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An updated checklist of Indian fleas (Insecta: Siphonaptera)

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Abstract. Fleas (Insecta: Siphonaptera) are India's most important vectors of plague and other flea-borne diseases. In India, the current record is 68 species which represents 2.56% of the total world fauna of the Order Siphonaptera, approximately 2652 flea species, including 35 genera (13.8%), 8 families (44.4%), and 8 subfamilies (29.6%). Due to the abundance of flea vectors in commensal rodents, there is a need for surveillance of flea-borne diseases in India. Here is a systematic list of species belonging to order Siphonaptera recorded in the Indian sub-continent mentioned with its vertebrate host-wise distribution pattern in India, which will help to identify the unexplored areas to research fleas (Insecta: Siphonaptera) widely distributed in India.

Keywords: fleas, Siphonaptera, India, updated valid checklist, host, distribution.

Introduction

India provides a wide range of ecological, climatic, and vertical distribution of insect fauna. There are many insect species that occur in a variety of habitats. Also, there are still areas that need to be adequately explored for insect wealth. So far, no in-depth research has been conducted on Siphonaptera, even though they are important vectors for the plague. Adult fleas are blood-sucking ectoparasites of mammals, and birds. Fleas require blood to reproduce, and most species infest mammals like rabbits, rats, mice, squirrels, and other rodents. Birds, bats, pigs, dogs, cats, and humans are also hosts before laying fertile eggs. Many flea species transmit diseases to their hosts, like the bubonic plague, caused by a bacterial pathogen Yersinia pestis of the family Enterobacteriaceae transmitted through rodent fleas, resulting in many millions of casualties in Asia, Africa, and America (Shrewsbury 1970, Appleby 1980, McEvedy 1988, Risse 1992, Scott et al. 1996). Hence to update the fleas' fauna in India, a systematic list of Order Siphonaptera distribution recorded and reported from the Indian subcontinent is reviewed. Worldwide more than 2652 species of fleas were recorded, of which 72 species were reported from different parts of India. Fleas are the most abundant in tropical areas, but also occur in the temperate and even in polar regions. We present the first comprehensive inventory of fleas in India using published records and own data from surveys conducted in Tamil Nadu and Kerala. Therefore, we compiled a checklist of fleas, of which results are presented in this paper.

Background

The initial work of fleas was initiated by Linnaeus (1758), which was the starting point for the Zoological nomenclature. The world fauna of the order Siphonaptera comprised 2652 species and subspecies belonging to 17 families (Hastriter et al. 2018). Research on taxonomic details of the Order Siphonaptera from the Indian fauna was undertaken by various authors (Sharif 1930, Traub 1972, Iyengar 1973, Smit 1973, Kulkarni et al. 1974, Lahiri 1984, Varshney 1998, Devi & Jauhari 2006, Sharma 2009, Chandra & Sharma 2009, Chandra 2011a, b, Zhang 2013, Chandra et al. 2018). The Indian fauna was represented by 46 species and 5 subspecies accommodated in 24 genera under 8 families (Sharma 2009). There were 2082 species of this order known globally; out of them, 46 species and 5 subspecies belonging to 24 subgenera under eight families were known from India (Sharma 2009, Chandra 2011a, b, Zhang 2013). Also, a systematic list of order Siphonaptera recorded from the Indian Himalayas was prepared and supplemented with the distribution of each species (Chandra et al. 2018).

Species composition

The world fauna of the order Siphonaptera includes 2652 species and subspecies belonging to 17 families. An updated systematic list of order Siphonaptera is presented here, with 72 species belonging to 35 genera from eight families, and five superfamilies. The distribution pattern of flea species under different superfamilies and families in India compared with world distribution is presented in Table 1. The superfamily Ceratophylloidea exhibited the maximum species diversity in India; it was recorded with three families, 1. Ceratophyllidae with 21 species from 7 genera; 2. Ischnopsyllidae with 7 species from 4 genera, and 3. Leptopsyllidae with 16 species from 9 genera. This is followed by the superfamily Pulicoidea showing two families, Family Pulicidae, recorded with 12 species from 6 genera, and family Tungidae with one species. The superfamily Hystrichopsylloidea was recorded with one family (Hystrichopsyllidae), 11 species from 5 genera. The next superfamily (Pygiopsylloidea) was recorded with one family (Stivaliidae) showing 3 species from 2 genera. Finally, the superfamily Vermipsylloidea was recorded with one family (Vermipsyllidae) and one species. Host records on the mammal species and distribution records of all the valid Indian flea species are furnished in Table 2. A complete list of flea species recorded in India is mentioned in Table 3.

