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Abundance and habitat ecology of Asian pied starling (*Sturnus contra*) in agricultural ecosystem of Punjab, India

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Abstract
The present investigation was undertaken to study the abundance and habitat ecology of Asian Pied Starling, *Sturnus contra* in agricultural field areas of Ludhiana, Punjab from February 2016 to January 2017. The field area under study was divided into four different sites i.e. Site I, II, III and IV. The relative annual abundance of Asian Pied Starling was highest (5.17%) at Site IV followed by 4.41% at site I, 3.70% at site II and 2.42% at site III. Overall annual relative abundance of Asian Pied Starling was 3.92%. Electrical wires were the most preferred perching site. Maximum flock size of approximately 23 individuals was recorded perching together on electrical wires. Courtship behavior like head bowing, head bobbling, moving head in different directions, fluffing of feathers and calling frequently was observed during perching and roosting period. Irrigated fields, harvested fields and ploughed fields were the most preferred foraging sites. It was concluded that habitat preference was directly proportional to the presence of feeding material, roosting places and nesting material.

Keywords: Asian pied starling (*Sturnus contra*), agricultural ecosystem, habitat, roosting

1. Introduction
The India is known to harbor about 12.5% of World's avifauna i.e. a total of 1263 species of birds [1]. Asian Pied Starling, *Sturnus contra* plays significant role as bio-control agent [2]. It is among the insectivorous birds which play important role in management of pest in agricultural fields by picking up of abundant amount of insects larvae from ground [3]. This species is mainly located in plains of Indian subcontinent, Southeast Asia and in the foothills up to 700 m above sea level. In India, it is mainly located in Gangetic plains and they have also propagated in westward areas of India particularly the parts of Rajasthan. This has been aided by changes irrigation pattern [4]. They often forage in grazing land or among cattle [5]. It is found in association with Cattle Egret on the foraging grounds along with some other bird species. They are seen picking up grubs, caterpillars, worms, beetles and other insects [6]. They are also seen sharing feeding sites with Jungle Babbler [7]. This species is predominantly insectivorous and ground feeding. It is found in flocks during non breeding season, commonly in association with other mynas, near villages and human habitation. Its favorite feeding grounds are damp grazing grounds, banks of ponds and tanks, sewage farms, municipal refuse damps, flooded fields and riverine belt [8]. Roosting is usually seen in groups of 30 individuals usually [9]. It is potential control agent of hairy caterpillar pests in tea plantation of North-east Asia [10].

2. Materials and Methods
2.1 Study area
The present study of abundance, perching and roosting ecology of Asian Pied Starling was undertaken in the agricultural field area of Punjab Agricultural University (30◦56'N, 75◦52'E and 247 meter above mean sea level) from February 2016 to January 2017. Punjab Agricultural University campus is located in Ludhiana city (Punjab State) in north-west India. The University covers an area of 580 ha on its main campus in Ludhiana. The campus includes agricultural fields, vegetable research farms, and fruit orchard and agro-forestry area. This location was further divided into four different sites *i.e.* Site I which include fruit crops, agricultural crops and medium tree plantation; Site II includes agricultural fields, water bodies and high number of large tree plantation; Site III includes agricultural fields, less number of

tree plantation and Site IV includes agricultural fields and low number of tall trees. The four sites were different in some respects having different crops, trees and water bodies. Point counted method was used for taking the observation about Asian Pied Starling.

2.2 Materials
Digital camera (Nikon P 500), Bushnell (8X42) Binocular was used for observing and recording the birds.

2.3 Methods
Observations were made twice a week and during data collection each transects were scanned carefully to record the birds and identification of birds was done on the basis of visual observations of their morphological characteristics by using binocular and comparing them with those described by Ali [11]. Observations were taken from 6:00-10.00 am and from 5.00 -7.00 pm in summer and from 7.00 -11.00 am in morning and from 4.00 -6.00 pm in evening during winter. Relative abundance, species richness, species evenness; Perching and roosting association of Asian Pied Starling with other bird species were recorded during the study as per the methodology given by Javed and Kaul [12]. Data collected on the occurrence and abundance of birds will be subjected to bird species, richness, their relative abundance, species diversity and species evenness will be calculated as per Shannon's-Wiener's Index [13].

