Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(5): 1478-1488

Received: 01-07-2020
Accepted: 03-08-2020

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Diversity of Amycoida and Astioida (Arachnida: Araneae: Salticidae: Salticinae) in India

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DOI: https://doi.org/10.22271/j.ento.2020.v8.i5u.7709

Abstract
A total of 56 species under 14 genera were recorded in most of the states and union territories of India except Himachal Pradesh, Jharkhand, Chattisgarh, Sikkim, Meghalaya, Daman & Du and Dadra & Nagar Haveli, and Lakshadweep. Out of them, 27 species are endemic. The Amycoida is represented by only 2 species of a single genus (tribe Sitticini), one from Ladakh (*Attulus avocator*) and one from Jammu & Kashmir (*Attulus diductus*). Maximum number of species of these spiders were recorded from Kerala (25 species) followed by Tamil Nadu (20 species), West Bengal (17 species), Maharashtra (14 species) and Gujarat (11 species). Extensive survey for these spiders is required in almost all states particularly in those where these jumping spiders are either not recorded or very poorly recorded. Despite the spiders are most diverse group of predators and being crucial to the health of terrestrial ecosystems, none of the species recorded in India is listed in IUCN Red List.

Keywords: Salticidae, Salticinae, Amycoida, Astioida, distribution, jumping spiders, India

Introduction
Spiders are chelicerate arthropods belonging to the order Araneae of class Arachnida. Till to date 48,783 described species under 4,182 genera and 128 families [1]. Indian spider fauna was updated up to 1845 species belonging to 470 genera and 61 families [2]. However, there are several species in wild and museum collections that await description and classification. It is estimated that only one third to one fifth of existing species have been described. Recently, the faunal record of mygalomorph spiders (tarantulas and their close kin), distributed in different states and union territories of India, was up to dated [3].

Salticidae Blackwall, 1841 (Arachnida: Araneae) includes jumping spiders which is the largest family of the order Araneae containing 646 genera and 6231 species globally [1]. These jumping spiders can easily be recognized by the shape of their cephalothorax and the pattern of their eight eyes. The faces are approximately rectangular surfaces perpendicular to their direction of motion. They have four eyes in front row, median two being very large and prominent specialized for high spatial resolution, appropriate to their predatory habits as stalker-hunters [4]. Their front 2 pairs of legs are generally larger than the rear two pairs. The rear legs are used in jumping while front legs are utilized in prey capture [5] and also in species recognition during courtship and mating [6]. The body length of jumping spiders generally ranges from 1 to 25 mm, largest being is *Hyllus giganteus* C.L. Koch. The silk is used for safety lines while jumping, as a tether to enable them to reach prey that otherwise would be inaccessible, and also for making "pup tents" where they rest at night and also as shelter home during bad weather [7]. In general, jumping spiders do not construct web to capture prey. However, exceptionally some species of *Portia* build unusual funnel shaped web [8]. Most of the jumping spiders have dazzling colours with sophisticated adornment, and display sexual colour dimorphism in that males are generally brighter than females [9]. This colourful decoration remains largely unanswered, but is supposed to be beneficial in sexual selection [10]. No doubt, it is attractive to conspecific females, there is also a risk of their predation [11]. The jumping spiders are master hunter, with and ability to jump vast distances. Although, most of the jumping spiders are predatory and feed on a large variety of prey in the wild but few are known to consume nectar and other plant materials [12, 13]. Larger jumping spiders like *Phidippus regius* C.L. Koch is known to prey on fishes [14] and amphibians [15] while *Grammostola quirogai* Montes de Oca *et al*. is known to predate snakes [16].