Table 1 Distribution of flea species, both global and India (Hastriter & Bossard 2018) (*-records of Indian flea families, **- records of Indian flea subfamilies)

Family	Subfamily	World		India	
		Genus	Species/ Subspecies	Genus	Species/ Subspecies
Ancistropsyllidae		1	3		
Ceratophyllidae**	Ceratophyllinae*	47	499	7	21
	Dactylopsyllinae	3	16		
	Chiastopsyllinae	3	22		
Chimaeropsyllidae	Chimaeropsyllinae	2	7		
	Epirimiinae	3	4		
Coptopsyllidae		1	23		
Ctenophthalmidae	Anomiopsyllinae	8	50		
	Ctenophthalminae	6	369		
	Dinopsyllinae	1	26		
	Doratopsyllinae	6	33		
	Listropsyllinae	1	11		
	Liuopsyllinae	1	3		
	Moeopsyllinae	1	1		
	Neopsyllinae	10	143		
	Neosyllinae	1	2		
	Rhadinopsyllinae	7	116		
	Stenoponiinae	1	20		
Hystrichopsyllidae**	Hystrichopsyllinae*	4	60	5	11
	Macropsyllinae	2	3		
Ischnopsyllidae**	Amphipsyllinae	23	276		
	Ischnopsyllinae*	19	137	4	7
	Leptopsyllinae*	6	97	9	16
	Thaumapsyllinae	1	4		
Lycopsyllidae		3	4		
Malacopsyllidae		2	3		
Pulicidae**	Moeopsyllinae	1	1		
	Pulicinae*	22	187	6	12
Pygiopsyllidae		10	57		
Rhopalopsyllidae	Parapsyllinae	6	86		
	Rhopalopsyllinae	7	73		
Stephanocircidae	Craneopsyllinae	6	48		
	Stephanocircinae	2	9		
Stivaliidae**		28	178	2	3
Tungidae**		4	27	1	1
Vermipsyllidae**		3	45	1	1
Xiphiopsyllidae		1	9		
17	26	253	2652	35	72

Table 2. List of flea species recorded in India ([A] synonyms for *Pulex furoris* Dale, 1878 (13); [B] synonyms for *Paraceras laxisinus* Xie, He & Li, 1980 (20); [C] synonyms for *Ischnopsyllus tateishii* Sugimoto, 1933(24); [D]synonyms for Ceratophyllus *variabilis var. decimpilata* Wagner, 1898 (25); [E] synonyms for *Thaumapsylla breviceps orientalis* Smit, 1954 (27); (Hastriter & Bossard 2018). [F] Synonyms for *Acropsylla girshami* Traub, 1950 (30); [F1] Synonyms for *Ctenophthalmus quadridentatus* Kolenati,1859 (39) [G] synonyms for *Permyscopsylla himalaica himalaica* Rothschild, 1915 (43); [H] synonyms for *Ctenocephalides elegans* Argyropulo, 1938 (45); [I] synonyms for *Neopsylla dispar dispar* Jordan, 1932 (46); [J] synonyms for *Neopsylla marleaneae* Lewis, 1971 (52); [K] synonyms for *Palaeopsylla remota nesicola* Traub & Evans, 1967 (53); [L] synonyms for *Xenodaeria bijiangensis* Li, Hsieh & Yang, 1978 (55). (Hastriter & Bossard 2018). [M] synonyms for *Pulex canis canis* Duges, 1832 (56); [N] synonyms for *Pulex cati* Megnin, 1880 (57); [O] synonyms for *Ctenocephalides caprae* Loff, 1953 (58); [P] synonyms for *Sarcopsylla gallinacean erinacea* Weiss, 1911 (59); [Q] synonyms for *Pulex irritans* var *bahiensis* Cunha, 1914 (62); [R] synonyms for *Synosternus pallidus infestus* Wagner, 1933 (63); [S] synonyms for *Loemosylla vigetus* Rothschild, 1909 (65); [T] synonyms for *Pulex murinus* Tiraboschi, 1904 (66); [U]synonyms for *Xenopsylla sewelli* Sharif, 1930 (67); [V] synonyms for *Pulex reptans* Illiger, 1805 (68); [W] synonyms for *Trichopsylla homoeus carenis* Jordan, 1932 (72). (Hastriter et al. 2018))

