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Original article

THE PROBLEM OF REFORESTATION OF WOODY VEGETATION OF MOUNTAIN RANGES OF KON CHU RANG NATURE RESERVE (VIETNAM)

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Background. *The article presents materials on the study of the main tree species especially valuable for reforestation in the Kon Chu Rang nature reserve (Vietnam). It has been established that the diversity, as well as the physico-chemical and granulometric composition of the soil cover of the mountain range are due to the diversity of rocks in connection with the geological structures to which they are confined (the Pleiku plateau is located on basalt shales). It was revealed that the climatic conditions of the Kon Chu Rang nature reserve are characterized by high humidity and an abundance of precipitation throughout the year, which is why, due to the high washing regime, the soils are depleted of elements valuable for the growth and development of tree species. Most of the species grown in the nurseries of Vietnam are introduced, in this regard, the cultivation of seedlings and seedlings of valuable species for reforestation with a closed root system and an established irrigation regime, herbicides and fertilizers is required.*

Purpose. *To study the possibility of reproduction of native forest tree species in the conditions of the mountain plateau of Central Vietnam.*

Materials and methods. *The object of research was the climatic conditions of Vietnam, the soils of various relief elements of the Kon Chu Rang nature reserve, rare and especially valuable tree species: Dacridyum elatum Roxb. Wall. ex Hook., Michelia tonkinensis A. Chev., Dialium cochinchinense Pierre, Dipterocarpus kerrii King., Dacrycarpus imbricatus de Laub., as well as methods of their accelerated*

reproduction for reforestation. In order to determine the physico-mechanical and physico-chemical, chemical, agrochemical and biological properties of soils on the territory of the Kon Chu Rang nature reserve, soil samples were taken to a depth of 120 cm in increments of 10 cm on various elements of the mountain relief: on a shrub meadow site, in a forest with native tree species, on a pilot site of a hospital in the area of the reserve reserved for a forest nursery. When solving the tasks, methods of field experiment, expedition research were used, with the help of the Garmin device, the coordinates of the seed and seedling collection points were determined and fixed in order to build a route survey map. Seasonal development of trees was studied on the basis of field and research. The height of seedlings was measured at the beginning and end of the study period. Every plant in the collection was measured. The reproductive ability of species was studied by quantitative and qualitative characteristics of fruiting. In laboratory analyses were used the Kapel' – 105M, capillary electrophoresis system, laboratory scales TO VK-600, analytical scales VL-220C, spectrophotometer PE-5400 UV. Mathematical processing of the results is carried out in the MS Exel and Statistica application programs using small arrays of observational data that were combined into homogeneous clusters.

Results. *The article contains data from studies of mountain forest territories, relief and soils of the Kon Chu Rang nature reserve (Vietnam), the main results of which are aimed at preserving and reproducing indigenous especially valuable tree species exposed to anthropogenic impact. It has been determined that many introduced species of 12 nurseries in Vietnam are extremely difficult to reproduce in mountainous terrain due to their morphological and biological characteristics, as a result of which they cannot be used for reforestation. It was revealed that the soil cover of the Kon Chu Rang nature reserve is characterized by variegation, distribution of areas, granulometric composition and humus content. Due to the large amount of precipitation, the soils are depleted of the necessary composition of elements necessary for good growth and development of woody species. It is determined that for the successful cultivation of especially valuable tree species in the nursery, surface watering and constant maintenance of soil moisture, treatment with herbicides and fertilizers are necessary. Seedlings are recommended to be grown in containers with a closed root system.*

Conclusions. *Based on the data obtained as a result of studying the soil and climatic conditions of the Kon Chu Rang nature reserve (Vietnam), as well as the results of creating an experimental nursery of seed material for reforestation, it can be concluded that with the correct selection of irrigation standards, herbicides and fertilizers, it is possible to obtain a standard yield of standard planting material from a unit to ensure a high survival rate of seedlings and seedlings, as well as their*

subsequent growth, which will solve the urgent problems of improving the species composition of the indigenous forests of the Vietnam.

Keywords: *development; growth; Kon Chu Rang; mountain range; nature reserve; native tree species; soils*

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Научная статья

К ПРОБЛЕМЕ ЛЕСОВОССТАНОВЛЕНИЯ ДРЕВЕСНОЙ РАСТИТЕЛЬНОСТИ ГОРНЫХ МАССИВОВ ЗАПОВЕДНИКА КОН ТЮ РАНГ (ВЬЕТНАМ)

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Обоснование. *В статье представлены материалы по изучению основных особо ценных для лесовосстановления древесных видов в условиях заповедника Кон Тю Ранг (Вьетнам). Установлено, что пестрота, а также физико-химический и гранулометрический состав почвенного покрова горного массива обусловлены разнообразием горных пород в связи с геологическими структурами, к которым они приурочены (плато Плейку расположено на базальтовых сланцах). Выявлено, что климатические условия заповедника Кон Тю Ранг отличаются высокой влажностью и обилием осадков на протяжении круглого года, ввиду чего, из-за высокого промывного режима, почвы обеднены ценными для роста и развития древесных видов элементами. Большая часть выращиваемых в питомниках Вьетнама видов – интродуценты, в связи с этим требуется выращивание сеянцев и саженцев ценных для лесовосстановления пород с закрытой корневой системой и установленным режимом орошения, внесения гербицидов и удобрений.*

Цель. *Изучение возможности воспроизводства нативных лесных видов деревьев в условиях горного плато Центрального Вьетнама.*

Материалы и методы. *Объектом изучения являлись климатические условия Вьетнама, почвы различных элементов рельефа заповедника Кон Тю Ранг,*

редкие и особо ценные древесные виды: Dacridyum elatum Roxb. Wall. ex Hook., Michelia tonkinensis A. Chev., Dialium cochinchinense Pierre, Dipterocarpus kerrii King., Dacrycarpus imbricatus de Laub., а также способы их ускоренного размножения для лесовосстановления.

