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WEED PTERIDOPHYTES FOR THE SOCIALIST REPUBLIC OF VIETNAM

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The study of the flora for the Socialist Republic of Vietnam (SRV) has received sufficient attention over the past decades. Pteridophytes were cited as an inherent spore component for the vascular flora. Active conversion of landscapes containing intact forests has created suitable habitats for alien species by changing the structure of phytocenosis. The government of Vietnam is actively developing a legislative framework on the issues for combating alien “agents” on its territory. In 2008, the Biodiversity Law appeared, which became the first national legislative document, then circulars were developed in 2011, 2013 and 2018. Thereby it’s circulars Vietnam officially began to combat and control the spread of invasive species on its territory. For the goal of our research, we chose pteridophytes, at the moment, 1133 species from 170 genera and 38 families have been identified in Vietnam (including Lycopodiopsida). Many species are quite widespread not only in natural habitats, but are also present in cities, on arable lands and in urban communities. We noted 82 species from 38 genera and 17 families, among which 20 are exotic species, and 62 are native species that can grow/occupy biotopes and cenoses that are not typical for them in nature. Most fern-like plants were observed in the synanthropic group and in disturbed habitats. The process of introduction in countries with tropical and subtropical climates is poorly controlled, and spore plants, due to the insignificant mass of spores, can spread over fairly large distances. However, data on “weedy” fern species in Vietnam are still insufficient or contain incomplete information on the geographical distribution and population size of specific species compared to studies of aquatic invasive plant species in developed countries [18]. Domestic standards need to be brought into line with international ones, and the provision of scientific and standardized work for biodiversity and ecosystem services must be strengthened.

Key words: *Vietnam; pteridophytes; weeds; invasion*

Introduction

The study of the flora within the Socialist Republic of Vietnam (SRV) has received sufficient attention over the past decades, however different systematic groups of plants have been identified with varying degrees of data. In most cases, the subject of botanical research is angiosperms, which are most common in modern environmental conditions. Pteridophytes were cited as an integral spore component for the general flora of vascular plants within the analyzed/studied territories of SRV or its constituent parts.

Situated in one of the world's 25 biodiversity hotspots, Indo-Burma, where biodiversity conservation is a national as well as a global concern, SRV is native habitat to 0.5% endemics of the region's 300,000 plant species [15] and has a wide range of habitats from cold temperate climates to tropical rain forests in the East Asian region. Gradual and sometimes active conversion of landscapes containing intact forests has not only led to direct loss of biodiversity, but has also created more suitable habitats for alien species by changing the structure of nature plant communities. Although most cultivated plants in Vietnam are native species, many are introduced from other regions or brought for food, medicine, horticulture or ornamental purposes.

It should be noted that the government of Vietnam is actively developing a legislative framework on the issues of combating alien “agents” on its territory. In 2008, the Biodiversity Law appeared, which became the first national legislative document [28]. It included a section assigning responsibilities and various tasks associated with the prevention, detection and control of invasive alien species. Later in 2011, the Ministry of Natural Resources and

Environment of SRV published the first list of 101 taxa, which included: microorganisms, invertebrates, fish, reptiles, birds and, group of plants we are interested in [2]. The list of species was divided into three categories for different levels of invasive impact. The circular was revised twice: in 2013 [11] and in 2018 [18], the new document was considered criteria for assessing the risks of alien species, as well as identifying invasions. Due to these circulars, Vietnam officially began to fight and control the spread of invasive species on its territory, considering alien "agents", the success of the invasion depends on many factors, including biological characteristics, ability to reproduce, disperse and disseminate, rivalry, as well as abiotic environmental factors habitats into which they were introduced [18, 30].

In the National Parks of Vietnam in 2012, work was carried out to detect invasive "agents", including several plant species, but, unfortunately, recommendations for combating invasions of these species were not developed [26]. The lack of scientifically based data and research for control against alien 'agents' in Vietnam is especially problematic, since the destruction of invasive species will be successful if the process is started before, they infiltrated and spread in nature habitats. According to the Biodiversity Convention, all efforts and decisions regarding the management of invasive species must be based on a "precautionary approach" which states "Where there is a threat of serious or irreversible damage, lack of full scientific certainty cannot be used as a reason to delay cost-effective measures to prevent environmental degradation" [29]. Many scientists involved in biological invasions [18, 21, 30] talk about the need to create a database for potential and invasive species, which, in particular, needs to be developed in SVR.

