

# Systematic, ecological-cenotic analysis and the problem of protection of plant species in the central site of the Way Carbon polygon

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**Abstract.** This report provides systematic, ecological-coenotic analyzes and the problem of protecting the studied plant species of the central site of the WAY CARBON carbon polygon. The data was obtained as a result of field research, study of herbarium material and literary data. Each species has a unique identifier that describes only that species. It is the second word in the two-word naming system of the species' scientific name. Protected species are vital to the conservation of global biodiversity. During the field survey of the study area, classical methods of route floristic and geobotanical research were used.

## 1 Introduction

The subalpine belt is predominantly meadow, although there are other formations here, in particular shrubs and trees. Along with meadows and shrubs, tall grasses are found in the subalpine zone, especially in its lower part, on the border with the forest. In general, tall grass is atypical for the subalpine zone.

Among the meadow cenoses, forb-grass groups predominate; there are cereal, mainly forb and sedge meadows, but the latter recede into the background. The dominant species in subalpine meadows almost everywhere is variegated fescue (*Festuca varia*). No less common is the variegated brome (*Zerna variegata*). These species determine the appearance of all meadows and the belt as a whole [2].

The subalpine belt extends at altitudes from 1400 to 2500 m above sea level. Meadow phytocenoses are developed here, which also include some representatives of dendroflora - *Salix kuznetzowii*, *S. caucasica*.

Scientific research site of the carbon test site "WAY CARBON" of the Chechen State University named after A.A. Kadyrov is located on the southern slope of the Khoisko-Makazhoisk (Cheberloisk) basin in the Vedenno region.

The basin is located in the eastern part of the North Caucasus, occupying a border position between the Eastern High Mountain and Dagestan physical-geographical provinces of the mountainous region of the Greater Caucasus of the Crimean-Caucasian mountainous country. The basin is located within the spurs of the Rocky Ridge, which have a complex structure, losing their general direction and integrity. The elevation difference in the study area reaches almost 1500 meters (1300-2806) [5].

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## 2 Research Methodology

The subalpine belt is predominantly meadow, although there are other formations here, in particular shrubs and trees. Along with meadows and shrubs, tall grasses are found in the subalpine zone, especially in its lower part, on the border with the forest. In general, tall grass is atypical for the subalpine zone.

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## 3 Results and Discussions

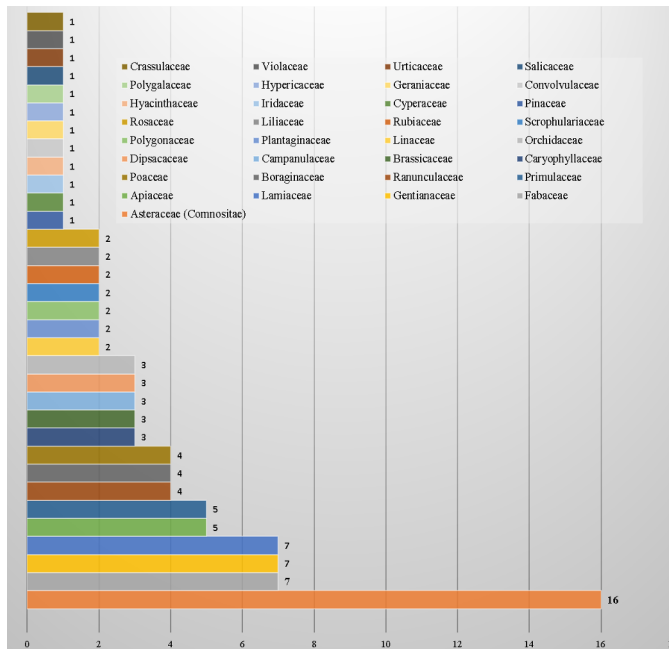
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**Table 1.** Systematic spectrum of plant species in the central area of the WAY CARBON carbon polygon.

