Sci Parasitol 13(2):65-72, June 2012
ISSN 1582-1366

An epidemiological study of *Sphaerirostris picae* (Acanthocephala: Centrorhynchidae) from Hooded crow *(Corvus corone cornix)* (Aves: Corvidae) in north Delta of Egypt

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Abstract. One hundred and ninety five hooded crows, *Corvus corone cornix* Linnaeus, 1758 from Khafr el sheikh Governorate, Egypt were examined during the year 2010 for helminth infections. Birds were infected with only one acanthocephalan species "*Sphaerirostris picae*" (Rudolphi, 1819) Golvan, 1960. Prevalence was highest in the summer (9.2%), being relatively higher in females (10.7%) than males (8.7%). The intensity of infection of both male and female hosts was highest in autumn; relatively higher in males than in females in all months, except in May, July, August and November when females had higher intensity than males. Female *S. picae* matured in winter (January) and maturation continued in the spring (May), when immature females exhibited their highest prevalence (7.6%), continued development in late autumn (November) and early winter (December), when the prevalence of females with both ovarian balls and eggs increased to 12%. The intensity of infection with male and female of different developmental stages was relatively higher in male than female hosts. No distinct relationship was observed between the sex of the host and that of the parasite. Female hosts with heavy weight had the highest prevalence of infection, while the intensity of infection reached its highest levels in the medium weight male and female hosts. Larger birds were more frequently infected with S. picae than smaller ones.

Keywords: Hooded crow; *Corvus corone cornix*; *Sphaerostris picae*; Acanthocephala; Epidemiology; Egypt.

Received 08/04/2012. Accepted 20/05/2012.

Introduction

The hooded crow is a common resident throughout Egypt inhabiting cultivated land and open and wooded terrain in the Nile Delta and valley (Tharwat, 1997). This species is particularly common in populated areas, especially where food resources are available in large amounts. The hooded crow is a pet characterized by a high reproductive potential

(Loman, 1980). Despite it's common and widespread occurrence, to the best of our knowledge, no comprehensive and annual survey of helminths in this bird has been done in Egypt. In recent years, there was numerical increase in hooded crow populations in Egypt, especially on the north costal governorates, where hunters are persuaded to include it in the list of hunted species. This encouraged the present researchers to evaluate the effect of helminth diversity and load on the reported increase in population density of this bird.

The feeding habits of hooded crow include wide range of intermediate (insects, mollusks) and paratenic (small vertebrates and carrion) hosts (Amici et al., 2011) that may qualify it to harbor a wide range of parasites.

Sphaerirostris picae (Rudolphi, 1819) Golvan, 1956 was described from many hosts including; little ringed plover; *Charadrius dubius* Scopoli, 1786 (see Dimitrova and Genov, 1992), Northern shrike; *Lanius excubitor* Sibley and Monroe 1990, 1993 (see Borgarenko and Khokhlova, 1987 and Dimitrova et al., 1997), Magpie; *Pica pica* Linnaeus, 1758 (see Kurbanov, 1978; Dimitrova et al., 1997; Amin et al., 2010) and *Lacerta agilis* Linnaeus, 1758 (a paratenic host) (see Krasnoshchekov and Lisitsyna, 2009). Under the synonyms *Sphaerirostris teres* it was recorded from fan-tailed raven *Corvus rhipidurus* Hartert, 1918 (see Schmidt, 1975), *Graculus graculus* Linnaeus, 1766 (see Borgarenko and Khokhlova, 1982) and *Armadillidium versicolor* Stein, 1859 (see Lisitsina and Tkach, 1994).

The present survey was undertaken to evaluate the prevalence of helminth infection in hooded crow in light of various host parameters.

Materials and methods

195 Hooded crow, *C. c.cornix* (92 female and 103 male) were collected from Khafr El-Sheikh Governorate ("32'831°C North, "42'3830°C East). Birds were examined for helminth infection from January to December, 2010. The average temperature in Khafr El-Sheikh Governorate is between 18 to 11°C in winter and 24 to 31°C in summer, and the annual rainfall is about 1.38 cm.

Birds were initially placed in ice coolers after being shot, sexed, measured (total length), weighted, and examined for parasites. Intestines were incised longitudinally and examined in 0.7% physiological saline. Collected acanthocephalans were sexed, counted, washed and fixed in 70% ethyl alcohol separately for further investigations, notes on their sites within the host and related observations were recorded.

