



Diet of three insectivorous birds in Nagapattinam District, Tamil Nadu, India – a preliminary study

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Abstract: The dietary composition of the White-breasted Kingfisher *Halcyon smyrnensis*, the Small Bee-eater *Merops orientalis* and the Black Drongo *Dicrurus macrocercus* was studied between 2005 and 2006 in Nagapattinam District, Tamil Nadu, India by analyzing regurgitated pellets. The analysis revealed that the White-breasted Kingfisher preys mainly on arthropods (83.40%) and less on vertebrates; seven orders of insects were identified, with Coleoptera, Hemiptera, Hymenoptera and Orthoptera predominant. The small bee-eater diet is composed of Coleoptera (22.3%), Hymenoptera (20.8%), Hemiptera (14.1%), Orthoptera (12.6%), Odonata (10.7%), Lepidoptera (10.4%) and Diptera (8.6%). Beetles were also found to be the most frequent prey (23.7%) in the diet of black drongos, followed by Hemiptera (21.6%), Orthoptera (19.3%), Hymenoptera (14.4%), Lepidoptera (7.5%), Diptera (6.8%) and Odonata (6.0%).

Keywords: Bio-control, birds, Coleoptera, diet, Hemiptera, Hymenoptera, Insectivory

INTRODUCTION

Agricultural ecosystem provides a concentrated and highly predictable source of food to many birds in the form of grain, seeds, insects and rodents. A large number of birds directly or indirectly depend upon crop fields, making them integral parts of agro-ecosystems. Insectivorous birds are beneficial to agriculturists since they keep a check on populations of various insect pests of crops. As enemies of insects, birds stand supreme among vertebrates because they are highly mobile and are able to congregate quickly in large numbers when sudden outbreaks of insect pests occur (Dhindsa & Saini 1994). Thus birds are highly motivated, efficient and cost-effective insect pest controllers.

Detailed analysis of food and feeding behaviour of insectivorous birds is fundamental to assessments of their economic importance. However, information on the feeding ecology of Indian birds is limited, being largely based on the findings of Beresford (1944), Mukherjee (1975), Mathew et al. (1978) and Ali & Ripley (1983). In southern India, reports on the food and feeding ecology of insectivorous birds are few and scanty (Mathew et al. 1978; Natarajan 1993; Asokan 1998; Sivakumaran & Thiyagesan 2003; Asokan et al. 2008). The present paper deals with the diets of three common insectivorous birds: the White-breasted Kingfisher *Halcyon smyrnensis*, Small Bee-eater *Merops orientalis* and Black Drongo *Dicrurus macrocercus* in Nagapattinam District, Tamil Nadu, India. Beyond general observations on their distribution and breeding seasons, our knowledge on feeding ecology of these three species is limited.

MATERIALS AND METHODS

The present study was conducted in two village's viz., Thiruvananthapuram and Manakudi (18°18'N & 79°50'E) of Cauvery Delta in Nagapattinam District, Tamil Nadu, India between 2005 and 2006. The study area is a portion of the granary of southern India because of extensive cultivation of paddy, sugarcane, cotton, groundnut, banana, pulses and other cereals. The river Cauvery and its tributaries, namely, *Kollidam*, *Uppanar*, *Vellar*, *Manjalar* and *Arasalar* are the major perennial water sources in the study area. The north-east monsoon brings rain between October and December (amounting to 65% of the total rainfall in a year).

Analysis of regurgitated pellets is a reliable, non-invasive method for studying food habits of insectivorous birds (Ralph et al. 1985). The regurgitated pellets were collected opportunistically at perch and roost-sites around the agricultural lands. The collected pellets were bagged, labeled and dried in a hot air oven at 60°C for identification of prey remains (Herrera & Ramirez 1974; Ralph et al. 1985). The prey fragments were identified