№	Семейство	Кол-во видов	%
1.	<i>Asteraceae (Compositae)</i>	16	16
2.	<i>Fabaceae</i>	7	7
3.	<i>Gentianaceae</i>	7	7
4.	<i>Lamiaceae</i>	7	7
5.	<i>Apiaceae</i>	5	5
6.	<i>Primulaceae</i>	5	5
7.	<i>Ranunculaceae</i>	4	4
8.	<i>Boraginaceae</i>	4	4
9.	<i>Poaceae</i>	4	4
10.	<i>Caryophyllaceae</i>	3	3
11.	<i>Brassicaceae</i>	3	3
12.	<i>Campanulaceae</i>	3	3
13.	<i>Dipsacaceae</i>	3	3
14.	<i>Orchidaceae</i>	3	3
15.	<i>Linaceae</i>	2	2
16.	<i>Plantaginaceae</i>	2	2
17.	<i>Polygonaceae</i>	2	2
18.	<i>Scrophulariaceae</i>	2	2
19.	<i>Rubiaceae</i>	2	2
20.	<i>Liliaceae</i>	2	2
21.	<i>Rosaceae</i>	2	2
22.	<i>Pinaceae</i>	1	1

23.	<i>Cyperaceae</i>	1	1
24.	<i>Iridaceae</i>	1	1
25.	<i>Hyacinthaceae</i>	1	1
26.	<i>Convolvulaceae</i>	1	1
27.	<i>Geraniaceae</i>	1	1
28.	<i>Hypericaceae</i>	1	1
29.	<i>Polygalaceae</i>	1	1
30.	<i>Salicaceae</i>	1	1
31.	<i>Urticaceae</i>	1	1
32.	<i>Violaceae</i>	1	1
33.	<i>Crassulaceae</i>	1	1
<i>Total:</i>		100	100

The family Asteraceae (Compositae) has 16 species each, which is 16%. The second place is occupied by the families Fabaceae, Gentianaceae, Lamiaceae include 7 species, which is 7%. In third place are representatives of the family Apiaceae, Primulaceae includes 5 species (5%). Seven families have two species each, which is 2%. 12 families contain one species each (1%).



**Fig. 1.** Systematic spectrum of plant species in the central area of the carbon fiber polygon «WAY CARBON».

When analyzing the plant species of the central site of the carbon polygon “WAY CARBON” according to ecological-coenotic ranking, 11 florocene elements were identified, among which the studied species are relatively evenly distributed. The percentages of these species are presented in Figure 2 and Table 2.

Forest florocene elements include 10 species (7.7%): *Pinus sosnowskyi* Nakai (*P. hamata* (Stev.) Sosn.; *P. kochiana* Klotzsch) – Sosnowsky Pine, *Orchis purpurea* Huds. – Purple orchis, *Cirsium canum* (L.) (C. *Biebersteinii* Charadze) – Gray thistle, *Symphytum asperum* Lepech. – Rough comfrey, *Ostrya carpinifolia* Scop. – Common hop hornbeam, *Gentiana septemfida* Pall. – Gentian seven-parted, *Primula cordifolia* Rupr. – Heartleaf

primrose, *P. macrocalyx* Bunge – *P. macrocalyx*, *Rosa tomentosa* Smith (*R. ciispidata* Bieb.) – Tomentose rosehip, *Salix caprea* L. – Goat willow

Plain elements include 31 species (23.8%): *Gladiolus tenuis* Bieb. (*G. apterus* Klok.) – Thin skewer, *Muscari neglectum* Guss. (*M. muscarimi* Medik.; *M. racemosum* (L.) Mill.) – Orchis *purpurea* Huds. – Purple orchis, *Phleum montanum* C. Koch – Mountain timothy, *Daucus carota* L. – Wild carrot, *Heracleum sibiricum* L. – Siberian hogweed, *Achillea setacea* Waldst. et Kit. – Bristlewood tree, *Cichorium inthybus* L. – Common chicory, *Cirsium canum* (L.) (*C. Biebersteinii* Charadze) – Gray thistle, *Tanacetum vulgare* L. – Common tansy, *Taraxacum officinale* Wigg. – Dandelion, *Echium russicum* J.F. Gmel. (*E. rubrum* Jacq.) – Russian bruise, *Draba nemorosa* L. – Copper weed, *Campanula elatior* (Fomin) Grossh. (*C. praealta* Galushko) – Tall bell, *Amoria ambigua* (Bieb.) Sojak (*T. ambiguum* Bieb.) – *Amoria* (Clover) fickle, *Trifolium pretense* L. – Red clover, *Gentiana cruciata* L. – Cruciform gentian, *G. dshimilensis* C.Koch – *G. dzhimilskaya*, *Geranium sanguineum* L. – Blood-red geranium, *Hypericum perforatum* L. – St. John's wort, *Salvia verticillata* L. – Whorled sage, *Teucrium polium* L. – White Dubrovnik, *Linum hypericifolium* Salisb. – St. John's leaf flax, *L. nervosum* Waldst. et Kit. – L. veined, *Plantago media* L. – Medium plantain, *Veronica gentianoides* Vahl – *Veronica* gentian, *Polygala anatolica* Boiss. et Heldr. – Anatolian springwort, *Primula macrocalyx* Bunge – Large-cupped primrose, *Thalictrum minus* L. – Small cornflower, *Rhinanthus minor* L. (*R. nigricans* Meinsh.) – Small rattle, *Viola ambigua* Waldst. et Kit. – Violet is dubious/

