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ORIGINAL ARTICLE

ALLIANCE BETWEEN BARN SWALLOW *HIRUNDO RUSTICA* LINNAEUS, 1758 AND INDIAN MUSTARD *BRASSICA JUNCEA* (L.) CZERNAJEW, 1859: A NEW INTUITION IN BIRD-PLANT ECOLOGICAL NETWORKS

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ABSTRACT

The habitat type and food availability always influence the population size of many organisms. Bird's feeding pattern should be abstracted to complete avian community structure data. The agronomy main research farm of Orissa University of Agriculture and Technology is a well-managed multi-crop agro-ecosystem which provides a suitable ground for ecological research. In a multi-crop farmland, the association of Barn Swallow *Hirundo rustica* Linnaeus, 1758, with the Indian mustard *Brassica juncea* (L.) Czernajew, 1859 crops have been recorded for the first time while hovering only on this field. A flock of Barn swallows was recorded in 32 field visits while flying continuously over the Indian mustard field after flowering to ripening of fruit in the morning and sometimes in afternoon also. The range of the birds was recorded from 6 to 61 with a mean individual of 36.03 ± 15.37 hovering for 1.83 hr daily. This may be the behaviour for the feeding pattern of these flying insectivorous birds which was not seen in other crop-fields with same insect diversity describing it as not the only reason for this behaviour. To reveal this poorly understood behaviour of flying insectivore birds, a detailed long term behavioural study with gut content analysis is needed to explain the particular reason behind this behaviour of Barn swallows which will support the conservation of these birds and control their population decline.

Keyword: Alliance, Barn swallow, Hovering, First record, Multi-crop Farmland.

INTRODUCTION

Agricultural areas support one-third of all bird species by satisfying their food demand (Blount *et al*., 2021). Multicrop farmlands always support the rich diversity and population of birds due to the availability of diversified crop habitats (Panda *et al*., 2020). Association among birds and crops which is supported by providing food in the form of grain, seed, leaves and vertebrates and invertebrates living in that cropland can be depicted by documenting the

birds in temporary primary crops (Elphick, 2010; Alexandrino *et al*., 2019). These habitats also protect the birds from predators by providing shelter (Linscott and Senner, 2021; Panda *et al*., 2021a). Various croplands are extensively used as quality habitats for migratory birds worldwide (Yamaguchi *et al*., 2012; Grishchenko *et al*., 2019).

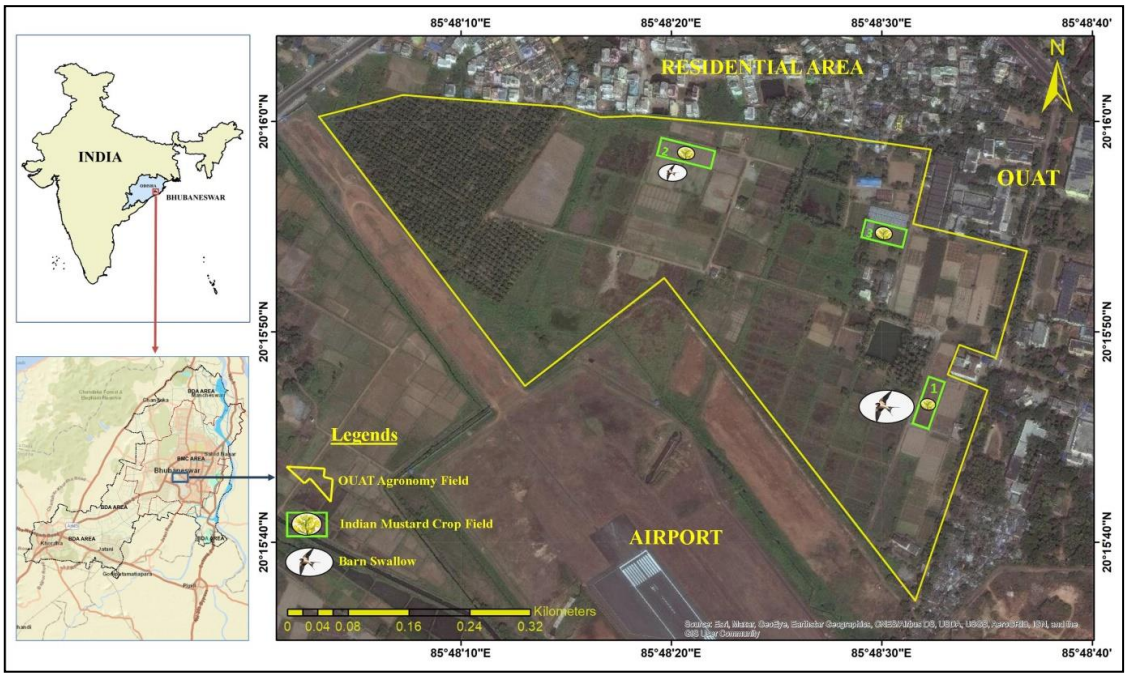
Ecological research always refers to this habitat type and food availability impact on the population size of many organisms (De Bonilla *et al*., 2012). So, studies of feeding guilds of any avian species can support exploring their community structure and habitat complexity which will help to create data on avian community structure (Tanalgo *et al*., 2015). Regurgitated food, fecal and gut content analysis are the techniques used for analyzing avian dietary habits (De Bonilla *et al*., 2012).

