The Scientific Temper
Vol. 13, No. 2, July-December, 2022:pp 180-185
ISSN 0976-8653, E-ISSN 2231-6396
A Web of Science Journal
DOI: https://doi.org/10.58414/SCIENTIFICTEMPER.13.2.2022.180-185
Doc ID: https://connectjournals.com/03960.2022.13.2.180

Analysis of Riparian Vegetation Diversity at Khanda Gad Stream, Garhwal Himalaya, Uttarakhand, India

Pratibha Baluni[1], Priya Kathait[2], Pankaj Bahuguna[3], C. B. Kotnala[4] and Rajesh Rayal[2*]

[1]Department of Botany, Government Degree College Dehradun Sehar-248001, Uttarakhand, India.
[2]Department of Zoology, Shri Guru Ram Rai University, Dehradun-248001, Uttarakhand, India.
[3]Department of Zoology, Government Degree College Dehradun Sehar-248001, Uttarakhand, India.
[4]Department of Zoology, HNB Garhwal University Campus (A Central University), Pauri Garhwal-246001, Uttarakhand, India
**Corresponding author: drrajeshrayal@gmail.com*

ABSTRACT

The floral diversity found along water streams and rivers is known as riparian vegetation. It is a zone of transition between terrestrial and aquatic ecosystems. Riparian vegetation helps to maintain nutrient balance and energy flow in ecosystems, as well as provides a variety of resources to aquatic mites and other macroinvertebrates. It also helps to control sediment load in water bodies, which affects water quality. The purpose of this study was to add new information about the status of riparian vegetation in the hill-stream Khanda Gad and to investigate its impact on the occurrence of aquatic mites. During the current study, 45 plant species from 31 different families were collected and identified. The Rosaceae were identified as the dominant family.

Keywords: Aquatic mites, Aquatic macroinvertebrates, Garhwal Himalaya, Khanda Gad, Riparian vegetation.

INTRODUCTION

The ecological complex known as riparian zones is where terrestrial and aquatic systems converge. The riparian zone can be seen as an extension of the river continuum, with "energy driver associations" that have an effect on the stream ecology (Cummins, 1993). These areas are extremely diverse and abundant in species due to their ecotone status. According to Pandey et al. (2022), the interrelationship between the area's vegetation, soil, and water is what gives the riparian zone its ecological significance. The vegetation of the riparian zone includes terrestrial species that live in the understorey and canopy as well as emergent aquatic and semi-aquatic plants (Parson, 1991). The geomorphological, physicochemical, and biological characteristics of aquatic ecosystems are significantly influenced by riparian vegetation (Srivastava, 2007). In addition to their function as photosynthetic organisms, they also support a variety of aquatic, amphibian, and terrestrial species and exchange nutrients and energy between two ecosystems (Gregory et al., 1991; Verry et al., 2000; Baluni and Chandola, 2019; Baluni et al., 2020; Sharma et al., 2022). Surface overflow is prevented by riparian vegetation, which reduces the sediment load. A low sediment rate increases light penetration, which benefits algal growth, fish size, and predators (ZumBerge et al., 2003). Micro- and macro-invertebrates and fish living in the stream or river use the debris and litter of the vegetation stuck in the water channel as food and a breeding ground (Harmon et al., 1986). Numerous aquatic mites and macrozoobenthos require the substrate to complete their life cycles, which aquatic plants and riparian vegetation provide (Sharma et al., 2022).

Aquatic biologists are very aware of the value of riparian vegetation, and as a result, extensive research has been done in this area. Sagir and Dobriyal (2017, 2018) and Sagir et al. (2018) studied the riparian vegetation of Western Nayar, while Balodi et al. (2004) provided a detailed analysis of the riparian vegetation of Eastern

Nayar. The goal of the current investigation is to document the riparian vegetation along the hill-stream Khanda Gad in Pauri, Uttarakhand, India. It also attempts to examine how the riparian zone affects aquatic mites.

MATERIAL AND METHOD

The hill stream Khanda Gad receives water from several springs, underground seeps, and surface runoff. It is a tributary of the spring-fed river Alaknanda and is located between Latitude 30°12°N and Longitude 79°43°E. (Map-1). The two parent streams, the Kathulshyun Gad and the Nandalshyun Gad join at Khanda Chatti, about 200 meters before the village of Khanda, to form the Khanda Gad. As a result, for the majority of its 23.5 Km length, the stream Khanda Gad is a third-order stream. One year of consistent monitoring was conducted to determine seasonal variations in the vegetation pattern.