Materials and methods

The research was carried out using the route method in three parts of Vietnam: North, Center and South. The field work (manipulations with living plant in situ and floristic description of its habitat) was performed by author in the Joint Russian-Vietnamese Tropical Scientific and Technological Center and A. N. Severtsov Institute of Ecology and Evolution of RAS in 2021.

Pteridophytes of Vietnam, including introduced ones. The IUCN Classification of Alien Species [10], the legislative documents of the Socialist Republic of Vietnam on alien "agents" - laws, list of alien species, circulars [2, 3, 11, 28] were used. The methodological basis was the generally accepted directions and approaches reflected in the works of Pysek P., Richardson D.M., as well as the Witt A.B.R. guide for invasive species of Southeast Asia [18, 30].

Results

The goal of our study was to identify pteridophytes in synanthropic and ruderal habitats of Vietnam. This group of plants is adequately represented in the general flora of SRV. The updated checklist of pteridoflora (including Lycopodiopsida) contains 1133 native species from 169 genera and 38 families according to the PPG I system [17] with additions from Testo et al. [27] where segregated genus *Bosmania* from the paraphyletic genus *Microsorum* Link, and Zhao et al. [31] expanded the definition of genus *Lepisorus* (J.Sm.) Ching and new vision of Thelypteridaceae [6]. Specific epithets are given according to GBIF Secretariat [7]. Many species are quite widespread not only in natural habitats, but are also present in cities, arable lands and urban communities. Among this group, we noted 82 species from 38 genera and 17 families, among which 20 are introduced species, i.e. 62 ferns are native species that can grow/occupy biotopes and cenoses that are not typical for them.

The composition of the general flora itself is largely determined by the presence of a certain number of ecological niches on the territory, on the one hand, and, on the other, the uniqueness of the ecological relationships of species to the conditions of the territory [12].

One of the most popular systems for life forms of vascular plants in the world is the classification proposed by the Danish botanist Ch. Raunkiaer [4, 20], which played “no less a role in the development of physiognomy than the work of K. Linnaeus in the field of taxonomy plants” [13]. The Raunkiaer's system is based on a feature that “at first glance seems private, has a deep biological meaning” [8] - position above the surface of the earth and a method of protecting renewal buds during an unfavorable, cold and dry period. It should be noted that Ch. Raunkiaer, when developing his system for life forms, ignored pteridophytes, considered them in passing, or excluded them altogether [23]. In our opinion, the biomorphs of ferns are quite correctly integrated into this system, which we used to process of pteridoflora.

Biomorphological analysis, in this case of “weedy” ferns, is important for understanding the characteristics of spatial division and place in the system of higher-ranking phytochories [12, 14]. The importance of biomorph analysis is reflected in the works of, for example, Ch. Raunkiaer [4, 20], but it should be noted that Christen himself worked on higher angiosperms and focused on boreal and subtropical forests, due to why epiphytic plants are poorly developed in its biomorphs. Later, Takahide Hosokawa [25] proposed supplementing the existing biomorph system with his own, based on epiphytic plants, which is why Raunkiaer’s system acquired the missing parameters. There are some clarifications that need to be clarified. It is absolutely clear that therophytes experience the first stages for their ontogenesis in the form of seeds, but seeds and spores in the evolution of plants arose, among other things, to survive the cold or dry seasons. The seeds and spores of phanerophytes, chamaephytes, hemicryptophytes and cryptophytes a priori have this ability. Monocarpic herbaceous plants can exist for more than one year, in which case their survival strategy fits into the hemicryptophyte scheme. In this connection, we believe that the use of Ch. Raunkiaer’s system when processing fern-like plants and pteridofloras is quite correct. Difficulty arose in classifying some species as biomorphs indicated by Ch. Raunkiaer. The studied habitats of these species allow us to identify joint groups, such as E-H, E-Ch, Th-Ch, H-E, especially since the possibility of such manipulations was indicated in the articles of foreign followers of Ch. Raunkiaer [23, 24].