The classification of Salticidae of the world is still unsatisfactory because of several grounds [17]. There exist three system of subdivision of family Salticidae in literature. The traditional system is based on cheliceral dentition, arrangements of eyes, body proportions, distribution of spines and characteristic groups of setae, visible with a hand lens [18, 19]. Eventually, selection of these characters for grouping is artificial and is not related to their affinities. In this system, groups of genera are named subfamilies [19]. Later on, on the basis of molecular data, especially by gene sequencing, the known genera are grouped into 7 subfamilies [20]. However, with lack of more morphological data, it is very difficult to identify the species in nature and captivity and its grouping into suprageneric taxa. To overcome these problems, Prószyński [17] proposed a realistic and practical classification based on easily noticeable and verifiable, morphological diagnostic characters, such as male palps together with internal structures of epigyne and recognized all the genera described in Salticidae following International Code of Zoological Nomenclature, into supergenera groups and genera groups rather than subfamilies, tribes, and subtribes. The purpose of this article is not to discuss the relationship between different species of salticids reported from India, rather to put in order - statewise distribution. We followed the classification of Maddison [20] and also mention the genera or supergenera group of Prószyński [17] where necessary.

Maddison [20] subgrouped Salticidae into 7 subfamilies: Asemoneinae, Eupoinae, Hisponinae, Lyssomaninae, Onomastinae, Salticinae and Spartaeinae. Out of all subfamilies, Salticinae comprises 93.7% of the species (5818 species, 576 genera, including few species of uncertain position, *incertae sedis*) followed by Spartaeinae (181 species, 31 genera), Lyssomaninae (100 species under 2 genera), Asemoneinae (37 species under 5 genera), Hisponinae (36 species, 6 genera), Eupoinae (34 species, 3 genera) and Onomastinae (16 species, single genus). Detail taxonomic features of all these subfamilies/tribes/subtribes and their phylogenetic relationship were already been explained [20, 21, 22]. Distribution of all subfamilies except Salticinae in India was recently accounted [23].

The members of Salticinae are grouped into 2 clades: Amycoida and Salticoida. Salticoida again comprises three clades, Astioida, Marpissoida and Saltafresia and each clade is further divided into tribes and subtribes.

Our knowledge on the Indian Salticinae is insufficient and highly patchy primarily due to unexplored diversity of these spiders and extensive surveys were done only in a few states. There are hundreds of species of jumping spiders yet to be described. Also, several species reported and described from India have been misidentified and seems to be reported erroneously. In addition, several species reported from India are said to be identified by using existing literature without a re-examination of the corresponding types [24] and without consulting any spider taxonomist. Hence, these reports need re-examination. The present article deals with the distribution of only two clades: Amycoida and Astioida-Salticoida recorded from different Indian states and union territories.

Materials and Methods

This checklist is based on the literature published in recent past books, journals and few authentic theses and World Species Catalogue up to 31 August, 2020 [1]. In most of the literature, published earlier, several errors crept in their scientific names even in the recent ones. It happened because such contents become outdated quickly and, due to their perceived comprehensiveness, readers sometimes overlook newer sources of data. Additionally, the researches on spider taxonomy are continued with the description of new taxa, their modified status, and the publication of other nomenclatural decisions. In the present compilation, attempts have been made to correct these errors in the scientific names of the spiders following WSC [1]. Only those synonymies were mentioned that were reported in India, for other synonymy WSC [1] may be consulted. All the endemic species are marked with (*).

Results

The members of Salticinae are grouped into 2 clades: Amycoida and Salticoida. Amycoida comprises 9 tribes [20], however, only one tribe Sitticini is represented in India. Only 2 species of genus *Attus* of this tribe was reported from India and belong to Sitticines genera group of Prószyński [17]. Most of the species of Salticinae belong to clade Salticoida. Salticoida is divided into tribes, some tribes are grouped under three clades, Astioida, Marpissoida and Saltafresia. Representation of different clades, tribes, subrtribes, genera and species in India is displayed in Table 1. Out of 27 tribes in Salticinae [20], only 17 tribes are recorded in India. Results displayed in Table 1 demonstrated that 56 species under 14 genera were recorded in the clades Amycoida and Astioida from different Indian states and union territories. These species are accounted along with available references in a taxonomic order: tribe, subtribe, genus and species.