After the confluence zone, riparian vegetation in Khanda Gad was collected from both banks of the river, identified with the assistance of the locals, and then confirmed using various keys to the floras of Uttarakhand and the Himalayas for their taxonomical specification (Gaur, 1999). Numerous subject matter experts have been consulted in order to validate and confirm the accuracy of the information gathered. In order to analyze the riparian vegetation precisely, the information collected is further divided into categories such as family, vernacular name, availability, and habit.

RESULTS AND DISCUSSION

There were 24 species of woody, climbers, shrubs, weeds, and herbs in addition to 21 tree species (Table 1). Out of the 45 species found, it was noted that a maximum of 21 (46.67%) were trees, followed by 24 (53.33%) woody species, climbers, shrubs, weeds, and herbs.

Rosaceae was noted as the dominant family with maximum 8 species followed by Cannabaceae, Dioscoreaceae, Poaceae, Polygonaceae, Solanaceae, smilacaceae and verbenaceae family each with 2 species Single plant species were to represent the remaining 23 species.

Environmental gradients in multiple dimensions are a defining characteristic of lotic ecosystems (Ward, 1989). The interaction of soil, water, and vegetation elements in riparian ecosystems determines the ecological importance of these ecosystems (Pandey et al., 2022). Riparian vegetation provides organic matter in the form of tree branches, dead leaves, needles, twigs, logs, buds, fruit, and dissolved organic matter (Zanetti et al., 2016, Sharma et al., 2022). The aquatic biota requires this additional availability of organic materials greatly because it depends on them for its main source of energy (Hynes 1963, Cummins 1974). According to Fisher and Likens (1973), riparian vegetation is heavily shaded by the forest canopy and provides 99 percent of the aquatic ecosystem's annual energy input.

Some researchers (Cummins, 1974; Hawkins and Sedell, 1981; Hefting et al., 2005) have examined the various ways opted by aquatic organisms to utilize and process the organic matter provided by riparian vegetation. According to Hynes (1975), there is a significant relationship between stream biota and riparian vegetation. The riparian vegetation along the Kyunja stream was found to be abundant and favorable for biological productivity, similar to previous studies in which we found abundant epilithic periphyton, standing stock of detritus, and macrozoobenthos, as reported by Baluni and Chandola (2019). The Western Nayar's riparian vegetation has been studied by Sagir and Dobriyal (2017, 2018), who came to the conclusion that it creates detritus, which benefits the growth of fish and macrozoobenthos.

Rich riparian vegetation along the stream demonstrated an improvement in the biological productivity of the stream (Baluni and Chandola, 2019; Sharma et al., 2022). Numerous authors noted detritus standing stock and abundant epilithic periphyton alongside macrozoobenthos. Khanda Gad stream has been reported to have 14 different species of water mites (Acari: Hydrachnidia) (Kumar and Dobriyal, 1992; Pesic et al., 2004; 2007a-b; 2010, 2019a,b; Kumar et al., 2007; Bahuguna and Negi, 2021). Periphyton diversity and distribution in relation to stream physicochemical parameters have a significant impact on the occurrence of several aquatic mites (Pesic et al., 2020a-b; 2022a,b; Baluni et al., 2017,2018,2020; Bahuguna et al., 2019a-b, 2020a-b; Baluni 2020; Negi et al., 2021a,b), drifting behaviour of micro and macrozoobenthos (Bahuguna et al., 2019b, 2020b; Bahuguna and Dobriyal, 2020,2022) and on the diversity of fishes (Rayal et al., 2021 a,b; Bahuguna 2020,2021; Bahuguna and Joshi, 2012; Bahuguna et al., 2010) as well as macrozoobenthos (Rautela, et al., 2006; Bahuguna and Dobriyal, 2018; Kumar and Dobriyal, 1999; Mamgain et al., 2021)