Spectrum’s analysis for the biomorphs of “weed” species (table 1) according to Ch. Raunkiaer’s system of Vietnam’s pteridoflora shows the absence phanerophytes life form, the presence of which, among ferns, is characteristic of tropical and subtropical floras and strongly depends on the altitude above sea level, where with increasing altitudes the number of species increases this group [22, 23, 24]. This group makes up 0.9% of the total amount of all pteridophytes flora. It is interesting to note that among fern-like plants there are also non-pure therophytes (T-Ch), which, according to Ch. Raunkiaer, experience an unfavorable period in the form of seeds, in this case in the form of spores. Indeed, a rather rare group in tropical climates, and is associated only with disturbed communities and weed associations. These are representatives of the Lycopodiopsida class of the Selaginellaceae family – *Selaginella helferi* Warb. and *S. uncinata* (Desv. ex Poir.) Spring, which completely die off during the dry period, and only after the wet period begin to germinate and vegetate, but at the same time, in the humid conditions of tropical and subtropical forests they behave like perennial plants and true chamaephytes.

From the Raunkiaer’s life forms we noted six in Vietnam: chamaephytes (2% of the composition of the pteridoflora), hemicryptophytes (2.1%), geophytes (0.5%), lianas (0.6%), epiphytes (1.1%), hydrophytes (0.4%) and four complex ones: hemicryptophytes-epiphytes (0.2%), therophytes-chamaephytes (0.2%), epiphytes-hemicryptophytes (0.1%), epiphytes-chamaephytes (0.1%).

Considering chamaephytes, in which renewal buds are located above the surface of the earth, we are forced to state that this is one of the numerous biomorphs among ferns from

SRV, which is second only to hemicryptophytes. These include representatives of the genera Cyrtomium, Diplazium, Dryopteris, Bolbitis and many representatives within the Thelypteridaceae family. Mature sporophytes of these species have vertical rhizomes of an orthotropic type, where renewal buds, according to our observations, are located at a height of mainly 15-18 cm. Only in the swamp-mangrove species Acrostichum aureum L. renewal buds can be located at a height of 25 cm from substrate, and in Pseudocyclosorus falcilobus (Hook.) Ching can reach 80 cm.

Table 1

Biomorphological features of "weedy" ferns of Vietnam

Life form by Raunkiaer, 1934, modified by Hosokawa, 1949			Families	Genera
CHAMAEPHYTES	Ch herb	18	5	12
	Ch herb rept	4		
HEMICRYPTOPHYTES	eH coesp	7	6	8
	eH rept	12		
	H ros	1		
	hyd H rept	3		
	hyd H caesp	1		
HEMICRYPTOPHYTES-EPIPHYTES	eHrept-Rd	2	1	2
GEOPHYTES	G rhiz	2	2	3
	G rad	4		
THEROPHYTES-CHAMAEPHYTES	metT rept-Ch herb rept	2	1	1
LIANAS	dGl	1	3	4
	elGl	3		
	stGl	3		
EPIPHYTES	F	3	1	1
	Rr	9	1	4
EIPIHYTES-CHAMAEPHYTES	F-Ch herb	1	1	1
EPIPHYTES-HEMICRYPTOPHYTES	Rr-eH rept	1	1	1
HYDROPHYTES	kHyd nat	5	1	2

Hemicryptophytes, in which renewal buds are located on the surface of the earth and are protected by litter during unfavorable periods, are the most numerous groups among synanthropic-ruderal species. As a rule, it has a massive distribution in humid regions and contains rich intragroup diversity. They have short rhizomes located close to the surface of the substrate and can quickly colonize new habitats (*Adiantum*, *Nephrolepis*, *Pteris*, *Marsilea*). This biomorph is dominant in humid regions, and is often the main group of plants in areas with deciduous forests [23, 24].

Geophytes are the smallest group of analyzed plants (6 species, 0.5% of the general pteridoflora composition), which, according to foreign researchers [23, 24], are characterize of regions with a Mediterranean or steppe climate and reflect seasonal moisture deficiency, they also indicate that Ch. Raunkiaer did not take into account the spore component in the spectra. For sparse bleached forests, as well as moderately transformed by anthropogenic or pyrogenic factors, roadsides and ditches, we noted the following genera: *Pteridium*, *Histiopteris*, *Equisetum*.

Lianas are considered as a special group of both woody -and herbaceous plants, with renewal buds both outside and close to the surface of the earth and under it, plants that are quite widespread in different types of climates and vegetation. Despite all the morphological diversity, the author singled out a separate group - annual (therophytic) lianas. Among pteridophites there are three varieties, which form 0.6% (7 species) of the general

pteridoflora. The most potentially dangerous in terms of "capturing" territory and fouling of tree and shrub species is the Lygodiaceae family, with three species *Lygodium flexuosum* (L.) Sw., *L. japonicum* (Thunb.) Sw., *L. microphyllum* (Cav.) R. Br.