S. No	Species	References
1	*Amphalius clarus* (Jordan & Rothschild, 1922)	(Rao et al. 1973)
2	*Callopsylla oreinus* (Jordan, 1937)	(Iyengar 1973, Sharma 2009)
3	*Ceratophyllus caliotes* Jordan, 1937	(Iyengar 1973)
4	*Ceratophyllus hirumdinis* (Curtis, 1832)	ibid
5	*Ceratophyllus orites* Jordan, 1937	ibid
6	*Macrostylophora fimbriata* (Jordan & Rothchild, 1922)	ibid
7	*Macrostylophora hastate sikkimensis* (Jordan & Rothschild, 1922)	ibid

(Table 2 – continued on the next page)

(Table 2 – continuation)

S. No	Species	References
8	*Macrostylophora lupata* (Jordan & Rothschild, 1921)	(Iyengar 1973, Sharma 2009)
9	*Macrostylophora phillippsi* (Jordan, 1925)	(Sharma 2009)
10	*Nosopsyllus alladinis* (Rothchild, 1904)	(Iyengar 1973)
11	*Nosopsyllus arcotus* (Jordan & Rothschild, 1921)	ibid
12	*Nosopsyllus argutus* ((Jordan & Rothschild, 1921)	ibid
13	*Nosopsyllus fasciatus* (Bosc,1801)[A]	ibid
14	*Nosopsyllus nilgiriensis* (Jordan & Rothschild, 1921)	ibid
15	*Nosopsyllus punensis* (Jordan & Rothschild, 1921)	ibid
16	*Nosopsyllus punjabensis* (Jordan & Rothschild, 1921)	ibid
17	*Nosopsyllus simla* (Jordan & Rothschild, 1921)	ibid
18	*Nosopsyllus tamilanus* (Jordan & Rothschild, 1921)	ibid
19	*Nosopsyllus vauceli* Kelein, 1962	ibid
20	*Paraceras sauteri* (Rothchild, 1914)[B]	(Rao et al. 1973)
21	*Simitipsylla prodigiosa* Smit, 1975	(Chandra et al. 2018)
22	*Largaropsylla putilla* Jordan & Rothschild, 1921	(Iyengar 1973)
23	*Ischnopsyllus delectabilis* Smit, 1952	ibid
24	*Ischnopsyllus indicus* Jordan, 1931[C]	ibid
25	*Ischnopsyllus octactenus* (Kolenati, 1856) [D]	(Chandra et al. 2018)
26	*Rhinolophopsylla unipectinata indica* Jordan & Rothschild, 1921	(Sharma 2009)
27	*Thaumapsylla breviceps* Rothchild, 1907[E]	(Iyengar 1973)
28	*Thaumapsylla breviceps orientalis* Smit, 1954	(Iyengar 1973)
29	*Aconothobius orientalis* (Lewis, Kulkarni and Bhat, 1972)	(Adams & Lewis1995)
30	*Acropsylla episema* (Rothchild, 1911)[F]	(Iyengar 1973)
31	*Acropsylla girshami* Traub, 1950	(Rao et al. 1973)
32	*Amphipsylla montana iskul* Shvarts,1953	(Chandra et al. 2018)
33	*Amphipsylla phaiomydis limonia Smit 1977*	ibid
34	*Amphipsylla primaris primaris* Jordan & Rothschild, 1915	ibid
35	*Amphipsylla gregorii* Brelih, 1976	ibid
36	*Frontopsylla ambigua* Fedina, 1946	(Rao et al. 1973)