The dietary habits in birds can be affected by habitat conditions/heterogeneity and anthropogenic impacts such as human disturbance, urban growth, and agricultural pesticides on their habitat. The present study focused on an interesting behaviour of Barn swallows at the time of foraging only over one crop in a multi-crop farmland recorded while hovering over the Indian mustard crop field and depicted the a new intuition in bird-plant ecological networks.

MATERIALS AND METHODS

The Orissa University of Agriculture and Technology (OUAT) is a well-managed Agronomy main research farm in the centre of Bhubaneswar City (Map 1) which is located in Eastern India. This Agronomy main research farmland has an area of 32.6 hectares and 3.09 km perimeter (Mallik *et al*., 2015). This agroecosystem is surrounded by highly populated human habitation and educational institute with adjacent to the Biju Patnaik international airport, Bhubaneswar boundary. There were three mustard fields in the study area identified for observation. The 1st (20.263108˚N, 85.808995˚E) and 2nd (20.266287˚N, 85.805741˚E) fields are of the size 120m in length and 40m in breath, whereas the 3rd field (20.265230˚N, 85.808488˚E) is of 100 m in length and 40m in breath. This observation was recorded in only two fields because the other one is covered with net houses due to some research activity. The numbers of the birds were counted by the point count technique (Bibby *et al*., 1998) without disturbing those birds. The observation of birds was conducted for 4 hours after the sunrise and 2 hours before sunset (Leveau *et al*., 2015; Panda *et al*., 2021b).

Photographic and video-graphic evidences (NIKON D5300 Camera with 70-300mm and 150-600mm lens) were recorded with behavioural observations for further analysis such as average time of hovering and the average height of flight etc. (Lewis *et al*., 2004). The hovering time of these birds was recorded and the disturbance level was recorded as the humans working in the peripheral fields. The height of flying birds over the crop fields were estimated by direct observation with comparing a five meter high pole near each field.



Map (1): Map of the study area and sampled Indian mustard (*B. juncea*) fields.

