A preliminary floristic checklist of Kazinag national park, Kashmir Himalaya

Riyaz Ahmad
Wildlife Trust of India
Tajamul Islam
islamtajamul66@gmail.com

University of Kashmir
Anzar Ahmad Khuroo
University of Kashmir
Yash Veer Bhatnagar
IUCN-International Union for Conservation of Nature
Gopal S. Rawat
Wildlife Institute of India

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Abstract

Protected areas play an important role in the conservation of biodiversity and provide life supporting ecosystem services to sustain the human wellbeing and their livelihood. In the present study, we provide a preliminary floristic checklist of Kazinag national park, located in the Kashmir Himalaya. The checklist includes 186 taxa (182 species, 2 subspecies, and 2 varieties) belonging to 147 genera in 55 families. The angiosperms were represented by 181 taxa (97.31%) belonging to 142 genera in 71 families, while gymnosperms are represented by 5 species (2.69%) belonging to 5 genera in 2 families. Asteraceae was the dominant family with 24 species, followed by Ranunculaceae and Rosaceae with 14 and 13 species respectively. Likewise, *Astragalus* followed by *Erigeron* and *Impatiens* were the dominant genera with 3 species each. The herbs were dominant (147 species, 79.03%), followed by shrubs (19, 10.22%) and trees (14, 7.53%). Lifespan wise, perennials were dominant (164 species, 88.17%), followed by annuals (21, 11.29%) and biennials (1, 0.54%). The hemicryptophytes were dominanat (110 species, 59.14%), followed by phanerophytes (36, 19.35%) and therophytes (22, 11.83%). This is the first comprehensive floristic checklist with assessment of their life-history traits from this Himalayan protected area, and the information can be used in conservation strategies for flora and management decisions about this national park and other protected areas in the region.

Introduction

The PAs refer to “a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values” (Dudley and Stolton, 2008). World over, PAs currently comprise 16.64% of terrestrial and freshwater environments and 7.74% of the marine realm (UNEP-WCMC and IUCN, 2021; https://livereport.protectedplanet.net/). Under the recently signed post-2020 global biodiversity framework, PAs are key to achieve the various biodiversity targets. The PAs such as national parks represent one of the main conservation mechanisms to sustainably manage biodiversity and ensure continuous flow of life-supporting ecosystem goods and services (Velazco et al., 2022). The PAs are prominent mechanisms to promote nature-based solutions in combating the challenges of the global climate change and contribute in realizing the United Nations sustainable development goals (Akasaka et al., 2022). In particular, the role of PAs is increasingly becoming important in addressing the challenges of global biodiversity loss (Folke et al., 2021; Pettorelli et al., 2021). The PAs play a crucial role in preserving natural habitats and conserving endangered species (Ekka et al., 2022) by providing a safe haven for flora and fauna. Therefore, documenting the existing biodiversity in these protected areas is essential for the long-term sustainability of our planet (Hoffman, 2022; Siqueira-Gay et al., 2022). Additionally, they provide opportunities for scientific research, education, and eco-tourism, which can contribute to the local economy and promote conservation efforts (Ekka et al., 2022). Given the increasing relevance of PAs in managing regional environment, scientific documentation of biodiversity in these natural areas assumes urgent priority.

India, being globally one of the recognized mega biodiversity nations, harbors about 12% of world’s biota, with only 2.2% of the world’s geographical area. The Himalaya, occupying a special place in the world’s mountain systems, has a dominant role in determining the climate of Indian subcontinent, supports a treasure-trove of biodiversity (Dar and Khuroo, 2020). In India, the Himalaya comprises just 13% of country’s geographical area, still it represents nearly half of the Indian flora (Dar and Khuroo, 2020). In India, protected areas covers about 1,73,629.52 km^2 of geographical area which is approximately 5.28% of the total area of the country (WII, 2023; https://wii.gov.in/). At present, the country has a network of 998 protected areas, including 106 national parks, 567 wildlife sanctuaries, 105 conservation reserves and 220 community reserves. In addition, 18 biosphere reserves, 32 elephant reserves and 51 tiger reserves are also found in India (WII, 2023; https://wii.gov.in/).

For their efficient management in the country, documentation of biodiversity is the first and foremost requirement. Although several studies have been conducted to undertake taxonomic documentation of floristic diversity in Indian PAs (Rawat et al., 2013; Shrivastava et al., 2017; Dwivedi et al., 2018; Negi et al., 2018; Sen and Bhakat, 2021; Islam et al., 2023), there are still many precious biodiversity rich areas for which no data is available. Due to the limited baseline biodiversity data for the majority of protected areas in the country, it's exceedingly challenging to implement management strategies based on scientific principles. Moreover, the biodiversity found in different regions varies significantly due to differences in climatic conditions and topography (Tukiainen et al., 2019). As a result, field-based lists of plant species are frequently the only available source of taxonomic information for a specific area. Therefore, field-based floristic checklists are often the sole source of taxonomic information for a particular region and forms the critical base for assessing current status of biodiversity status, effective monitoring and developing management plans (Villaseñor et al., 2022).

In India, Jammu and Kashmir region is located in the north-western boundary of the Himalaya biodiversity hotspot (Dar and Khuroo, 2020). This Himalayan region has 48 protected areas, which comprises of 4 national parks, 14 wildlife sanctuaries, 16 conservation reserves and 14 wetland reserves, covering about 4907.41 km^2 (FSI, 2021; https://fsi.nic.in/). Since earlier times, several floristic studies have been undertaken in Jammu and Kashmir (Wali and Tiku, 1964; Javeid, 1968; Kaul, 1986; Nawchoo and Kachroo, 1995; Dar et al., 2002; Raina and Sharma, 2010; Bhellum, 2012; Sharma and Raina, 2017; Dar, 2021; Islam et al., 2023). In this study, we aimed to document the flora of

Kazinag national park — holds the largest Markhor population in India. With the present study, we contribute to filling this knowledge gap. Keeping into consideration, present study was aimed to identify and enlist the plant species of Kazinag national park along their life-history traits, which provide a baseline for further ecological investigations, devising conservation strategies and management plans.

Materials and methods

Study area

This study was conducted in Kazinag national park, which comprises of the Lachipora wildlife sanctuary, the Limber wildlife sanctuary and the Naganari Conservation Reserve, located in the Kashmir Himalaya — a region falling towards the northwestern side of the Indian Himalaya (Rodgers and Panwar, 1988; Dar and Khuroo, 2020). The Kazinag national park is situated in Kazinag range (34°10'0" North, 74°2'0" East), with altitude ranging from 1800–4700 m a.s.l. (Dar et al., 2020) (Fig. 1). The KNP occupies the north bank of the River Jhelum in Buniyar close to the international border with Pakistan on the northwestern side and Shamshabari Range (Langate Forest Division area of Kupwara District) to its north. The KNP falls under the Kathai forests within the district Baramulla. Some of the compartments of the Kathai range were a game reserve of the erstwhile Maharaja of Jammu and Kashmir were declared into three protected areas, namely the Lachipora wildlife sanctuary, the Limber wildlife sanctuary and the Naganari Conservation Reserve in 1987, providing for the first time in the area, protected refuge for wildlife (Kumar and Kaul, 2014). However, the three protected areas were merged and upgraded as the Kajinag National Park within an area of 157 km^2.

The region is characterised by severe to moderate cold temperature in winters and moderate temperature in summer. Temperature varies from a minimum of -10°C in winter to a maximum of 30°C in summer. The study area receives on an average 704.97 mm of precipitation each year (IMD, 2023; https://mausam.imd.gov.in/), largely in the form of snow during the winter with rains in March with occasional showers during July. In the higher regions of the area snow accumulation can reach up to 2 m. The KNP experiences four well defined seasons: winter (December–February) with very low temperatures and snow covering most of the area, spring (March–May) when temperatures begin to rise and sprouts appears at lower elevations first and gradually move to upper elevations, summer (June–August) when temperatures rise further and the area contains abundant forage and receives some monsoon showers (residual) and autumn (September–November) when senescence sets in plant. The KNP is interspersed with rocky cliffs more or less uniformly along the altitude (Mani, 1981). There are temperate grasslands with rolling terrain at lower elevations. The narrow belt along streams is flatter and is bounded by extensive but steep slopes. Similarly, some part of the alpine meadows is rolling but most of the alpine and subalpine areas have steep slopes.