37	*Frontopsylla elata vara* Mikulin ,1960	(Chandra et al. 2018_
38	*Frontopsylla spadix* (Jordan & Rothschild, 1921)	(Rao et al. 1973)
39	*Leptopsylla segnis* (Schoenherr,1811)[F1]	(Sharma 2009)
40	*Ophthalmopylla celata* Traub, 1965	(Iyengar 1973)
41	*Paradoxopsyllus custodis* Jordan, 1932	(Rao et al. 1973)
42	*Pectinoctenus sp.* Loff, 1946	ibid
43	*Permyscopsylla himalaica* (Rothschild, 1915)[G]	(Iyengar 1973)
44	*Permyscopsylla himalaica himalaica* Rothschild, 1915	(Sharma 2009)
45	*Ctenophthalmus golovi alpestris* Argyropulo, 1935[H]	(Rao et al. 1973)
46	*Neopsylla dispar* Jordan, 1932[I]	(Iyengar 1973)
47	*Neopsylla dispar dispar* Jordan, 1932	(Sharma 2009)
48	*Neopsylla kasmirensis* Kulkarni & Bhat, 1972	(Rao et al. 1973)
49	*Neopsylla marleaneae* Lewis, 1971	(Iyengar 1973)
50	*Neopsylla secura* Rothschild, 1915	ibid
51	*Neopsylla setosa* group (Wagner, 1898)	(Rao et al. 1973)
52	*Neopsylla stevensi* group Rothschild, 1915[J]	(Rao et al. 1973, Iyengar 1973)
53	*Palaeopsylla remota* Jordan, 1929[K]	(Iyengar 1973)
54	*Steischia pagiana* Lewis, 1969	(Sharma 2009)
55	*Xenodaeria telios* Jordan, 1932[L]	(Rao et al. 1973, Iyengar 1973)
56	*Ctenocephalides canis* (Curtis, 1826)[M]	(Iyengar 1973)
57	*Ctenpcephalides felis felis* Bouche,1835[N]	ibid
58	*Ctenocephalides orientis* (Jordan,1925)[O]	ibid
59	*Echidnophaga gallinacean* (Westwood, 1875)[P]	(Rao et al. 1973)
60	*Echidnophaga liopus* Jordan & Rothchild 1906	(Iyengar 1973)
61	*Pariodontis riggenbachi wernecki* Costa Lima, 1940	ibid
62	*Pulex irritans* Linnaeus, 1758[Q]	ibid
63	*Synosternus pallidus* (Taschenberg, 1880)[R]	ibid
64	*Xenopsylla astia* Rothschild,1911	(Iyengar 1973, Philip Samuel et al. 2020, 2021)
65	*Xenopsylla brasiliensis* (Baker, 1904)[S]	ibid
66	*Xenopsylla cheopis* (Rothschild, 1903)[T]	(Iyengar 1973, Philip Samuel et al. 2020, 2021)
67	*Xenopsylla hussaini* Sharif, 1930 [U]	ibid
68	*Tunga penetrans* (Linnaeus,1758)[V]	ibid
69	*Stivalius ahalae* (Rothschild,1904)	ibid
70	*Sivalius aporus* Jordan & Rothschild, 1922	ibid
71	*Lentistivalius ferinus* (Rothschild, 1908)	(Sharma 2009)
72	*Chaetopsylla homoea homoea* Rothschild, 1906[W]	(Iyengar 1973)

Table 3 List of valid updated flea species and distribution in India (Hastriter & Bossard, 2018)

