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# INTENSITY AND AGGREGATION OF *TANQUA ANOMALA* (LINSTOW, 1904) IN THE DICE SNAKE FROM CENTRAL IRAQ

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## Abstract

*Tanqua anomala* is a parasitic helminth of reptiles. In Iraq, the infection patterns of this nematode are not well studied. To better understand patterns of infection of *T. anomala* in Iraq, dice snakes (n = 41) were collected from three locations (Tarmyah and Jisr Diyala, central Iraq and Chibayish, southern Iraq) and necropsied. The overall prevalence of *T. anomala* was 41% (95% CI = 25.5 – 57.9). Mean intensity was 6.06 (CI = 2.75 – 12.56), and *T. anomala* was greatly aggregated among hosts such that nearly 25 % of hosts had 97.8 % of this nematode. The intensity of parasitism proposes that *T. anomala* has likely been widespread in the region.

***Key words :*** Infection patterns; Iraq; *Natrix tessellata;* Parasitism intensity; *Tanqua anomala.*

## Introduction

The Colubrid dice snake *Natrix tessellata*, Laurenti 1768 is a semi-aquatic snake that inhabits an extensive variety of water bodies, including streams, rivers, lakes, marshes, lowlands, ponds and heavily irrigated river systems (Sindaco *et al.,* 2000; Conelli *et al.,* 2011; Ibrahim, 2012). It has an extensive distribution range from central and southeastern Europe to central Asia and northern Africa (Arnold and Ovenden, 2002; Gautschi *et al.,* 2002).

*N. tessellata* is considered as one of the most endangered snakes in some countries (Conelli *et al.,* 2011). It is listed according to the guidelines of the International Union for Nature Conservation (IUCN) in the Red List of Threatened Reptiles (Endangered) group (Strugariu *et al.,* 2011). Its habitats are decreasing slowly due to disadvantageous improvements in watercourses such as obstructions, cemented and closed coastal barriers, dredging, closing watercourse land reclaims, river bed corrections and changes in the water regime (Conelli *et al.,* 2011). In Iraq, *N. tessellata* has been documented in about sixteen different regions from the north to the south (Habeeb and Rastegar-Pouyani, 2016).

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Parasites and other infectious agents can cause a temporary or permanent decline in wildlife populations (Smith *et al.,* 2009). Globally, nevertheless, the infectious disease continues to be a sporadic cause of extinction or endangerment of species worldwide (Smith *et al.,* 2006). A review of (IUCN) found that the disease was a major factor in < 4% of identified species extinctions (Smith *et al.,* 2006). Although the identity of *T. anomala* in dice snake has been reported in a previous study by Al-Moussawi (2010), while detailed examinations of intensity and aggregation have not been reported. Intensity information is most important because it makes it possible to assess the degree of aggregation within the host population, especially for wildlife animals (Al-Warid *et al.,* 2017). Thus the objective of this study was to estimate the intensity and aggregation of *T. anomala* among dice snakes from some localities in Iraq.

## Materials and Methods

Thirty-nine specimens of dice snake were collected from three different locations in Iraq (Fig. 1). Three snakes have been collected from Chibayish, Dhi Qar province, southern Iraq, 5 from Tarmyah and 23 snakes from Jisr Diyala, Baghdad province, central Iraq. The carcasses of the snake were possessed fresh. The sex of each snake was identified (females, n=25 and males n=16). Digestive tracts were removed, opened longitudinally and nematodes, including the 4th stage of *T. anomala*, have been removed and recognized morphologically following Yamaguti (1961) and York and Maplestone (1962). Infection prevalence was measured as the percentage of hosts examined/infected as described by Bush *et al.* (1997). Based on Quantitative Parasitology 3.0 (Rózsa *et al.,* 2000), confidence intervals (95% CI) were considered for prevalence. Prevalence variations between regions were analyzed using Fisher's exact and chi-square tests. According to Bush *et al*., (1997), the intensity of infection was measured as the number of helminths in an infected host/number of infected hosts with 95% mean intensity CIs considered using bootstrap tests of Rózsa *et al*., (2000). Mean infection intensity was calculated by region, but statistical comparisons were made across regions using a Mood's median test. Variance / mean ratios ($s^2$/m) were used to measure the aggregation of *T. anomala* parasites among hosts. All intensity and regression statistical analyses were performed using QP 3.0.