The vegetation of the KNP is broadly comprises of temperate coniferous, subalpine and alpine type (Champion and Seth, 1968). However, the sanctuary harbours various vegetation types (Fig. 2). The vegetation is dominated by *Pinus wallichiana*, *Cedrus deodara* and *Abies pindrow* in the lower and middle elevations. At higher elevations, the subalpine forest is dominated by *Betula utilis* and mixed forests, whereas the alpine vegetation is dominated by *Juniperus squamata* and herbaceous vegetation. The lower areas of riverine forests are dominated by *Aesculus indica* and *Viburnum grandiflorum*. The KNP is critical habitat of many faunal species, such as Goral (*Nemorhaedus goral*i), Kashmir Musk Deer (*Moschus cupereus*) and the Markhor (*Capra falconeri*).

Data collection

For the present study, the entire Kazinag national park from forest to alpine zone was extensively surveyed over different peak growing seasons during the years 2019 to 2010. To collect the plant specimens and the information regarding their life-history traits, general walk-over surveys were carried out across the protected areas. The life forms were classified according to Raunkiaer (1934). The data so generated were arranged in spreadsheets for further analysis. We followed the standard taxonomic procedures for collection, drying and further processing of the herbarium specimens (Bridson and Forman, 1998). The field photographs of plant species were taken by Digital Camera (Make: Nikon D 3500). The photography of micro-morphological characters was carried out under a stereozoom microscope (Make: Leica S9D, Germany) integrated with image processing software (LASX). The location map of the Kazinag national park was prepared using ArcGIS (version 10.2; https://www.arcgis.com/). We used multiple literature sources to identify the collected specimens. The specimens were identified after the critical scrutiny based on morphological characters of live as well as mounted specimens using relevant taxonomic literature (Hooker, 1882; Stewart, 1972), and online floras and databases (eFlora of China; BSI Flora of India; eFlora of Pakistan). For each plant species in the inventory, scientific name, common synonym (i.e., recently changed names), family, growth form, lifespan and Raunkiaer life form are provided. We followed Angiosperm Phylogeny Group IV classification for the systematic arrangement and taxonomic circumscription of the angiosperm families (Chase et al., 2016), while Christenhusz et al. (2011) was followed for Gymnosperms. The botanical nomenclature and most common synonym of the plant species were updated using the POWO (2023) (http://www.plantsoftheworldonline.org/).

Results

The floristic checklist of the Kazinag national park comprises of 186 taxa (182 species, 2 subspecies and 2 varieties), belonging to 147 genera in 55 families. The angiosperms were represented by 181 taxa (97.31%) belonging to 142 genera in 71 families, while gymnosperms are represented by 5 species (2.69%) belonging to 5 genera in 2 families. The distribution of species in different families and genera is disproportionate with top ten families and genera contributing 105 species (56.45%) and 28 species (15.05%) respectively. Asteraceae was the dominant family with 24 species, followed by Ranunculaceae and Rosaceae with 14 and 13 species respectively (Fig. 3a and Table 1). Likewise, the dominant genera were *Astragalus*, *Erigeron* and *Impatiens* with 3 species each (Fig. 3b and Table 1).

Table 1
Inventory of flora and life-history traits recorded in Kazinag national park.

S. No.	Scientific name	Common synonym	Family	Growth form	Lifespan	Raunkiaer life form
1.	*Abies pindrow* (Royle ex D.Don) Royle		Pinaceae	Tree	Perennial	Phanerophyte
2.	*Acanthophyllum cerastioides* (D.Don) Madhani & Zarre	*Gypsophila cerastioides* D.Don	Caryophyllaceae	Subshrub	Perennial	Hemicryptophyte
3.	*Acer caesium* Wall.ex Brandis		Sapindaceae	Tree	Perennial	Phanerophyte
4.	*Achillea millefolium* L.		Asteraceae	Herb	Perennial	Hemicryptophyte
5.	*Achnatherum sibiricum* (L.) Keng ex Tzvelev	*Stipa sibirica* (L.) Lam.	Poaceae	Herb	Perennial	Hemicryptophyte
6.	*Aconitum heterophyllum* Wall. ex Royle		Ranunculaceae	Herb	Perennial	Cryptophyte
7.	*Aconitum violaceum*		Ranunculaceae	Herb	Perennial	Cryptophyte
8.	*Actaea spicata* L.		Ranunculaceae	Herb	Perennial	Hemicryptophyte
9.	*Adonis chrysocyathus* Hook.f. & Thomson		Ranunculaceae	Herb	Perennial	Hemicryptophyte
10.	*Aesculus indica* (Wall. ex Cambess.) Hook.		Sapindaceae	Tree	Perennial	Phanerophyte
11.	*Agrimonia pilosa* Ledeb.		Rosaceae	Herb	Perennial	Hemicryptophyte
12.	*Ajuga integrifolia* Buch.-Ham. ex D.Don	*Ajuga bracteosa* Wall. ex Benth.	Lamiaceae	Herb	Perennial	Hemicryptophyte
13.	*Allium humile* Kunth		Amaryllidaceae	Herb	Perennial	Cryptophyte
14.	*Amaranthus retroflexus* L.		Amaranthaceae	Herb	Annual	Therophyte
15.	*Amaranthus viridis* L.		Amaranthaceae	Herb	Annual	Therophyte
16.	*Anaphalis busua* (Buch.-Ham.) DC.		Asteraceae	Herb	Perennial	Hemicryptophyte
17.	*Anaphalis triplinervis* (Sims) Sims ex C.B. Clarke		Asteraceae	Herb	Perennial	Hemicryptophyte
18.	*Anemonastrum obtusilobum* (D.Don) Mosyakin	*Anemone obtusiloba* D.Don	Ranunculaceae	Herb	Perennial	Hemicryptophyte
19.	*Aquilegia fragrans* Benth.		Ranunculaceae	Herb	Perennial	Hemicryptophyte
20.	*Aquilegia pubiflora* Wall. ex Duby		Ranunculaceae	Herb	Perennial	Hemicryptophyte
21.	*Arisaema jacquemontii* Blume		Araceae	Herb	Perennial	Cryptophyte
22.	*Arnebia benthamii* (Wall. ex G.Don) I.M.Johnst.		Boraginaceae	Herb	Perennial	Hemicryptophyte
23.	*Artemisia absinthium* L.		Asteraceae	Herb	Perennial	Hemicryptophyte
24.	*Aster falconeri* (C. B. Clarke) Hutch.		Asteraceae	Herb	Perennial	Hemicryptophyte
25.	*Astragalus chlorostachys* Lindl.		Fabaceae	Herb	Perennial	Hemicryptophyte
26.	*Astragalus grahamianus* Benth.		Fabaceae	Subshrub	Perennial	Hemicryptophyte
27.	*Astragalus rhizanthus* Benth.		Fabaceae	Herb	Perennial	Hemicryptophyte
28.	*Athanasia linifolia* Burm.f.	*Tanacetum longifolium* Thunb.	Asteraceae	Herb	Perennial	Hemicryptophyte
29.	*Aulacospermum stylosum* (C.B.Clarke) Rech.f. &	*Pleurospermum stylosum* C.B.Clarke	Apiaceae	Herb	Perennial	Hemicryptophyte

