

# Vegetation of Colchis Mires

Izolda Matchutadze<sup>1</sup>, Tamar Bakuradze<sup>2,\*</sup>, Tamar Tcheishvil<sup>3</sup>, Bulbuli Bolkvadze<sup>4</sup>

<sup>1</sup>Department of Kolkheti Mire and Water Ecosystem Conservation Department, Institute of Phytopathology and Biology, Batumi Shota Rustaveli State University, Batumi, Georgia

<sup>2</sup>Environmental Specialist, Environmental Division of GIS & Remote Sensing Consulting Center "GeoGraphic", Tbilisi, Georgia

<sup>3</sup>Department of Ecology, Tsereteli State University, Kutaisi, Georgia

<sup>4</sup>Department of Biology, Batumi Shota Rustaveli State University, Batumi, Georgia

## Email address:

izo.muho@gmx.ne (I. Matchutadze), tbakuradze@geographic.ge (T. Bakuradze), tamu-ioka@rambler.ru (T. Tcheishvili), bolkvadze1961@mail.ru (B. Bolkvadze)

## To cite this article:

Izolda Matchutadze, Tamar Bakuradze, Tamar Tcheishvil, Bulbuli Bolkvadze. Vegetation of Colchis Mires. *Earth Sciences*. Special Issue: Modern Problems of Geography and Anthropology. Vol. 4, No. 5-1, 2015, pp. 73-78. doi: 10.11648/j.earth.s.2015040501.23

---

**Abstract:** Georgia with the admired Colchis lowland surrounded by the Great and Lesser Caucasus Ranges belongs to critical ecological hotspot region. Because of its climatic and geographic situation the Colchis lowland represents a centre of biodiversity and human activity on the transition of Europe and Asia. The main habitats in the Colchis lowland are the relict Colchis forests, the peatlands, the wetlands, coastal sand zones, river mouths, open fresh and salt water areas. Globally extraordinary habitats in the Colchis lowland are the relict Colchis forests and the percolation bogs only existing here. The Colchis forests are unique ecosystems of characteristic warm-humid broad-leaved deciduous mixed forests with evergreen understory, rich in endemic and relict tertiary species, which are mostly spread on the Colchis lowland and the adjacent foothills of the Lesser Caucasus Range. The main purpose of the work is the study of main habitats of Colchis Lowland and determining the value for biodiversity. The different habitats and their vegetation were studied during the period of 1998-2008. The vegetation mapping with the determination of the cover of the vascular plant and moss species followed the abundance method after DAFOR (D – Dominant, - Abundant, F – Frequent, O-Occasional, R-Rare). On the basis of the research the list of Rare and endangered plant species of Colchis wetlands was revealed. Some of them (5 habitats) has a high value for biodiversity.

**Keywords:** Colchis Mires, Peatlands, Rare and Endangered Plant Species, Value for Biodiversity

---

## 1. Introduction

There are 34 critical hotspots of biodiversity in the world (Conservation International). The Caucasus hotspot, which spans 532,658 km<sup>2</sup> is one of them. Consequently, Georgia with the admired Colchis lowland surrounded by the Great and Lesser Caucasus Ranges belongs to this hotspot region. Because of its climatic and geographic situation the Colchis lowland represents a centre of biodiversity and human activity on the transition of Europe and Asia. The main habitats in the Colchis lowland are the relict Colchis forests, the peatlands, the wetlands, coastal sand zones, river mouths, open fresh and salt water areas.

Here are located the Colchis National Park. It lies on a coastal plain on the Black Sea, between the mouths of the Rivers of Tikori and Supsa. It covers an area of 28.940 hectares. The natural conditions has resulted in a rich biodiversity of flora, represented by the coastal marshes and

swamped forests, the deciduous wetland forest.

In recent years the ecosystems of Colchis are changed under the influence of the anthropogenic factor. The solution of this problem is possible only by means of mutually-comparison and time-spatial analysis the territory. Such researches should become a basis of sustainable use of natural resources and territorial planning.