No	Species	Host	Distribution
1	*Amphalius clarus clarus*	Mouse	Uttar Pradesh
2	*Callopsylla oreinus*	*Delichon*	Kashmir (Dras)
3	*Ceratophyllus caliotes*	*Delichon*	Kashmir (Dras)
4	*Ceratophyllus hirumdinis*	*Delichon, Hirundo, Mus*	Kashmir (Dras)
5	*Ceratophyllus orites*	*Delichon*	Kashmir (Dras)
6	*Macrostylophora fimbriata*	*Hylopetes and Pataurista*	Simla, Dehradun, Narkanda (India)
7	*Macrostylophora hastate sikkimensis*	*Callosciurus pygerythrus*	Sikkim (Gopaldhara and Mongu)
8	*Macrostylophora lupata*	*Callosciurus, Dremomys* and *Rattus*	Sikkim and Manipur
9	*Macrostylophora phillippsi*	Rodent	India
10	*Nosopsyllus alladinis*	*Funambulus*	Siddapur
11	*Nosopsyllus arcotus*	*Funambulus*	Madras (Tamil Nadu) and Kolar (Karnataka)
12	*Nosopsyllus argutus*	*Mus and Funambulus*	India-Dharwar
13	*Pulex furoris*	*Rattus norvegicus* and Buffalo	Bombay-India
14	*Nosopsyllus nilgiriensis*	*Rattus* and *Bandicota.*	Tamil Nadu (Coonoor, Peermade)
15	*Nosopsyllus punensis*	*Funambulus*	Pune
16	*Nosopsyllus punjabensis*	*Rattus, Tatera, mus,* and *Millardia*	Patiala, Punjab and Uttar Pradesh
17	*Nosopsyllus simla*	*Rattus* and *Apodemus*	Simla, Patiala and Koenthal (Himachal Pradesh) Kashmir (Gilgit Agency)
18	*Nosopsyllus tamilanus*	Rodent	India
19	*Nosopsyllus vauceli*	*Tatera* and *Millardia*	Saharanpur and Bara Banki
20	*Paraceras laxisinus*	Pine-martin	Uttar Pradesh
21	*Simitipsylla prodigiosa*	*Petaurista magbificus*	Himalaya
22	*Largaropsylla putilla*	*Tadarida*	Guindy (Tamil Nadu)
23	*Ischnopsyllus delectabilis*	*Pipistrellus*	Manipur and Assam
24	*Ischnopsyllus tateishii*	*Barbastella, Pipistrellus and Rhinolophus*	Uttar Pradesh
25	*Ceratophyllus variabilis var.decimpilata*	Bats	Himalaya
26	*Rhinolophopsylla unipectinata indica*	Small mammals	India
27	*Thaumapsylla breviceps orientalis*	Bats	Bombay
28	*Aconothobius orientalis*	Mouse	Uttar Pradesh (Chamoli)
29	*Acropsylla girshami*	Rodent and shrew	Karnataka (Kolar) and Uttar Pradesh
30	*Amphipsylla montana*	*Alticolo roylei, Apodemus flvicollis, Mus musculus* and *Ochotona daurica*	Himalaya
31	*Amphipsylla phaiomydis limonia*	*Alticolo roylei, Apodemus flvicollis, A.sylvalicus, Rattus rattus rufescens*	Himalaya
32	*Amphipsylla primaris primaris*	*Alticolo roylei*	Himalaya
33	*Amphipsylla tuta gregorii*	*Neodon sikimensis* and *Rattus eha*	Himalaya
34	*Frontopsylla ambigua*	Rodent	Himachal Pradesh and Jammu Kashmir
35	*Frontopsylla elata vara*	Voles	Himalaya
36	*Frontopsylla spadix*	Rodent	Himachal Pradesh and Jammu Kashmir
37	*Ctenophthalmus quadridentatus*	*Rattus rattus* and *Mus musculus*	Tamil Nadu (Coonoor, Peermade)
38	*Ophthalmopylla celata*	*Rattus, Ochotona, Apodemus* and *Cricetellus*	Gupis and Phandar (JK)
39	*Paradoxopsyllus custodis*	Rodent	Jammu Kashmir
40	*Pectinoctenus sp.*	Rodent	Himalaya
41	*Permyscopsylla himalaica himalaica*	*Barbastella* Bat	Tamil Nadu (Coonoor, Kodaikanal & Peermade)
42	*Ctenophthalmus golovi alpestris*	Rodent	Uttar Pradesh
43	*Neopsylla dispar*	Rodent	Manipur, Sikkim
44	*Neopsylla marleaneae*	Rodent	Sikkim, Kangra, Kulu (Himachal Pradesh)
45	*Neopsylla secura kasmirensis*	*Apodemus, Mus, Rattus* and *Suncus*	Kargil and Pahalgam (Jammu Kashmir)
46	*Neopsylla secura secura*	*Apodemus, Mus, Rattus Soriculus and Alticola*	North West Himalaya (Keontbal, Solon and simla)
47	*Neopsylla setosa setosa*	Rodent	Spiti, Lahul and Kinnanur (Himachal Pradesh and Ladakh (Jammu Kashmir)
48	*Palaeopsylla remota nesicola*	*Anourosorex* and *Soriculus*	Sikkim (Lingtarn) and Assam (Bondi-La)
49	*Steischia pagiana*	Rodent	India
50	*Xenodaeria bijangensis*	Mainly shrew but also *Rattus, Mus, Soriculus* and *Prionodon*	Sikkim (Lingtarn), Himachal Pradesh and Jammu Kashmir.
51	*Ctenocephalides caprae*	Mainly dogs and cats, but also rats	Temperate areas of India
52	*Sarcopsylla gallinacea erinacea*	Small mammals and fowl	India