С целью определения физико-механических и физико-химических, химических, агрохимических и биологических свойств почв на территории заповедника Кон Тю Ранг были отобраны почвенные пробы на глубину 120 см с шагом в 10 см на различных элементах горного рельефа: на участке кустарникового луга, в лесу с нативными древесными видами, на опытном участке стационара в зоне заповедника, отведенном под лесной питомник. При решении поставленных задач использовались методы натурного эксперимента, экспедиционные исследования, с помощью прибора «Garmin» были определены и зафиксированы координаты точек сбора семян и сеянцев с целью построения карты маршрутного обследования. Сезонное развитие деревьев изучалось на основе натурных и исследований. Высота сеянцев измерялась в начале и конце периода исследований. Замерялось каждое растение в коллекции. По количественным и качественным характеристикам плодоношения изучалась репродуктивная способность видов. При лабораторных анализах использовалась система капиллярного электрофореза Капель – 105М, весы лабораторные К ВК-600, весы аналитические ВЛ-220С, спектрофотометр ПЭ-5400 УФ. Математическая обработка результатов осуществляется в прикладных программах MS Exel и Statistica с использованием малых массивов данных наблюдений, которые объединялись в однородные кластеры.

Результаты. *Статья содержит данные исследований горных лесных территорий, рельефа и почв заповедника Кон Тю Ранг (Вьетнам), основные результаты которых направлены на сохранение и воспроизводство коренных особо ценных древесных видов, подвергающихся антропогенному воздействию. Установлено, что большая часть ассортимента 12 питомников Вьетнама представлена интродуцированными видами, которые в условиях горного рельефа крайне трудно размножаются из-за своих морфологических и биологических особенностей, вследствие чего не могут быть использованы для лесовосстановления. Выявлено, что почвенный покров заповедника Кон Тю Ранг отличается пестротой, распределением площадей, гранулометрическим составом и содержанием гумуса. Ввиду большого количества осадков почвы обеднены необходимым составом необходимого для хорошего роста и развития древесных видов элементов. Определено, что для успешного выращивания особо ценных древесных видов на питомнике необходим поверхностный*

полив и постоянное поддержание почвенной влаги, обработка гербицидами и удобрениями. Сеянцы рекомендуется выращивать в контейнерах с закрытой корневой системой.

Выводы. *Основываясь на полученных в результате изучения почвенно-климатических условий горной территории заповедника Кон Тю Ранг (Вьетнам) данных, а также результатах создания экспериментального питомника посевного материала для проведения лесовосстановительных работ, можно сделать выводы о том, что при правильном подборе норм орошения, гербицидов и удобрений возможно получить нормативный выход стандартного посадочного материала с единицы площади, обеспечить высокую приживаемость сеянцев и саженцев, а также последующий их рост, что решит актуальные проблемы по улучшению видового состава коренных лесов Вьетнама.*

Ключевые слова: *заповедник; горный массив; Кон Тю Ранг; почвы; древесные виды; рост; развитие*

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Introduction

The relevance and novelty of research at the tropical research and technology center is due to the lack of database on dynamics and succession processes occurring in the most complexly organized and species-rich ecological systems. Research in the field of growing seedlings of the main species of native trees is of particular importance in the study and selection of species that can withstand the aggressive effects of tropical climate factors and anthropogenic impacts. Growing seedlings, nursery farming, conservation of biodiversity (gene pool), studying the transformation of nature and climate, restoration and management of environment-forming ecosystems, biosystems safety are relevant for both Russia and Vietnam. The conservation and restoration of tropical forest ecosystems currently faces numerous difficulties, since the structure of tropical forests is very complex: most of them are secondary forests that are influenced by anthropogenic factors, so their restoration in a natural way is difficult [6]. Wood resources, which are of high importance for the forest sector, ecology and economy, require constant assessment of the level of efficiency of their use [9]. The trends of the timber industry in Vietnam are currently developing insufficiently efficiently, which requires adjustment of their integrated use and

development of the most effective areas of use [1]. Most territories and rare endangered tree species are subject to intense anthropogenic impact, and their response is determined by the terrain, the general species composition of the monsoon tropical forest, the structure of the forest stand, natural and climatic factors, biological and morphological features, microclimate, soil and hydrological features of the growing area. Wooded areas are characterized by sharp boundaries of savanna-like communities and forest stands, which is not typical for tropical forests. The long-term stable existence of herbaceous communities, which is not typical for this territory, may indicate a violation of successional changes, and the absence of the possibility of reproduction of indigenous species due to the lack of seed sources (diasporic subclimax). soil and hydrological features of the growing area. Wooded areas are characterized by sharp boundaries of savanna-like communities and forest stands, which is not typical for tropical forests. The long-term stable existence of herbaceous communities, which is not typical for this territory, may indicate a violation of successional changes, and the absence of the possibility of reproduction of indigenous species due to the lack of seed sources (diasporic subclimax). soil and hydrological features of the growing area. Forested areas are characterized by sharp boundaries of savanna-like communities and tree stands, which is not typical for tropical forests. The long-term stable existence of herbaceous communities, which is not typical for this territory, may indicate a violation of successional changes, and the absence of the possibility of reproduction of indigenous species due to the lack of seed sources (diasporic subclimax).

An analysis of the assortment of 12 nurseries in Vietnam showed that, as before, more than half of the assortment are introduced species. Native tree species cannot be renewed even when seedlings are planted due to their biological and morphological characteristics.

In this regard, the issue of creating conditions for the restoration of native species through the formation of nurseries, where seedlings will be consistently introduced to artificially form the canopy of the buffer tree zone, is particularly relevant.

The purpose of this work is to study the possibility of reproducing native forest tree species of the mountain plateau in the Central Highlands of Vietnam.

Scientific novelty

Based on the data obtained as a result of further research on the growth, development, methods of reproduction of tree species (vegetative, seed), it is possible to develop a nursery base, the main task of which will be the cultiva-

tion of high-quality planting material with optimal conditions for its cultivation. Priority and topical areas are also measures to create a breeding base and maintain forest reproduction, preserve and increase biodiversity by providing a nursery on the basis of the Kon Chu Rang nature reserve with seed material for reforestation. This will make it possible to obtain the normative yield of standard planting material per unit area, to ensure high survival rate when transplanting seedlings and seedlings to the afforestation area, as well as their subsequent growth.