Epiphytes. In fact, this group of plants was rather poorly studied by the author and only 15 years later it was refined and developed by T. Hosakawa in 1943, and supplemented in 1949, where he identified the main environmental factors that had a significant impact on vascular epiphytic plants [25]. In this case, these are the two main factors associated with water and light. Life forms that are an adaptation to the water factor are clearly distinguished, for example, succulent (xerophilic form), and another as hygromorphic (inflated character and filmy character of leaves). Life forms in relation to the light factor are those types of plants that manage to increase the perceived area of light to receive it sufficiently; these include the following adaptations: elongated internodes, mostly sympodial shoots or elongated monopodia with shortened internodes or axes. In the conditions of the SRV, this group is not the most representative in terms of the variety of adaptations, where nesting sedentary ones include *Platycerium alcicorne* (P.Willemet) Desv., *P. bifurcatum* (Cav.) C.Chr., *P. coronarium* (D.Koenig ex O.F.Müll.) Desv. being cultivated and synanthropic species except for crown platycerium, and two genera - mobile creeping *Selliguea enervis* (Cav.) Ching, *S. triloba* (Houttuyn) M.G. Price and *Pyrrosia lingua* Farw. Also, in this group there is an interesting feature in the small-leaved pyrrosias - *Pyrrosia adnascens* (Sw.) Ching, *P. nummularifolia* (Sw.) Ching, *P. piloselloides* (L.) M.G. Price, under the shoots of which wood-destroying fungi develop, harming the nursery industry of Vietnam.

Hydrophytes include species that do not attach or take root on substrates and float freely on the surface of the water in watercourses and reservoirs. Ch. Raunkier called this group of life forms "Errant vascular Hydrophytes". The group contains 5 species from two genera *Salvinia* and *Azolla* from the Salviniaceae family, in which, with the onset of an unfavorable period, sporocarps sink to the bottom of standing or slow-flowing water bodies, where the next year they germinate and form annual plants, which in favorable conditions, especially in the southern regions and regions with a tropical climate they are capable of producing significant biomass.

From the combined groups we found hemicryptophyte-epiphytes (*Bosmannia membranacea* (D. Don) Testo, *Microsorum punctatum* (L.) Copel.), epiphyte-chamaephytes (*Asplenium australasicum* (J. Sm.) Hook.), epiphyte-hemicryptophyte (*Goniophlebium amoenum* (Wall. Ex Mett) J. Sm.), therophytes-chamaephytes were discussed above. All noted species are synanthropic or cultivated.

The prevalence of invasive plant species is determined by their reproductive characteristics, including seeds and vegetative propagation [5]. For example, among the 403 invasive plant species from the People's Republic of China (PRC), 389 species reproduce by seeds, 110 species reproduce vegetatively, and 96 species reproduce by both methods. The characteristics of invasive plant species seeds determine their ability to disperse over long distances [19]. One hundred and fifty invasive plants have light or small seeds that are easily spread by wind, water, or other similar media. Based on this, in this matter we cannot use the degrees of impact/categories of the IUCN Classification [10], since natural species are not taken into account in works of this kind, and only alien species that have invaded the flora are considered. It is interesting to note that in some research on the PRC, the authors introduce a new category - native/local species, and they also indicate that of all 403 invasive species of the PRC, they make up 0.5% and have light or small seeds that are easily spread by the wind.

We identified eight groups of fern-like plants according to impact criteria (table 2). Dangerous "agents" for plantations were local species of *Pyrrosia* genus*: Pyrrosia adnascens*, *P. nummularifolia*, *P. piloselloides*, under the phytomass of whose shoots wood-decaying fungi develop, harming the nursery industry of Vietnam. In fact, in 96% of cases, mycelia of

wood-decaying fungi develop en masse under the stems of these epiphytes. Also, it is necessary to note the work of Chie Tsutsumi et al. [1] where he and his co-authors studied the anatomical features of *Pyrrosia piloselloides* and provided evidence that this species can be classified as semi-parasites, in any case, this feature needs to be studied further.