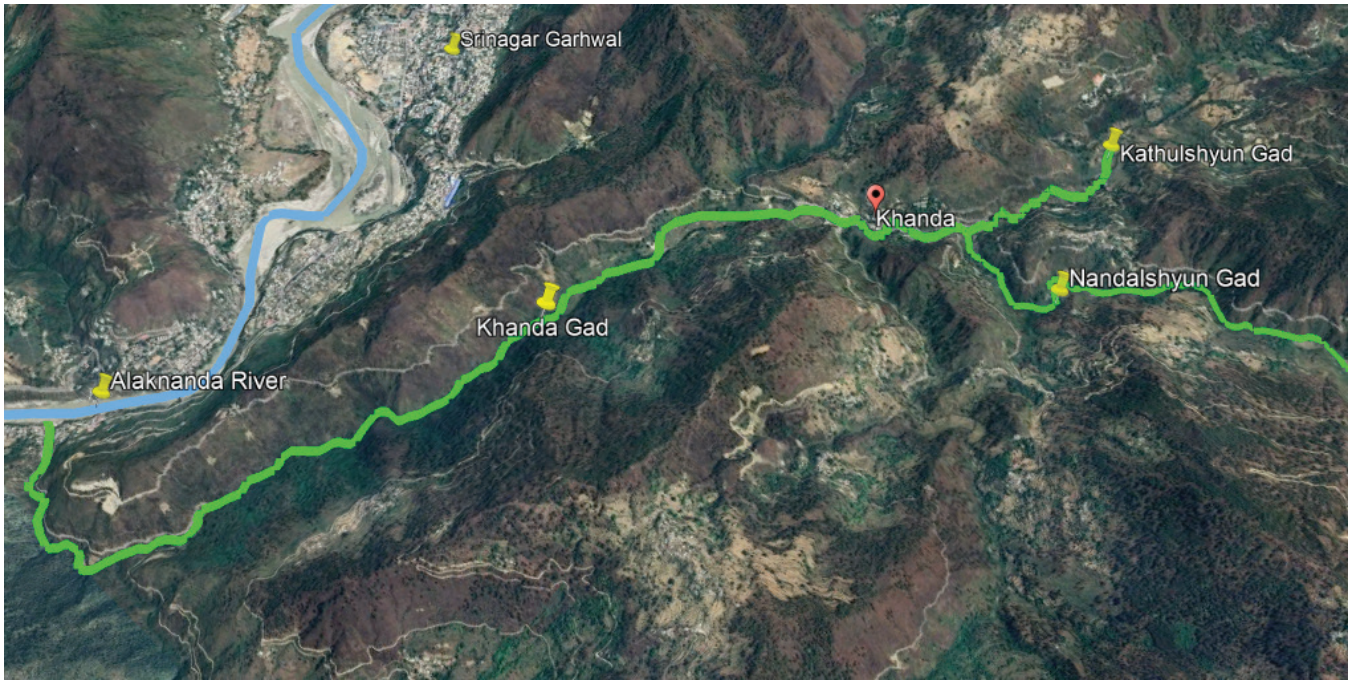
ACKNOWLEDGEMENT

The authors are grateful to Prof. A.K. Dobriyal, Professor of Zoology and Dean of Life Sciences, HNB Garhwal University (A Central University) Campus, Pauri Garhwal for encouraging and critically going through the manuscript. We declare that all ethical guidelines were followed during the study and there are no confliting interest among us.

Table 1: List of Riparian vegetation along the Khanda Gad 3rd order stream.