Materials and methods

In order to determine the physicomechanical and physicochemical, chemical, agrochemical and biological properties of soils on the territory of the Kon Chu Rang nature reserve, soil samples were taken to a depth of 120 cm in increments of 10 cm (coordinates of the sampling site N 14’28.449 E 108’32.552). Also, soil samples were taken on the territory where the model nursery was created for the purpose of comparative analysis (Fig. 1).

Fig. 1. Taking soil samples on the territory of the reserve

To take soil samples, samples were taken at a depth of 10–20 cm using a Kachinsky drill in layers (10 cm) to a depth of 120 cm. The mass of one sample was 0.5 kg. Immediately after sampling, the samples were transferred to plastic bags with labels indicating the date and place of sampling, and the depth of sampling. After transportation to the Russian Federation, the soil was dried to an air-dry state. Large aggregates were ground, plant roots and foreign inclusions were removed. The dried soil was ground in a porcelain mortar and sifted through a sieve, repeating the operation until only its stony part remained in the sieve. The unused part of the soil was placed in storage and provided with a label for future analyzes [11].

Using thermoweight analysis, the moisture content of the samples was determined, the moisture reserves were calculated using formula 1:

$$W\ 0.1*qh\ (u–k) \quad (1)$$

where W – reserves of productive moisture, mm in. With.

q – mass of 1 cm3 of soil, g

h – thickness of the horizon, or soil layer, cm

k – moisture content of stable wilting, %

0.1 – mm water column, conversion factor corresponding to a water reserve of 1 m/ha/

The following equipment was also used in the analysis: droplet electrophoresis system Kapel - 105M, laboratory scales K VK-600, analytical scales VL-220S, spectrophotometer PE-5400 UV.

When solving the assigned problems, methods of natural experiment and expeditionary research were used. Mathematical processing of the results is carried out in the MS Exell and Statistica application programs using small arrays of observational data, which were combined into homogeneous clusters.

Objects of research were selected based on the construction of survey routes. Species names were specified on the website of the International Nomenclature IPNI [14]. Using data from catalogs and reference books of the reserve, an analysis of the flora of the study area was carried out.

To study the growth of seedlings and the increments of germinating seeds, annual measurements of the stem height were carried out.

Phenological observations were carried out on the main phases of plant development.

The seasonal development of trees was studied on the basis of natural and research. Seedling height was measured at the beginning and end of the study period. Each plant in the collection was measured. According to the quantitative and qualitative characteristics of fruiting, the reproductive ability of the species was studied.

During the route study of a part of the territory of the reserve, fruits and seeds of the main species of woody vegetation found and valuable for further reproduction were identified and collected:

1) *Dialium cochinchinensis* Pierre. Dialium Colchis, or velvet tamarind. A protected species of the legume family (Fabaceae). A tree of medium height is about 35 m. The trunk diameter is 80-100 cm, the fruit is an ovoid pod, 18-20 mm long and 13-15 mm wide, the seeds (usually 1-2 pieces per fruit) are surrounded by edible pulp.
2) *Michelia tonkinensis* Dandy. (*Magnolia balansae* A. DC.). Valuable species of the Magnoliaceae family.
3) *Michelia mediocris*. Valuable species of the Magnoliaceae family. It is promising for reforestation of the forests of the Kon Chu Rang nature reserve.
4) *Dacrydium elatum* Roxb. wall. ex Hook. Family Podocarpaceae Endl. A tree is up to 30 m in height, with a diameter of up to 80 cm. It is a rare species, promising for propagation and restoration in natural plantings of the reserve.
5) *Dacrycarpus imbricatus* de Laub. A tree is up to 50 m in height and 50-70 cm in diameter. The species is nationally vulnerable species in Vietnam. It is important for the restoration of indigenous forests.

Also, the seed material of the main genera and families of high value for reforestation and nursery production in Kon Chu Rang nature reserve and the Central Highlands of Vietnam was isolated and collected: the family Lauraceae Juss. – 6 species, all of which were fruiting at the time of the survey of the territory of the reserve, the family Dipterocarpaceae Blume. – 3 species bearing fruit 2-3 weeks before the study, *Choeraspondias axillaris* BL Burtt and AW Hill (Anacardiaceae R. Br. family) – 1 species, Fagaceae Dumort family. nom. cons. - *Lithocarpus* - 8 species, almost all fruited in October-November, *Castanopsis* - 2 species (fruited in October-November), *Quercus* - 1 or 2 species, fruited in October-November, *Mastixia* Blume. (family Nyssaceae Juss. ex. Dumort.) - 1 species, fruiting in November, *Camellia* L. (family Theaceae Mirb. ex. Ker Gawl.) - 2 species, of which one fruited in November, the second - in October, *Hydnocarpus* Gaerth. (family Achariaceae Harms.), family Fabaceae Lindl. - Ormosia Jacks. – 2 species, fruiting in October-November, *Archidendron* sp. - 1 species, fruited in October-November, *Dialium cochinchinensis* - 1 species, fruited in October-November. With the help of the Garmin device, the coordinates of the places for collecting seeds and seedlings were determined and recorded in order to build a map of the route survey (Fig. 2).