For identification purpose, stained cleared preparations (Amin, 1998) were examined thoroughly. Acanthocephalan specimens were identified according to Dimitrova et al. (1997; 2000). Ecological terminology follows Bush et al. (1997). Statistical analyses were performed using Fisher exact test for prevalence, and 2-way ANOVA and Tukey post hoc test to evaluate differences in intensity and abundance (Belle et al., 2004).

In the present study the length of the bird was taken as indicator of the age as reported by (Sandilands, 2005), who reported a proportional relationship between the length and age of the bird.

Results

Host

A total of 195 hooded crows were examined ; 92 females (47.1%) and 103 males (52.8%). The mean length of these hosts was 32-52 (43.72 ± 4.42) and 30-50 (38 ± 5.29) cm respectively and overall weight was 250-620 (460 ± 72.41) and 210-510 (337± 63.34) g, respectively. The frequency in sizes and weight of males and females corresponded with their seasonal development, being smallest in summer and increasing with growth to a maximum in the spring (recorded data in this study).

Parasites

The present investigation revealed that the entire intestine of the hooded crow hosts was infected with only one acanthocephalan species "*S. picae*" with no infection of any other helminth species. Infection with *S. picae* was

detected throughout the entire ileum in both males and females host.

The prevalence, intensity and abundance of infection with *S. picae* varied with seasons and host sex, weight and length (tables 1-4).

Seasons (table 1)

The prevalence of infection with *S. picae* was similar in both host sexes in all months, but relatively higher in males than females. Late summer and early autumn were the seasons of highest prevalence.

The intensity of infection of both male and female hosts with *S. picae* was highest in autumn; higher in males than in females, except in May, July, August and November, where the mean in male showed a slight decline. The intensity of infection in females was significantly higher in November when compared with that in February (p=0.008), March (p=0.039), April (p=0.013), June (p=0.013), September (p=0.013) and December (p=0.011).

Table 1. Seasonal sex relation and prevalence, intensity and abundance of *Sphaerirostris picae* infection in adult hooded crow

Month	Infection in male crow		Infection in female crow		Infection in male and female crow	
	I (P%)	Intensity Mean ± SD Range	I (P%)	Intensity Mean ± SD Range	I (P%)	Intensity Mean ± SD Range
Jan.	7/8 (87.5)	6.8±5 2-15	6/7 (85)	6±4.3 2-12	13/15 (86.6)	6.5±4.6 2-15
Feb.	9/10 (90)	4.3±2.5 1-8	5/6 (83.3)	2.8±1.3 1-4	14/16 (87.5)	3.6±2.1 1-8
March	8/9 (88.8)	5.8±3.6 2-10	8/10 (80)	4.4±3.4 1-9	16/19 (84.2)	5.3±3.4 1-10
Apr.	5/6 (83.3)	8.8±9.3 1-26	7/9 (77.7)	4.2±2.9 2-10	12/15 (80)	6.3±6.8 1-26
May	8/11 (72.7)	5.5±4.5 1-15	3/6 (50)	7 ±4.3 4-12	11/17 (64.7)	5.9±4.3 1-15
June	6/9 (56)	7.4±2.7 3-10	4/8 (50)	4.2±2.6 1-9	10/17 (58.8)	5.8±3 1-10
July	10/11 (91)	5.0±3 1-11	5/6 (83.3)	7.8±5 2-15	15/17 (88.2)	6.3±4.2 1-15
Aug.	6/6 (100)	7.5±5 1-15	9/9 (100)	10.3±7.1 1-25	15/15 (100)	9.0±6.2 1-25
Sep.	9/10 (90)	11.1±6.5 3-22	6/6 (100)	8.2±3 1-10	15/16 (93.7)	8.2±6.2 1-22
Oct.	5/5 (100)	13.3±10 4-33	8/10 (80)	8.1±6 2-18	13/15 (86.6)	10.5±8.2 2-33
Nov.	9/9 (100)	10±3.9 6-14	7/8 (87.5)	14.5±8.7 6-32	16/17 (94.1)	12.2±6.7 6-32
Dec.	7/8 (87.5)	5.8±2.4 2-9	6/7 (85.7)	4.14±2.4 2-9	13/15 (86.6)	5±2.5 2-9
Total	**89/103 (86.4)**		**74/92 (80.4)**		**163/195 (83.5)**	

I – Infect./exam. host; P – Prevalence.