S. N	SCIENTIFIC NAME	COMMON NAME	FAMILY
1.	**Trees**		
2.	*Mangifera indica* Linn.	Aam	Anacardiaceae
3.	*Alnus nepalensis* D.Don	Utis	Betulaceae
4.	*Celtis australis* Linn	Khirk	Cannabaceae
5.	*Cupressus torulosa* D.Don	Surai	Cupressaceae
6.	*Rhododendron arboreum* Smith	Burans	Ericaceae
7.	*Dalbergia sissoo* Roxb.	Shisham	fabaceae
8.	*Aesculus indica* (Wall.ex Camb.)Hook.f.	Paangar	Hippocastanaceae
9.	*Juglans regia* Linn.	Akhroot/akhod	Juglandaceae
10.	*Cinnamomum tamala* Nees	Daalchini/tejpata	Lauraceae
11.	*Toona ciliata* M.Roem.	Tun	Meliaceae
12.	*Cocculus laurifolius* DC	Tilkar/tilfada	Menispermaceae
13.	*Ficus benghalensis* Linn.	Vat, Bargad	Moraceae
14.	*Myrica esculenta (*butch-Ham.ex.D.Don	Kafal	Myricaceae
15.	*Cedrus deodara* (Roxb. ex Lambert.).Don	Devdar	Pinaceae
16.	*Punica granatum* L.	Annar	Punicaceae
17.	*Prunus cerasoides* D.Don. xyn	Padam/ paiyan	Rosaceae
18.	*Prunus persica* (L) Batsch	Aadu	Rosaceae
19.	*Pyrus granatum* L.	Naspati	Rosaceae
20.	*Pyrus pashia* Buch-hem.ex. D.Don	Mehal	Rosaceae
21.	*Citrus medica* Linn	Galgal	Rutaceae
22.	*Grewia optiva* J.R Drumn. ex Burrett	Bhimal	Tiliaceae
23.	WOODY / CLIMBERS/ SHRUBS/ HERBS		
24.	*Carissa opaca* Stapf ex Haines	Karonda	Apocynaceae
25.	*Berberis asiatica* Roxb. ex DC	Kilmoda	Berberidaceae
26.	*Cannabis sativa* Linn.	Bhang	Cannabaceae
27.	*Trichosanthes palmata* Roxb.	Ilaadu/indrayan	Cucurbitaceae
28.	*Dioscorea belophylla* (Prain) Haines	Taidu/tarud	Dioscoreaceae
29.	*Dioscorea bulbifera* Linn.	Gethi/ratalu	Dioscoreaceae
30.	*Reinwardtia indica*	Fauli	Linaceae
31.	*Cynodon dactylon*	Doob ghass	Poaceae
32.	*Arundo donax*	Baru, Nal	Poaceae
33.	*Polygonum nepalensis*		Polygonaceae
34.	*Rumex hastatus*	Almora	Polygonaceae
35.	*Zizipus sp.*		Rhamnaceae
36.	*Pyracantha crenulata* (D.Don)	Ghigharu	Rosaceae
37.	*Rosa brunonii*	Kunj	Rosaceae
38.	*Rosa multiflora*	Jungali gulab	Rosaceae
39.	*Rubus ellipticus*	Hisool	Rosaceae
40.	*Smilax aspera*	Kukur darh	Smilacaceae
41.	*Smilax sp.*		Smilacaceae
42.	*Datura stramonium* Linn.	Dhatura	Solanaceae
43.	*Solanum nigrum*		Solanaceae

44.	*Urtica dioica*	Kandali	Urticaceae
45.	*Vateriana hardwickii* Wall.	Samoya/tager	Valerianaceae
46.	*Lantana indica*	Panjphulli	Verbenaceae
47.	*Lantana camara*	Raimuniya	Verbenaceae



Map-1: The study area; Khanda Gad (Source: Google Map)

Declaration: *We also declare that all ethical guidelines have been followed during this work and there is no conflict of interest among authors.*

REFERENCES

Bahuguna, P. (2020). Fish diversity in different habitats in the 1st, 2nd and 3rd order streams of Kyunja Gad from Garhwal Himalaya, India. *Uttar Pradesh Journal of Zoology*. **41(3)**: 24-29.

Bahuguna, P. (2021). Distribution pattern of Ichthyofauna diversity in different habitats in the first, second and third order streams of Randi Gad from Garhwal Himalaya, India. *Natl. Acad. Sci. Lett.* **44(5):** 393-395

Bahuguna, P. and Dobriyal A.K. (2020). Population structure and drifting pattern of aquatic mites in Randi Gad, a tributary of River Alaknanda in Garhwal Himalaya, Uttarakhand, India. *J. Mountain Res.* **15**: 63-70.

Bahuguna, P. and Dobriyal, A.K. (2018). First report on the occurrence of some benthic macroinvertebrates in the spring-fed streams of Garhwal Himalaya, India, *I.J.R.A.R.* **5(4)**: 437-443.

Bahuguna, P. and Dobriyal, A.K. (2022). Study of drifting behaviour of aquatic mites in the snow fed river Alaknanda from Garhwal Himalaya: Density, Diversity and Diel Pattern. *J. Mountain. Res.*17 (1):159-167.

Bahuguna, P. and Joshi, H.K. (2012). A study on fish and fisheries of river Kalapani from Kumaun Himalaya, India. *J. Mountain. Res.***7:** 65-71.