Subalpine elements include 37 (28.5%) species: *Carex tristis* Bieb. (*C. meinshauseniana* V.Krecz.) – Sad sedge, *Lilium monadelphum* Bieb. – Monofraternal lily, *Fritillaria collina* Adams (*F. ophioglossifolia* Freyn et Sint.; *F. lutea* Bieb.) – Hill hazel grouse, *Orchis simia* Lam. – Monkey orchis, *Anthoxanthum odoratum* L. (*A. alpinum* A. et D. Love) – Common fragrant brome, *Bromopsis variegata* (Bieb.) Holub (*Z. variegata* (Bieb.) Nevski) – Variegated brome, *Festuca woronowii* Hack. (*F. varia* auct.) – Crow's fescue, *Astrantia trifida* Hoffm. – Three-cut astrantia, *Bupleurum falcatum* L. – Crested saxifrage, *Pimpinella saxifraga* L. – *Centaurea cheiranthifolia* Willd. – Pale yellow cornflower, *Cirsium obvallatum* (Bieb.) Fisch. – Shrouded thistle, *Inula orientalis* Lam. – Eastern elecampane, *Onopordum acanthium* L. – Prickly tartar, *Senecio taraxacifolius* (Bieb.) DC. – Dandelion ragwort, *Aiphanthus echioides* (L.) Stev. (*Macrotomia echioides* (L.) Boiss., *Huynhia pulchra* (Roem. et Schult.) Greuter et Burdet) – Apianthus, *Gadellia lactiflora* (Bieb.) Schulkinia (*Campanula lactiflora* Bieb.) – *Gadellia lactiflora*, *Oberna wallichiana* Klotzsch – *Oberna Wallich*, *Cephalaria gigantea* (Ledeb.) Beaver. – Giant capitata, *Scabiosa caucasica* Bieb. – Caucasian scabiosa, *Onobrychis biebersteinii* Sirj. – Bieberstein sainfoin, *Gentiana angulosa* Bieb. – Angular gentian, *G. aquatic* L. – *G. aquatic*, *G. septemfida* Pall. – *G. seven-parted*, *G. schistocalyx* (C. Koch) C. Koch – *G. septatecalyx*, *Betonica macrantha* C. Koch (*B. Grandiflora* Willd.) – Large-flowered letter, *Thymus nummularius* Bieb. – Monetary thyme, *Bistorta carnea* (C.Koch) Kom. (*Polygonum carneum* C. Koch) – *Bistorta* (Buckwheat), *Racetoselloides alpines* L. – Alpine sorrel, *Primula algida* Adams – Cold primrose, *P. cordifolia* Rupr. – *P. cordifolia*, *P. ruprechtii* Kusn. – *P. Ruprecht*, *Anemonastrum fasciculatum* (L.) Holub (*Anemone fasciculata* L.) – *Anemone strum*, *Trollius ranunculinus* (Smith) Steam (*T. patulus* Salisb.) – Buttercup, *Rhinanthus minor* L. (*R. nigricans* Meinsh.) – Small rattle, *Rhynchocorys orientalis* (L.) Benth. – Oriental proboscis.