S. No.	Scientific name	Common synonym	Family	Growth form	Lifespan	Raunkiaer life form
	Riedl					
30.	*Berberis lycium* Royle		Berberidaceae	Shrub	Perennial	Phanerophyte
31.	*Bergenia ciliata* (Haw.) Sternb.		Saxifragaceae	Herb	Perennial	Chamaephyte
32.	*Bergenia stracheyi* (Hook.f. & Thomson) Engl.		Saxifragaceae	Herb	Perennial	Chamaephyte
33.	*Betula utilis* D. Don		Betulaceae	Tree	Perennial	Phanerophyte
34.	*Bistorta amplexicaulis* (D.Don) Greene	*Polygonum amplexicaule* D.Don	Polygonaceae	Herb	Perennial	Hemicryptophyte
35.	*Brachypodium sylvaticum* (Huds.) P.Beauv.		Poaceae	Herb	Perennial	Hemicryptophyte
36.	*Bupleurum candollei* Wall. ex DC.		Apiaceae	Herb	Perennial	Hemicryptophyte
37.	*Bupleurum longicaule* Wall. ex DC.		Apiaceae	Herb	Perennial	Hemicryptophyte
38.	*Campanula latifolia* L.		Campanulaceae	Herb	Perennial	Hemicryptophyte
39.	*Capsella bursa-pastoris* (L.) Medik.		Brassicaceae	Herb	Annual	Therophyte
40.	*Cardamine hirsuta* L.		Brassicaceae	Herb	Annual	Therophyte
41.	*Cardamine macrophylla* Willd.		Brassicaceae	Herb	Perennial	Hemicryptophyte
42.	*Carex canescens* L.		Cyperaceae	Herb	Perennial	Hemicryptophyte
43.	*Carex nubigena* D.Don		Cyperaceae	Herb	Perennial	Hemicryptophyte
44.	*Cedrus deodara* (Roxb. ex D.Don) G.Don		Pinaceae	Tree	Perennial	Phanerophyte
45.	*Chaerophyllum villosum* Wall.ex DC.		Apiaceae	Herb	Annual	Therophyte
46.	*Chenopodium album* L.		Amaranthaceae	Herb	Annual	Therophyte
47.	*Cirsium arvense* (L.) Scop.		Asteraceae	Herb	Perennial	Hemicryptophyte
48.	*Cirsium falconeri* (Hook. f.) Petr.		Asteraceae	Herb	Perennial	Hemicryptophyte
49.	*Clematis montana* Buch.-Ham. ex DC.		Ranunculaceae	Climber	Perennial	Phanerophyte
50.	*Colchicum luteum* Baker		Colchicaceae	Herb	Perennial	Cryptophyte
51.	*Corydalis govaniana* Wall.		Papaveraceae	Herb	Perennial	Hemicryptophyte
52.	*Cotoneaster microphyllus* Wall. ex Lindl.		Rosaceae	Shrub	Perennial	Phanerophyte
53.	*Cypripedium cordigerum* D.Don		Orchidaceae	Herb	Perennial	Cryptophyte
54.	*Dactylis glomerata* L.		Poaceae	Herb	Perennial	Hemicryptophyte
55.	*Dactylorhiza hatagirea* (D.Don) Soó		Orchidaceae	Herb	Perennial	Cryptophyte
56.	*Decalepidanthus echioides* (Royle ex Benth.) Dickoré & Hilger	*Pseudomertensia echioides* (Royle ex Benth.) Riedl	Boraginaceae	Herb	Perennial	Hemicryptophyte
57.	*Delphinium vestitum* Wall. ex Royle		Ranunculaceae	Herb	Perennial	Hemicryptophyte
58.	*Dipsacus inermis* Wall.		Caprifoliaceae	Herb	Perennial	Hemicryptophyte
59.	*Dolomiaea costus* (Falc.) Kasana & A.K.Pandey	*Saussurea costus* (Falc.) Lipsch.	Asteraceae	Herb	Perennial	Hemicryptophyte

S. No.	Scientific name	Common synonym	Family	Growth form	Lifespan	Raunkiaer life form
60.	*Dolomiaea macrocephala* DC. ex Royle	*Jurinea dolomiaea* Boiss.	Asteraceae	Herb	Perennial	Hemicryptophyte
61.	*Doronicum kamaonense* (DC.) Alv.Fern.	*Doronicum roylei* DC.	Asteraceae	Herb	Perennial	Hemicryptophyte
62.	*Duthiea bromoides* Hack.		Poaceae	Herb	Perennial	Hemicryptophyte
63.	*Dysphania botrys* (L.) Mosyakin & Clemants	*Chenopodium botrys* L.	Amaranthaceae	Herb	Annual	Therophyte
64.	*Epilobium angustifolium* L.		Onagraceae	Herb	Perennial	Hemicryptophyte
65.	*Epilobium laxum* Royle		Onagraceae	Herb	Perennial	Hemicryptophyte
66.	*Erigeron acris* var. *multicaulis* (Wall. ex DC.) C.B.Clarke		Asteraceae	Herb	Perennial	Hemicryptophyte
67.	*Erigeron canadensis* L.	*Conyza canadensis* (L.) Cronquist	Asteraceae	Herb	Annual	Therophyte
68.	*Erigeron multiradiatus* (Lindl. ex DC.) Benth. ex C. B. Clarke		Asteraceae	Herb	Perennial	Hemicryptophyte
69.	*Erodium cicutarium* (L.) L'Hér.	*Geranium cicutarium* L.	Geraniaceae	Herb	Annual	Therophyte
70.	*Euphorbia wallichii* Hook.f.,		Euphorbiaceae	Herb	Perennial	Hemicryptophyte
71.	*Euphrasia himalayica* Wettst.		Orobanchaceae	Herb	Annual	Therophyte
72.	*Fagopyrum tataricum* (L.) Gaertn.		Polygonaceae	Herb	Annual	Therophyte
73.	*Filipendula vestita* (Wall. ex G.Don) Maxim.		Rosaceae	Herb	Perennial	Hemicryptophyte
74.	*Fragaria nubicola* (lindl. ex Hook. f.) Lacaita		Rosaceae	Herb	Perennial	Hemicryptophyte
75.	*Geranium collinum* Stephan ex Willd.		Geraniaceae	Herb	Perennial	Hemicryptophyte
76.	*Geum elatum* Wall. ex Hook.f.		Rosaceae	Herb	Perennial	Hemicryptophyte
77.	*Griffitharia vestita* (Wall. ex G.Don) Rushforth	*Sorbus cuspidata* (Spach) Hedl.	Rosaceae	Tree	Perennial	Phanerophyte
78.	*Hackelia uncinata* (Benth.) C.E.C.Fisch.		Boraginaceae	Herb	Perennial	Hemicryptophyte
79.	*Heracleum candicans* Wall.ex DC.		Apiaceae	Herb	Perennial	Hemicryptophyte
80.	*Hibiscus trionum* L.		Malvaceae	Herb	Annual	Therophyte
81.	*Hylotelephium ewersii* (Ledeb.) H.Ohba	*Sedum ewersii* Ledeb.	Crassulaceae	Herb	Perennial	Hemicryptophyte
82.	*Hymenolaena candollei* DC.	*Pleurospermum candollei* (DC.) Benth. ex C.B.Clarke	Apiaceae	Herb	Perennial	Hemicryptophyte
83.	*Hypericum perforatum* L.		Hypericaceae	Herb	Perennial	Hemicryptophyte
84.	*Impatiens brachycentra* Kar. & Kir.		Balsaminaceae	Herb	Annual	Therophyte
85.	*Impatiens glandulifera* Royle		Balsaminaceae	Herb	Annual	Therophyte
86.	*Impatiens scabrida* DC.		Balsaminaceae	Herb	Annual	Therophyte
87.	*Indigofera cassioides* Rottler ex DC.	*Indigofera pulchella* Roxb.	Fabaceae	Shrub	Perennial	Phanerophyte
88.	*Indigofera hebepetala* Benth. ex Baker		Fabaceae	Shrub	Perennial	Phanerophyte