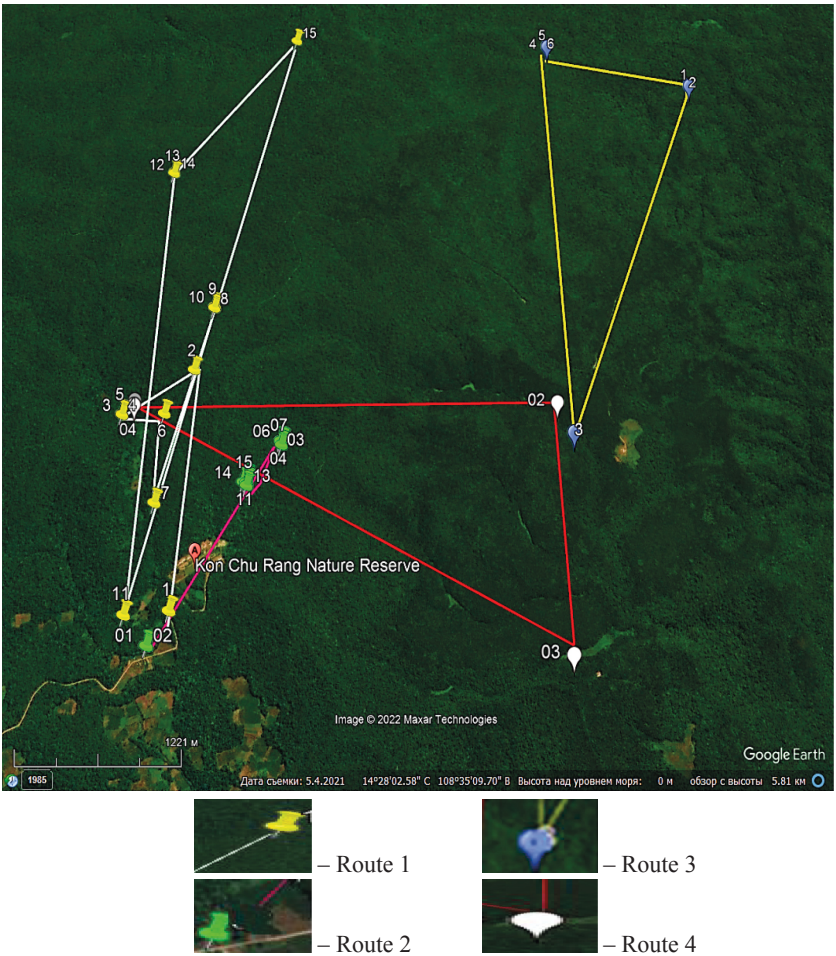

Fig. 2. Research routes

Results and discussion

During the study of natural conditions, it was found that the Con Thu Rang Nature Reserve is located on the border of the North Central Highlands and the South Central Coast of Vietnam [3, 7]. Thus, the climate simultaneously bears the characteristics of a tropical monsoon climate in the highlands and a tropical monsoon climate in the southern Central Coast (Fig. 3).

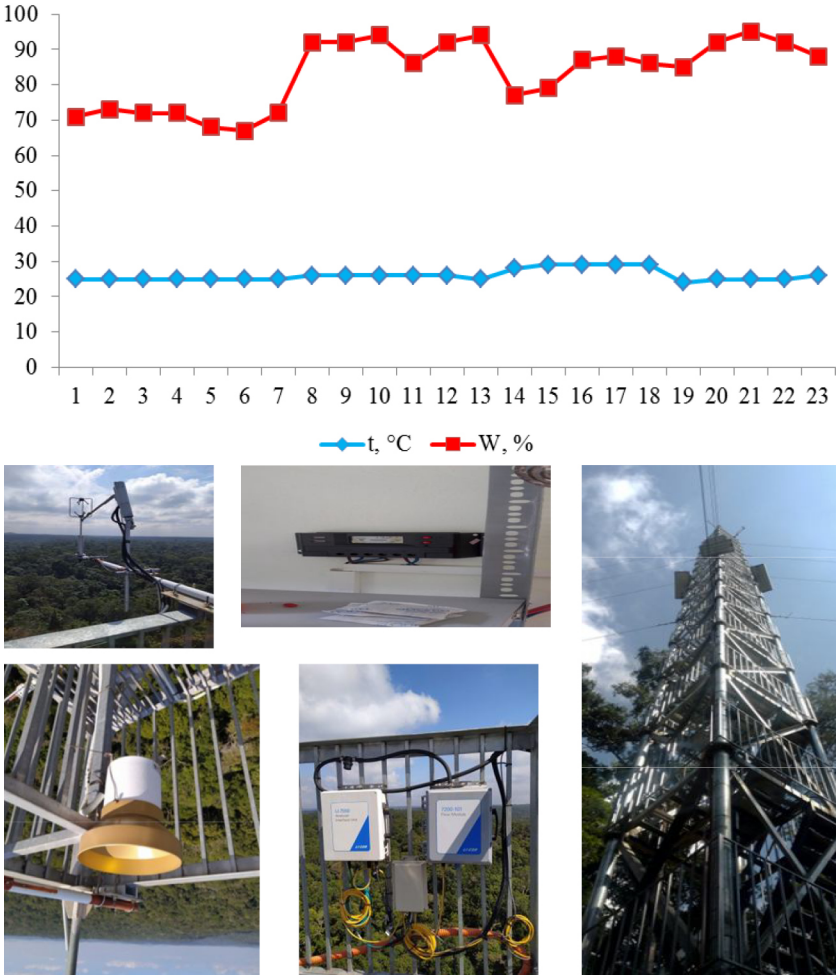

Fig. 3. Climatic conditions of the Kon Chu Rang nature reserve during the observation period and the climate tower

The climate of the reserve has the following main characteristics:

– There are 2 different seasons throughout the year: the rainy season and the dry season.

– The rainy season lasts from May to December. There are 2 periods of maximum precipitation - in May-June and October-November. There is usually a

dry period between the rainy season in July, August or September. Rare rainfall occurs during these months.

– The dry season lasts from January to April, the driest is in February, the amount of precipitation in this month is sometimes less than 10 mm. Precipitation during the dry season accounts for only 10-20% of the total annual precipitation.

– Temperature regime: the average annual temperature ranges from 20 to 23 °C. The temperature range between day and night is quite large - about 10 °C. The highest temperature does not exceed 38 °C (usually in April), the lowest temperature does not fall below 7 °C (usually in January).

– Rainfall: Due to the direct influence of the climate regime of the south-central coast, the rainy season lasts longer than in other areas of K'Bang district. Total annual precipitation ranges from 2000 to 2400 mm.

– Humidity: The average annual air humidity is quite high – 82%, the maximum value sometimes reaches > 90%, then, in the dry season, it decreases to 70-75% (Fig. 4) [10].

In the course of studying the territory of the Con Chu Rang Reserve along the route trails, it was found that a tree stand dominates in the tropical monsoon forest, along with this, tiers subordinate to the stand develop (Fig. 4).