Alpine florocene elements include 20 species (15.5%): *Carex tristis* Bieb. (*C. meinshauseniana* V.Krecz.) – Sad sedge, *Fritillaria collina* Adams (*F. ophioglossifolia* Freyn et Sint.; *F. lutea* Bieb.) – Hill hazel grouse, *Bromopsis variegata* (Bieb.) Holub (*Z. variegata* (Bieb.) Nevski) – Variegated brome, *Astrantia trifida* Hoffm. – Three-cut astrantia, *Senecio taraxacifolius* (Bieb.) DC. – Dandelion ragwort, *Cerastium cerastoides* (L.) Britt. – Common parsley, *Onobrychis biebersteinii* Sirj. – Bieberstein sainfoin,

*Gentiana angulosa* Bieb. – Angular gentian, *G. aquatic* L. – *G. aquatic*, *G. schistocalyx* (C. Koch) C. Koch – *G. septocalyx*, *Betonica macrantha* C. Koch (B. *Grandiflora* Willd.) – Large-flowered letter, *Thymus caucasicus* Willd. – Caucasian thyme, *Th.nummularius* Bieb. – Ch. coin, *Racetoselloides alpines* L. – Alpine sorrel, *Primula algida* Adams – Cold primrose, *P. luteola* Rupr. – P. yellow, *P. ruprechtii* Kusn. – P. Ruprecht, *Aconitum confertiflorum* (DC.) Worosch. – Crowed-flowered fighter, *Anemonastrum fasciculatum* (L.) Holub (*Anemone fasciculata* L.) – *Anemonastrum fasciculatum*, *Trollius ranunculinus* (Smith) Steam (*T. patulus* Salisb.) – Buttercup.

There are 14 species of steppe florocene elements (10.8%): *Muscari neglectum* Guss. (*M. muscarimi* Medik.; *M. racemosum* (L.) Mill.) – Mouse hyacinth unnoticed, *Achillea millefolium* L. – Tree yarrow, *Ach. setacea* Waldst. et Kit. – D. bristly, *Artemisia campestris* L. – *Artemisia*, *Centaurea adpressa* Ledeb. – Cornflower, *Scorzonera filifolia* Boiss. – Threadleaf goat, *Nonea rosea* (Bieb.) Link – Pink nonea, *Bunias orientalis* L. – Oriental frog, *Convolvulus arvensis* L. – Field grass, *Lotus corniculatus* L. – Horned grasshopper, *Medicago falcate* L. – Sickleweed, *Teucrium polium* L. – White Dubrovník, *Thalictrum minus* L – Small cornflower, *Galium verum* L. – Spring bedstraw.

There are 5 species of calcetrophilic florocene elements (3.8%): *Hieracium umbellatum* L. – Umbrella hawkweed, *Scorzonera filifolia* Boiss. – Threadleaf goat, *Gentiana grossheimii* Doluch. – Grossheim's gentian, *Thymus collinus* Bieb. – Chebrets Kholmovoy, *Th. daghestanicus* Klok.et Shost. (*77 mashukensis* Klok.) – Ch. Dagestan,

There are only 3 species of psammophilic florocene elements (2.3%): *Hieracium umbellatum* L. – Umbrella hawkweed, *Dianthus arenarius* L. – Sandy carnation, *Scabiosa ucranica* L. – Ukrainian scabiosa,

There is 1 species (0.8%) of argilophilic florocene elements: *Tussilago farfara* L. – Common coltsfoot.

Oxylophilic florocene elements 4 types (3.1%): *Senecio taraxacifolius* (Bieb.) DC. – Dandelion ragwort, *Gentiana dshimilensis* C.Koch – Dzhimil gentian, *Thymus caucasicus* Willd. – Caucasian thyme, *Primula cordifolia* Rupr. – Primrose cordifolia.

There are 3 types of segetal florocene elements (2.3%): *Bunias orientalis* L. – Oriental Sverbiga, *Convolvulus arvensis* L. – Field grass, *Amoria repens* (L.) C. Presl (*T. repens* L.) – Creeping *Amoria* (Clover) .