Seasonal development of adult female Sphaerirostris picae (table 2)

Female *S. picae* at different developmental stages were collected during all seasons, however gravid females (with mature eggs) were reported at higher prevalence than females with no sex cells in all months. Maturity of females begins in late winter and proceeded in spring, where females with no sex cells, recorded their highest prevalence (41.1%) in May. In late summer and early autumn, the percentage of females with only ovarian balls was highest (47-50%). With progressive development, the prevalence of females with both ovarian balls and eggs

increases (64.7%) in late autumn and early winter. By summer, most females (82.3%) were gravid with ripe eggs.

High significant differences for intensity of infection with gravid females were reported in November when compared with December (P=0.013) and February (P=0.028) and for abundance of infection in November compared to January (P=0.034), February (P=0.004), March (P=0.008), May (P=0.003), and June (P=0.020).

Host sex (table 3)

The prevalence of infection with males and different developmental stages of female *S. picae* was significantly higher in male than in female hosts. High significant differences were reported between male and female hosts for prevalence of infection with female worms with no sex cells (P=0.000), with ovarian balls (P=0.000), with ovarian balls and eggs (P=0.002), and gravid female (P=0.005). No significant variations were reported in the intensity of infection in relation to the sex of the bird.

Host weight (table 4)

The weight of the 54 captured male hosts ranged from 300 to 400 gm was the most frequently infected with *S. picae* when compared with heavier (400-500 gm) and lighter (200-300 gm) birds. On the other hand, 39 female birds with a weight range of 400 to 500 gm had the highest prevalence of infection compared with lower weight categories. However, the intensity of infection reached its highest levels in the medium weight (300-400 gm) male and female hosts.

Table 2. Seasonal development of *adult Sphaerirostris picae* in hooded crow

Month	Male		Female with							
			No sex cells		Ovarian balls		Ovarian ball and eggs		Eggs	
	I (P%)	Intensity Mean ± SD Range	I (P%)	Intensity Mean ± SD Range	I (P%)	Intensity Mean ± SD Range	I (P%)	Intensity Mean ± SD Range	I (P%)	Intensity Mean ± SD Range
Jan.	14/15 (93.3)	2.4±1.4 1-5	7/15 (46.6)	2.7±0.9 1-4	6/15 (40)	2±0.89 1-3	6/15 (40)	2±0.89 1-3	9/15 (60)	2.3±1.4 1-5
Feb.	9/16 (56.2)	1.4±0.52 1-2	3/16 (18.7)	2±1 1-3	1/16 (6.2)	1±0 1-1	3/16 (18.7)	2±1 1-3	9/16 (56.2)	1.5±1.01 1-4
March	10/15 (66.6)	2.5±1.63 1-5	6/15 (40)	1.7±0.4 1-2	5/15 (33.3)	1.6±0.54 1-2	5/15 (33.3)	2.8±1.1 2-4	8/15 (53.3)	1.8±0.99 1-4
Apr.	12/16 (75)	2.8±2.2 1-6	4/16 (25)	3.7±1.5 2-5	2/16 (12.5)	1±0 1-1	4/16 (25)	1.5±0.57 1-2	5/16 (31.2)	6±6.8 1-18
May	10/17 (58.8)	2.6±1.2 1-8	7/17 (41.1)	1.8±1.0 1-3	7/17 (41.1)	1.8±0.89 1-3	2/17 (11.7)	1.5±0.7 1-2	5/17 (29.4)	2.8±2.4 1-7
June	13/17 (76.4)	2.4±1.5 1-5	4/17 (23.5)	1.5±1 1-3	6/17 (35.2)	1.6±0.81 1-3	3/17 (17.6)	2.6±0.57 2-3	11/17 (64.7)	2.1±1.3 1-5
July	15/17 (88.2)	3.1±1.9 1-6	3/17 (17.6)	2±1 1-3	8/17 (47)	1.3±0.51 1-2	7/17 (41.1)	2.5±1.4 1-5	14/17 82.3)(	2.8±1.6 1-6
Aug.	16/17 (94.1)	2.8±1.7 1-7	5/17 (29.4)	2.8±1.4 1-5	8/17 (47)	2±1.77 1-6	7/17 (41.1)	2.5±2.1 1-7	14/17 (82.3)	4.1±3.2 1-10
Sep.	17/18 (94.4)	2.6±1.8 1-6	6/18 (33.3)	3±4.4 1-12	9/18 (50)	1.7±0.66 1-3	6/18 (33.3)	1.3±0.51 1-2	14/18 (77.7)	3.6±3.1 1-10
Oct.	13/15 (86.6)	3.6±3 1-12	5/15 (33.3)	2±1.2 1-4	6/15 (40)	2.8±0.75 2-4	6/15 (40)	2.8±1.1 1-4	11/15 (73.3)	4.1±4.5 1-14
Nov.	14/17 (82.3)	4.4±2.7 1-11	2/17 (11.7)	1.5±0.7 1-2	4/17 (23.5)	1.7±0.5 1-2	11/17 (64.7)	2.9±2.1 1-7	15/17 (88.2)	5.6±3.1 2-13
Dec.	13/15 (86.6)	2.5±1.7 1-6	3/15 (20)	1±0 1-1	5/15 (33.3)	1.2±0.44 1-2	7/15 (46.6)	1.2±0.75 1-3	14/15 (93.3)	1.7±0.92 1-4