Fig. 4. Monsoon rainforests of the Central Highlands of Vietnam

It has been established that shrubs play a small role in the shrub layer [17]. Due to root competition for oxygen, the content of which in tropical soils is very low, in places with dense shade, the undergrowth of tree species is well developed, plant vitality is 5 points (high).

Fig. 5. A typical epiphyte on a tree and a termite tree

On most tall trees, the presence of tubers of *Myrmecodia tuberosa* is noted, a species that is light-loving and does not tolerate shade under the canopy of a closed forest. Many species of ants settle in accumulations of detritus or in tuber cavities and build nests there (Fig. 5) [8].

It was revealed that significant changes in the tropical forest are currently taking place under the influence of anthropogenic factors, large areas of the forest, even after a single irrational selective felling, are not restored due to the poor soil composition. The development of a secondary forest was noted, characterized by rapid growth (12 m in 3 years), but short-lived, and low in height compared to the primary (Fig. 6).

Fig. 6. The results of anthropogenic impact on the rainforest and its pronounced tiering

During the study of mountain tropical forests, the authors studied the available information, including a trip to Pleiku (250 km from Kon Chu Rang nature

reserve) to the Tropical Forest Science Center nursery to get acquainted with the main assortment of plants. The nursery has been operating for more than 30 years, the total area of the center is about 400 hectares. Tree species grown: *Pterocarpus makrokarpus*, *Dalbergia cochinchinensis*, *Hopea odorata*, *Afzelia xylocarpa*, *Dalbergia bariaensis*, *Irvingia malayana*, *Pinus kesiya*, *Michelia mediocris*, *Paramichelia braiannesis*, *Dalbergia tonkinensis*, *Dipterocarpus alatus*, *Lagerstroemia speciosa*, *Dialium cochinchinensis*, *Michelia alatus kinensis*, *Gliptostrobus pensilis*, *Prunus arborea*, *Eurycoma longifolia*. Many of these species are grown for landscaping and urban greening.

During route surveys of the reserve territory, seeds and seedlings of rare and endangered tree species were collected, the preservation of which required a more detailed study of their morphological and taxonomic features using modern technology and equipment [4, 5, 2]:

– *Dacridium elatum* Roxb. wall. ex Hook. (Podocarpaceae). Tree (coordinates for collecting seeds and seedlings N 14028.164" E 108032.953"; N 14029.985" E 108032.738");

– *Michelia tonkinensis* A. Chev. (*Magnolia balansae* A. DC.). Tree (collection coordinates N 14028.214" E 108032.913");

– *Dialium cochinchinense* Pierre (Fabaceae). Tree (collection coordinates N 14028.214" E 108032.913");

– *Dipterocarpus kerrii* King. (Dipterocarpaceae). Tree (seed collection coordinates N 14030.745" E 108034.313").

– *Dacrycarpus imbricatus* de Laub. Tree (seed collection coordinates N 14029.081" E 108032.480") (Fig. 7).

During the research, it was found that the soils of Vietnam differ in the distribution of areas and granulometric composition [12]:

– Red-yellow ferrallitic soil (Fha): Area 7680 hectares, which is 49.8% of the reserve area in the northeastern mountains and upstream of the Sai stream. The soil is formed on hard rocks, so the humus layer and abundant litter are difficult to decompose. The soil texture is medium to light and porous, making it susceptible to erosion.

– Red-brown ferrallitic soil (FHk): An area of 5470 hectares, which is 35.5% of the reserve's area, occupies the southwest of the reserve, on the right bank of the Sai stream. The soil is formed on basalt rocks, the humus layer is quite thick. The soil layer is deep and uniform. The mechanical composition of the soil is heavy. The soil is porous and does not contain stone particles.

– Yellow-red feralite soil on sedimentary and metamorphic rocks (FHs): the area is 1450 hectares, which is 9.4% of the total area of the reserve. It spreads

from the northeast and left bank of the Sai stream to the border with Binh Dinh province. The soil is formed on sedimentary rocks and has a fine-grained composition. The soil layer is thick to medium, the humus layer is quite thick, more than 20 cm. The mechanical composition is heavy, the soil is quite dense.

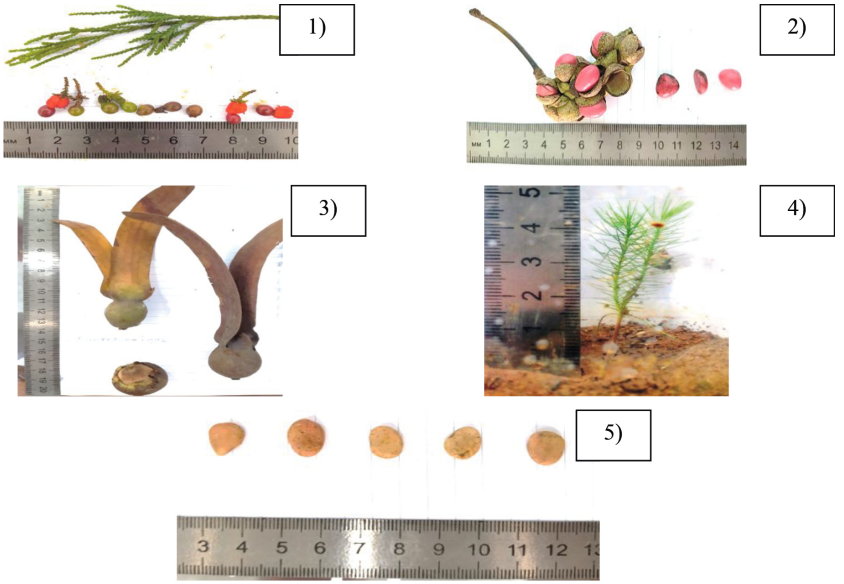

Fig. 7. Valuable tree species for reforestation of the mountainous territory of the Republic of Vietnam*: 1 – Dacridyum elatum, 2 – Michelia tonkinensis*, 3 – *Dipterocarpus kerrii*, 4 – *Dacrycarpus imbricatus, 5 – Dialium cochinchinense*

– Light yellow feralite soil (Fa): an area of 840 ha, which is 5.5% of the total area of the reserve. It extends along the valley of the Sei stream and the lowlands bordering Binh Dinh province, southeast of the reserve. The soil is formed on granite and rhyolite rocks. The rock is hard and difficult to weather, there are many mixed rocks in the soil layer, the humus layer is thin, the mechanical composition is light and coarse.