3. Results and Discussion
A total of 48 bird species were recorded during the study period (Table 1). Common Myna with 18.80% and House Crow with 14.53% annual relative abundance were the most abundant bird species. The annual relative abundance of Asian Pied Starling was 3.92% (Table 1). The relative abundance of Asian Pied Starling was highest (8.2%) in the month of June 2016 (Figure 1); this may be due to the presence of maximum feeding niches available in the form of irrigated fields. Minimum relative abundance was recorded in February; as crops are grown to some extent in fields during this period and Asian Pied Starling did not prefer to feed in such fields. Relative abundance at site III was highest (5.92%). This may be due to the fact that; as comparatively less bird diversity was present at this site due to human disturbances. Which lead to an increment in relative abundance of the bird at site III and similar finding was also reported by Inglis [14]. Relative abundance of 4.41% was recorded on site I followed by 3.70% relative abundance at site II and 2.70% at site III. The site I was mostly preferred for feeding, roosting and nesting; due to availability of maximum suitable feeding niches, roosting places and nesting material. The site II was preferred comparatively less than site I; this can be due to the fact that less availability of preferred perching and roosting structures this finding was supported by study of Narang *et. al* [15]. The preferred perching structures like electrical wires and poles were intermittently covered with tree foliage. The relative abundance at site IV was least as less tree diversity was present at this site as compared to other sites. It was observed during the study period that abundant food supply leads to a high relative abundance of Asian Pied Starling i.e. the abundance of Asian Pied Starling was directly proportional to feeding niches, similar observations were also documented by the other workers [5, 6, 7, 8]. More relative abundance was recorded from April to July this may be due to breeding season of Asian Pied Starling this observation was in line with other studies [9, 4, 16].

During the study it was recorded that the Asian Pied Starling, perches either individually or in a small flock of 3-5 individuals. Maximum flock size of 23 individuals was once recorded perching together on electrical wires during the study at site I. Krusskal walley's test shows significant results in preference of different perching structures which was also reported by Kler [9]. The most preferred perching structure was electrical wires followed by electrical poles, trees, buildings and fencing wires.

Roosting was observed either individually or in a small flock of 3-7 individuals. During roosting, some courtship behavior activities like head bobbing, fluffing of feathers and calling frequently were observed and similar activities were also observed by other workers [8, 9]. Most preferred roosting site was Site I as compared to other sites. This may be due to the presence of more availability of preferred roosting structures electrical wires, poles and trees at site I. At site II, electrical wires were less or either intermittently covered by tree canopies. Site III included small ornamental plants whereas tree diversity was less as compared to site I and II. So, this site was less preferred for roosting activity. Due to more human disturbances, the site IV was least preferred for roosting. Roosting association was seen with Rose-ringed Parakeet, Black Drongo and Common Myna. Height of roosting structure varied from 1.00 m to 21m in height with a mean height of 10.15 m from the ground (Table 2) and earlier reports further strengthen these observations [17, 18, 19].

During the study it was recorded that the Asian Pied Starling, forage individually or in a small flock (3-5 individuals). Foraging activities were observed in different fields. At site I, foraging was observed in harvested, ploughed and irrigated fields as also observed by Meier [19]. Foraging was also observed in moist vegetation. This area was mostly irrigated or harvested throughout the year. Foraging association of *Sturnus contra* with other bird species was also recorded which complement the earlier studies [2, 20]. *Sturnus contra* foraged in association with Common myna, Red-wattled Lapwing, Blue-Rock Pigeon and House Crow at site I, at site II, foraging was mostly observed on garbage dump station near the poultry farm and moist ground near pond area. It can easily find insect and small invertebrate species here to feed on. Foraging association was seen with Red-wattled Lapwing, Black-winged Stilt, Common Myna, Cattle Egret, Indian Peafowl, House Crow and Common Tailorbird. At site III, It was recorded feeding in irrigated, harvested and ploughed fields. Foraging association at site III, was observed with Common Myna, House Crow, Blue Rock Pigeon and Eurasian-collared Dove. At site IV, foraging was observed in lawns, orchard area, irrigated and harvested areas. Foraging association was observed with Common Myna, Indian Peafowl, and House Crow (Table 3). Joshi and Shrivastva [6] reported the association of Asian Pied Starling with Cattle Egret on the foraging grounds along with some other bird species. It was also reported sharing feeding sites with Jungle Babbler, Red-wattled Lapwing, Common Myna, Cattle Egret, Indian Peafowl and House Crow [2, 4, 7, 19, 20].