Bahuguna, P. and Negi, S. (2021). A checklist of the water mites (Acari: Hydrachnidia) of Garhwal Himalaya with some new records. (Edit. By R. A. Singh & P.K. Singh, ASR Publication, Lucknow), Conference Book on "Geology and Natural Resource of Himalaya". 274-280.

Bahuguna, P., Joshi, H.K. and Dobriyal, A.K. (2010). Conventional and Non-conventional fishing techniques used by rural folk in Mandal Valley, Uttarakhand. *Uttar Pradesh J. Zool.* **30(2)**: 221-223.

Bahuguna, P., Joshi, H.K. and Kumar, K. (2019b). A report on drifting behaviour of Odonata (aquatic insects) in Kyunja Gad, a spring-fed tributary of river Mandakini, Chamoli Garhwal, Uttarakhand. *J. Mountain. Res.* **14(2)**: 63-67.

Bahuguna, P., Negi, S. and Dobriyal, A.K. (2019a). Density and diversity of aquatic mites in a spring-fed steam of Garhwal Himalaya. *J. Mountain Res.***14 (2)**: 57-61.

Bahuguna, P., Rana, K.K., Rayal, R. and Joshi, H.K. (2020b). Studies on the drifting behavioural patterns of macrozoobenthos in Kyunja Gad, a mountain stream from Garhwal Himalaya. India. *J. Mountain. Res.***15**: 97-108.

Bahuguna, P., Rana, K.K., Rayal, R. and Khanduri, N.C. (2020a). Density and diversity of aquatic mites in a glacier-fed river Mandakini from Garhwal Central Himalaya, India. *Uttar Pradesh Journal of Zoology*. **41(10)**: 1-8.

Balodi, V.P., Dobriyal, A.K., Joshi, H.K., Uniyal, S.P. & Thapliyal, A.(2004). Epilithic periphyton and detritus ecology of the spring-fed stream Eastern Nayar in Garhwal Himalaya. *Environmental Conservation Journal.* **5(1-3):**1-5

Baluni, P. (2020). Ecological prescriptive in the density and diversity of periphyton from Ragda Gad stream from Garhwal Himalaya, India. Applied Ecology and Environmental Science. **8(5):** 192-198.

Baluni, P. and Chandola, A. (2019). Preliminary survey of riparian vegetation of the Spring-Fed stream Kyunja Gad, A tributary of River Mandakini, Rudraprayag Garhwal, Uttarakhand. *J. Mountain Res.***14 (2)**: 67-69.

Baluni, P., Bahuguna, P., Rajani, Rayal, R. and Kahera, N.S. (2020): Periphyton community structure of the spring-fed foothill stream Tamsa Nadi from Doon Valley, Uttarakhand, India. *The Scientific Temper, Vol. XI, No 1-2, January-July: 81-86.*

Baluni, P., Kumar, K. and Joshi, H.K. (2018). Ecology Distribution Pattern, Density and Diversity of Periphyton in Khankra Spring fed stream of Garhwal Himalaya, India. *J. Mountain. Res.* **12:** 73-79.

Baluni, P., Kumar, R., Chamoli, K.P. and Joshi, H.K. (2017). Studies on the periphyton density, diversity and physiological parameters of Laster Gad stream in district Rudraprayag from India. *J. Mountain Res* **12:** 73-79.

Cummins, K.W. (1974). Structure and function of stream ecosystems. *Biosci.* **24**: 631-641.

Cummins, K.W. (1993). Riparian Stream Linkages: In stream Issues. *Ecology and management of riparian zones in Australia*. 5-20.

Fisher, S.G. and Likens, G.E. (1973). Energy flow in Bear Brook, New Hampshire: an integrative approach to stream ecosystem metabolism. *Ecol. Monog.* **43**: 421-439.

Gaur, R.D. (1999). Flora of district Garhwal North Himalaya (with ethnobotanical notes). Transmedia, Srinagar (Garhwal).

Gregory, S.V., Swanson, F.J., Mckee, W.A. and Cumimins, K.W. (1991). An ecosystem perspective of riparian zones. *Bio. Science.* **41**: 540-551.

Harmon, M.E., Franklin, J.F., Swanson, F.W., Sollins, P., Gregory, S.V., Lattin, J.D., Anderson, N.H., Cline, S.P., Aumen, N.G., Sedell, J.R., Lienkaemper, G.W., Cromack Jr., K. and Cummins, K.W. (1986). Ecology of coarse woody debris in temperate ecosystems. *Advances in Ecological Research*. **15:**133-302.