– In addition to the four types of soils described above, the presence of waterlogged soils in swamps, alluvial soils in the mouths of rivers and streams is also noted in the territory of the Kon Chu Rang nature reserve (Table 1) [19, 17, 16, 21, 13, 15, 20].

According to the results of soil analysis carried out jointly by the staff of the Tropical Center and the laboratory of the Federal Scientific Center for Agro-

ecology of the Russian Academy of Sciences, the soils of the mountainous areas of the Kon Chu Rang nature reserve are characterized by an extremely low content of substances necessary for tree species for good growth and development (Table 1, 2, 3).

Table 1.

The results of the analysis of 12 soil samples on the site of a shrub meadow with regenerating woody species (the territory of the implementation of the reforestation model)

Code	Ground depth	pH (KCl)	Soil mass ratio (g/cm^3)	(%)				(mg/100g)			Mechanical composition of the soil (%)			
				Humus	Total nitrogen	Total P_2O_5	Total K_2O	Total nitrogen	Total P_2O_5	Total K_2O	Coarse-grained sand (2-0,2)	Fine sand (0,2-0,05	Sludge (0,05-0,002)	Clay (<0,002)/
5762	0-10	4.309	2.456	5.785	0.278	0.186	0.060	5.88	1.61	21.63	9.19	12.42	29.20	49.19
5763	10-20	4.246	2.523	5.047	0.254	0.135	0.065	5.46	1.03	9.11	7.98	11.43	25.60	54.99
5764	20-30	4.242	2.518	3.446	0.197	0.147	0.053	4.48	0.67	7.98	7.05	5.76	23.00	64.19
5765	30-40	4.267	2.547	2.954	0.176	0.145	0.053	4.2	0.71	7.41	6.02	5.79	22.00	66.19
5766	40-50	4.280	2.479	2.462	0.148	0.140	0.048	4.06	0.58	7.69	6.82	6.98	18.20	68.00
5767	50-60	4.329	2.524	2.338	0.145	0.127	0.046	3.78	0.70	10.55	6.93	5.07	16.40	71.60
5768	60-70	4.375	2.55	2.092	0.131	0.116	0.046	3.36	0.64	7.41	6.87	4.13	15.60	73.40
5769	70-80	4.473	2.582	1.969	0.114	0.118	0.048	2.66	0.61	6.85	6.71	4.89	13.60	74.80
5770	80-90	4.522	2.581	1.477	0.095	0.115	0.043	2.52	0.84	5.46	6.57	4.04	15.40	73.99
5771	90-100	4.567	2.622	1.354	0.089	0.129	0.046	2.38	0.70	5.46	6.09	3.91	15.00	75.00
5772	100-110	4.600	2.621	1.354	0.086	0.133	0.048	2.24	0.82	7.41	6.48	4.52	14.60	74.40
5773	110-120	4.617	2.664	1.231	0.081	0.140	0.046	2.1	0.64	4.63	6.59	4.01	15.00	74.40

Table 2.

The results of the analysis of washed away soil on the territory of the Kon Chu Rang nature reserve in containers with plants

№ p/p	The name of the indicator	Units of measurement	Test results	Measurement uncertainty (error)	ND on the test procedure
1	Chloride	mg/kg	6.1	1.5	PND F 16.1:2:2.3:2.2.69-10
2	Fluoride	mg/kg	< 1		PND F 16.1:2:2.3:2.2.69-10
3	Total phosphorus	%	0.119	0.038	PND F 16.2:2.3.73-2012
4	Phosphate	mg/kg	< 3		PND F 16.1:2:2.3:2.2.69-10
5	Formate	mg/kg	< 1		PND F 16.1:2:2.3:2.2.69-10
6	Sulfate	mg/kg	6.9	1.7	PND F 16.1:2:2.3:2.2.69-10
7	Mobile phosphorus	mln^{-1}	0	0	GOST R 54650-2011

8	Mobile potassium	mln^{-1}	88	14	GOST R 54650-2011
9	Humus	%	0.79	0.16	GOST R 26213-2021
10	Oxalate	mg/kg	< 3		PND F 16.1:2:2.3:2.2.69-10
11	Nitrate	mg/kg	8.2	1.3	PND F 16.1:2:2.3:2.2.69-10
12	Sodium	mg/kg	3.95	0.64	PND F 16.1:2:2.2:2.3.74-2012
13	Magnesium	mg/kg	< 1		PND F 16.1:2:2.2:2.3.74-2012
14	Calcium	mg/kg	4.45	0.72	PND F/ PND F 16.1:2:2.2:2.3.74-2012
15	Potassium	mg/kg	2.79	0.45	PND F 16.1:2:2.2:2.3.74-2012
16	pH	pH	6.2	0.2	GOST R 26423-85
17	Acetate	mg/kg	< 3		PND F 16.1:2:2.3:2.2.69-10
18	Ammonium	mg/kg	< 2		PND F 16.1:2:2.2:2.3.74-2012
19	Nitrite nitrogen	mg/kg	0.061	0.025	PND F 16.1:2:2.2:3.51-08
20	Nitrogen of nitrates	mln^{-1}	3.9	1.3	PND F 16.1:2:2.2:3.67-10
21	Ammonium exchange	mln^{-1}	< 5		GOST R 26489-85

Table 3.