Table 1: Total Salticidae spiders described in the world and in India in different taxonomic categories that were recorded from India.

Clades	Clades	Clades	Tribes	Subtribes	World		India	
					Genera	Species	Genera	Species
Amycoida			Sitticini		9	110	1	2
Salticoida			Agoriini		2	64	1	5
Salticoida			Baviini		5	26	4	6
Salticoida	Astioida		Astiini		11	73	1	1
Salticoida	Astioida		Myrmarachnini		19	256	4	38
Salticoida	Astioida		Viciriini	Viciriina	20	191	3	4
Salticoida	Marpissoida		Ballini		15	148	3	9
Salticoida	Marpissoida		Dendryphantini	Dendryphantina	58	598	6	34
Salticoida	Marpissoida		Dendryphantini	Marpissina	9	102	3	13
Salticoida	Saltafresia		Chrysillini		39	637	19	56
Salticoida	Saltafresia		Hasariini		15	127	6	14
Salticoida	Saltafresia	Simonida	Aelurillini		11	293	7	27
Salticoida	Saltafresia	Simonida	Euophryini		118	1166	11	16
Salticoida	Saltafresia	Simonida	Leptorchestini		8	60	2	3

Salticoida	Saltafresia	Simonida	Plexippini	Harmochirina	14	300	5	20
Salticoida	Saltafresia	Simonida	Plexippini	Plexippina	47	516	17	52
Salticoida	Saltafresia	Simonida	Salticini		7	132	3	11
Incertae sedis					48	226	3	3
Total					455	5025	99	314

1. Clade: Amycoida Maddison & Hedin, 2003
1.1 Tribe: Sitticini Simon, 1901
1. *Attulus avocator* (Pickard-Cambridge, 1885)
=*Sitticus avocator* (Pickard-Cambridge, 1885)
- Ladakh [25]

2. *Attulus diductus* (Pickard-Cambridge, 1885)
=*Attus diductus* Pickard-Cambridge, 1885
=*Sitticus diductus* Caporiacco, 1935)
- Jammu & Kashmir [26]

3. *Attulus* sp.
= *Sitticus* sp.
- Jammu & Kashmir [27]
- Tamil Nadu [28]

2. Clade: Salticoida Maddison & Hedin, 2003
2.1 Tribe: Agoriini Simon, 1901
1. *Synagelides brahmaputra* Caleb *et al*., 2018*
- Assam [29]

2. *Synagelides darjeelingus* Logunov & Hereward, 2006*
- West Bengal [30]

3. *Synagelides lehtineni* Logunov & Hereward, 2006*
- Tamil Nadu [30, 31]

4. *Synagelides martensi* Bohdanowicz, 1987
- Uttar Pradesh [30]

5. *Synagelides munnar* Logunov, 2017*
- Kerala [32]

2.2 Tribe: Baviini Simon, 1901
1. *Bavia sexpunctata* (Doleschall, 1859)
- Tamil Nadu [33]

2. *Bavia* sp.
- Assam [34, 35]
- Gujarat [36]
- Kerala [37, 38]
- Maharashtra [39]
- Rajasthan [40]
- Uttar Pradesh [41]

3. *Bavirecta casteti* (Simon, 1900)*
=*Piranthus casteti* Simon, 1900
- Tamil Nadu [31, 42, 43, 44]

4. *Indopadilla darjeeling* Caleb & Sankaran, 2019*
- West Bengal [43]

5. *Indopadilla insularis* (Malamel *et al*., 2015)*
=*Bavia insularis* Malamel *et al*., 2015)
- Assam [45]
- Goa [46]
- Kerala [43, 47, 48, 49, 50, 51, 52]

6. *Piranthus decorus* Thorell, 1895
- Gujarat [53]
- Maharashtra [54]