Hawkins, C.P., & Sedell, J.R. (1981). Longitudinal and seasonal changes in functional organization of macroinvertebrate communities in four Oregon streams. *Ecology*. ***62*(2):** 387-397.

Hefting, M.M., Clement, J.C., Bienkowski, P. Dowrick, D., Guenat, C., Butturini, A., Topa, S., Pinay, G. and Verhoeven, J.T.A. (2005). The role of vegetation and litter in the nitrogen dynamics of riparian buffer zones in Europe. *Ecol. Eng.***24**: 465-482.

Hynes, H. B. N. (1963). Imported organic matter and secondary productivity in streams. *Proc. XVI Internat. Congr. Zool*. **3**: 324–329.

Hynes, H.B.N. (1975). The stream and its valley. *Verh. Int. Ver. Limnol.* **19:** 1-15.

Kumar, N. and Dobriyal, A. K. (1992). Some observations on the water mites of a Hill stream Khanda Gad in Garhwal Himalaya. *Journal of Freshwater Biology* **4:** 193-197.

Kumar, N. and Dobriyal, A.K. (1999). Correlation of some environmental variables with adaptive net spinning strategies in stream larval Hydropsychids (Trichoptera) in Garhwal Himalaya. *Tropical Freshwater Biology, Nigeria*. **8**: 27-30.

Kumar, N., Kumar, K. and Pesic, V. (2007). Two new species of *Sperchon*Kramer (Acari: Hydrachnidia: Sperchontidae) from the Garhwal Himalayas (India). *Systematic and Applied Acarology* **12:** 31–36.

Mamgain, D., Bahuguna, P., Dobriyal, A.K. and Rayal, R. (2021). Macrozoobenthos of Basti dammar stream in Rudraprayag district Garhwal Uttarakhand: Diversity and habitat analysis. *J. Mountain Res.***16 (1)**: 235-246.

Negi, S., Bahuguna, P. and Dobriyal, A.K. (2021a). Drifting behaviour: of aquatic mites and regulating ecological parameters in Khankra gad stream, a spring-fed tributary of Alaknanda River, Rudraprayag Garhwal, Uttarakhand, India. *J. Mountain Res.* **16(1)**: 61-75.

Negi, S., Dobriyal, A.K. and Bahuguna, P. (2021b). Biodiversity and monthly density fluctuations of water mites in Khankra gad, a spring-fed tributary of river Alaknanda. Pauri Garhwal, Uttarakhand. *Journal of Applied and Natural Sciences.* **13(1)**: 258-267.

Pandey, S., Kumari, T., Verma, P., Singh, R. and Raghubanshi, A.S. (2022). Impact of anthropogenic stresses

on riparian ecosystem and their management perspectives. Ecological significance of River Ecosystems: *Challenges and Management Strategies.* 299-324.

Parson, A. (1991). The Conservation & Ecology of Riparian Tree Communities in the Murray Darling Basin, NSW "A Review" NSW NPWS Hurstville.

Pesic, V., Chatterjee, T. and Bordoloi, S. (2010). A checklist of the water mites (Acari: Hydrachnidia) of India, with new records and description of one new species. *Zootaxa* **2617:** 1–54.

Pesic, V., Kumar, N. and Kumar, K. (2007a). Two new species of water mites of the family Hygrobatidae (Acari: Hydrachnidia) from the Garhwal Himalayas (India). *Systematic and Applied Acarology* **12:** 161–166.

Pesic, V., Kumar, N. and Kumar, K. (2007b). A new species of *Monatractides*(Acari: Hydrachnidia: Torrenticolidae) and new records of other torrenticolid water mites from the Garhwal Himalayas (India). *Systematic and Applied Acarology* **12(3–4):** 205–212.

Pesic, V., Saboori, A. and Asadi A. (2004). Water mites of the genus *Torrenticola* Piersig (Acari: Hydrachnidia, Torrenticolidae) from Iran. *Ann. Limnol. - Int. J. Lim.* 2004, 40 **(3):** 260-266.

Pesic, V., Smith, H. and Bahuguna, P. (2019a). New records of water mites (Acari: Hydrachnidia) from the Western Himalaya and description of three new species from Asia. *Systematic & Applied Acarology.* **24(10)**: 1868-1880.