The main purpose of the work is the study of main habitats of Colchis Lowland and determining the value for biodiversity.

## 2. Methods of Floristically Investigations

The different habitats and their vegetation were studied during the period of 1998-2008. The research is based on the field work materials, also the data amassed in different scientific sources. These materials represent a description of vegetation peculiarities of different ecosystems of Colchis

lowland, especially the mires.

The vegetation mapping with the determination of the cover of the vascular plant and moss species followed the abundance method after DAFOR (D – Dominant, - Abundant, F – Frequent, O – Occasional, R – Rare).

### 3. Study Area

During the last Glacial Maximum, Colchis lowland constituted an important refuge for the flora of the Europe [Tarasov *et al.* 2000], where many plant species have preserved that used to be wide-spread in Europe before and disappeared. For example the Colchis mires currently harbour – next to Tertiary relict species like *Rhododendron ponticum* – many sub Mediterranean, temperate, and boreal relict species [Denk *et al.* 2001].

Globally extraordinary habitats in the Colchis lowland are the relict Colchis forests and the percolation bogs only existing here. The Colchis forests are unique ecosystems of characteristic warm-humid broad-leaved deciduous mixed forests with evergreen understory, rich in endemic and relict tertiary species, which are mostly spread on the Colchis lowland and the adjacent foothills of the Lesser Caucasus Range.

The peatlands of the Colchis lowland with their luxurious Sphagnum vegetation form a structural and functional transition between the peatlands of the boreal and those of the tropical zones. The special character of the area and its peatlands brought Botch & Masing [1983] and Succow & Joosten [2001] to the distinction of a special Colchis peatland region within Eurasia.

Colchis Lowlands belongs to: Oldest Mediterranean (World), Sub -Mediterranean (Region), Colchis, or Eastern Euxinus (Province), and Colchis Lowland and Foothills (District) [Gagnidze, R. 1996]. The main habitats in the Colchis lowland are the relict Colchis forests, the peatlands, the wetlands, coastal sand zones, river mouths, open fresh and salt water areas.

In plain subtropical humid landscapes, located in the central parts of Colchic lowland, average annual temperature had slightly increased in recent years. Analysis of data from 1936 to 2012 revealed that within 10-year-long interval, a quite difficult situation was observed [Nikolaishvili, *et al.*, 2015].

## 4. Main Results

### 4.1. Anthropogenic Transformation

Anthropogenic transformation of ecosystems of Colchis Lowland has very diverse character and this diversity is related to many factors. The significant change has undergone in XX century, when 2/3 part of this territory was transformed. In 1990s, on background an energy crisis influence has increased woods from population. Some forest cover which was considered untouched during centuries was destroyed. As a result of this anthropogenic pressure

ecosystem degradation processes have become frequent phenomena [Nikolaishvili, Salukvadze, *et al.* 2013].

Anthropogenic pressure on the Colchis forests and peatlands started to rise in the second half of the 19th century and accelerated significantly in Soviet Union. The peatlands had been affected by drainage and peat extraction, thus only a few almost natural peatlands remained intact. Similarly, huge deforestation destroyed the forests in the Colchis lowland almost completely and only at the foothills some natural forest fragments still exist.

Recent pressures include major industrial developments as well as prevailing social conditions that lead to continuous decline of these unique ecosystems by encroachment, illegal logging, fires, unregulated hunting and grazing.

The former destruction and damaging of the habitats as well as recent pressure to the areas are endangering all kind of these habitats and led to a distinction of plant species and development of plant communities comprising by invasive plant species like *Polygonum thunbergii* (Table 1).