There are 12 species of ruderal florocene elements (9.2%): *Daucus carota* L. – Wild carrot, *Tanacetum vulgare* L. – Tansy, *Nonea rosea* (Bieb.) Link – Pink nonea, *Symphytum asperum* Lepech. – Comfrey, *Bunias orientalis* L. – Eastern Sverbiga, *Cardaria draba* (L.) Desv. (*Lepidium draba* L.) – *Cardaria*, *Convolvulus arvensis* L. – Field grass, *Amoria repens* (L.) C. Presl (*T. repens* L.) – Creeping *Amoria* (Clover), *Melilotus officinalis* (L.) Pall. – Elecampane, *Salvia verticillata* L. – Whorled sage, *Aconitum confertiflorum* (DC.) Worosch. – Crowed-flowered fighter, *Urtica dioica* L. – Stinging nettle.

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(L.) Holub (*Anemone fasciculata* L.) – *Anemonastrum fasciculatum*, *Trollius ranunculinus* (Smith) Stearn (*T. patulus* Salisb.) – Buttercup.

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There are 5 species of calcepetrophilic florocene elements (3.8%): *Hieracium umbellatum* L. – Umbrella hawkweed, *Scorzonera filifolia* Boiss. – Threadleaf goat, *Gentiana grossheimii* Doluch. – Grossheim's gentian, *Thymus collinus* Bieb. – Chebrets Kholmovoy, *Th. daghestanicus* Klok.et Shost. (*77 mashukensis* Klok.) – Ch. Dagestan,

There are only 3 species of psammophilic florocene elements (2.3%): *Hieracium umbellatum* L. – Umbrella hawkweed, *Dianthus arenarius* L. – Sandy carnation, *Scabiosa ucranica* L. – Ukrainian scabiosa,

There is 1 species (0.8%) of argilophilic florocene elements: *Tussilago farfara* L. – Common coltsfoot.

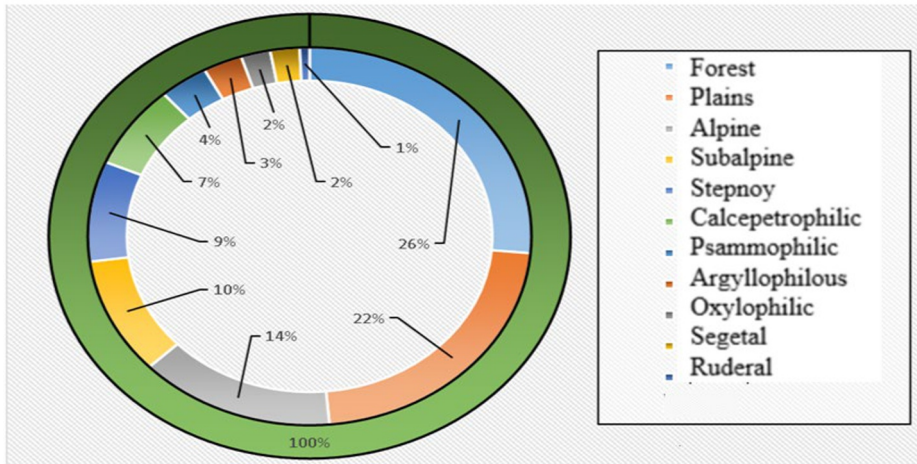
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There are 12 species of ruderal florocene elements (9.2%): *Daucus carota* L. – Wild carrot, *Tanacetum vulgare* L. – Tansy, *Nonea rosea* (Bieb.) Link – Pink nonea, *Symphytum asperum* Lepech. – Comfrey, *Bunias orientalis* L. – Eastern Sverbiga, *Cardaria draba* (L.) Desv. (*Lepidium draba* L.) – *Cardaria*, *Convolvulus arvensis* L. – Field grass, *Amoria repens* (L.) C. Presl (*T. repens* L.) – Creeping *Amoria* (Clover), *Melilotus officinalis* (L.) Pall. – Elecampane, *Salvia verticillata* L. – Whorled sage, *Aconitum confertiflorum* (DC.) Worosch. – Crowded-flowered fighter, *Urtica dioica* L. – Stinging nettle.