Another group of species from the Lygodiaceae family (*Lygodium flexuosum*, *L. japonicum*, *L. microphyllum*) is also noted by us on plantations, in disturbed habitats, identifies a separate category - "physical or structural impact on the ecosystem" and can be included in disturbed habitats and plantations. According to the classification [10] for invasive species, certain "agents" can have a structural impact on the ecosystem, capable of transmitting diseases, reducing water quality, and some of the same criteria can be applied to weedy native species. A priori, native species may not threaten local biodiversity, but may have structural impacts on the ecosystem. For example, species of the genus *Lygodium* - *L. flexuosum*, *L. japonicum*, *L. microphyllum* can be very aggressive environmental transformers due to their unlimited growth and, in our opinion, these species can be transferred from progressive to invasive species in the future. Pteridophytes from natural phytocenoses are actively settling into ruderal and synanthropic habitats. These species include 62 representatives from the pteridoflora of Vietnam, which, according to the modern classification, can be classified as "progressive". In regions with similar climate types, representatives of this group can become invasive and even transform ecosystems, since in a fairly short period they can lead any type of vegetation to degradation, especially since this trend has already been noted in the USA, such as in the state of Florida *L. japonicum* and *L. microphyllum* are strong transformative aggressors.

Aquatic ecosystems, watercourses, lakes are also actively exposed to the effects (overgrowth/fouling) of ferns. It should be noted that these species behave like annual plants, but in tropical climates they can also be perennial-green species. Basically, this category, which worsens water quality and affects aquatic ecosystems in Vietnam, consists of the Salviniaceae family - *Azolla caroliniana*, *A. cristata*, *A. pinnata*, *Salvinia cucullata*, *S. natans*. The most widespread in the study area are two potentially dangerous species: *Azolla pinnata* and *Salvinia cucullata*. The first one is of historical significance, it appeared quite a long time ago and went into natural aquatic ecosystems from rice paddies, moreover, it is already part of the pteridoflora of SRV, and we can classify it as an archaeophyte, and salvinia penetrated into reservoirs and watercourses as a garden plant, a neophyte. Both representatives behave very aggressively and produce colossal amounts of phytomass, which harms both water quality and aquatic biocenoses.

For the meadow type vegetation, as well as agrophytocenoses, chamaephytes and long-rhizome geophytes and lianas from the family Gleicheniaceae have a negative impact. As is known, ferns and horsetails are not eaten by cattle; in addition, genera such as *Pteridium*, *Diplopterigyum*, *Dicranopteris* modify the environment and impair the growth qualities of angiosperms. Most pteridophytes were observed in the synanthropic group and also in disturbed habitats. The process of introduction in countries with tropical and subtropical climates is often poorly controlled, and spore plants, due to the insignificant mass of spores, can spread over fairly large distances. On the one hand, they can occupy different stations in urban communities, and on the other hand, they can penetrate into neighboring plant communities. In large cities of Vietnam, you can find many cultivated alien species, such as *Asplenium australasicum*, *Nephrolepis biserrata* cv. *Furcans*, *N. hirsutula* cv. *Duffii*, *Phlebodium aureum*, *P. pseudoaureum*, *Platycerium alcicorne*, *P. bifurcatum*, *Adiantum latifolium*, *A. raddianum*, *Pteris cretica* cv. *Wilsonii*, *P. ensiformis* cv. *Victoriae*, *P. parkeri*, *P. tremula* R.Br., *Tectaria gemmifera*. Aboriginal species penetrate well into cities, mainly *Bosmania membranacea*, *Goniophlebium amoenum*, *Microsorum punctatum*, *Ceratopteris thalictroides*, *Pteris multifida*, *P. vittata*, *Cyrtomium falcatum*, *C. fortunei*, *C. macrophyllum*,

Odontosoria chinensis, *Amblovenatum terminan*, *Christella dentata*, *C hispidula*, *C. parasitica*, *Cyclosorus interruptus*, *Macrothelypteris torresiana*, etc.