RESULTS AND DISCUSSION

This is a multi-crop agroecosystem that provides a research ground for agricultural researchers as well as supports the habitat of various mammals, birds, reptiles, amphibians and insects. This agroecosystem has various permanent farmlands and many seasonal crops. The coconut *Cocus nucifera* L. farm is the permanent farm at the western part of the field and the seasonal crops are rice *Oryza sativa* L., maize *Zea mays* L., mustard *Brassica juncea*, urad dal *Vigna mungo* L., sunflower *Helianthus* sp., and moong dal *Vigna radiata* L. (Rahul *et al*., 2019; Giri *et al*., 2020). Some vegetables like tomato *Solanum lycopersicum* L., brinjal *Solanum melongena* L., lady's finger *Abelmoschus esculentus* L., cauliflower *Brassica Oleracea var. botrytis* L., cabbage *Brassica Oleracea var. capitate* L., and radish *Raphanus sativus* L. are also cultivated seasonally (Rojalin *et al*., 2018; Tripathy *et al*., 2020).

Indian mustard *B. junceais* is also cultivated in the multi-crop field in winter because it requires cool and dry weather with higher soil moisture during the growth of the plants (Mohapatra *et al*., 2019). Due to its climatic requirements of dry and clear weather at the time of harvesting, in India, the Indian mustard is cultivated in the Rabi season which is from October to March (Winter). The flowering starts from 7-8 weeks after plantation (Satyagopal *et al*., 2014) (Pl. 1).

Plate (1): Indian mustard *B. juncea* crop field in different stages of the life cycle; (A) Flowering, (B) Fruit development, (C) Ripening, (D) Senescence (before harvest).

OUAT agronomy main research farm has a high faunal diversity due to the higher crop diversity. More than 95 species of birds have been recorded in this multi-crop farmland of OUAT (Mallik *et al*., 2015); while doing a regular avian diversity survey in the agronomy main research farm, a peculiar behaviour of barn swallow was recorded over the Indian mustard crop field. To record this behaviour of these birds, a special attention was given to mustard crop field. Some species preferred the mustard crop and were found abundantly in those fields. Besides the barn swallow, the abundant species are: Red Avadavat *Amandava amandava* (Linnaeus, 1758); Zitting Cisticola *Cisticola juncidis* (Rafinesque, 1810), Scaly-breasted Munia *Lonchura punctulata* (Linnaeus, 1758), and Plain Prinia *Prinia inornata* Sykes, 1832 (Pl. 2). Among all the species found only in this Indian mustard field, the abundance of these species was observed higher among all.

The other recoded species with peculiar behaviour and hovering over the Indian mustard crop field is barn swallow. The Barn swallow is a sparrow-sized small bird of 15-19 cm length, weighing 17-20 g with blue-black wing and forked tail (Pl. 3). It is an aerial insectivore, that catches insects from just above the ground to around 100 ft height sometimes even more (Warrick *et al*., 2016). Barn swallows are commonly recorded at grassland habitats, marshes, wetlands and agricultural lands (Orłowski *et al*., 2014). They are local migratory in India, breed in Himalayan areas and winter visitor towards Southern India and also for the study area (BirdLife International, 2019; Panda *et al*., 2020). Their diet comprises beetles, ants and different flying insects like bees, wasps, moths and butterflies; barn swallows prefer larger single insects than a group of smaller prey (Ali, 2002).

Plate (2): Most abundant species recoded in Indian mustard crop fields; (A) Red Avadavat *Amandava amandava*, (B) Zitting Cisticola *Cisticola juncidis*, (C) Scaly-breasted Munia *Lonchura punctulata*,(D) Plain Prinia *Prinia inornata* (Photographs – A &B: Mr. Soumya Ranjan Biswal; C & D: Dr. Bibhu Prasad Panda).

Plate (3): This image of Barn Swallow *H. rustica* was taken at OUAT agronomy field. (Photograph by Dr. Bibhu Prasad Panda)