S. No.	Scientific name	Common synonym	Family	Growth form	Lifespan	Raunkiaer life form
89.	*Indigofera heterantha* Brandis		Fabaceae	Shrub	Perennial	Phanerophyte
90.	*Inula royleana* DC.		Asteraceae	Herb	Perennial	Hemicryptophyte
91.	*Iris kemaonensis* Wall. ex D.Don		Iridaceae	Herb	Perennial	Cryptophyte
92.	*Iris hookeriana* Foster		Iridaceae	Herb	Perennial	Cryptophyte
93.	*Isodon rugosus* (Wall. ex Benth.) Codd	*Plectranthus rugosus* Wall. ex Benth.	Lamiaceae	Shrub	Perennial	Phanerophyte
94.	*Jacobaea analoga* (DC.) Veldkamp	*Senecio chrysanthemoides* DC.	Asteraceae	Herb	Perennial	Hemicryptophyte
95.	*Juglans regia* L.		Juglandaceae	Tree	Perennial	Phanerophyte
96.	*Juncus effusus* L.		Juncaceae	Herb	Perennial	Hemicryptophyte
97.	*Juniperus squamata* Buch.-Ham. ex D.Don		Cupressaceae	Shrub	Perennial	Phanerophyte
98.	*Jurinea albescens* (DC.) N.Garcia, Herrando & Susanna	*Saussurea albescens* (DC.) Sch.Bip.	Asteraceae	Herb	Perennial	Hemicryptophyte
99.	*Klasea pallida* (DC.) Holub	*Serratula pallida* DC.	Asteraceae	Herb	Perennial	Hemicryptophyte
100.	*Leontopodium nivale* subsp. *alpinum* (Cass.) Greuter	*Leontopodium alpinum* Cass.	Asteraceae	Herb	Perennial	Hemicryptophyte
101.	*Leonurus cardiaca* L.		Lamiaceae	Herb	Perennial	Hemicryptophyte
102.	*Lepyrodiclis holosteoides* (C.A.Mey.) Fenzl ex Fisch. & C.A.Mey.		Caryophyllaceae	Herb	Annual	Therophyte
103.	*Lespedeza gerardiana* Wall. ex Maxim.		Fabaceae	Subshrub	Perennial	Hemicryptophyte
104.	*Ligularia fischeri* (Ledeb.) Turcz.		Asteraceae	Herb	Perennial	Hemicryptophyte
105.	*Ligusticopsis wallichiana* (DC.) Pimenov & Kljuykov	*Selinum wallichianum* (DC.) Raizada & H.O.Saxena	Apiaceae	Herb	Perennial	Hemicryptophyte
106.	*Lilium polyphyllum* D.Don		Liliaceae	Herb	Perennial	Cryptophyte
107.	*Lolium giganteum* (L.) Darbysh.	*Festuca gigantea* (L.) Vill.	Poaceae	Herb	Perennial	Hemicryptophyte
108.	*Lomelosia speciosa* (Royle) Soják		Caprifoliaceae	Herb	Perennial	Hemicryptophyte
109.	*Lonicera angustifolia* var. *myrtillus* (Hook.f. & Thomson) Q.E.Yang, Landrein, Borosova & Osborne	*Lonicera myrtillus* Hook.f. & Thomson	Caprifoliaceae	Shrub	Perennial	Phanerophyte
110.	*Lonicera purpurascens* (Jacquem. ex Decne.) Walp.		Caprifoliaceae	Shrub	Perennial	Phanerophyte
111.	*Lotus corniculatus* L.		Fabaceae	Herb	Perennial	Hemicryptophyte
112.	*Malva cachemiriana* (Cambess.) Alef.	*Lavatera cachemiriana* Cambess.	Malvaceae	Herb	Perennial	Hemicryptophyte
113.	*Megacarpaea polyandra* Benth.		Brassicaceae	Herb	Perennial	Hemicryptophyte
114.	*Morina coulteriana* Royle		Caprifoliaceae	Herb	Perennial	Hemicryptophyte
115.	*Nepeta connata* Royle ex Benth.		Lamiaceae	Herb	Perennial	Hemicryptophyte
116.	*Nepeta erecta* (Royle ex Benth.) Benth.		Lamiaceae	Herb	Perennial	Hemicryptophyte

S. No.	Scientific name	Common synonym	Family	Growth form	Lifespan	Raunkiaer life form
117.	*Oenothera rosea* L'Hér. ex Aiton		Onagraceae	Herb	Perennial	Hemicryptophyte
118.	*Origanum vulgare* L.		Lamiaceae	Herb	Perennial	Hemicryptophyte
119.	*Orobanche alba* Stephan ex Willd.		Orobanchaceae	Herb	Annual	Therophyte
120.	*Pedicularis bicornuta* Klotzsch		Orobanchaceae	Herb	Perennial	Hemicryptophyte
121.	*Pedicularis pyramidata* Royle ex Benth.		Orobanchaceae	Herb	Perennial	Hemicryptophyte
122.	*Pedicularis trichoglossa* Hook.f.		Orobanchaceae	Herb	Perennial	Hemicryptophyte
123.	*Phleum alpinum* L.		Poaceae	Herb	Perennial	Hemicryptophyte
124.	*Phlomoides bracteosa* (Royle ex Benth.) Kamelin & Makhm.	*Phlomis bracteosa* Royle ex Benth.	Lamiaceae	Herb	Perennial	Hemicryptophyte
125.	*Phytolacca acinosa* Roxb.		Phytolaccaceae	Herb	Perennial	Hemicryptophyte
126.	*Picea smithiana* (Wall.) Boiss.		Pinaceae	Tree	Perennial	Phanerophyte
127.	*Picris hieracioides* L.		Asteraceae	Herb	Biennial	Therophyte
128.	*Pinus wallichiana* A. B. Jackson		Pinaceae	Tree	Perennial	Phanerophyte
129.	*Plantago lanceolata* L.		Plantaginaceae	Herb	Perennial	Hemicryptophyte
130.	*Poa annua* L.		Poaceae	Herb	Annual	Therophyte
131.	*Podophyllum hexandrum* Royle	*Sinopodophyllum hexandrum* (Royle) T.S.Ying	Berberidaceae	Herb	Perennial	Hemicryptophyte
132.	*Polemonium caeruleum* L.		Polemoniaceae	Herb	Perennial	Hemicryptophyte
133.	*Polygonatum cirrhifolium* (Wall.) Royle		Asparagaceae	Herb	Perennial	Cryptophyte
134.	*Polygonatum multiflorum* (L.) All.		Asparagaceae	Herb	Perennial	Cryptophyte
135.	*Polygonatum verticillatum* (L.) All.		Asparagaceae	Herb	Perennial	Cryptophyte
136.	*Populus ciliata* Wall. ex Royle		Salicaceae	Tree	Perennial	Phanerophyte
137.	*Potentilla argyrophylla* Wall. ex Lehm.		Rosaceae	Herb	Perennial	Hemicryptophyte
138.	*Potentilla atrosanguinea* G.Lodd.		Rosaceae	Herb	Perennial	Hemicryptophyte
139.	*Primula denticulata* Sm.		Primulaceae	Herb	Perennial	Hemicryptophyte
140.	*Primula matthioli* subsp. *brotheri* (R.Knuth) Kovt.	*Cortusa brotheri* (R.Knuth) Losinsk.	Primulaceae	Herb	Perennial	Hemicryptophyte
141.	*Primula rosea* Royle		Primulaceae	Herb	Perennial	Hemicryptophyte
142.	*Prunella vulgaris* L.		Lamiaceae	Herb	Perennial	Hemicryptophyte
143.	*Prunus cornuta* (Wall. ex Royle) Steud.		Rosaceae	Tree	Perennial	Phanerophyte
144.	*Ranunculus distans* D.Don	*Ranunculus laetus* Wall. ex D.Don	Ranunculaceae	Herb	Perennial	Hemicryptophyte
145.	*Ranunculus palmatifidus* Riedl		Ranunculaceae	Herb	Perennial	Hemicryptophyte
146.	*Rheum webbianum* Royle		Polygonaceae	Herb	Perennial	Cryptophyte
147.	*Rhododendron anthopogon* D. Don		Ericaceae	Shrub	Perennial	Phanerophyte