**Fig. 1:** Map shows the three locations included in this study.

## Results

Ninety seven nematodes, *Tanqua anomala*, were recovered and identified from dice snake specimens (range= 1-35 nematodes/snake). The identification was based on the morphology of rostral bulb and caudal alae. Results showed that *T. anomala* occurred in 41% (CI = 25.5 – 57.9) of dice snakes. Results showed that there were no significant differences (Fisher's Exact test; p = 0.74) between males (n = 25; prevalence = 44 %; CI = 24.4 – 65) and females (n = 14; prevalence = 35.7 %; CI = 12.7 – 64.8).

Alterations in prevalence occurred through the three regions, although they were non-significant ($X^2$ = 1.9, df = 2, P = 0.386). Snakes tested from Jisr Diyala had higher prevalence (52.2 %; CI = 30.58 – 73.19) than those sampled from Chibayish (33.3 %; CI = 0.8-90.0) and Tarmyah (20 %; CI = 0.5 – 71.6). While the sample size of both Chibayish and Tarmyah animals were minor, and therefore the CI was great and overlapped noticeably with the CI for snakes tested from Jisr Diayala. The overall mean intensity of *T. anomala* was 6.06 (CI = 2.75 – 12.56). For subsets of hosts (Table 1), there was no significant difference in mean intensity between the sexes (t = 0.365; bootstrap p = 0.7315). As well as, there was no statistically significant variance in intensity through regions (Mood's median test; p = 0.604), although the intensity of *T. anomala* in snakes sampled from Jisr Diayala had high mean intensity (5.5; CI = 2.17 – 14.33) compared with snakes sampled from other regions. For all snakes combined, $s^2$/m and k values (18.58 and 0.14, respectively) showed that *T. anomala* was greatly aggregated among snakes (Fig. 2). Fairly limited hosts had a great proportion of the *T. anomala* population. Ranked infrapopulations indicate the four most greatly infected hosts (10.2 % of collected snakes; range in parasites per snake = 7 – 35) had 78.3 % of the *T. anomala* component population, and 25.6 % of hosts infected with 97.8 % of parasites (Figure 2). Excluding uninfected snakes, 18.7 % of snakes were infected by 74.2 % of *T. anomala*. Host subsets (males, females, Jisr Diayala, Chibayish and Tarmyah) have similar patterns of parasite aggregation. There was a high level of *T. anomala* aggregation among hosts in each case (Table 2). Although aggregation was higher in females than males, and Jisr Diayala compared to Chibayish and Tarmyah.

**Table 1:** *Tanqua anomala* prevalence and mean intensity, with 95 % confidence interval of mean derived, for all dice snakes collected, as well as subsets of the total snake population.

| Snake Population | n | n infected(%) | Mean intensity (median) | 95% CI |
|---|---|---|---|---|
| All | 39 | 16 (41%) | 6.06 (2) | 25.56-57.91 |
| Female | 14 | 5 (35.7%) | 9.2 (3) | 12.75-64.87 |
| Male | 25 | 11 (44%) | 6.64 (1) | 24.4-65.08 |
| Jisr Diayala | 23 | 12 (52.2%) | 5.5 (1.5) | 30.58-73.19 |
| Chibayish | 3 | 1 (33.3%) | 3 (3) | 8.4-90.58 |
| Tarmyah | 5 | 1 (20%) | 2 (2) | 0.5-71.65 |

## Discussion

*Tanqua anomala* has been reported from Iraq previously by Al-Moussawi (2010). It is common in Australia, Middle East and South Asia (Rao *et al.,* 1977; Naidu 1978; Farooq and Khanum, 1982; Dewi *et al.,* 2008; Goldberg and Bursey, 2011). Nevertheless, no

**Table 2:** Aggregation metrics for *Tanqua anomala* through all dice snakes population and subsets of dice snakes. Host collected from Chibayish and Tarmyah are excluded as a distinct subset because of small sample size (n =3) and (n=5) respectively.

| Population | n | $s^2/m$ | k |
|---|---|---|---|
| All | 39 | 18.58 | 0.141 |
| Female | 14 | 25.91 | 0.131 |
| Male | 25 | 15.67 | 0.199 |
| Jisr Diayala | 23 | 19.24 | 0.144 |
| Chibayish | 3 | 3 | - |
| Tarmyah | 5 | 2 | - |