(Table 3 – continued the next page)

(Table 3 – continuation)

No	Species	Host	Distribution
53	*Echidnophaga liopus*	Rat and *Echidna*	Delhi (Agra)
54	*Pariodontis riggenbachi wernecki*	Rat species of *Hystrix*.	Darjeeling (West Bengal) Agra, East Khandesh and Kanpur.
55	*Synosternus pallidus infestus*	Mainly hedgehogs, but also hares, dogs, foxes	Gujarat (Kutch)
56	*Xenopsylla astia*	Mainly rats	Temperate areas of India
57	*Loemosylla vigetus*	Mainly rat, but also mammals and mice	Mainly hill region of India
58	*Pules murinus*	Mainly rat	Temperate areas of India
59	*Xenopsylla sewelli*	Rat species of *Tatera*	North India (Tundla and Saharanpur
60	*Pulex canis*	Mainly dog and cat	Temperate areas of India
61	*Pulex cati*	Cats, rodents, dogs, carnivores, and mammals	Temperate areas of India
62	*Pulex furoris*	*Sorex, Apodemus and Rattus*	Bombay and Bareilly
63	*Pulex irritans* var *bahiensis*	Cats, rats, dogs, and other mammals	Temperate areas of India
64	*Pulex reptans*	Humans, cats, dogs, and other mammals	Kerala and Bombay
65	*Stivalius ahalae*	*Funambulus* and *Rattus*	Tamil Nadu (Coonoor, Kodaikanal and Peermade) and Kolar (Karnataka)
66	*Sivalius aporus aporus*	*Funambulus* and *Rattus*	Tamil Nadu (Coonoor, Kodaikanal and Peermade) and Kolar, Coorg, Berar (Karnataka)
67	*Lentistivalius ferinus*	*Sorex, Suncus and Rattus*	Tamil Nadu (Coonoor, Kodaikanal and Peermade) and Kolar, Coorg, Berar (Karnataka)
68	*Trichopsylla homoea homoea*	*Mustela* and dogs	Jammu Kashmir (Leh)

Gap areas

So far, no in-depth study has been undertaken on the enumeration of Insecta order Siphonaptera, even though it is considered an important vector for the transmission of plague. There are still areas that need to be adequately explored for its insect wealth from many parts of India. Like other animal groups, there are few studies on order Siphonaptera to understand this group's species diversity, including our studies in Tamil Nadu and Kerala (Philip Samuel et al. 2020, 2021). There is a rich diversity of mammal and bird hosts in India, and possibly many new species in India are yet to be discovered. However, a survey exclusively for this group in the entire country must be undertaken for a complete list of fleas and their hosts with their possible role as vectors in transmitting the different pathogens.