Thus many peatlands and relict forest species, including Georgian and Caucasian endemics, are included in the “Red List” for woody plants like *Quercus imeretina*, *Quercus hatwissiana*, *Pterocarya pterocarpa*, *Buxus colchica* (by Georgia law of Parliament 2006) and herbs like *Drosera rotundifolia*, *Ranunculus acris*, *Hibiscus ponticus*, *Nymphaea colchica*, *Osmunda regalis*, *Molinia litoralis* [Red Data Book of Georgia, 1982].

There is interdependence between the species and its habitat. Relicts and endemic plants can develop in their historically established habitats. The habitat is a micro-ecological environment, created by its plants. In order to protect the endangered species, it is necessary to protect their habitats as well. In Georgian law of environment do exist law about fauna but there is no law similar to this about habitats.

### 4.2. Evaluation of Vegetation Biodiversity

The Colchis mires display a diverse vegetation with many endemic species and relicts from the glacial period. Ispani II and I (partly) are dominated by *Sphagnum papillosum*, *S. imbricatum*, and *S. palustre*. The vegetation further comprises amazingly few species, including *Molinia litoralis*, *Rhynchospora alba*, *R. caucasica*, *Rhododendron ponticum*, *R. luteum*, *Vaccinium arctostaphylos*, and *Drosera rotundifolia*. This monotony makes Ispani II to a paradigm example of low internal (a-) diversity that contributes substantially to global ecosystem [ - and -] biodiversity [Joosten 2001].

In Imnati *Sphagnum palustre*, *S. papillosum*, and *S. magellanicum* are interestingly accompanied by *Carex lasiocarpa*, *C. rostrata*, and *Cladium mariscus*. The minerotrophic parts of Nabada are characterized by *Cladium mariscus*, *Sphagnum palustre*, *Carex gracilis*, *C. lasiocarpa*, *C. riparia*, *Potentilla erecta*, *Lysimachia vulgaris*, *Hydrocotyle vulgaris*, *Molinia litoralis*, and *Eupatorium cannabinum*. Most data on the vegetation of the Colchis mires go back to Dokturowski [1931, 1933] and Flerow [1936]. In the 1960s

some studies were published by Kolakowski [1961], Tumadjanow [1962] and Kimeridse [1962, 1963, 1966], but since then the subject has drawn little scientific attention [Kimeridse 1992 unpublished, Potskhishvili et al. 1997, Matchutadze 1999]. All studies have been confined to the floristic composition of the vegetation. A compatibility with a modern vegetation typology is absent.

Among the major peat accumulating species, *Sphagnum* deserves special attention. Colchis is the only subtropical area in the world with *Sphagnum* dominated ombrotrophic mires. *Sphagnum palustre* grows here under ombrotrophic conditions, whereas the species elsewhere is restricted to mesotrophic, i.e. minerotrophic sites [Daniels & Eddy 1985].

*Sphagnum imbricatum* is a main peat forming species in Ispani and Imnati [Dokturowski 1931, 1933, Potskhishvili et al. 1997, Kaffke et al. 2000]. From 800 years BC on, its massive occurrence in the bogs of Central and Western Europe [Overbeck 1975] led to the accumulation of slightly decomposed *Sphagnum* peat ("white peat"), which is now of high economic value. In recent centuries, the species has become extremely rare in Europe [Green 1968], its massive decline being ascribed to climate change, fires, and eutrophication [Mauquoy & Barber 1999]. In Colchis the widespread dominance of *Sphagnum imbricatum* [Kaffke unpubl.] enables the study of vegetational characteristics and peat accumulation processes of this species. This will provide important information for advancing commercial *Sphagnum* cultivation that is currently being developed as a sustainable substitute for the exhausting fossil "white peat" [Joosten 1998, 2000, Gaudig & Joosten 2002].