Table 2

Pteridophytes of SRV and criteria for their distribution/impact

Distribution/impact criteria	Species
gardens and plantations, accompanying the spread of mycoses	*Pyrrosia adnascens* (Sw.) Ching, *P. nummularifolia* (Sw.) Ching, *P. piloselloides* (L.) M.G.Price, *Lygodium flexuosum* (L.) Sw., *L. japonicum* (Thunb.) Sw., *L. microphyllum* (Cav.) R.Br., *Platycerium coronarium* (D.Koenig ex O.F.Müll.) Desv., *Diplazium dilatatum* Blume, *D. esculentum* (Retz.) Sw.
reduce water quality or are biofouling	*Azolla caroliniana* Willd., *A. cristata* Kaulf., *A. pinnata* R.Br., *Salvinia cucullata* Roxb. & Wall., *S. natans* (L.) All., *Ceratopteris thalictroides* (L.) Brongn.
physical or structural impact on an ecosystem	*Lygodium flexuosum* (L.) Sw., *L. japonicum* (Thunb.) Sw., *L. microphyllum* (Cav.) R.Br.
meadows/fields	*Diplazium dilatatum* Blume, *D. esculentum* (Retz.) Sw., *Stenochlaena palustris* (Burm.) Bedd., *Histiopteris incisa* (Thunb.) J.Sm., *Pteridium aquilinum* (L.) Kuhn subsp. *wightianum* (Wall. ex J.Agardh) W.C.Shieh, *P. esculentum* (G.Forst.) Nakai, *P. rostratum* (Burm.fil.) Fraser-Jenk., Equisetum arvense L. subsp. *diffusum* (D.Don) Fraser-Jenk., *E. ramosissimum* Kunth, *Diplopterygium chinense* (Rosenst.) De Vol, *Dicranopteris linearis* (Burm.f.) Underw., *D. pedata* (Houtt.) Nakaike
disturbed habitats	*Selaginella helferi* Warb., *S. uncinata* (Desv. ex Poir.) Spring, *Lygodium flexuosum* (L.) Sw., *L. japonicum* (Thunb.) Sw., *L. microphyllum* (Cav.) R.Br., *Acrostichum aureum* L., *Tectaria impressa* (Fée) Holttum, *Diplazium dilatatum* Blume, *D. esculentum* (Retz.) Sw., Stenochlaena palustris (Burm.) Bedd., *Histiopteris incisa* (Thunb.) J.Sm., *Equisetum arvense* L. subsp. *diffusum* (D.Don) Fraser-Jenk., *E. ramosissimum* Kunth, *Diplopterygium chinense* (Rosenst.) De Vol, *Dicranopteris linearis* (Burm.f.) Underw., *D. pedata* (Houtt.) Nakaike, *Amblovenatum terminans* (Wall. ex Hook.) J.P.Roux, *Christella dentata* (Forssk.) Brownsey & Jermy, *C. hispidula* (Decne.) Holttum, *C. parasitica* (L.) Lév., *Cyclosorus interruptus* (Willd.) H.Ito, *Macrothelypteris torresiana* (Gaudich.) Ching, *Thelypteris confluens* (Thunb.) C.V. Morton
forest edges	*Pyrrosia lingua* Farw., *Selliguea enervis* (Cav.) Ching, *S. triloba* (Houttuyn) M.G.Price, *Diplazium dilatatum* Blume, *D. esculentum* (Retz.) Sw., *Stenochlaena palustris* (Burm.) Bedd., *Histiopteris incisa* (Thunb.) J.Sm., *Pteridium aquilinum* (L.) Kuhn subsp. *wightianum* (Wall. ex J.Agardh) W.C.Shieh, *P. esculentum* (G.Forst.) Nakai, *P. rostratum* (Burm.fil.) Fraser-Jenk., *Arachniodes grossa* (Tardieu & C.Chr.) Ching, *Dryopteris hasseltii* (Bl.) C.Chr., *Diplopterygium chinense* (Rosenst.) De Vol, *Dicranopteris linearis* (Burm.f.) Underw., *D. pedata* (Houtt.) Nakaike
roadsides/ditches, canal banks	*Marsilea crenata* C.Presl, *M. minuta* Schumach., *M. quadrifolia* Burm., *Selaginella helferi* Warb., *S. uncinata* (Desv. ex Poir.) Spring, *Nephrolepis cordifolia* (L.) C.Presl, *N. hirsutula* (Forst.) C.Presl, *Pyrrosia lingua* Farw., *Selliguea enervis* (Cav.) Ching, *S. triloba* (Houttuyn) M.G.Price, *Acrostichum aureum* L., *Adiantum caudatum* Forssk., *Pteris multifida* Poir., *P. vittata* L., *Tectaria impressa* (Fée) Holttum, *Diplazium dilatatum* Blume, *D. esculentum* (Retz.) Sw., *Stenochlaena palustris* (Burm.) Bedd., *Arachniodes grossa* (Tardieu & C.Chr.) Ching, *Bolbitis heteroclita* (Pr.) Ching, *Dryopteris hasseltii* (Bl.) *C.Chr.*, *Equisetum arvense* L. subsp. *diffusum* (D.Don) Fraser-Jenk., *Equisetum ramosissimum* Kunth, *Diplopterygium chinense* (Rosenst.) De Vol, *Dicranopteris linearis* (Burm.f.) Underw., *D. pedata* (Houtt.) Nakaike, *Odontosoria chinensis* (L.) J.Sm., *Amblovenatum terminans* (Wall. ex Hook.) J.P.Roux, *Ampelopteris prolifera* (Retz.) Copel., *Christella dentata* (Forssk.) Brownsey & Jermy, *C. hispidula* (Decne.) Holttum, *C. papilio* (C.Hope) Holttum, *C. parasitica* (L.) Lév., *Cyclosorus interruptus* (Willd.) H.Ito, *Grypothrix cuspidata* (Blume) S.E.Fawc. & A.R.Sm., *Macrothelypteris torresiana* (Gaudich.) Ching, *Pseudocyclosorus falcilobus* (Hook.) Ching, *P. tylodes* (Kunze) Ching, *Thelypteris confluens* (Thunb.) C.V. Morton

