4** showed that *Corylus mandshurica* was plumper, had much more kernel and much less empty shell than *Corylus heterophylla*, and what's more, shell sickness of it turned to be significantly thinner than *Corylus heterophylla*, all of which showed great cultivation value and economic commodity value.

That yield of *Corylus mandshurica* was smaller than *Corylus heterophylla* was due to its poor distribution. So, it can be predicted that *Corylus mandshurica* would create significant economic value if cultivated artificially in large-scale.

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