#### 4.3. Rare and Endangered Plant Species of Colchis Wetlands

There are a lot of Rare and endangered plant species in Colchis wetlands. They are represented by different species [Handbook of European Sphagna, 1985; R. E. Daniels, A. Eddy, Institute of Terrestrial ecology, London, Dorset; Matchutadze I., 2008; S.K. Czerepanov., 1995., Vascular Plants of Russia and adjacent states (the former USSR), 516 p. A.A.Kolakovskiy. 1961; The Flora and Vegetation of Colchida, 459 p; Matchutadze I., 2008]:

- 1) *Sphagnum imbricatum* Russ. *S. austinii* Sull. ex Aust., Category: LEAST CONCERN (LC);
- 2) *Hymenophyllum tunbridgense* (L.) Smith - 2, *Wrightii* Bosch = *Mecodium wrightii*, Category: Critically Endangered (CR);
- 3) *Marsilea quadrifolia* L., Category: Critically Endangered (EN), EN A1acdB1(i,ii);
- 4) *Osmunda regalis* L. (*O. longifolia* (C. Presl) A. Bobr., *O. regalis* var. *longifolia* C. Presl), subsp. *Japonica* (Thunb.) A. & D. Loven = *O. japonica*, var. *longifolia* C. Presl = *O. regalis*, Category: Endangered (EN), EN A1adB2b(i,ii);
- 5) *Dreosera rotundifolia* L. 1,2,3,4,5, Category: Endangered (EN), EN A1adB2b(i,ii);
- 6) *Hibiscus ponticus* Rupr., Category: Critically Endangered (CR), CR B2b(i,ii,iii,iv);

- 7) *Kosteletzkya pentacarpa* (L.) Ledeb., Category: Extinct in the wild (EW);
- 8) *Rhynchospora caucasica* Palla -2, Category: Critically Endangered (CR), CR B1b(i,ii,iii)c(i,ii);
- 9) *Rhynchospora alba* (L.) Vahl - 1,2,3,4,5, Category: CRITIUCALLY ENDANGERED (CR), CR A2+B1ac(i,ii);
- 10) *Ruscus colchicus* - P.EF.Yeo (*Ruscus hypophyllum* auct.) -1,2, Category: VULNERABLE (VU), VUA1a;
- 11) *Pterocarya pterocarpa* (Michx.) Kunth ex I. Iljink. (*Juglans pterocarpa* Michx., *Pterocarya fraxinifolia* (Poir.) Spach, nom. Ambig.-2, Category: VULNERABLE (VU), VUB1b(i,ii)+2c(i,ii,iii);
- 12) *Ilex colchica* Pojark. -2-subsp. *Imerethica* (Gagnidze) Gagnidze = *I. imerethica*, Category: NEAR THREATENED (NT);
- 13) *Quercus imeretina* Stev. ex Woronow (*Q. erucifolia* Stev. Var. *imeretina* (Stev. ex Woronow) O. Schwarz, *Q. ruber* L., subsp. *Imeretina* (Stev. ex Woronow) Menitsky) -2, *infectoria* Oliv. subsp. *boissieri* (Reut.) O. Schwarz = *Q. boissieri*, *kochiana* O. Schwarz = *Q. dshorochensis*, *komarowii* A. Camus = *Q. dshorochensis*, *kozlowskyi* Woronow ex Grossh. = *Q. iberica*, *lanuginosa* lam. Subsp. *Crispata* (Stev.) A. Camus = *Q. rubescens*-subsp. *Medwedewii* A. Camus = *Q. dalehampii*, *longifolia* C. Koch = *Q. dshorochensis*, *longipes* Stev. = *Q. pedunculiflora*, Category: NEAR THREATENED (NT);
- 14) *Quercus hartwissiana* Stev.-1(cult.), 2, 6(cult.), *Hypochryza* Stev. = *Q. iberica*, Category: NEAR THREATENED (NT);
- 15) *Trapa colchica* Albov - 1,2, Category: VULNERABLE (VU), VUA1a4+B1b(i,ii)c(i,ii);
- 16) *Trapa maleevii* V. Vassil. - 2, Category: VULNERABLE (VU), VUA1a4+B1b(i,ii)c(i,ii)E;
- 17) *Asparagus litoralis* Stev., Category: EXTINCT IN THE WILD (EW);
- 18) *Convolvulus persicus* L.-2,6, Category: EXTINCT IN THE WILD (EW);
- 19) *Lycopodiella inundata* (L.) Holub (*Lycopodium inundatum* L., *Lepidotis inundata* (L.) Boern.) - 1,2,3, Category: ENDANGERED (EN), EN C2a(i,ii);
- 20) *Pancratium maritimum* L. - 2, Category: VULNERABLE (VU), VUB2c(i,ii,iii);
- 21) *Eryngium maritimum* L. - 1,2, *mirandum* Bobr. = *E. octophyllum*, *nigromontanum* Boiss. & Buhse = *E. billardieri*, *noenum* Boiss. = *E. billardieri*, Category: VULNERABLE (VU), VUD1+E;
- 22) *Glaucium flavum* Crantz - 1,2, Category: VULNERABLE (VU), VUD1+E;
- 23) *Salvinia natans* (L.) All. - 1,2,3,5, 6, Category: VULNERABLE (VU), VUC1+D+E;
- 24) *Cladium mariscus* (L.) Pohl - 1,2, subsp. *martii* (Roem. & Schult.) Egor. = *C. martii*, subsp. *Martii* (Roem. & Schult.) Soo. = *C. martii*, Category: VULNERABLE (VU), VUA1a;