S. No.	Scientific name	Common synonym	Family	Growth form	Lifespan	Raunkiaer life form
148.	*Rhododendron campanulatum* D.Don		Ericaceae	Shrub	Perennial	Phanerophyte
149.	*Rosa webbiana* Wall. ex Royle		Rosaceae	Shrub	Perennial	Phanerophyte
150.	*Salix denticulata* Andersson		Salicaceae	Tree	Perennial	Phanerophyte
151.	*Salix flabellaris* Andersson		Salicaceae	Subshrub	Perennial	Phanerophyte
152.	*Salvia hians* Royle ex Benth.		Lamiaceae	Herb	Perennial	Hemicryptophyte
153.	*Scrophularia koelzii* Pennell		Scrophulariaceae	Herb	Perennial	Hemicryptophyte
154.	*Scutellaria prostrata* Jacquem. ex Benth.		Lamiaceae	Herb	Perennial	Hemicryptophyte
155.	*Selinum vaginatum* (Edgew.) C.B.Clarke		Apiaceae	Herb	Perennial	Hemicryptophyte
156.	*Sibbaldia cuneata* Edgew.		Rosaceae	Herb	Perennial	Hemicryptophyte
157.	*Silene coronaria* (L.) Clairv.	*Lychnis coronaria* (L.) Desr.	Caryophyllaceae	Herb	Perennial	Hemicryptophyte
158.	*Silene vulgaris* (Moench) Garcke		Caryophyllaceae	Herb	Perennial	Hemicryptophyte
159.	*Skimmia anquetilia* N.P.Taylor & Airy Shaw		Rutaceae	Shrub	Perennial	Phanerophyte
160.	*Sonchus arvensis* L.		Asteraceae	Herb	Perennial	Hemicryptophyte
161.	*Sonchus asper* (L.) Hill		Asteraceae	Herb	Annual	Therophyte
162.	*Sorbaria tomentosa* (Lindl.) Rehder		Rosaceae	Shrub	Perennial	Phanerophyte
163.	*Spiraea canescens* D.Don		Rosaceae	Shrub	Perennial	Phanerophyte
164.	*Strobilanthes wallichii* Nees		Acanthaceae	Herb	Perennial	Hemicryptophyte
165.	*Sunhangia elegans* (DC.) H.Ohashi & K.Ohashi	*Desmodium elegans* DC.	Fabaceae	Shrub	Perennial	Phanerophyte
166.	*Swertia petiolata* D. Don		Gentianaceae	Herb	Perennial	Hemicryptophyte
167.	*Swertia thomsonii* C.B.Clarke		Gentianaceae	Herb	Perennial	Hemicryptophyte
168.	*Taraxacum campylodes* G.E.Haglund	*Taraxacum officinale* F.H.Wigg.	Asteraceae	Herb	Perennial	Hemicryptophyte
169.	*Taxus contorta* Griff.		Taxaceae	Tree	Perennial	Phanerophyte
170.	*Thalictrum alpinum* L.		Ranunculaceae	Herb	Perennial	Hemicryptophyte
171.	*Thalictrum cultratum* Wall.		Ranunculaceae	Herb	Perennial	Hemicryptophyte
172.	*Thalictrum reniforme* Wall.		Ranunculaceae	Herb	Perennial	Hemicryptophyte
173.	*Thymus linearis* Benth.		Lamiaceae	Subshrub	Perennial	Phanerophyte
174.	*Torilis nodosa* (L.) Gaertn.		Apiaceae	Herb	Annual	Therophyte
175.	*Trifolium repens* L.		Fabaceae	Herb	Perennial	Hemicryptophyte
176.	*Trillium govanianum* Wall. ex D.Don	*Trillidium govanianum* (Wall. ex D.Don) Kunth	Melanthiaceae	Herb	Perennial	Cryptophyte
177.	*Tulipa clusiana* Redouté	*Tulipa stellata* Hook.	Liliaceae	Herb	Perennial	Cryptophyte
178.	*Ulmus villosa* Brandis ex Gamble		Ulmaceae	Tree	Perennial	Phanerophyte
179.	*Valeriana hardwickei* Wall.		Caprifoliaceae	Herb	Perennial	Hemicryptophyte
180.	*Valeriana pyrolifolia* Decne.		Caprifoliaceae	Herb	Perennial	Hemicryptophyte

S. No.	Scientific name	Common synonym	Family	Growth form	Lifespan	Raunkiaer life form
181.	*Verbascum thapsus* L.		Scrophulariaceae	Herb	Perennial	Hemicryptophyte
182.	*Viburnum cotinifolium* D. Don		Viburnaceae	Shrub	Perennial	Phanerophyte
183.	*Viburnum grandiflorum* Wall. ex DC		Viburnaceae	Shrub	Perennial	Phanerophyte
184.	*Vicia bakeri* Ali		Fabaceae	Herb	Annual	Therophyte
185.	*Viola odorata* L.		Violaceae	Herb	Perennial	Hemicryptophyte
186.	*Wikstroemia canescens* Meisn.		Thymelaeaceae	Shrub	Perennial	Phanerophyte

In terms of growth forms, the flora is dominated by herbs (147 species, 79.03%), followed by shrubs (19 10.22%), trees (14, 7.53%) and subshrubs (5, 2.69%), while climbers are represented by 1 species (0.54%) (Fig. 4 and Table 1). In terms of lifespan category, perennials are dominant (164 species, 88.17%), followed by annuals (21, 11.29%) and biennials (1, 0.54%) (Fig. 5 and Table 1). With respect to Raunkiaer's life form, hemicryptophytes are dominant (110 species, 59.14%), followed by phanerophytes (36, 19.35%), therophytes (22, 11.83%) and cryptophytes (16, 8.60%), while chamaephytes the least ones (2, 1.08%) (Fig. 6 and Table 1).

Discussion

The disappearance of plant species and degradation of ecosystem due to anthropogenic activities in Himalaya are depleting at an alarming rate (Dar and Khuroo, 2020). It is estimated that about 10% of the flowering plants are under severe threat due to several factors, primarily unsustainable anthropogenic disturbances (Dash et al., 2022). Consequently, there is the urgent need to preserve genetic diversity for sustenance of human wellbeing and their livelihood (Bawa et al., 2021). This will guarantee the availability of the potential resources for the benefit of the successive generations (Zhang et al., 2023). To tackle these serious issues and prevent biodiversity loss, the national park has been promulgated (Wang et al., 2023). In this regard, the Kazinag national park — the home of the largest Markhor population in India has been established. The KNP has numerous human settlements located in the lower valleys, who depend on it either entirely or partially for various life-supporting ecosystem services and goods like food, fodder, fuelwood, pastures, and medicinal plants for sustaining their livelihood. This indicates that there is a need for proper conservation of flora occurring in the KNP. However, an authentic floristic dataset are highly prerequisite to facilitate management decisions for the protected area (Comes et al., 2022).

In this background, the preliminary floristic checklist of the KNP made available for the first time along with their life-history traits, will help in future conservation and management planning. With a total of 186 plant species recorded in the KNP, it represents 3.68% of the total 2500 vascular plants occurring in Kashmir Himalaya (Dar and Khuroo, 2020) and 1.62% of the 11456 vascular plants occurring in Indian Himalayan region (Wani et al., 2023). Our results revealed that the floristic composition of the KNP shows the dominance of angiosperms (97.31%), and the gymnosperms have a meager contribution (2.69%) to the floristic composition. However, the dominant tree species (e.g., *Abies pindrow*, *Pinus wallichiana*, *Picea smithiana*) plays a major role in maintaining the understory vegetation in the KNP. Similarly, the scrub of *Juniperus* and *Rhododendron* species acts as micro-refugia to facilitate the cushion flora in sub-alpine and alpine zones of KNP. Our results also revealed Asteraceae as the dominant family, which is consistent with studies carried out in other Himalayan regions (Sapkota et al., 2017; Khakurel et al., 2020; Islam et al., 2023). Subsequently, the temperate climate of the region favours the dominance of families like Asteraceae, Rosaceae, Lamiaceae and Brassicaceae (Dar and Khuroo, 2020).

In terms of life history traits, herbs were the dominant growth form recorded in present study, which is similar to other regions of the Himalaya (Chawla et al., 2012; Khakurel et al., 2020; Rawal and Tewari, 2022; Wani et al., 2022; Islam et al., 2023). The plausible reasons behind this could be the diverse understory forest vegetation and vast expanse of subalpine and alpine in the KNP. Further, the continental temperate climate of Himalayan region favours the predominance of herbaceous flora rather than arboreal ones (Mehraj et al., 2018). During present study, shrubs were dominant than trees, which is consistant to some similar studies carried out in other regions of Himalaya (Gairola et al., 2010; Chawla et al., 2012), but contrary to other studies undertaken in other Himalaya regions (Khan et al., 2015; Islam et al., 2023). Furthermore, perennials were found the dominant lifespan category, which is consistent with the similar studies in the Himalayan region (Nafeesa et al., 2021; Islam et al., 2023). The plausible reason for their dominance can be attributed to the fact that perennial species have the distinctive adaptive strategy of storing carbon rich sources in below ground portion in order to tolerate the harsh and prolonged environmental conditions (Gulzar et al., 2021). Another reason could be that the perennial species usually employ the vegetative propagation and clonal strategies in their life cycle (Wani et al., 2022). The Raunkiaer life form is also an important physiognomic attribute that reflects the ecological adaptation of the flora in a particular region (Haq et al., 2021). Our results revealed that hemicryptophytes largely predominate the flora, representing the ground vegetation of herbaceous plant species. This trait seems indicative of their habitat and adaptive strategy at

higher elevation and temperate climate (Haq et al., 2021). These results are correspond with studies carried out in other Himalayan region (Amjad et al., 2016; Zhu et al., 2019; Majeed et al., 2022; Islam et al., 2023). Our results also showed that the phanerophytes considerably contributed to the total percentage of flora, representing the scrub and canopy forming plant species. Further, trees and shrubs determine the diversity and vegetation of understory plant species in the KNP. These results are consistant with the similar studies carried out in other Himalayan regions (Gairola et al., 2010; Chawla et al., 2012; Khan et al., 2015; Islam et al., 2023).