Alliance between barn swallow *Hirundo rustica*

The interesting behaviour of barn swallows was the hovering pattern above the Indian mustard crop field. A flock of barn swallows was recorded while flying continuously over the Indian mustard field (Pl. 4). This behaviour of birds was seen every day regularly and particularly over that Indian mustard field only. The phenomenon of hovering of many passerine species on foraging cites have been seen before but particularly Barn Swallow hovering over Indian mustard crop field was recorded for the first time. This observation was first recorded on 29th December 2020. The hovering of the barn swallows was recorded from end-December (29th December 2020) to mid-February (17th February 2020). The birds were hovering over the mustard field with a minimum height of 0.5 meters or just over mustard plants up to 10 m height approximately. Our observation described the average height of flight as 2-4 m from the ground. To check this behaviour of birds, if it is regular or accidental, more than 32 field visits were conducted during those two months and this was recorded in every field visit. This activity was seen after the flowering in Indian mustard up to the ripening of fruits (Pl. 1 b, c). During the observation, this hovering pattern was recorded only in the morning nearly from 7 am to 10 am regularly.

Plate (4): Barn Swallows hovering over Indian Mustard crop field (Photograph by Mr. Soumya Ranjan Biswal).

Most of the time the hovering of the birds was seen in particular field 1 with a higher number of individuals (n= 6-61) (Tab. 1). Sometimes the field 2 was also seen with this phenomenon but with very few individuals (n = 0-21). The average number of birds recorded daily was 36.03 ± 15.37 in field 1 and 4.97 ± 5.78 in field 2. It was also observed that these birds were influenced by peripheral disturbance by human activity. The field 1 was recorded with higher abundance of birds while field 2 was lower. The field 2 was recorded with higher human interference due to a small construction work in the nearby field; this phenomenon

was recorded last time on 17th February 2020 and this hovering behaviour of Barn Swallow was not found afterward.

Table (1): Details of Barn Swallow *Hirundo rustica* recorded from Indian Mustard *Brassica juncea* crop fields.

Sampling Sl. No.	No. of barn swallows		Hovering time duration (in hr)		Disturbance level (working persons)	
	Field 1	Field 2	Field 1	Field 2	Field 1	Field 2
1	35	0	2.50	0.00	0	6
2	40	0	2.25	0.00	3	8
3	43	0	2.50	0.00	0	8
4	57	0	2.50	0.00	0	0
5	55	0	1.25	0.00	2	4
6	58	0	3.00	0.00	3	6
7	25	21	2.25	1.25	1	6
8	49	6	1.50	0.50	2	7
9	34	10	2.00	1.00	2	5
10	41	4	1.75	0.75	0	6
11	55	0	1.50	0.00	2	7
12	23	18	2.50	1.00	6	5
13	61	0	2.75	0.00	0	2
14	48	6	2.25	0.25	2	2
15	54	0	1.25	0.00	2	6
16	51	0	1.50	0.00	0	5
17	44	10	2.00	1.00	0	6
18	36	6	2.25	0.25	4	4
19	28	8	1.25	0.75	2	5
20	27	12	2.25	1.50	3	0
21	46	0	1.50	0.00	3	6
22	39	0	2.75	0.00	0	5
23	25	12	1.25	0.75	3	2
24	37	9	2.00	0.50	3	2
25	41	14	1.50	1.00	2	2
26	22	6	0.75	0.50	2	4
27	18	8	2.00	0.50	2	0
28	24	5	1.50	0.25	0	0
29	11	4	1.25	0.50	0	3

30	14	0	1.00	0.00	2	4
31	6	0	1.25	0.00	2	5
32	6	0	0.75	0.00	2	5
Min	6	0	0.75	0	0	0
max	61	21	3	1.5	6	8
Mean	36.03	4.97	1.83	0.38	1.72	4.25
SD	15.37	5.78	0.60	0.44	1.42	2.29
Mean±SD	36.03±15.37	4.97±5.78	1.83±0.60	0.38±0.44	1.72±1.42	4.25±2.29

Being an agricultural area, this region is highly rich in insect diversity (Nayak *et al*., 2019; Singh *et al*., 2020). Several insects were found in the Indian mustard plants (Satyagopal *et al*., 2014). These insects had also been identified as the food for Barn swallows (Law *et al*., 2017). Considering the Barn Swallow as a flying insectivorous bird, this observation can be considered as one of the behaviour for their feeding pattern. This can be considered as natural history behaviour of this species but, this might not be the only reason for this behaviour of Barn swallows. The insectivorous guild being the species-rich feeding guild in agricultural landscapes (Panda *et al*., 2021b) supports this behaviour of these birds. The particular insects taken as food by this species cannot be identified due to their small size for photographic observation and detailed research. The food composition of this species can be identified by doing the gut content analysis which requires further research. Considering this observation as a first record for the alliance between Barn Swallow and Indian mustard, a long term detailed study is suggested by the authors to depict the exact relation between them in this plant animal interaction.