- 25) *Solidago turfosa* Woronow ex Grossh. –2, Category: CRITICALLY ENDANGERED (CR), CRA1a+Bc(i,ii,iii);
- 26) *Spiranthes amoena* (Bieb.) Spreng. (*S. sinensis* (Persl.) Ames var. *amoena* (Bieb.), Hara, *S. australis* auct.) 1,3,4,5, *australis* auct. = *S. amoena*, *autumnalis* (Balb.) Rich. = *S. spiralis*, Category: VULNERABLE (VU), VUD1;
- 27) *Spiranthes spiralis* (L.) Chevall. (*Ophrys spiralis* L., *Spiranthes autumnalis* (Balb.) Rich.) –1,2, Category: VULNERABLE (VU), UA1a;
- 28) *Rhamphicarpa medwedewii* Albov – 2, Category: ENDANGERED (EN), ENE;
- 29) *Gentiana pneumonanthe*, Category: ENDANGERED (EN), ENE.

Table 1. Main Habitats of Colchis Lowland.

Habitat	IUCN	Definition/ Description	Value for Biodiversity	Location
1. Sea littoral 2. Coastal zone		Littoral/benthos with <i>Zostera marina</i>		Grigoleti, Tskaltsminda
2.1. Coastal dunes	VUL	Significant areas in Chorokhi delta and Anaklia-Churia coastline are still unpolluted. Dominated by: <i>Pantratum maritimum</i> , <i>Convolvulus persicus</i> , <i>Cakile euxina</i> , <i>Asparagus litoralis</i> , <i>Tamarix tetrandra</i> , <i>Paliurus spina christi</i>	high	Kobuleti, Chaqvi, Piti, Grigoleti
2.2. River delta		Rivers mouth	low	Riv. Chorokhi, Rioni, Khobi
2.3. Brackish/saline waters		Small ponds with brakish waters along the coast, dominating with <i>Bolboschoenus maritimus</i>	low	Chorokhi
3. Wet grassland (Without peat)		wet and often inundated areas, which are usually developed and maintained under pastoral influence. Used as low quality grassland,	Med	Surroundings of the peatlands of Imnati, Grigoleti, Maltakva, Ispani
3.1. Juncetum		Areas dominated by <i>Juncus</i> sp. (but without peat) often inundated	med	North of Ispani II mires, South of the mires Imnati, North of Supsa
3.2. Typhetum+Iris+ Polygonum Mixed grassland		Vegetation of channels dominated <i>Typha angustifolia</i> , <i>Iris pseudocorus</i> , <i>Sparganium neglectum</i> , <i>Polygonum thunbergia</i> , <i>Butomus umbellatus</i> , <i>Equisetum palustris</i>	med	Guria, Piti-Maltakva, Samurzakano
4. Open water		Includes lakes, ponds, and channels,		
4.1. Channels, little lakes , mirror like surface		Lakes and channels with with submerged plants such as: <i>Potamogeton</i> sp. <i>Ceratophyllum demersum</i> , <i>Egeria denca</i> (as invasive species ) dominated by <i>Nymphaea alba</i> , <i>Nymphaea colchica</i> and <i>Nuphar lutea</i>	med	Palistomi, Imnati
4.2. Permanent freshwater lakes, ponds	KE	Dominant species is <i>Trapa colchica</i> , <i>Trapa maleevi</i> , <i>Trapa hyrcana</i> , Artificial (former fish ponds)	high	Chorokhi delta, Grigoleti, Tskaltsminda, Narionali. Narionali, Grogoleti, Anaklia, Imnati, Chorokhi
5. Peatland		A Peatland is an area with or without vegetation with a naturally accumulated peat layer at the surface bog which is fed by rain water or precipitation (ombrogenous) Raised above surrounding landscape. Percolation bogs are found in landscapes where water supply is large end evenly distributed all over the year.		
5.1. Sphagnum bog in particular Percolation bog	VUL	With regard to the bog the water supply only arises from the precipitation. The water table in the mire is almost constant. Species like <i>Sphagnum imbricatum</i> , <i>Sphagnum papillosum</i> , <i>Molinia litoralis</i> are dominating. Peat is presented with under moss layer from overheated plants remnants, alive roots.	high	Ispani II, Imnati, Grigoleti
5.2. Fen	VUL	Fens (geogenous), are fed by groundwater water from the surroundings. Situated in depressions. After peat extraction which was carried out by dredging open water remained.	high	Anaklia-Churia
5.3. Juncetum-Caricetum		Dominated by <i>Juncus effusus</i> , <i>J. articulatus</i> , <i>Carex vesicaria</i>	low	Nabada, Narionali
5.4. Cladietum mariscus		Dominant species <i>Cladium mariscus</i> , <i>Sphagnum palustre</i> , <i>Carex vesicaria</i> , <i>Carex rostrata</i>	high	Anaklia-churia
5.5. Typhetum+Phragmitetum		Typhetum is more frequent, and is widely distributed in low-lying areas. Contributes swamping and peat-formation processes.	med	Maltakva
5.6. Degraded peatlands		Peatlands, that have been drained, or peat was extracted, mainly for agricultural purposes. At huge areas the vegetation comprises recently by <i>Pteridium aquilinum</i> , <i>Rubus spec.</i> , <i>Polygonum perfoliatum</i>	low	Onaria, Shavtskala, Ispani I