7. *Piranthus planolancis* Malamel *et al*., 2019*
- Karnataka [55]
- Kerala [55, 56]

8. *Piranthus* sp.
- Goa [46]
- Karnataka [57]
- Kerala [58]

2.2 Clade: Astioida Maddison *et al*., 2008
2.2.1 Tribe: Astiini Simon, 1901
1. *Helpis minitabunda* (L. Koch, 1880)
- Bihar [59]

2.2.2 Tribe: Myrmarachnini Simon, 1901
1. *Myrmaplata aureonigra* (Edmunds & Prószyński, 2003)
=*Myrmarachne maxillosa* Badcock, 1918
- Kerala [58]

2. *Myrmaplata plataleoides* (Pickard-Cambridge, 1869)
=*Myrmarachne daitarensis* Prószyński, 1992
=*Myrmarachne megachelae* Ganesh Kumar & Mohanasundaram, 1998
=*Myrmarachne plataleoides* (Pickard-Cambridge, 1869)
=*Salticus plataleoides* Pickard-Cambridge, 1869
- Andhra Pradesh [60, 61, 62]
- Andman [63, 64]
- Assam [34, 35, 45, 65, 66]
- Bihar [59, 61, 62, 65, 67, 68, 69, 70]
- Goa [46, 69]
- Gujarat [71, 72, 73, 74, 75, 76, 77, 78, 79]
- Haryana [80]
- Jammu & Kashmir [81]
- Karnataka [82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93]
- Kerala [37, 47, 50, 58, 61, 65, 94, 95, 96, 97, 98, 99, 100]
- Madhya Pradesh [101, 102, 103]
- Maharashtra [61, 63, 69, 70, 104, 105, 106]
- Manipur [107]
- Mizoram [108]
- Odisha [24, 109]
- Tamil Nadu [31, 61, 63, 65, 69, 70, 87, 110, 111, 112, 113]
- Telangana [114, 115]
- Tripura [116]
- Uttarakhand [117]
- West Bengal [61, 63, 65, 67, 69, 70, 87, 118, 119]

3. *Myrmarachne calcuttaensis* Biswas, 1984*
- Manipur [107, 120, 121, 122]
- West Bengal [70, 120, 121, 122]

4. *Myrmarachne caliraya* Barrion & Litsinger, 1995
- West Bengal [61, 123, 124, 125, 126]

5. *Myrmarachne cornuta* Badcock, 1918
- Kerala [58]

6. *Myrmarachne corpuzrarosae* Barrion, 1981
- Jammu & Kashmir [27, 127]

7. *Myrmarachne dirangicus* Bastawade, 2002*
- Arunachal Pradesh [79, 128, 129]
- Kerala [58]

8. *Myrmarachne formicaria* (De Geer, 1778)
- Arunachal Pradesh [79]
- Karnataka [57]
- Kerala [58]

9. *Myrmarachne hidaspis* Caporiacco, 1935*
- Jammu & Kashmir [26]

10. *Myrmarachne himalayensis* Narayan, 1915*
- Jammu & Kashmir [130, 131, 132]
- Uttar Pradesh [133, 134]
- West Bengal [67]

11. *Myrmarachne incerta* Narayan, 1915*
- Bihar [67]
- Maharashtra [104, 105, 135, 136]
- Manipur [107]
- West Bengal [67]

12. *Myrmarachne japonica* (Karsch, 1879)
- Kerala [58]

13. *Myrmarachne kiboschensis* Lessert, 1925
- Manipur [107, 137]
- West Bengal [24]

14. *Myrmarachne kochi* Reimoser, 1925
- Kerala [50]

15. *Myrmarachne kuwagata* Yaginuma, 1967
- Tamil Nadu [87, 138]

16. *Myrmarachne laeta* (Thorell, 1887)
- Bihar [67]
- Gujarat [139]
- Maharashtra [104]
- Tamil Nadu [44, 67]