**Table 2.** Analysis of florocenosis of elements of the central site of the carbon polygon "WAY CARBON".

№	Florocene element	Number of element types	% of total species
1.	Forest	10	7,7
2.	Plains	31	23,8
3.	Alpine	20	15,5
4.	Subalpine	37	28,5
5.	Stepnoy	14	10,8
6.	Calcepetrophilic	5	3,8
7.	Psammophilic	3	2,3
8.	Argyllophilous	1	0,8
9.	Oxylophilic	4	
10.	Segetal	3	2,3
11.	Ruderal	12	9,2
Total:		130	100



**Fig. 2.** Spectrum of florocene elements of the central site of the WAY CARBON carbon polygon.

Preservation of the genetic fund of flora, especially regional flora, is extremely important [7].

To compile a list of species subject to protection, we were guided by two criteria – the category of protection and the status of the species [6, 7, 8].

Stenoendemics (Es) include 1 species: *Gentiana grossheimii* Doluch. - Gentian. Grossheim.

Subendemics (Esub) include 2 species: *Gentiana grossheimii* Doluch. – Grossheim's gentian, *Primula luteola* Rupr. - Yellow primrose.

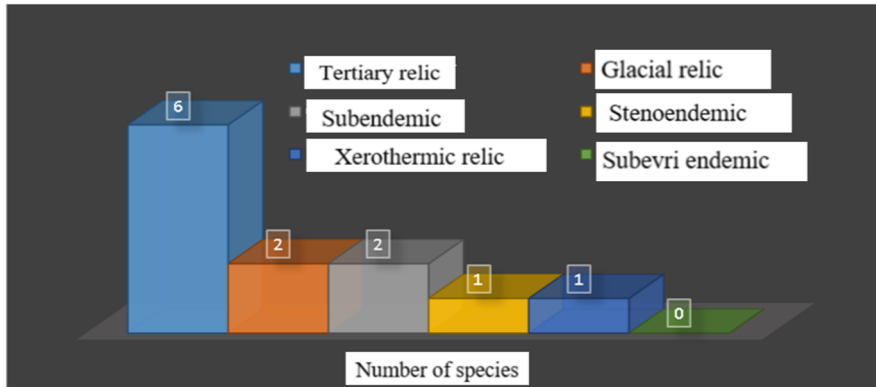
Tertiary relicts (Rt) are 6 species: *Pinus sosnowskyi* Nakai (*P. hamata* (Stev.) Sosn.; *P. kochiana* Klotzsch) - Sosnowsky pine, *Dactylorhiza incarnate* (L.) Soo (*Orchis latifolia* L.) - Red fingerroot. *Heracleum sibiricum* L. – Siberian hogweed, *Ostrya carpinifolia* Scop. – Common hop hornbeam, *Thalictrum minus* L – Small cornflower, *Trollius ranunculinus* (Smith) Stearn (*T. patulus* Salisb.) – Buttercup buttercup.

There are 2 species of glacial (Rg) relicts: *Sedum stoloniferum* S.G. Gmel. – Sedum, soft bedstraw.

A xerothermic relict (Rx) is 1 species: *Dianthus arenarius* L. – Sandy carnation.

**Table 3.** Relict and endemic plant species of the central site of the WAY CARBON carbon test site.

Species to be protected	Tertiary relict	Glacial relict	Xerothermic relict	Stenoendemic	Subendemic	Subendemic
Number of species	6	2	1	1	2	0
% of total	49,8	16,7	8,3	8,3	16,7	0



**Fig. 3.** Quantitative distribution of relict and endemic plant species of the central site of the WAY CARBON carbon polygon.

## 4 Conclusions

Among the studied plant species at the central site of the WAY CARBON carbon test site, there are 100 species belonging to 33 families. Thanks to the conducted research, the following conclusions can be drawn:

- the largest number of species belongs to the family Asteraceae (Compositae) (16 species, 16%), the smallest number of species belongs to the families Pinaceae, Cyperaceae Iridaceae, Hyacinthaceae, Convolvulaceae, Geraniaceae, Hypericaceae, Polygalaceae, Salicaceae, Urticaceae, Violaceae, Crassulaceae (1 each mind, 1%) ;
- according to ecological-coenotic analysis, the largest number of species belongs to the subalpine element (37 species), lowland (31 species) and alpine (20 species), the smallest number belongs to the argillophilic florocene element (1 species).
- 9 species are relict species, 3 are endemic species.

## Acknowledgments

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