6. Meadow (formed after Drainage/deforestation)	Agricultural used land		
6.1. Fallow	Covering big vast areas and represented with the secondary cenosis after the former agricultural use dominant species is: <i>Cynodon dactylon</i> , <i>Sisyrinchium angustifolium</i>	low	Narionali, Samurzakano, Guria lowland
6.2. Pasture land	Used for hay-meadow Pastureland dominated by: <i>Paspallum thunbergii</i> , <i>Polygonum thunbergii</i> .	low	Grigoleti, Anaklia-churia, chorokhi
6.3. Arable land	Used for growing of monoculture ( <i>Zea mays</i> )	low	Guria, Kobuleti, Anaklia-chiria, Kakhabaeri
7. Forest and shrubs	Dominant species all kind of trees and shrubs mires of Colchis are unique for the fact that they are naturally transformed into the fragmentally presented Colchis forests characteristic warm-humid broad-leaved deciduous forests with evergreen understory, rich in endemic and relict tertiary species: <i>Pterocaria pterocarpa</i> , <i>Quercus hartwissiana</i> , <i>Buxus colchica</i> , <i>Carpinus betulus</i> , <i>Morus nigra</i> , <i>Crataegus macrophylla</i> , <i>Humulus lupulus</i> , <i>Salix caprea</i>	high	Churia, Imnati, Ispani I and Ispani II
7.1. Relict Colchis forest	VUL		
7.2. Hippophaeta	Shrubbery dominated by <i>Hippophae rhamnoides</i>	med	Chorokhi delta, Narionali
7.3. Degraded forest	Degraded forest now secondary meadows	low	surroundings of Ispani II and Imnati
7.4. Alder ( <i>Alnus barbata</i> ) + <i>Salicata</i> ( <i>Salix caprea</i> ) shrubs	Water-logged soil with a summer ground water level close to the surface, but seldom above it. Are often invaded by trees and shrub including willows and alder with lianas ( <i>Lonicera caprifolia</i> , <i>Smilax excelsa</i> )	med	Chorokhi delta, margins of the bogs and parts of the Colchis National Park

## 5. Conclusions

On the basis of the research the list of Rare and endangered plant species of Colchis wetlands was revealed. Some of them (5 habitats) has a high value for biodiversity: Coastal dunes, Permanent freshwater lakes, ponds, Sphagnum bog in particular Percolation bog, Fen, *Cladietum mariscus*, and Relict Colchis forest.

## References

- [1] Matchutadze I., 2008., Kolkheti Relict forest: past, present, future., Batumi, 44 p.;
- [2] Matthias Krebs, Andreas Kaffke, Pim de Klerk, Izolda Matchutadze, Hans Joosten: A future for Ispani 2 (Kolkheti, Georgia) and adjacent lands International Mire Conservation Group Newsletter 2009/2: pp. 3-14;