The results of the analysis of the forest soil on the territory of the Kon Chu Rang nature reserve in the horizon of 110-120 cm

№ p/p	The name of the indicator	Units of measurement	Test results	Measurement uncertainty (error)	ND on the test procedure
1	Chloride	mg/kg	32.0	4.8	PND F 16.1:2:2.3:2.2.69-10
2	Fluoride	mg/kg	< 1		PND F 16.1:2:2.3:2.2.69-10
3	Total phosphorus	%	0.116	0.038	PND F 16.2:2.3.73-2012
4	Phosphate	mg/kg	< 3		PND F 16.1:2:2.3:2.2.69-10
5	Formate	mg/kg	2.65	0.40	PND F 16.1:2:2.3:2.2.69-10
6	Sulfate	mg/kg	31.3	4.7	PND F 16.1:2:2.3:2.2.69-10
7	Mobile phosphorus	mln^{-1}	0	0	GOST R 54650-2011
8	Mobile potassium	mln^{-1}	98	15	GOST R 54650-2011
9	Humus	%	0.78	0.16	GOST R 26213-2021
10	Oxalate	mg/kg	< 3		PND F 16.1:2:2.3:2.2.69-10

11	Nitrate	mg/kg	10.0	1.5	PND F 16.1:2:2.3:2.2.69-10
12	Sodium	mg/kg	401	65	PND F 16.1:2:2.2:2.3.74-2012
13	Magnesium	mg/kg	13.8	2.3	PND F 16.1:2:2.2:2.3.74-2012
14	Calcium	mg/kg	32.1	5.2	PND F/ PND F 16.1:2:2.2:2.3.74-2012
15	Potassium	mg/kg	14.1	2.3	PND F 16.1:2:2.2:2.3.74-2012
16	pH	pH	7.3	0.2	GOST R 26423-85
17	Acetate	mg/kg	3.65	0.55	PND F 16.1:2:2.3:2.2.69-10
18	Ammonium	mg/kg	< 2		PND F 16.1:2:2.2:2.3.74-2012
19	Nitrite nitrogen	mg/kg	0.061	0.025	PND F 16.1:2:2.2:3.51-08
20	Nitrogen of nitrates	mln^{-1}	7.6	1.7	PND F 16.1:2:2.2:3.67-10
21	Ammonium exchange	mln^{-1}	< 5		GOST R 26489-85

To research on the reproduction of valuable species and develop a technology for their reproduction for the purpose of subsequent planting on a forestry area, an experimental nursery with an area of 36 m^2 was created with a surface irrigation system and various levels of shading. The form of growing plants on this site is a closed root system, in containers (for better survival of seedlings and saplings when planted in reforestation areas). In addition, seeds of most species were prepared to study the possibilities of their storage, as well as to test various germination methods in the laboratory (Fig. 8).

Seeds and seedlings were treated with preparations against pests - Katera 50 EC, 0.75 ml/l of water, against diseases - Cymanil 720 WP, 3 g/l of water, liquid complex fertilizers containing NPK + ME. The preparations were applied using a hand sprayer. After planting, constant soil moisture was maintained.

Treatments for pests and diseases were carried out every 15-20 days, these treatments were recommended to be combined (two preparations in one solution).

Fertilizers were applied every 20 days according to instructions, after which additional watering was used for 10 minutes. Seedlings and seeds in containers at the nursery were placed evenly on the sunny and shady sides. Presumably, in shade-loving species, too intense sunlight can cause burns and pathological pigmentation of leaves. Light-loving plants prefer scattered and indirect sunlight, which does not burn as they pass through the upper tier of the tropical forest into the second tier, where they are located.

In the course of studying the germination and germination of seeds, we found that many species that are valuable for reforestation and nursery production in Vietnam are difficult to propagate by seeds, or their seed germination is extremely low.

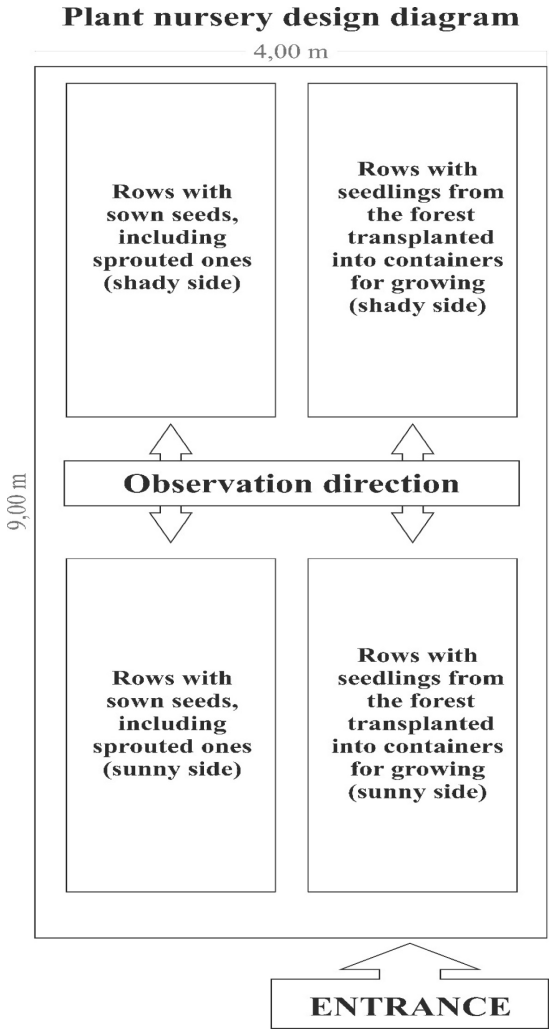

Fig. 8. Nursery diagram

Seedlings of the valuable species *Dacrydium elatum* and *Dacrycarpus imbricatus* responded positively to the method of planting and treatment; during the study period, growth dynamics of 1 to 3 cm were observed, the root system also grew and developed evenly (Fig. 9, 10).