4. Conclusion
It was concluded from the present study that the habitat preference was directly proportional to the presence of feeding material and roosting places. The areas having irrigated agricultural fields, structures providing roosting places were the most preferred habitat by Asian Pied Starling. The sites having more feeding niches were comparatively more preferred for the day to day activities. As *Sturnus contra* feeds on insect, it can be useful as a bio-control agent.

5. Acknowledgement
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Table 1: Annual Relative abundance of Asian Pied Starling

S. No	Sites Bird species	Scientific names	Site I	Site II	Site III	Site IV	Annual abundance
1	Alexandrine Parakeet	*Psittacula eupatria*	0.05	-	-	-	0.01
2	Asian Koel	*Eudynamys scolopacea*	0.02	-	-	-	0.01
3	Asian Pied Starling	*Sturnus contra*	4.41	3.7	2.42	5.13	3.92
4	Bank Myna	*Acridotheres ginginianus*	0.97	0.32	1.48	-	0.69
5	Bay-backed Shrike	*Lanius Vittatus*	-	-	0.01	-	0.00
6	Black Drongo	*Dicrurus macrocercus*	1.42	3.23	0.73	0.75	1.53
7	Black Ibis	*Pseudibis papillosa*	0.19	-	2.74	-	0.73
8	Black Kite	*Milvus migrans*	3.23	3.95	-	-	1.80
9	Black Redstart	*Phoenicurus ochrurus*	-	0.02	-	-	0.01
10	Black-winged Stilt	*Himantopus himantopus*	-	1.84	-	-	0.46
11	Black-headed Oriole	*Oriolus larvatus*	-	0.02	-	-	0.01
12	Blue Rock pigeon	*Columba livia*	8.47	4.37	13.01	4.12	7.49
13	Brahminy Starling	*Sturnus pagodarum*	0.51	1.75	0.82	-	0.77
14	Brown-headed Barbet	*Megalaima zeylonensis*	-	0.09	-	-	0.02
15	Cattle Egret	*Bubulcus ibis*	0.36	2.38	0.97	5.39	2.28
16	Common Golden-backed Woodpecker	*Dinopium javanense*	0.08	0.12	-	-	0.05
17	Common Hoopoe	*Upupa epops*	0.75	0.96	1.24	0.35	0.83
18	Common Myna	*Acridotheres tristis*	13.44	14.77	19.61	27.37	18.80
19	Common Starling	*Strnus vulgaris*	-	0.62	-	-	0.16
20	Common Swallow	*Hirundo rustica*	0.2	0.38	0.01	-	0.15
21	Common Swift	*Apus affinis*	0.43	0.41	0.64	-	0.37
22	Common Tailorbird	*Orthotomus sutorius*	0.19	1.28	0.29	-	0.44
23	Copper Smith Barbet	*Psilopogon haemacephalus*	-	0.02	-	-	0.01
24	Eurasian Collared-Dove	*Streptopelia decaocto*	3.11	4.73	7.91	4.73	5.12
25	Greater Coucal	*Centropus sinensis*	0.02	0.2	-	-	0.06
26	Grey Wagtail	*Motacilla cinerea*	0.02	0.6	-	-	0.16
27	House Crow	*Corvus splendens*	12.14	14.24	-	31.73	14.53
28	House Sparrow	*Passer domesticus*	0.05	-	14.95	-	3.75
29	Indian Grey Hornbill	*Ocyceros birostris*	0.4	-	-	-	0.10
30	Indian Peafowl	*Pavo cristatus*	2.24	2.18	-	0.97	1.35
31	Indian Pond-Heron	*Ardeola grayii*	-	0.07	-	-	0.02
32	Indian Roller	*Coracias benghalensis*	-	0.07	0.14	-	0.05
33	Indian Treepie	*Dendrocitta vagabunda*	0.13	-	-	-	0.03
34	Jungle Babbler	*Turdoides striatus*	4.77	5.82	7.82	6.78	6.30
35	Large Pied Wagtail	*Motacilla maderaspatensis*	0.04	0.97	0.27	-	0.32
36	Little Brown Dove	*Streptopelia senegalensis*	0.11	-	-	-	0.03
37	Oriental Magpie-Robin	*Copsychus saularis*	0.15	0.56	1.35	-	0.52
38	Purple Sunbird	*Nectarinia asiatica*	0.16	0.65	0.25	-	0.27
39	Red-vented Bulbul	*Pericrocotus cafer*	4.03	5.12	6.88	0.5	4.13
40	Red-wattled Lapwing	*Vanellus indicus*	0.97	6.67	1.41	2.79	2.96
41	Rose-ringed Parakeet	*Psittacula krameri*	9.17	11.45	13.25	10.09	10.99
42	Small Bee-eater	*Merops orientalis*	0.84	1.2	1.19	0.15	0.85
43	Spotted Dove	*Streptopelia chinensis*	0.09	-	-	-	0.02
44	Spotted Owlet	*Athene brama*	0.76	3.08	0.18	-	1.01
45	White-breasted Kingfisher	*Halcyon smyrnensis*	0.05	0.11	0.01	-	0.04
46	White-breasted Waterhen	*Amaurornis phoenicurus*	-	0.46	-	-	0.12
47	Yellow-legged Green-Pigeon	*Motacilla flava*	-	1.55	0.43	-	0.50
48	Yellow wagtail	*Treron phoenicoptera*	0.01	-	-	-	0.00