I – Infect./exam. host; P – Prevalence.

Table 3. Sex of *Sphaerirostris picae* in relation to the host sex

Developmental stages of the parasite	Infection in male hosts		Infection in female hosts	
	N (P%)	Intensity Mean ± SD Range	N (P%)	Intensity Mean ± SD Range
Male	87/103 (84.4)	8± 5.6 1-33	69/92 (75)	7.4±5.8 1-32
Female with No sex cells	34/103 (33)	9.8±7 2-33	21/92 (22.8)	10±6.2 1-25
Female with ovarian balls	39/103 (37.8)	9.1±4.8 1-22	28/92 (30.4)	8.9±7.2 1-32
Female with ovarian balls and eggs	38/103 (36.8)	10.1±5.5 3-33	28/92 (330.4)	9.6±7.1 2-32
Female with eggs	70/103 (67.9)	8.8±5.8 1-33	57/92 (61.9)	7.8±6 2-32

N – No. infect./ no exam.; P – Prevalence.

Host length (table 5)

Larger birds were more frequently infected with *S. picae* than smaller ones. Among 66 males measuring 40-50 cm in length and 71 females measuring 40-50 cm in length, the prevalence of infection with *S. picae* was 64% in males and 77.2% in females respectively. However the intensity of infection was highest in larger (50-60cm) male and female hosts.

Table 4. Host weight in relation to *Sphaerirostris picae* load of infection

Weight of host (gm)	Infection in male host		Infection in female host	
	N (P%)	Intensity Mean ± SD Range	N (P%)	Intensity Mean ± SD Range
200-	25/103 (24.3)	7.9±5.1 1-15	*2/92 (2.2)	2±0 2-2
300-	54/103 (52.4)	8.0±6.5 1-33	14/92 (15.2)	10±9.6 1-32
400-500	22/103 (21.4)	6.1±2.9 1-11	39/92 (24.8)	6.8±4.9 2-18

N – No. infect./no exam. host; P – Prevalence;
* Small-sized sample.

Table 5. Host length in relation to *Sphaerirostris picae* load of infection

Length of host (cm)	Infection in male host		Infection in female host	
	N (P%)	Intensity Mean± SD Range	N (P%)	Intensity Mean± SD Range
30-	34/103 (33)	7.1±5.5 0-26	16/92 (17.4)	7.8±6.1 2-18
40-	66/103 (64)	6.5±6.4 0-33	71/92 (77.2)	4.7±4.2 0-16
50-60	*3/103 (2.9)	9±1.7 7-10	*5/92 (5.4)	9.8±9.2 0-32

N – No. infect./no exam. host; P – Prevalence;
* Small sample size.

Discussion

Birds of the family Corvidae are among the most common species of wild birds and their free roaming in human residential areas and poultry farms, native or industrial, may be a threat to the health of other birds and, to some extent, to human beings (Halajian et al., 2011). Although the hooded crow is common and widespread occurrence in Egypt since ancient times, to the best of our knowledge, no comprehensive studies of its parasitic fauna has been done.

The primary goal of this study was to identify the helminth fauna in the hooded crow in an attempt to reveal the relationship between the continuously increasing population density of this species in recent years and its parasitic load as stress factor affecting the bird's population.

The present investigation revealed that the entire intestine of the hooded crow is a microhabitat of only one acanthocephalan species, *S. picae*, with no infection of any other helminth species. This finding agrees with Crompton (1973) who suggested that acanthocephalans and cestodes are likely to be competitors because both groups are generally restricted to the small intestine and both share the same feeding habitat, providing the potential for significant niche overlap. The absence of trematode infection may be due to the lack of mollusk intermediate hosts essential for trematode development in the diet of this bird. Otherwise, acanthocephalan-trematode infection is a common pattern in bird hosts (Smith, 2007).