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Table 1. Frequency and percent composition of various prey items in the diet of the White-breasted Kingfisher (n=638 pellets)

| Prey items | Frequency | % composition | Rank |
|--|-------------|---------------|------|
| Invertebrates | | | |
| Arthropoda | | | |
| Coleoptera (beetles) | 1290 | 21.95 | I |
| Hemiptera (bugs) | 1009 | 17.17 | II |
| Hymenoptera (ants, bees and wasps) | 866 | 14.74 | III |
| Orthoptera (grasshoppers and crickets) | 806 | 13.72 | IV |
| Diptera (flies) | 411 | 6.99 | V |
| Odonata (dragonflies) | 279 | 4.75 | VII |
| Lepidoptera (butterflies and moths) | 240 | 4.08 | VIII |
| Total | 4901 | 83.4 | |
| Mollusca | | | |
| Crab | 372 | 6.33 | VI |
| Vertebrates | | | |
| Pisces | 166 | 2.83 | X |
| Amphibians | 195 | 3.32 | IX |
| Reptiles | 165 | 2.81 | XI |
| Unidentified prey items | 77 | 1.31 | XII |
| Total | 5876 | 100 | |

Table 3. Frequency and percent composition of various prey items in the diet of the Small Bee-eater (n=714 pellets)

| Prey items | Frequency | % composition | Rank |
|--|-------------|---------------|------|
| Coleoptera (beetles) | 1950 | 22.3 | I |
| Hemiptera (bugs) | 1230 | 14.1 | III |
| Hymenoptera (ants, bees and wasps) | 1821 | 20.8 | II |
| Orthoptera (grasshoppers and crickets) | 1102 | 12.6 | IV |
| Diptera (flies) | 757 | 8.6 | VII |
| Odonata (dragonflies) | 933 | 10.7 | V |
| Lepidoptera (butterflies and moths) | 914 | 10.4 | VI |
| Unidentified insects | 47 | 0.5 | VIII |
| Total | 8754 | 100 | |

using a dissecting microscope and reference books. We identified the prey taxa by means of analyzing various body-parts in the remains of the diets as follows: Coleoptera (mandibles, elytra and leg fragments), Hemiptera (H-shaped tergal plates, mouthparts and leg fragments), Hymenoptera (mouthparts, leg fragments and wing fragments), Orthoptera

(raptorial leg fragments and mandibles), Diptera (antennae, eyes and wings), Odonata (wings, leg fragments and head capsules), Lepidoptera (wing scales and proboscis), crabs (pedipalps and shell fragments), fish (cartilage bones and scales), amphibians (mandibles and pelvic girdle) and reptiles (mandibles).

RESULTS AND DISCUSSION

Analysis of the diet of the White-breasted Kingfisher based on 638 regurgitated pellets reveals that it preys primarily on arthropods (83.40 %). Among the insects Coleoptera (21.95 %), Hemiptera (17.17 %), Hymenoptera (14.74 %) and Orthoptera (13.72 %) occur most frequently in its diet (Table 1). In addition, crabs, fishes, amphibians and reptiles comprise about 16.60% of the total diet (Table 1). Our findings are consistent with the results of some of the earlier studies (e.g., Sen 1944; Mukherjee 1975; Yahya 2001). In another study carried out in Malaysia (Burton 1998), insects - mostly grasshoppers, ants and beetles - and lizards were observed to be the main diet of White-breasted Kingfisher. A similar trend was found in terms of prey composition, with as many as 613 of the total 638 pellets (96%) having remains of insects belonging to order Coleoptera, followed by Hemiptera (93%), Orthoptera (91%) and Hymenoptera (89%). Other prey remains were found in less than 50% of the total pellets analyzed (Table 2). The remains of fishes, mostly restricted to rainy season, were detected in 103 pellets. During the rainy season (September to January) when the water level is much higher and the river and ponds largely inundated, the birds fed more on aquatic animals like fish and frogs, while during the drier months from February to August they consumed more terrestrial organisms.

The remains of 8757 insect prey items were found in the regurgitated pellets of Small Bee-eaters. The most dominant prey were Coleoptera (22.3%), Hymenoptera (20.8%), Hemiptera (14.1%), Orthoptera (12.6%), Odonata (10.7%), Lepidoptera (10.4%) and Diptera (8.6%) (Table 3). Earlier, Asokan (1998) found that beetles and Hymenoptera were the principal food items of Small Bee-eaters in Nagapattinam District. Mathew et al. (1978) reported that they consumed almost equal proportions of Hymenoptera, Coleoptera, Odonata and Lepidoptera. However, Fry (1984) who studied the Little Bee-eater *Merops pusillus* in Africa, reported that Hymenoptera formed the major diet. The percentage occurrence of Hymenoptera in the study area in the diet of Small Bee-eaters