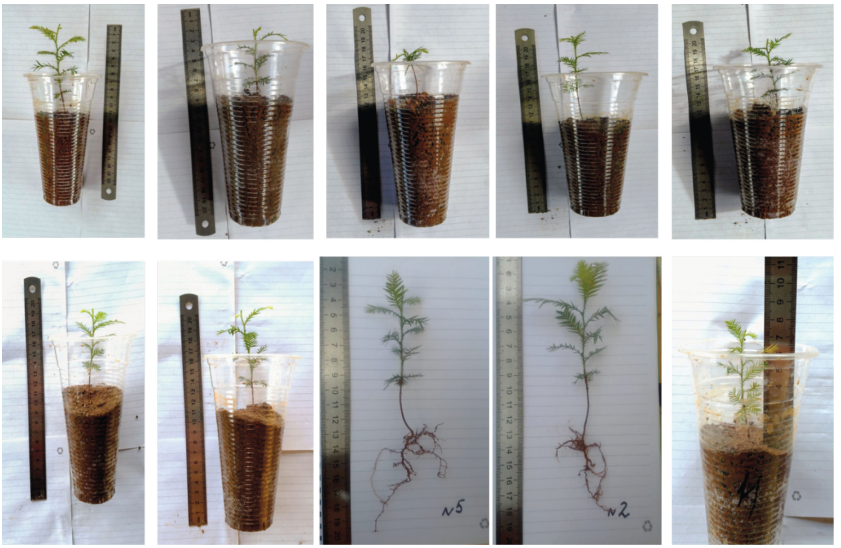

Fig. 9. Observations of *Dacrycarpus imbricatus* seedlings in containers

High rainfall and leaching regime remove all nutrients from the soil and direct them deeper. The remaining nutrients are quickly absorbed by a large number of plants. Litter helps increase the organic matter content, but it decomposes quickly due to high temperatures, insect activity and high humidity. The remaining nutrients are quickly consumed by plants, resulting in depleted soil.

Given the constancy of climatic conditions in the tropical monsoon forests of the Kon Chu Rang Reserve, the periodicity is not expressed here. It should be noted that the tree stand here is equally green throughout the year. The phenomena of the periodicity of growth and development of species require additional study, due to the fact that the phases of development in some species do not coincide - moreover, these phases are not synchronous even in individual individuals of the same species. Due to short dry periods, the moisture consumption of the entire transpiring leaf mass increases, and the root system uses only an insignificant part of the soil moisture reserve - as a result, trees often experience a regular moisture deficit. Based on the data obtained, the following conclusions can be drawn:

– The article contains data from studies of mountain forest areas, topography and soils of the Kon Chu Rang nature reserve (Vietnam), the main results of which are aimed at the conservation and reproduction of indigenous, especially valuable tree species exposed to anthropogenic impact.

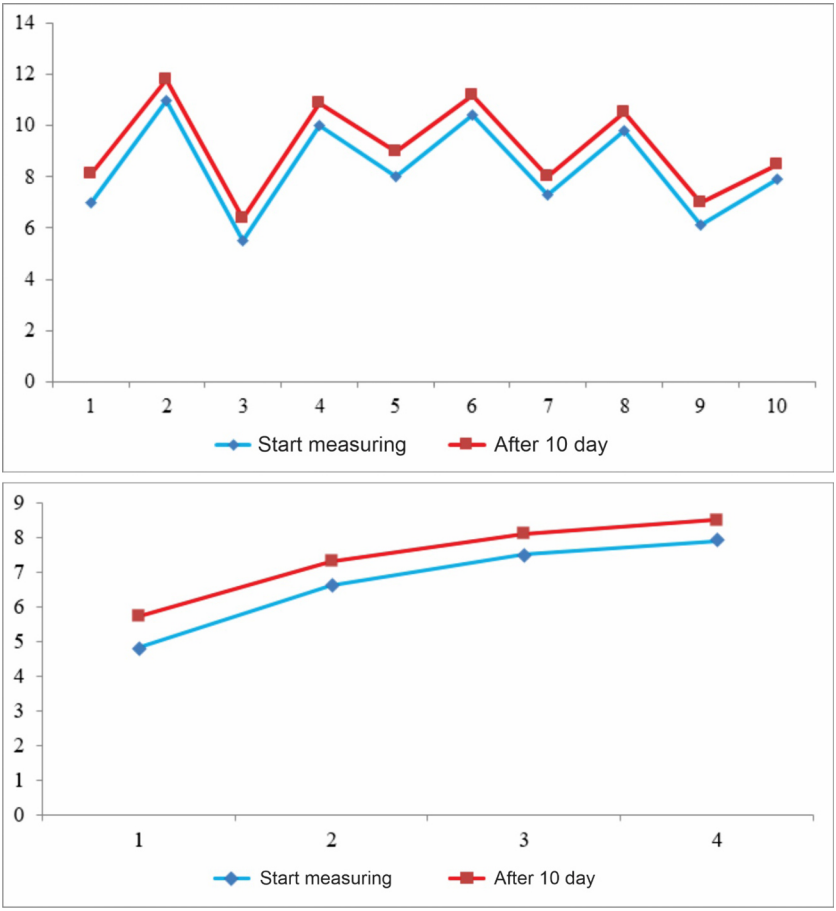

Fig. 10. Growth of seedlings of *Dacrycarpus imbricatus* (a) and *Dacrydium elatum* (b) on washed-away soils of the Kon Chu Rang nature reserve

– It has been established that most of the assortment of 12 nurseries in Vietnam is represented by introduced species, which in mountainous terrain are extremely difficult to reproduce due to their morphological and biological characteristics, as a result of which they cannot be used for reforestation.

– It was revealed that the soil cover of the Kon Chu Rang nature reserve is distinguished by diversity, distribution of areas, granulometric composition and humus content. Due to the large amount of precipitation, the soils are depleted

in the necessary composition of the elements necessary for the good growth and development of woody species. Thus, in the conditions of shrub meadows, the content of humus is much higher than in a forest with a primary stand.

– It was determined that for the successful cultivation of especially valuable tree species in the nursery, surface watering and constant maintenance of soil moisture, treatment with herbicides and fertilizers are necessary. It is recommended to grow seedlings in containers with a closed root system.

Sponsorship information. The work was carried out within the framework of the topic E-1.6 "Development of technology for growing seedlings of the main native trees species of indigenous forests in Vietnam as the basis for solving the fundamental scientific problem of tropical forest restoration." Joint Vietnam-Russian Tropical Science and Technology Research Center.

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Tran T.T. Huong: drafting of the manuscript and its critical revision with the introduction of valuable comments of intellectual content, participation in a scientific experiment.

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