The present results showed that summer was the season of highest prevalence of infection with *S. picae* in both host sexes, which is compatible with Zduniak and Kuczynsk (2003) who noted that the breeding season of the crows mostly consumed 70-86 days beginning from March, with incubation time between 20-22 days. This suggests that the ability of crows to fly and capture meals mostly begins in the summer.

The finding that the intensity of infection with *S. picae* reached its highest levels in autumn may be explained by the fact that in summer and early autumn, the natural food supplies reach their highest levels, so birds could get a wide variety of food products and consequently a high load of parasite intermediate hosts. Atkinson (2008) reported the gradual increase in size of the bird in this season, which is partially responsible for high increase of acanthocephalan intensity. The relatively higher intensity of infection with *S. picae* in male than in female birds, is reversed in summer and autumn months which possibly reflects variations in host behavioral patterns or food habits. This could explain that crows are one of a few bird species that exhibit "cooperative breeding behavior" i.e. males almost do all nest building and feed the incubating females (Tombac, 1986) and as the nest building usually commences in late February and through March followed by eggs laying in late April that hatch in about 20-22 days (Zduniak and Kuczynsk, 2003), This behavior allows males to consume large amount of food during this season and are exposed to higher intensity of infection with helminths than females. Otherwise, in early summer, while the young remain in the nest, both parents take the role of feeding, then the intensity pattern in females increases.

The present results suggest that young parasite generation of female *S. picae* are recruited in late winter and spring, as revealed by high percentage of females with no sex cells then. During July till September, about 50% of female worms were in the ovarian ball stage, almost half of the rest included gravid females. As the maturation of the worm continues, the percentage of gravid females reached its highest level (88-93%) by late autumn and winter. The percentage of older females actually decreased till 29.4% by the following spring. Some of these females might have been remnants of the previous generations. Similar seasonal cycles were detected for *Neoechinorhynchus pungitius* Dechtiar, 1971 by Lasee (1989), *Diplosentis nudus* Harada, 1938 By Hassanine (2006) and *Acanthocephalus tumescens* Linstow, 1896 by Rauque and Semenas (2007).

Outreman et al. (2007) suggested that the distribution of parasites within host natural populations has often been found to be host age-dependent. The present findings revealed that larger/older birds (Sandilands, 2005) were frequently infected with than smaller/younger ones. This result could be explained by the fact that larger hosts ingest greater amounts of food. The larger surface area of the intestine in older than younger birds result in making more space available to accommodate greater numbers of worms as long as they stay in their preferred habitats. The very small-sized sample collected from both male (3) and female (5) hosts larger than 50 cm in length could not accurately record the

prevalence of infection, however the intensity of infection reached its highest (9±1.7) for male and(9.8±9.2) for female in this length category.

Lindenfors et al. (2007) reported that the larger hosts represent larger 'islands' for parasites to colonize, predicting that more parasites will be found in larger hosts. In addition, larger hosts require a greater intake of resources, potentially exposing these hosts to more infectious stages of parasites through incidental ingestion.

In the present investigation, medium weight male hosts (300-400 gm) birds were more frequently infected with *S. picae* than heavier and lighter birds, while heavier female host (400-500 gm) had the highest prevalence of infection. However, the intensity of infection reached its highest levels in the light and medium (200-400 gm) male and female hosts (only two females with weight less than 300 gm could be hunted, however the prevalence and intensity of infection of such very small-sized sample could not be expressive). Amin (1975) discussed factors affecting the abundance of acanthocephalan infections in their definitive fish hosts and attributed the change in the abundance pattern of infection to host age. Moreover, that author referred to host feeding behavior, as well as spatial and seasonal distribution of invertebrate and vertebrate larval hosts as factors affecting the infection pattern.

An interesting finding in this study is that the hooded crow was free of any helminth infection except for *S. picae* throughout the year of survey. Considering the finding of Atkinson et al. (2008) that acanthocephalans cause little overt pathology in their avian hosts, in addition to the fact that crows have high reproductive potential (Loman, 1980), the acanthocephalan infection does not appear to affect the increasing population pattern of hooded crow, even at high intensities of infection as during the months August till November.

Acknowledgements

Authors thank miss Shymaa Fawzi Al Kotb Parasitology researcher for helping in examination the birds.

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