- [3] Pim de Klerk, Andreas Haberl, Andreas Kaffke, Matthias Krebs, Izolda Matchutadze, Merten Minke, Jenny Schulz, Hans Joosten, 2009, Vegetation history and environmental development since ca. 6000 cal yr BP in and around Ispani 2 Kolkheti lowlands, Georgia;
- [4] Matchutadze I. 2009, Anthropogenic impact on Kolkheti mires and succession, IMCG scientific congress;
- [5] Matchutadze I., Bakuradze T., 2009, Habitats of Kolkheti Lowland, poster presentation, IMCG Scientific Congress;
- [6] Integrated Plan for Sustainable Development of Tskaltsminda Coastal Community, 2009., Tamar Bakuradze, Amiran Gigineishvili, Mamuka Gvilava, Kakhaber Kheladze, Inesa Kuzanova, Irene Lucius, Izolda Matchutadze. EU funded ECBSea Project. 44 p. www.iczm.ge , <http://ECBSea.org>;
- [7] Nikolaishvili Dali, Salukvadze Elene., Donadze Tsetsili. Dynamics of Anthropogenic Transformation of Colchic Landscapes. International conference "Kolkheti Lowland Water Ecosystems – Protection and Efficient Use". 2013. pp.123-129.
- [8] D. Nikolaishvili, V. Trapaidze, B. Kalandadze, T. Mamukashvili, M. Sharashenidze. Complex Evaluation of Climate Change - An Example FROM THE Georgia's Landscapes. Journal of Environmental Biology, 2015. vol. 36. Special issue, January, 2015. pp.43-49.
- [9] [http://www.jeb.co.in/journal\\_issues/201501\\_jan15\\_supp/paper\\_07.pdf](http://www.jeb.co.in/journal_issues/201501_jan15_supp/paper_07.pdf)
- [10] The Biomes of Caucasus part two: "The mires of Kolkheti Lowland", 2009., Krebs M., Kaffke A., I. Chavleishvili, I. Matchutadze., R. Papuashvili, H. Joosten. IMCG simposium and Scientific atumin.
- [11] Matchutadze I. Biodiversity of Ecosystems of South Colchis. Proceedings of International conference "Biodiversity of South Colchis". Batumi, 2009. pp. 34-39.
- [12] The mires of the Kolkheti - a paradigm example for global ecosystem [ - and -] biodiversity., 2009., Matthias Krebs, Hans Joosten, Andreas Haberl, Andreas Kaffke, Izolda Matchutadze. Proceedings of International conference "Biodiversity of South Colchis". Batumi, 2009. pp. 39-45.
- [13] 10 Karen Jenderejan (Armenia), Nikolay Bambalov, Nina Tanovitskaya and Alexander Kozulin (Belarus), Janus Paal (Estonia), Izolda Matchutadze (Georgia), Mara Pakalne (Latvia), Ilona Jukoniene, Valerijus Rasomavicius and Romas Pakalnis (Lithuania), Tatiana Minayeva and Andrey Sirin (Russian Federation), Predrag Lazarevic (Serbia), Serhan C, agirankaya (Turkey), 2009., A quick scan of Peatlands in Central and Eastern Europe., Wetlands 77atumi77ncia77l., pp.111-116;
- [14] Krebs M., Kaffke A., I. Chavleishvili, I. Matchutadze., R. Papuashvili, H. Joosten., 2009., The 77atum of Caucasus., The Kolkheti mires., pp.117-179;