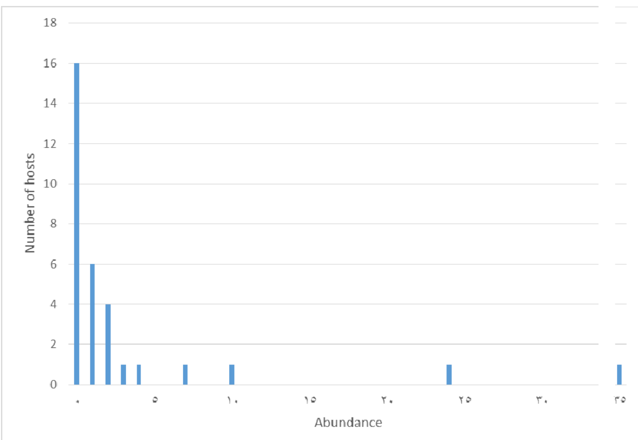


**Fig. 2:** Distribution of *Tanqua anomala* abundance (number of parasites per host, including uninfected hosts) among n = 39 dice snakes collected from central Iraq.

detailed assessments of the prevalence or intensity of *T. anomala* parasitism based on necropsies have been previously recorded in Iraq. Other, earlier works on dice snake parasite communities in Iraq directed in the 1990s and 2000s failed to isolate *T. anomala* from dice snake (Rhaemo and Ami, 1993; Al-Barwari and Saeed, 2007) which proposes that *T. anomala* is not distributed in the region or it was miss identified. While in current study, although limited numbers of dice snakes were collected and only three locations surveyed from central and south of Iraq, but *T. anomala* found to occur in 41% of dice snakes collected, these findings propose that *T. anomala* is expected to be ubiquitous among the samples collected and may spread in the region. Dice snakes are rapidly maturing and short-lived compared to other members of the local snake assembly (Brown and Shine, 2002; Brown *et al.,* 2002). Investing in self-maintenance and resistance strategies against chronic infections with such a short life expectation may be less successful than an animal with a longer life expectation would be (Madsen *et al.,* 2005; Sears *et al*., 2011). According to this explanation, dice snakes are likely showed high prevalence and intensity of infection with other parasites (some blood parasites), and similarly showed no sign of the adverse effect of infection (Brown *et al.,* 2006). The prevalence observed in this study was high and it was agreed with the result of Mayer *et al*., (2015) who showed a high prevalence rate of *T. anomala* among road-killed keel backs. Characteristics of the infrapopulations of *T. anomala* infecting snakes suggest that the common condition may be high levels of infection (Mayer *et al.,* 2015). No statistically significant differences in prevalence as a function of host sex were noticed in the current study. This result agreed with the result of Mayer *et al*., (2015) who showed that the sex ratio of *T. anomala* in keelbacks was 50:50, proposing that inbreeding avoidance and low mating chances were not significant selective factors acting on this parasite's populations.

No significant differences in prevalence in populations were observed among the three locations included in this study. Although strong site-specific differences in the extent of parasitism are well known in parasitology (Gibson *et al.,* 2016). In the current study, habitat characteristics are almost the same among the three locations included. Besides the prevalence and intensity may be influenced by animal populations or contact rates (Gompper and Wright, 2005; Monello and Gompper, 2011).

This absence of robust intensity alterations when individual subsets were contrasted may depend on the high aggregation rates of the nematode across snakes. Whereas prevalence rates were comparatively high, most (90%) infrapopulations were comprised of d”6 nematodes. On the other hand, a small proportion of snakes were infected with an excessive number of *T. anomala*, this agreed with the finding of Al-Warid *et al*. (2017) who noticed that high aggregation levels were observed when the total host population was divided into demographic or spatial subpopulations.

Although the sample size of snakes considered in this study is relatively limited, but the results make it possible to highlight several significant points regarding *T. anomala*. First, the fairly high prevalence and intensity collective rates suggest that *T. anomala* is widespread in the study areas. Second, the observed aggregation patterns indicate the potential to use quantitative methodologies to determine which ecological or demographic features of snake are best to expect infection patterns of *T. anomala* among the snake population.

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