Table continuation

synanthropic	*Asplenium australasicum* (J.Sm.) Hook., *Nephrolepis cordifolia* (L.) C.Presl, *N. exaltata* (L.) Schott, *N. biserrata* (Sw.) Schott cv. *Furcans* *N. hirsutula* (Forst.) C.Presl cv. *Duffii*, *N. hirsutula* (Forst.) C.Presl, *Bosmania membranacea* (D.Don) Testo, *Goniophlebium amoenum* (Wall. ex Mett) J.Sm., *Microsorum punctatum* (L.) Copel., *Phlebodium aureum* (L.) J.Sm., *P. pseudoaureum* (Cav.) Lellinger, *Platycerium alcicorne* (P.Willemet) Desv., *P. bifurcatum* (Cav.) C.Chr., *P. coronarium* (D.Koenig ex O.F.Müll.) Desv., *Acrostichum aureum* L., *Adiantum capillus-veneris* L., *A. caudatum* Forssk., *A. latifolium* Lam., *A. raddianum* C.Presl, *Ceratopteris thalictroides* (L.) Brongn., *Pteris cretica* L. cv. *Wilsonii*, P. ensiformis Burm. cv. *Victoriae*, *P. multifida* Poir., *P. parkeri* J.J.Parker, *P. tremula* R.Br., *P. vittata* L., *Tectaria gemmifera* (Fée) Alston, *T. impressa* (Fée) Holttum, *Stenochlaena palustris* (Burm.) Bedd., *Bolbitis heteroclita* (Pr.) Ching, *Cyrtomium falcatum* (L.fil.) C.Presl, *C. fortunei* J.Sm., *C. macrophyllum* (Makino) Tagawa, *Odontosoria chinensis* (L.) J.Sm., *Amblovenatum terminans* (Wall. ex Hook.) J.P. Roux, *Christella dentata* (Forssk.) Brownsey & Jermy, *C. hispidula* (Decne.) Holttum, *C. parasitica* (L.), *Cyclosorus interruptus* (Willd.) H. Ito, *Macrothelypteris torresiana* (Gaudich.) Ching, *Thelypteris confluens* (Thunb.) C.V. Morton

Spectrum analysis for the biomorphs of “weed” species according to H. Raunkiaer’s system in the Socialist Republic of Vietnam shows the absence of phanerophytes ferns, the presence of which depends on the altitude above sea level, where with increasing altitude the number of species of this group increases. From the life forms proposed by H. Raunkiaer, we noted six in Vietnam: chamaephytes (1.9% of the composition of the pteridoflora), hemicryptophytes (2.1%), geophytes (0.5%), lianas (0.6%), epiphytes (1.1%), hydrophytes (0.4%) and four complex ones: hemicryptophytes-epiphytes (0.2%), therophytes-chamaephytes (0.2%), epiphytes-hemicryptophytes (0.1%), epiphytes-chamaephytes (0.1%). Hemicryptophytes are the most numerous group among synanthropic-ruderal species, as a rule, it has a massive distribution in humid regions and contains rich intragroup diversity.