Discussion

At the end of the 19th century, a plague epidemic struck in several parts of the world, and the worst happened in India; in about 20 years, some 10 million people died India; the rat flea *Xenopsylla cheopsis* was the primary transmitter of *Bacillus pestis*, which caused human bubonic plague (Farhang- Azad et al. 1985). After the death of a significant number of rats with this disease, the illness spread to humans through flea bites. In India, a major plague outbreak occurred in Surat, Gujarat, in 1994 (Ganapati 1995, Saxena & Verghese 1996). Later, during 2002, 16 cases of pneumonic plague with 4 deaths were reported in Hat Koti village, Shimla district, Himachal Pradesh (National Institute of Communicable Diseases). Another outbreak of bubonic plague was reported in Dangud village, Barkhot tehsil, Uttarkashi district, Uttarakhand, in October 2004, with eleven human cases and three deaths (Biswas 2018). Due to the fleas mentioned above, related epidemics occurred in different parts of India, and this group gained much importance.

Fleas are known vectors of both human and animal diseases. An attempt was made to publish an updated checklist based on the available publications, which will streamline future research activities on the flea species recorded in India. In India, Rao et al. 1973 and Kulkarni et al. 1974 undertook extensive surveys in Western Himalayas and reported the biodiversity of fleas from that region. Varshney (1998) reported 52 flea species belonged to 8 families in India. Sharma (2010) and Sharma & Chandra (2013) reported a checklist of fleas showing 46 species of fleas reported from 5 subspecies and 24 genera classified under 8 families. Chandra et al. 2018 reported 38 species from 22 genera of fleas from the Himalayas. The Himalayas harbored the world's richest flea fauna. The current list contains a valid updated flea species reported in India, along with distribution in different states and host animals furnished in Table 2. There were 2082 species of fleas recorded worldwide in this order Siphonaptera (Zhang 2013). Currently, more than 2652 species of fleas are recorded worldwide, of which 68 species reported from India are accommodated under 35 genera belonging to 8 families and 8 subfamilies. The distribution pattern of flea species in the world and India are mentioned in Table 3 (Hastriter et al. 2018). Thus, an updated systematic list of species belonging to fleas (order Siphonaptera) found in the Indian sub-continent is prepared with its distribution pattern in India.

Fleas are very important ectoparasites found on humans and are natural plague vectors. Fleas can act as disease vectors for several bacteria, viruses, and helminths. Many species of the order Siphonaptera act as vectors of many important diseases. Fleas of the family Pulicidae and the family Ceratophyllidae are the medical and veterinary importance, distributed worldwide. *Ctenocephalides felis felis* found on dogs, cats, rodents, monkeys, and opossums, are a

vector to spread the diseases like Murine typhus, bartonellosis, cat scratch disease, flea-borne spotted fever, rickettsioses in animals, and plague. *Ctenocephalides canis,* found on dogs and cats, causes ectoparasites, itching, and weight loss. *Ctenocephalides orientis* found on dogs, sheep, goats, and small ruminants, causes flea bites and dermatitis. *Pulex irritans* found on humans and rodents causes flea bites and rarely plague. *Echidnophaga gallinacean* found on chickens and other mammals, causes flea bites and weight loss. *Tunga penetrans* found on humans causes Tungiasis disease. *Xenopsylla astia*, *X. brasiliensis*, and *X. cheopis* found on rodents and shrews cause plague and Murine typhus. Finally, *Nosopsyllus fasciatus* found on rodents and shrews causes flea-borne spotted fever and plague (Rodhain 2015, Philip Samuel et al. 2020). Even now, there are reservoirs from which it might break into epidemics at any time. Due to the sudden reappearance of human plague cases, regular plague surveillance work must be initiated in the endemic states in India (Biswas et al. 2020). Thus, it is emphasized that there should be a need for a permanent flea surveillance system with improved flea-borne disease diagnostics to initiate effective vector control efforts to stop the transmission of flea-borne diseases in the future.

This publication will be highly useful in identifying the potential areas in flea research in India and help to initiate further biodiversity studies on fleas and undertake future faunistic surveys in unexplored regions. Thus, this publication will also be enormously helpful for imparting training, teaching, and research on ectoparasites.

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