Conclusion

The Kazinag national park harbours a diverse flora including threatened plant species. The present study provides a preliminary floristic checklist with assessment of their life-history traits that will serve as a pilot project to enable decision-makers in formulating future conservation and management strategies for biodiversity in the KNP. The present study would also open the opportunities for further advanced scientific studies. To our best knowledge, this is the preliminary comprehensive checklist of this Kashmir Himalayan protected area and the information can be used in conservation strategies for flora and management decisions about this national park and other protected areas in the region.

Declarations

Ethical statement

The collection of the plants used in the study complies with local or national guidelines with no need for further affirmation.

Conflict of Interest

The authors declare that they have no financial or non-financial competing interests.

Author Contribution

Riyaz Ahmad: Writing Original draft; Methodology; Data collection. Tajamul Islam: Conceptualization, Data analysis; Software; Writing Reviews. Anzar Ahmad Khuroo: Conceptualization; Writing Reviews. Yash Veer Bhatnagar: Conceptualization; Methodology; Plant identification. Gopal A. Rawat: Conceptualization; Methodology; Supervision; Investigation; Plant identification. All authors reviewed the manuscript.

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Data availability

All the primary data generated is present in the manuscript.

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Figures

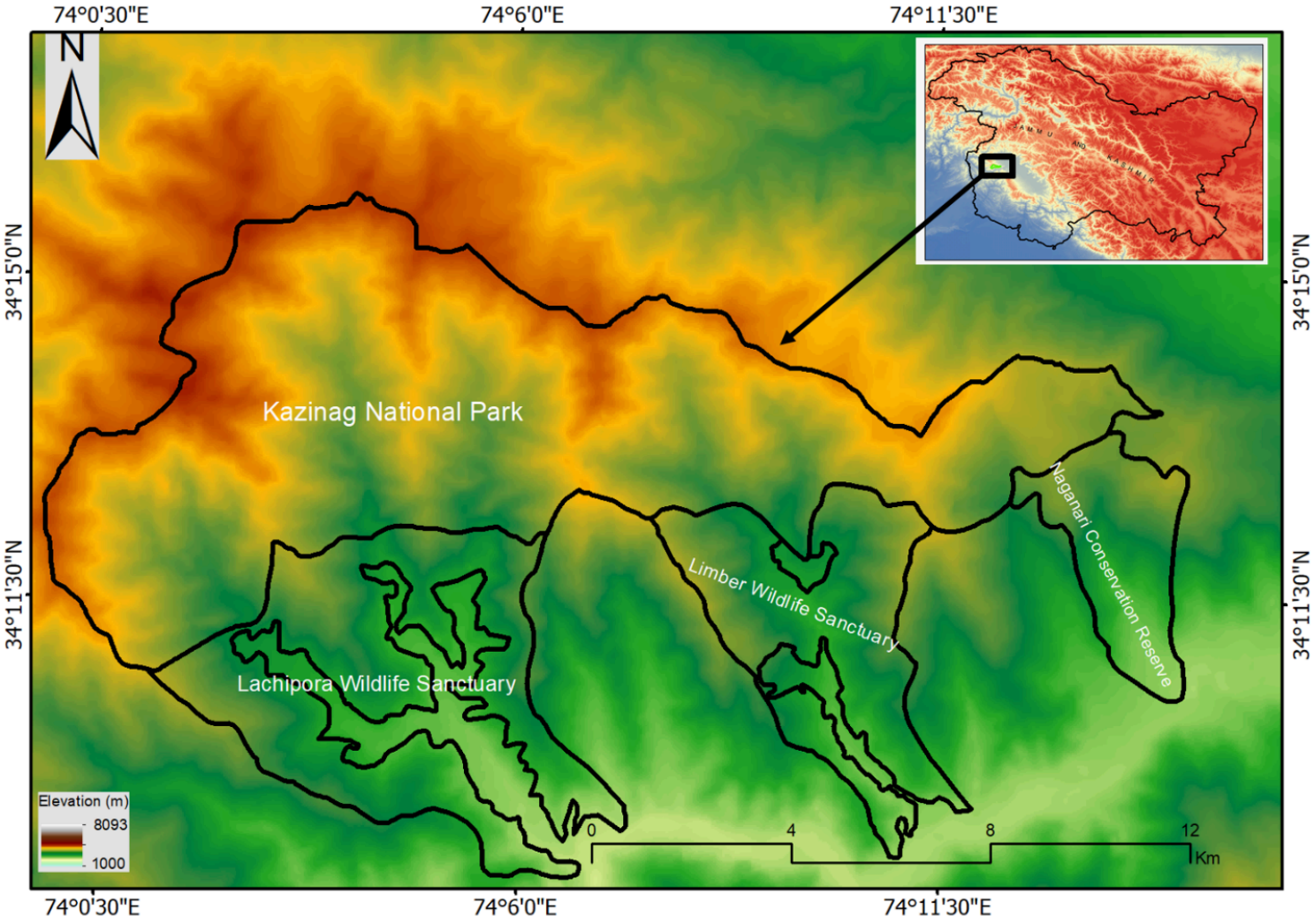

Figure 1

Location map of the Kazinag national park in Kashmir Himalaya.

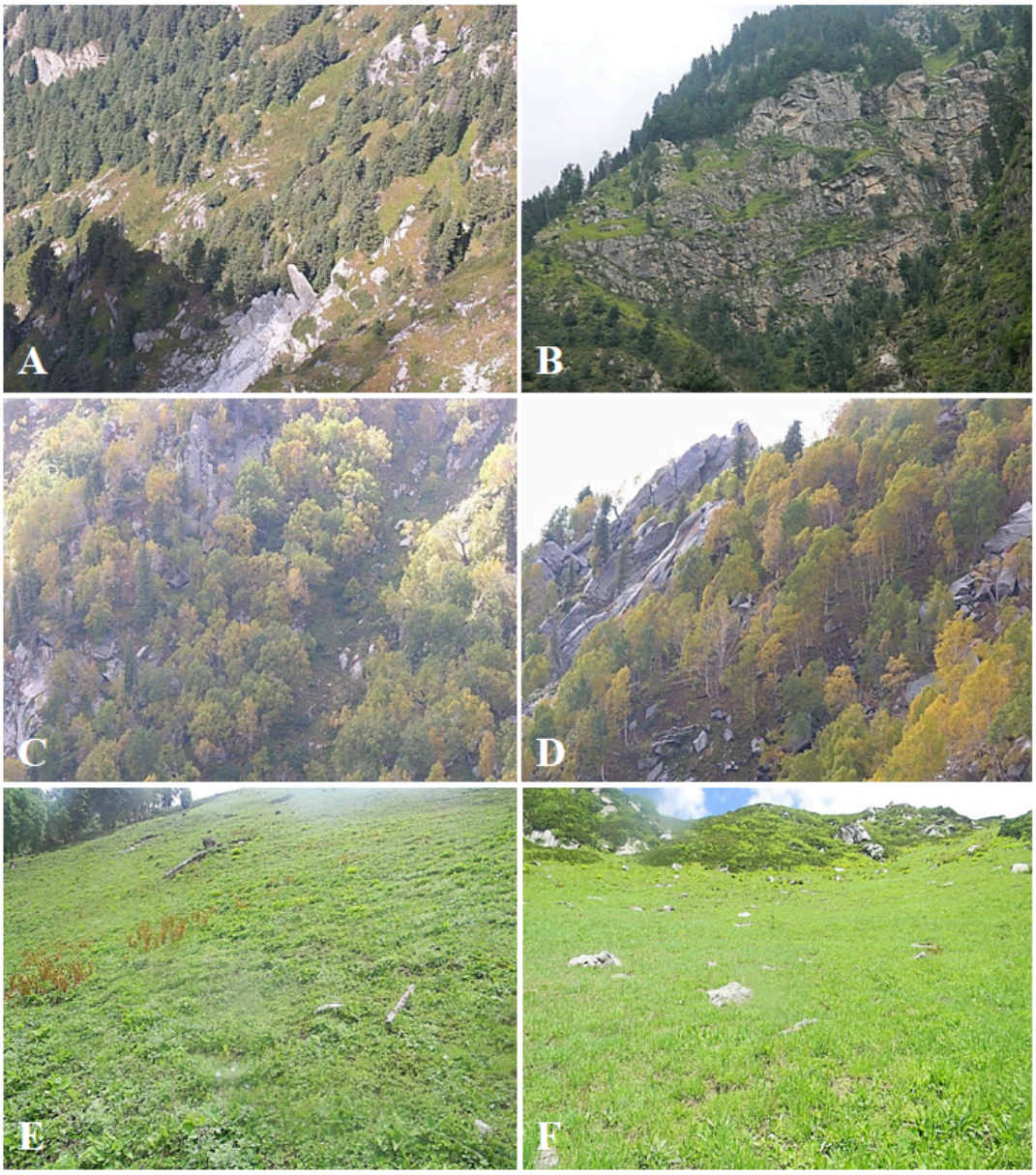

Figure 2

Vegetation types in the Kazinag national park **A&B.** Coniferous forest; **C.** mixed forest; **D.** treeline ecotone; **E.** subalpine meadows; **F.** alpine scrubs.