Table 2. Comparative statistics for different prey items found in the White-breasted Kingfisher pellets (n=638)

| | Coleoptera | Hemiptera | Hymenoptera | Orthoptera | Diptera | Odonata | Lepidoptera | Crab | Pisces | Amphibians | Reptiles |
|------------|------------|-----------|-------------|------------|---------|---------|-------------|------|--------|------------|----------|
| Presence | 613 | 596 | 569 | 584 | 302 | 188 | 161 | 298 | 103 | 182 | 153 |
| Presence % | 96% | 93% | 89% | 91% | 47% | 29% | 25% | 47% | 16% | 28% | 24% |
| Absence | 25 | 42 | 69 | 54 | 336 | 450 | 477 | 340 | 535 | 456 | 485 |
| Absence % | 4% | 7% | 11% | 9% | 53% | 71% | 75% | 53% | 84% | 72% | 76% |
| Minimum | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Maximum | 19 | 8 | 6 | 11 | 2 | 4 | 2 | 4 | 4 | 2 | 2 |
| Range | 0-19 | 0-8 | 0-6 | 0-11 | 0-2 | 0-4 | 0-2 | 0-4 | 0-4 | 0-2 | 0-2 |
| Sum | 1290 | 1009 | 866 | 806 | 411 | 279 | 240 | 372 | 166 | 195 | 165 |

Presence - The number of pellets containing remains of the respective prey item; Presence % - The percentage of pellets containing remains of the respective prey item; Absence - The number of pellets not containing remains of the respective prey item; Absence % - The percentage of pellets not containing remains of the respective prey item; Minimum - The minimum number of remains in any pellets of the respective prey item; Maximum - The maximum number of remains in any pellets of the respective prey item; Range - The range of remains in pellets of the respective prey item; Sum - The total number of remains of the respective prey item in all pellets.

Table 4. Comparative statistics for different prey items found in the Small Bee-eater pellets (n=714)

| | Coleoptera | Hemiptera | Hymenoptera | Orthoptera | Diptera | Odonata | Lepidoptera |
|------------|------------|-----------|-------------|------------|---------|---------|-------------|
| Presence | 688 | 496 | 661 | 579 | 368 | 515 | 420 |
| Presence % | 96% | 69% | 93% | 81% | 52% | 72% | 59% |
| Absence | 26 | 218 | 53 | 135 | 346 | 199 | 294 |
| Absence % | 4% | 31% | 7% | 19% | 48% | 28% | 41% |
| Minimum | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Maximum | 18 | 5 | 6 | 10 | 2 | 4 | 3 |
| Range | 0-18 | 0-5 | 0-6 | 0-10 | 0-2 | 0-4 | 0-3 |
| Sum | 1950 | 1230 | 1821 | 1102 | 757 | 933 | 914 |

Presence - The number of pellets containing remains of the respective prey item; Presence % - The percentage of pellets containing remains of the respective prey item; Absence - The number of pellets not containing remains of the respective prey item; Absence % - The percentage of pellets not containing remains of the respective prey item; Minimum - The minimum number of remains in any pellets of the respective prey item; Maximum - The maximum number of remains in any pellets of the respective prey item; Range - The range of remains in pellets of the respective prey item; Sum - The total number of remains of the respective prey item in all pellets.

Table 5. Frequency and percent composition of various prey items in the diet of the Black Drongo (n=676 pellets)

| Prey items | Frequency | % composition | Rank |
|--|-------------|---------------|------|
| Coleoptera (beetles) | 2166 | 23.7 | I |
| Hemiptera (bugs) | 1971 | 21.6 | II |
| Hymenoptera (ants, bees and wasps) | 1315 | 14.4 | IV |
| Orthoptera (grasshoppers and crickets) | 1766 | 19.3 | III |
| Diptera (flies) | 619 | 6.8 | VI |
| Odonata (dragonflies) | 548 | 6 | VII |
| Lepidoptera (butterflies and moths) | 682 | 7.5 | V |
| Unidentified insects | 61 | 0.7 | VIII |
| Total | 9128 | 100 | |

could be attributed to less numbers of bee-hives in the study area. In terms of prey composition, most pellets had remains of insects belonging to order Coleoptera (96%) followed by Hymenoptera (93%), Orthoptera (81%) and Odonata (72%). The other prey remains such as Hemiptera, Diptera and Lepidoptera were found in less than 60% of pellets (Table 4).