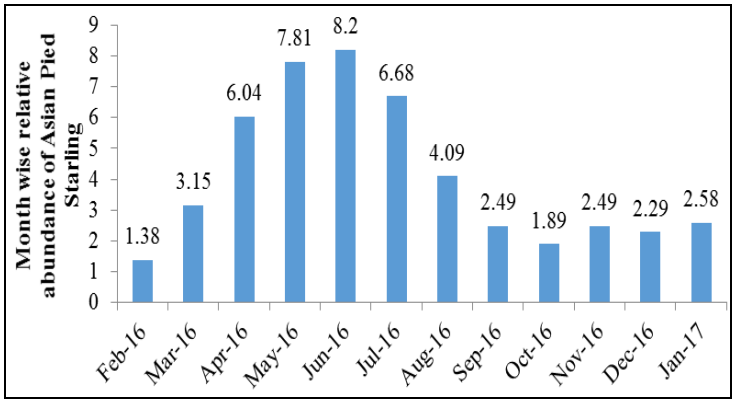

Fig 1: Month wise relative abundance of Asian Pied Starling

Table 2: Roosting structures used by Asian Pied Starling

Roosting structures	Height (m)
Man-made structures	
Electrical wires	3.75
Electrical poles	4.00
Fencing wires	1.00
Trees	
Amla (*Phyllanthus emblica*)	7.00
Bottle brush (*Callistemon spp)*	16.00
Kanak champa (*Pterospermum acerifolium*)	14.06
Chukrasia (*Chukrasia velutina*)	9.01
Dhek (*Melia azedarach)*	6.50
Dye Fig (*Ficus tingtoria*)	6.20
Euclyptus (*Eucalyptus globules*)	16.00
Mango (*Magnifera indica)*	6.20
Mulberry (*Morus Alba)*	6.50
Neem (*Azadirachta indica*)	7.00
Peepal (*Ficus religiosa)*	18.00
Pilkan (*Ficus lacor)*	17.00
Satpatia (*Alstonia scholaris)*	21.00
Siris (*Albizzia* spp.)	6.50
Simbal (*Bombax ceiba)*	17.00

Table 3: Foraging association of Asian Pied Starling with other bird species

	Site I	Site II	Site III	Site IV
Black-winged Stilt		✓		
Blue Rock Pigeon	✓		✓	
Cattle Egret		✓		
Common Myna	✓	✓	✓	✓
Common Tailorbird		✓		
Eurasian collared- Dove			✓	
House Crow	✓	✓	✓	✓
Indian Peafowl		✓		✓
Red-wattled Lapwing	✓	✓		✓

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