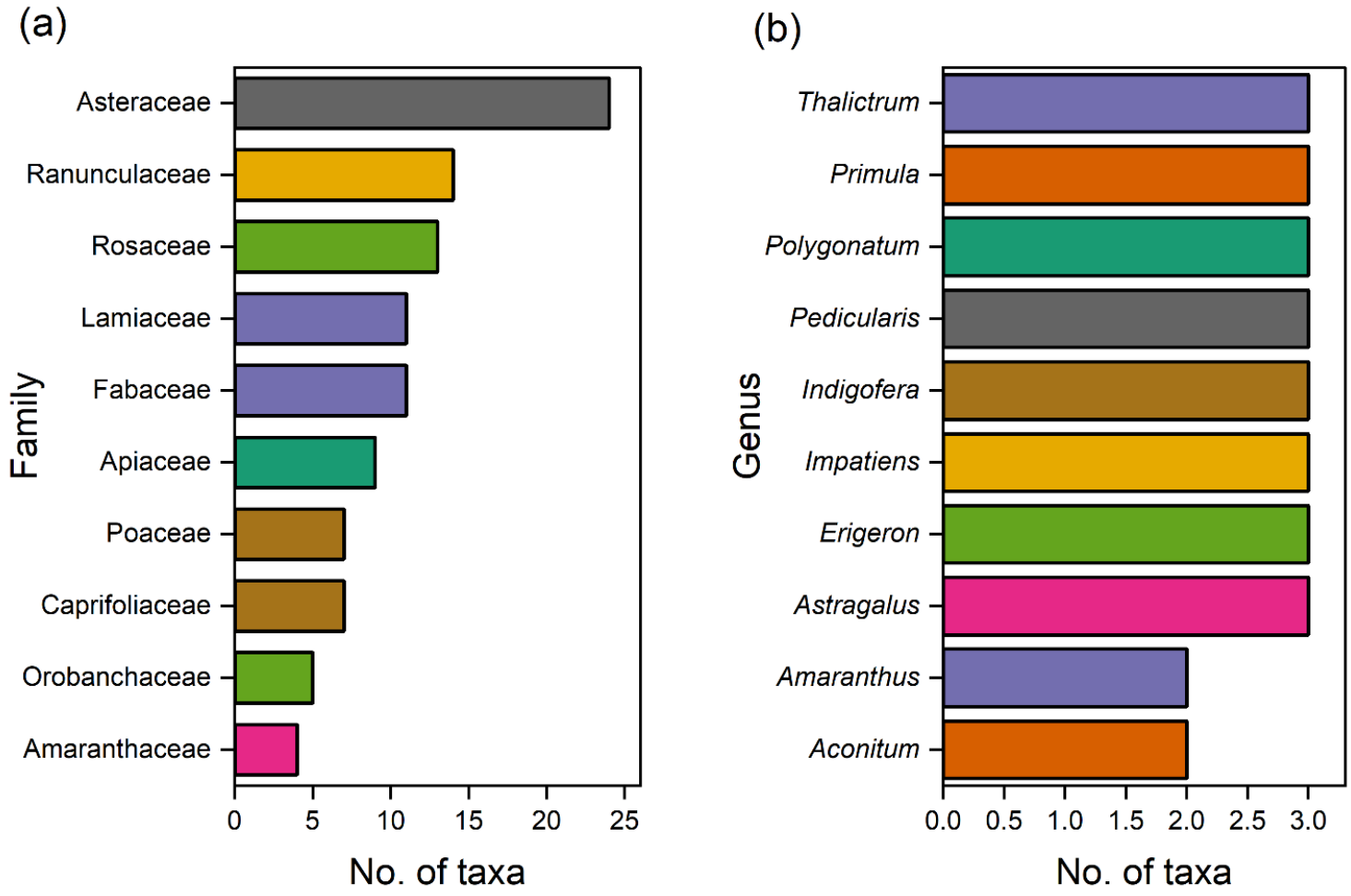

Figure 3

Top-ten largest families and genera in terms of number of taxa recorded in the Kazinag national park.

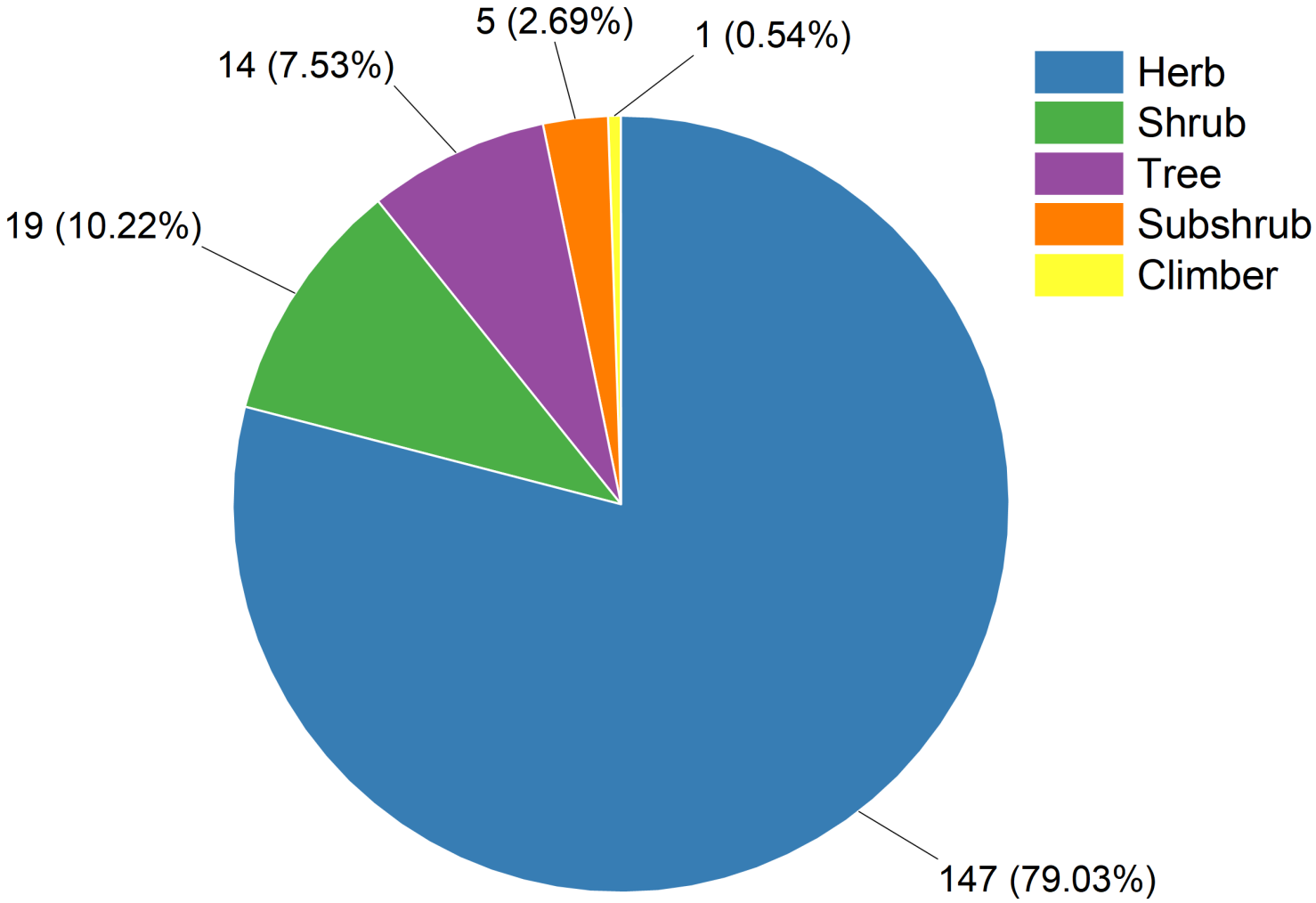

Figure 4

Number and percentage contribution of different growth forms in the flora of the Kazinag national park.