The analysis of 676 pellets of Black Drongo indicated the high frequency occurrence of insects belonging to order Coleoptera (23.7%) followed by Hemiptera (21.6%), Orthoptera (19.3%), Hymenoptera (14.4%), Lepidoptera (7.5%), Diptera (6.8%) and Odonata (6.0%) (Table 5). Mathew et al. (1978) reported that Coleoptera, Hemiptera and Orthoptera as major food of Black Drongos, and the present study showed a similar trend. Hussain & Bhalla (1937) found that Black Drongos feed

largely on grasshoppers and locusts. In terms of prey composition totally 676 regurgitated pellets were analyzed, of these 92% of the pellets contained Coleopteran remains, 83% contained Hemipteran remains, 76% contained Orthopteran remains and 72% contained Hymenopteran remains. The Diptera, Odonata and lepidoptera were found in 368 (54%), 389 (58%) and 413 (61%) pellets respectively (Table 6).

White-breasted Kingfishers, Small Bee-eaters and Black Drongos consumed almost similar proportions of Coleopterans, Hemipterans, Hymenopterans and Orthopterans in our study. These three species were predominantly found in agricultural lands and the above insect prey formed principal food items due to their greater availability. Moorman et al. (2007) reported that Coleopterans and Hemipterans formed the major diet of foliage-gleaning and ground-gleaning insectivorous birds. Many other investigators also have determined Coleopterans, Hemipterans and Hymenopterans (Mason & Maxwell-Lefroy 1912; Sodhi 1986; Kaspari & Joern 1993; Parasharya et al. 1994; Sivakumaran & Thiyagesan 2003; Yard et al. 2004; Asokan et al. 2008) as primary food resource of insectivorous birds.

The findings of the present study revealed that a wide variety of insects are consumed by the three birds showed and hence they act as very active bio-control agents against agricultural insects pests. Nathan & Rajendran (1982) reported that Black Drongos destroying injurious insects like stem-borer, skippers and leaf rollers in enormous numbers in the rice ecosystem of Pondicherry region. Parasharya et al. (1994)

Table 6. Comparative statistics for different prey items found in the Black Drongo pellets (n=676)

| | Coleoptera | Hemiptera | Hymenoptera | Orthoptera | Diptera | Odonata | Lepidoptera |
|------------|------------|-----------|-------------|------------|---------|---------|-------------|
| Presence | 624 | 562 | 485 | 517 | 368 | 389 | 413 |
| Presence % | 92% | 83% | 72% | 76% | 54% | 58% | 61% |
| Absence | 52 | 114 | 191 | 159 | 308 | 287 | 263 |
| Absence % | 8% | 17% | 28% | 24% | 46% | 42% | 39% |
| Minimum | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Maximum | 18 | 5 | 5 | 11 | 3 | 4 | 3 |
| Range | 0-18 | 0-5 | 0-5 | 0-11 | 0-3 | 0-4 | 0-3 |
| Sum | 2166 | 1971 | 1315 | 1766 | 619 | 548 | 682 |

Presence - The number of pellets containing remains of the respective prey item; Presence % - The percentage of pellets containing remains of the respective prey item; Absence - The number of pellets not containing remains of the respective prey item; Absence % - The percentage of pellets not containing remains of the respective prey item; Minimum - The minimum number of remains in any pellets of the respective prey item; Maximum - The maximum number of remains in any pellets of the respective prey item; Range - The range of remains in pellets of the respective prey item; Sum - The total number of remains of the respective prey item in all pellets.

also stated that White-breasted Kingfishers, Small Bee-eaters and Black Drongos are important bio-control agents against white grub (*Holotricha* sp.), an important subterranean pest damaging root system of several crops.

Interestingly, the local farmers are aware of the beneficial role of these insectivorous birds in bio-control of crop pests. Farmers can encourage these birds in agricultural fields by providing perching sites, by keeping dried tree stumps in different localities in the rice fields, and also by planting plantain along the farm boundaries.

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Author Contribution: The field study was conducted AMSA and RM under the supervision of Dr. S.A. AMSA analyzed data and wrote the manuscript and Dr. S.A. provided necessary suggestions during manuscript preparation.