Pesic, V., Smith, H. and Bahuguna, P. (2019b). New records of water mites (Acari: Hydrachnidia) from the Western Himalayas with the description of four new species. *Systematic & Applied Acarology.* **24(1)**: 59-80.

Pesic, V., Smith, H. and Bahuguna, P. (2020b). A new species of Kongsbergia from the Western Himalaya with a key to the species of the genus of India (Acari: Hydrachnidia). *Journal of Ecologica Montenegerina*. **27:** 35-38.

Pesic, V., Smith, H., Negi, S., Bahuguna, P. and Dobriyal, A.K. (2020a). Torrenticolid water mites of India with description of three new species (Acari: Hydrachnidia, Torrenticolidae). *Systematic & Applied Acarology.* **25(2)**: 255-267.

Pesic, V., Smit, H., Sharma, N., Bahuguna, P. and Rayal, R. (2022). First description of the male of *Neoatractides tashiwangmoi* Pešić, Smit & Gurung, 2022from the Indian Himalayas (Acariformes, Hydrachnidia, Torrenticolidae). *Ecologica Montenegrina*. **57:** 32-36. http://dx.doi.org/10.37828/em.2022.57.4

Pesic, V., Smit, H., Sharma, N., Rana, K.K., Bahuguna, P. and Rayal, R. (2022). First DNA barcodes of water mites from the Indian Himalayas with description of two new species (Acari, Hydrachnidia). *International Journal of Acarology.* **48(6):** 479-485. https://doi.org/10.1080/01647954.2022.2130424

Rautela, K.K., Kumar, K., Bisht, K.L., Joshi, V.D., Negi, K.S., Rautela, A.S. and Dobriyal, A.K. (2006). Ecological studies on the biodiversity of river Khoh in the foothills of Garhwal Himalaya: Part II. Macrozoobenthic analysis. *Aquacult*. **7:** 277-283.

Rayal, R., Bhatt, A. and Bahuguna, P. and Joshi, H.K. (2021a). Fish Fauna of River Yamuna from Doon Valley, Uttarakhand, India. *Journal of Experimental Zoology*. **24(2)**: 973-977.

Rayal, R., Bhatt, A. and Bahuguna, P. and Joshi, H.K. (2021b). Fish diversity of Mal Gad stream near Purola town from district – Uttarkashi, Uttarakhand, India. *Uttar Pradesh Journal of Zoology*. **42(14)**: 54-59.

Sagir, M. and Dobriyal, A.K. (2017). Diversity of riparian vegetation in Western Nayar valleyon selected experimental spots. *J. MountainRes*.**12:**115-118.

Sagir, M. and Dobriyal, A.K. (2018). Influence of riparian vegetation on detritus standing stock of western Nayar valley Uttarakhand. *Int. Res. Anal. Rev*. **5(04***):*1051-1064.

Sagir, M., Rashid, M., Bahuguna, P. and Dobriyal, A.K. (2018). Impact of riparian vegetation on the structure and function of Nayar River Ecosystem. *J. Mountain Res.***13**: 21-28.

Sharma, N., Rayal, R., Chamoli, K.P., Bahuguna, P. and Baluni, P. (2022). Observation on the Diversity of Riparian Vegetation in Sahastradhara Stream from Doon Valley (Uttarakhand) India. *The Scientific Temper.* **13(1):** 37-45.

Srivastava, V.K (2007). River Ecology in India: present status and future research strategy for management and conservation. *Proc. Indian Natn. Sci. Acad.* **73(4):** 255-269.

Verry, E.S., James, W., Hoenbeck, C. and Dolloff, C.A. (2000). Riparian Management in forests of the continental Eastern United States. Lewis Publishers, Boca Raton, FL.

Ward, J.V. (1989). The four-dimensional nature of lotic ecosystems. *Journal of the North American Benthological Society.* **8(1)**: 2-8.

Zanetti, C., Macia, J., Liency, N., Vennetier, M., Meriaux, P. and Provansal, M. (2016). *E3S Web of Conferences*. **7:** 13-15.

ZumBerge, J.R., Perry, J.A. and Lee, K.E. (2003). Influence of local riparian cover and watershed runoff potential on invertebrate communities in agricultural streams in the Minnesota River Basin. Water-Resources Investigations Report.