- [15] I. Matchutadze, H. Joosten, M. Krebs, 2010, "Values of Peatlands on global climate regulation" 78 International conference "atumi-gazafxuli 2010" www.bsu.edu.ge International Turk-Japan conference in Trabzon, vol.1., pp.33-65
- [16] I. Matchutadze, 2010, "Vegetation of mires of height mountain of Ajar a " MCG Field Symposium and scientific congress in Poland and Slovakia www.imcg.net
- [17] Matchutadze I., Gvilava M. The Needs of Restoration of Relic Forest of Colchis Lowland.
- [18] www.bsu.edu.ge
- [19] Karen Jenderejan (Armenia), Nikolay Bambalov, Nina Tanovitskaya and Alexander Kozulin (Belarus), Janus Paal (Estonia), Izolda Matchutadze (Georgia), Mara Pakalne (Latvia), Ilona Jukoniene, Valerijus Rasomavicius and Romas Pakalnis (Lithuania), Tatiana Minayeva and Andrey Sirin (Russian Federation), Predrag Lazarevic (Serbia), Serhan C, agirankaya (Turkey), 2009., A quick scan of Peatlands in Central and Eastern Europe., Wetlands International., pp.111-116
- [20] I. Matchutadze, I.Goradze, M. Tsinaridze, E.Jakeli, "Inventory of height conservation value forest in Ajara, 2010, 1st International Turk-Japan conference in Trabzon, vol.1., pp.33-65
- [21] I. Matchutadze, T. Qurkhuli, M. Tsinaridze, 2010. "Why kolkheti relict forest is so valuable and significant", 1st International Turk-Japan conference in Trabzon, vol.3, pp. 45-49
- [22] Matchutadze I., Tsinaridze M., 2013, "IUCN critically endangered woody plant species of Kolkheti relict forest", International forestry symposium of Caucasus eco region"
- [23] M. Gvilava, T.Bakuradze, A. Gigineishvili, K. Allenbach, E. Guisado, C. Martínez and G. Malvárez, 2013, "Remote Sensing, Coastal and Marine Databases Data Sharing Inspired by Pegaso SDI – Georgian CASES", pp. 707-716.
- [24] S.K. Czerepanov., 1995., Vascular Plants of Russia and adjacent states (the former USSR), 516 p.
- [25] A.A.Kolakovsky. 1961. The Flora and Vegetation of Colchida, 459 p, Matchutadze I., 2008.