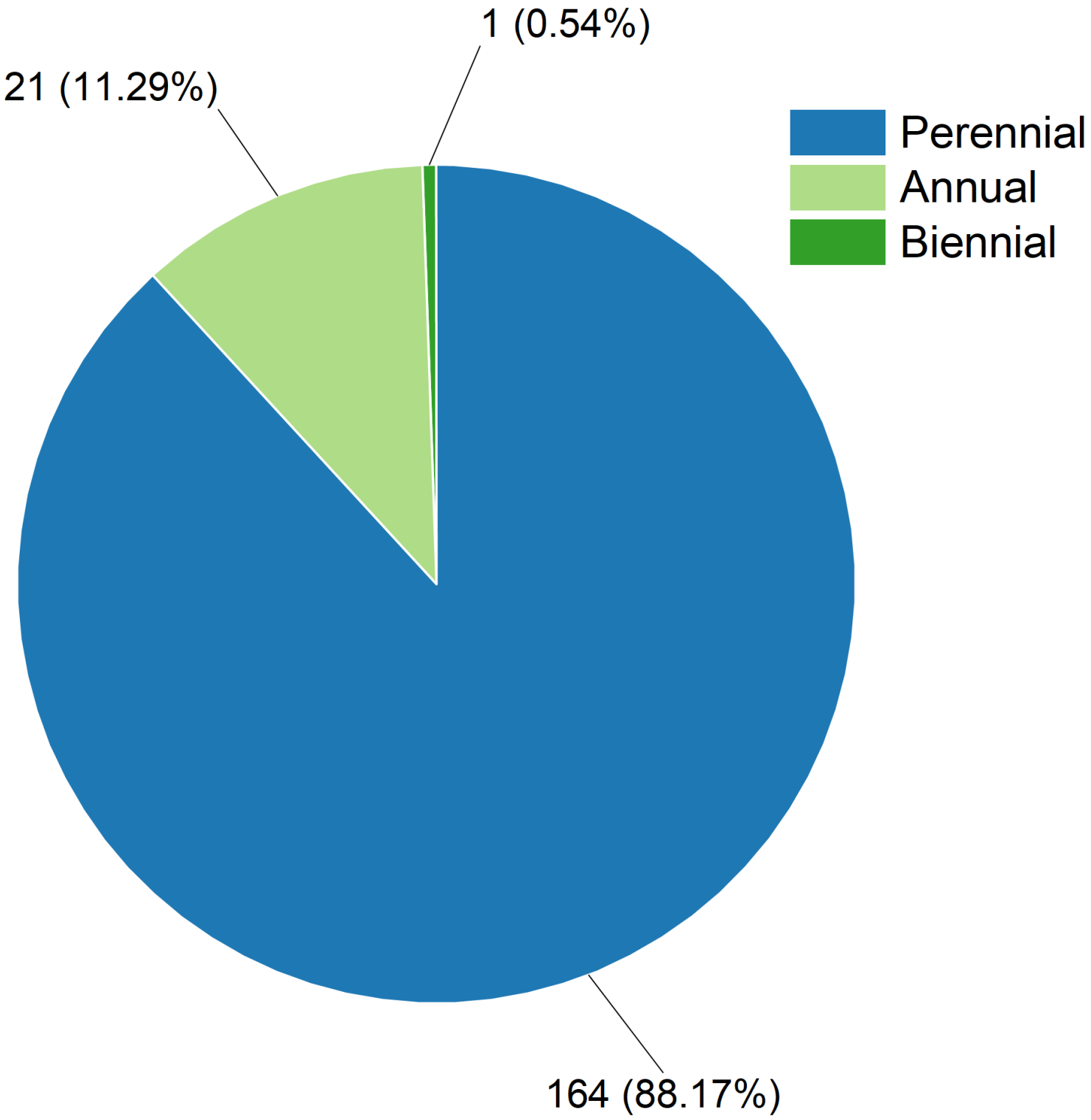

Figure 5

Number and percentage contribution of different lifespan categories in the flora of the Kazinag national park.

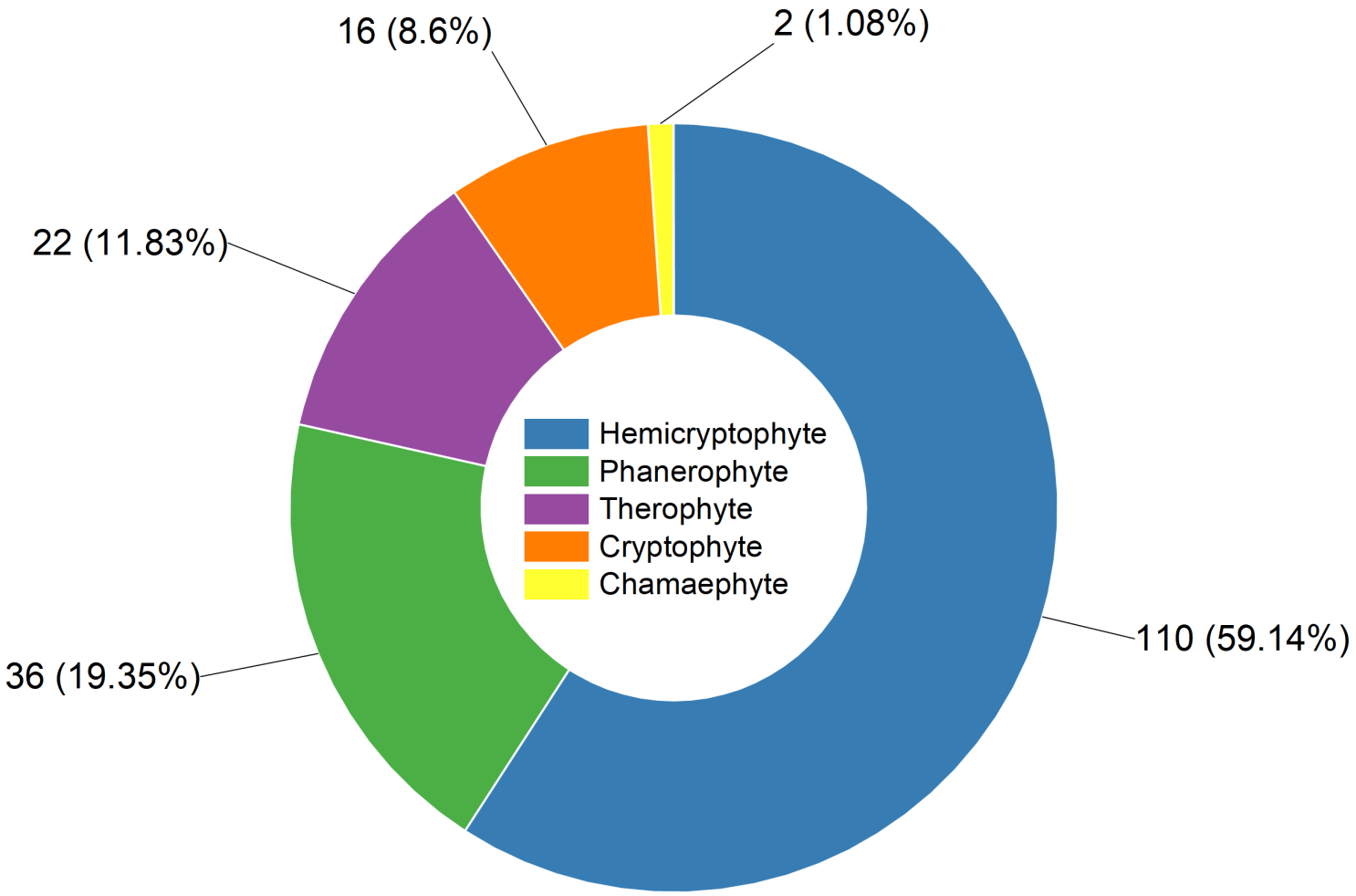

Figure 6

Number and percentage contribution of different Raunkiaer's life form categories in the flora of the Kazinag national park.