CONCLUSIONS

The study area consists of various crops which were also with high insect diversity. This phenomenon was not seen in any other crop fields nearby. If this behaviour of Barn swallows is only due to the food abundance, then why it was not found in any other crop field nearby? This condition confirmed that this particular behaviour of barn swallows was not only due to the presence of higher availability of food as rich insect diversity. The present study depicted the behaviour of this insectivorous species as well as focused on one particular aspect which may be influenced by some other reason. This common behaviour of Barn swallows may be a new intuition for the bird-plant association ship with Indian mustard plants. The behaviour of aerial foraging insectivore birds is still poorly understood; therefore a detailed study is needed to explain such peculiar behaviour of these birds. Long-term observation of this phenomenon can depict the reason behind this behaviour of barn swallows. The association of birds with the plants in that habitat is an essential part of understanding their ecological behaviour. Conservation and management of birds can only be possible by knowing their ecological status as well as their association with vegetation of the habitat. It will also help in conserving these birds whose population is declining day by day.

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CONFLICT OF INTEREST STATEMENT

"The authors have no conflicts of interest to declare ".

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تحالف بين طائري سنونو الحقول *Hirundo rustica* Linnaeus, 1758 و الخردل الهندي *Brassica juncea* (L.) Czernajew, 1859: بديهية جديدة في الشبكات البيئية لطير-نبات

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الخلاصة

يؤثر نوع الموائل وتوافر الغذاء دائمًا على حجم السكان للعديد من الكائنات الحية، يتوجب تلخيص نمط تغذية الطيور لاستكمال بيانات بنية مجتمع الطيور؛ تعد مزرعة الأبحاث الرئيسية في الهندسة الزراعية بجامعة أوريسا للزراعة والتكنولوجيا نظامًا بيئيًا زراعيًا متعدد المحاصيل جيد الإدارة والذي يوفر أرضية مناسبة للبحث البيئي؛ في الأراضي الزراعية متعددة المحاصيل، سجل ارتباط طائر السنونو Barn Swallow *Hirundo rustica* Linnaeus, 1758، مع طائر الخردلة الهندية Indian Mustard *Brassica juncea* (L.) Czernajew, 1859 لأول مرة أثناء التحليق فقط في هذا الحقل.

سجل سرب من طيور السنونو في 32 زيارة ميدانية أثناء التحليق المستمر فوق حقل الخردل الهندي بعد التزهير حتى نضج الثمار خلال الصباح وأحيانًا بعد الظهر أيضًا. تم تسجيل مدى الطيور من 6 إلى 61 بمتوسط فرد يبلغ 36.03 ± 15.37 تحوم لمدة 1.83 ساعة يوميًا. قد يكون هذا هو السلوك الخاص بنمط التغذية لهذه الطيور اكلات الحشرات insectivorous والتي لم يتم رؤيتها في حقول المحاصيل الأخرى مع تنوع الحشرات نفسه ووصفها بأنها ليست السبب الوحيد لهذا السلوك. للكشف عن هذا

السلوك غير المفهوم جيدًا للطيور اكلات الحشرات، هناك حاجة إلى دراسة سلوكية مفصلة طويلة المدى مع تحليل محتوى الأمعاء لشرح السبب المحدد وراء هذا السلوك لطيور السنونو Barn swallows والذي سيدعم الحفاظ عليها والسيطرة على انخفاض أعدادها.