17. *Myrmarachne laeta flava* Narayan, 1915*
- Bihar [67]
- Gujarat [78, 140]

18. *Myrmarachne ludhianaensis* Sadana & Gupta, 1998*
- Punjab [141]

19. *Myrmarachne manducator* (Westwood, 1841)
=*Salticus manducator* Westwood, 1841
- Bihar [67]

20. *Myrmarachne markaha* Barrion & Litsinger, 1995
- Tamil Nadu [111]

21. *Myrmarachne melanocephala* MacLeay, 1839
=*Myrmarachne orientales* Tikader, 1973
- Andaman & Nicobar [61, 63, 65, 126]
- Assam [34, 45, 61, 65, 126, 142]
- Goa [46, 143]
- Gujarat [77, 78, 144]
- Jammu & Kashmir [81]
- Karnataka [57, 86, 88, 90, 93]
- Kerala [37, 38, 50, 58, 61, 65, 98, 126]
- Madhya Pradesh [103]
- Maharashtra [104, 105, 145, 146]
- Odisha [76, 147]
- Rajasthan [40]
- Tamil Nadu [87, 113, 138]
- Tripura [116]
- Uttar Pradesh [41, 148, 149, 150, 151]
- Uttarakhand [87, 152, 153, 154]
- West Bengal [61, 62, 65, 68, 70, 82, 87, 122, 126, 155, 156, 157, 158, 159]

22. *Myrmarachne opaca* (Karsch, 1880) `
- West Bengal [123]

23. *Myrmarachne platypalpa* Bradoo, 1980*
- Chandigarh [160]

24. *Myrmarachne poonaensis* Tikader, 1973*
- Maharashtra [62, 105]

25. *Myrmarachne prava* (Karsch, 1880)
=*Myrmarachne paivae* Narayan, 1915
=*Myrmarachne bengalensis* Tikader, 1973
- Andaman [63]
- Bihar [67]
- Goa [46]
- Gujarat [78, 144, 161, 162, 163]
- Kerala [58]
- Maharashtra [104]
- Punjab [164]
- Tamil Nadu [87, 138]
- Uttarakhand [152]
- West Bengal [62, 68, 156, 70, 122, 124]

26. *Myrmarachne providens* (Peckham & Peckham, 1892)
- Andhra Pradesh [60]
- Maharashtra [105]
- West Bengal [123]

27. *Myrmarachne pumilio* (Karsch, 1880)
- West Bengal [165]

28. *Myrmarachne ramunni* Narayan, 1915*
- Karnataka [86]
- Kerala [97]
- Odisha [166]
- Tamil Nadu [31, 67, 87, 112, 138]

29. *Myrmarachne robusta* (Peckham & Peckham, 1892)
=*Myrmarachne maratha* Tikader, 1973
- Gujarat [144, 161, 163]
- Madhya Pradesh [103]
- Maharashtra [61, 62, 104, 105, 122, 126, 136, 156]
- West Bengal [61, 70, 122, 126, 156]

30. *Myrmarachne roeweri* Reimoser, 1934*
- Tamil Nadu [33, 31]

31. *Myrmarachne satarensis* Narayan, 1915*
- Maharashtra [67, 105, 136]

32. *Myrmarachne transversa* (Mukerjee, 1930*)

=*Synemosyna transversa* Mukerjee, 1930
- West Bengal [167]

33. *Myrmarachne tristis* (Simon, 1882)
- Gujarat [75, 78, 168, 169]
- Tamil Nadu [44, 67]
- West Bengal [67]

34. *Myrmarachne uniseriata* Narayan, 1915*
=*Myrmarachne aurantiaca* Benjamin, 2015
- Maharashtra [105, 136]
- Tamil Nadu [44, 67, 170]

35. *Myrmarachne vulgarisa* Barrion & Litsinger, 1995
- Manipur [107]