Conclusion

We identified eight groups of pteridophytes according to impact criteria. The family Lygodiaceae is the most potentially dangerous in terms of taking over territory and overgrowing tree and shrub species, with three potentially “aggressive” species *Lygodium flexuosum*, *L. japonicus*, *L. microphyllum*. Local species of pyrrosia’s were dangerous “agents” for plantations: *Pyrrosia adnascens*, *P. nummularifolia*, *P. piloselloides* under the phytomass of which wood-destroying fungi develop, harming the nursery industry of Vietnam. In fact, in 96% of cases, mycelia of wood-decaying fungi develop en masse under the stems of these epiphytes. The most widespread on the territory of Vietnam are two potentially dangerous species: *Azolla pinnata* and *Salvinia cucullata*. The first one is of historical significance, an archaeophyte, it appeared quite a long time ago and went into natural aquatic ecosystems from rice paddies; moreover, it is already part of the pteridoflora of Vietnam, and salvinia penetrated into reservoirs and watercourses as a garden plant. Both representatives behave very aggressively in warm climates and produce enormous amounts of phytomass, which harms both water quality and aquatic biocenoses. Most ferns were observed in the synanthropic group and in disturbed habitats. The process of introduction is often poorly controlled in countries with tropical and subtropical climates, and spore plants, due to the insignificant mass of debris, can spread over fairly large distances; on the one hand, they can occupy various stations in urban communities, and on the other hand, they will take root in neighboring plant communities. There is currently a trend to include native species in invasive species.

The peculiarities of agriculture in Vietnam greatly influence changes in the vegetation cover of many districts of country. Sparsely populated areas are developed mainly for farming, where they either grow vegetable crops such as rice, corn, cassava, cabbage and local varieties of leaf and root vegetables - clearing or reducing vegetation, or use large open areas for pasture. It should be noted that livestock income represents the largest contribution to net farm income for most households [16]. Smallholder farmers can maintain stable cattle production on available feed resources from natural grasslands, making cattle production very popular among low-income farmers [9]. However, data on "weedy" fern species in SRV are still insufficient or contain incomplete information on the geographical distribution and population value of specific species compared to studies of aquatic invasive plant species in developed countries [18]. Internal standards, processes, and research need to be brought into line with international standards, cooperation with international organizations needs to be developed, and the provision of scientific and standardized work on biodiversity and ecosystem services must be strengthened.

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Калюжный С.С. Сорные папоротники Социалистической Республики Вьетнам // Бюллетень Государственного Никитского ботанического сада. – 2024. – № 150. – С. 90-100

Изучению флоры Социалистической Республики Вьетнам (СРВ) в последние десятилетия уделяется достаточное внимание. Папоротникообразные обычно рассматривались как неотъемлемый споровый компонент флоры сосудистых растений. Происходящее преобразование ландшафтов, содержащих ненарушенные леса создает новые местообитания для чужеродных. Правительство Вьетнама активно разрабатывает законодательную базу по вопросам борьбы с заносными видами. В 2008 г. появился «Закон о биоразнообразии» за которым последовали циркуляры в 2011, 2013 и 2018. В качестве цели наших исследований мы выбрали птеридофиты, на данный момент во Вьетнаме выявлено 1133 вида из 170 родов и 38 семейств (включая Lycopodiopsida). Нами отмечено 82 вида из 38 родов и 17 семейств, среди которых 20 экзотических и 62 аборигенных вида. Большинство папоротниковидных растений наблюдалось в синантропной группе и в нарушенных местообитаниях. Процесс интродукции в странах с тропическим и субтропическим климатом плохо контролируется, а споровые растения из-за незначительной массы спор могут распространяться на довольно большие расстояния. Однако данные о «сорных» видах папоротников во Вьетнаме все еще недостаточны или содержат неполную информацию о географическом распространении и численности популяций конкретных видов по сравнению с исследованиями водных инвазивных видов растений в развитых странах (Pysek, Richardson, 2010). Внутренние стандарты необходимо привести в соответствие с международными, а также необходимо усилить проведение научных и стандартизированных работ.

Ключевые слова: *Вьетнам; птеридофиты; сорняки; инвазия*