36. *Myrmarachne* sp.
- Assam [142]
- Gujarat [73, 74, 78, 139]
- Jammu & Kashmir [27, 127, 130, 131, 132]
- Karnataka [86]
- Kerala [171, 94]
- Madhya Pradesh [101]
- Maharashtra [106, 172]
- Odisha [79, 173, 174]
- Rajasthan [175, 176, 177, 178]
- Tamil Nadu [28]
- Tripura [116]
- Uttar Pradesh [134, 150, 179, 180, 181]
- Uttarakhand [154, 182]
- West Bengal [183]

37. *Myrmatheca alticephalon* (Yamasaki & Ahmad, 2013)
- Gujarat [184]

38. *Toxeus jajpurensis* (Prószyński, 1992)*
=*Myrmarachne jajpurensis* Proszyński, 1992
- Maharashtra [104, 105, 135, 136]
- Odisha [24]

39. *Toxeus maxillosus* C. L. Koch, 1846
=*Salticus modestus* Thorell, 1892
- Andaman [185]

2.2.3 Tribe: Viciriini Simon, 1901
2.2.3.1 Subtribe: Viciriina Simon, 1901
1. *Opisthoncus* sp.
- Kerala [186]

2. *Viciria diademata* Simon, 1902*
- Puducherry [187]
- Tamil Nadu [44]

3. *Viciria minima* Reimoser, 1934*
- Tamil Nadu [31, 33]

4. *Viciria* sp.
- Tamil Nadu [28]

5. *Zebraplatys* sp.
- Assam [45]

Discussion
Table 1 demonstrates that all tribes/subtribes of Salticinae are not represented in India. The clade Amycoida is poorly represented by only one tribe out of 9 tribes. Similarly, 2 tribes of the clade Salticoida-Astioida (Neonini and Mopsini) are not represented in India. A total of 56 species under 14 genera were recorded in most of the states and union territories of India except Himachal Pradesh, Jharkhand, Chattisgarh, Sikkim, Meghalaya, Daman & Du and Dadra & Nagar Haveli, and Lakshadweep (Figure 1). The Amycoida is represented by only 2 species of a single genus (tribe Sitticini), one from Ladakh [*Attulus avocator* (Pickard-Cambridge, 1885)] and one from Jammu & Kashmir [*Attulus diductus* (Pickard-Cambridge, 1885)]. Maximum number of species of these spiders were recorded from Kerala (25 species) followed by Tamil Nadu (20 species), West Bengal (17 species), Maharashtra (14 species) and Gujarat (11 species) (Figure 1). Extensive survey for these spiders is required in almost all states particularly in those where these jumping spiders are either not recorded or very poorly recorded. Despite the spiders are most diverse group of predators and being crucial to the health of terrestrial ecosystems, none of the species recorded in India is listed in IUCN Red List.

Fig 1: Distribution of spiders belonging to Amycoida and Astioida (Salticinae: Salticidae) in Indian states and union territories; Ag-Agoriini, As-Astiini, B-Baviini, M-Myrmarachnini, S-Sitticini and V-Viciriini.

Conclusion
A total of 56 species under 14 genera of clade Amycoida and Salticoida-Astioida were recorded in (27) 21 states and 6 union territories of India. Maximum species of these spiders were recorded from Kerala (25 species) followed by Tamil Nadu (20 species), West Bengal (17 species), Maharashtra (14 species) and Gujarat (11 species). Strangely, no species of these spiders was recorded in larger states like Chhattisgarh, Jharkhand and Himachal Pradesh. Extensive survey for these spiders is required in almost all states particularly in those where these jumping spiders are either not recorded or very poorly recorded.

Acknowledgements
We thank to Dr. Shelley Acharya, Scientist E, Zoological Survey of India, M-Block, Kolkata, India and Dr. J.T.D. Caleb, Department of Zoology, Madras Christian College, Tambaram, Chennai, Tamil Nadu, India for providing valuable literatures.

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