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Mark Release Re-capture of *Ischnura elegans* (Odonata: Zygoptera, Coenagrionidae) in Dakahliya Governorate (Egypt).

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ABSTRACT

Mark Release Re-capture studies used in the evolution of animals and animal ecology. While it is probably to be used in some animals, it is considerably more challenging in small fast-moving invertebrate species, especially insects. In these groups, low rates of recapture can bias estimates of demographic parameters, thereby handicapping effective analysis and management of wild animal populations. The author used the mark-recapture method and daily movement of *Ischnura elegans*. The retention rate probability was different between males and females of *Ischnura elegans*. 969 individuals of *Ischnura elegans* (710 males and 259 females) were marked, recaptured and measured over the course of the study, of which 409 individuals (42.2%) 357 males and 52 females, were recaptured. The daily movement of *Ischnura elegans* shows, that 401 individuals were marked and 223 individuals were moved throughout the station or among stations.

INTRODUCTION

Relatively, few studies have been carried out on the movement and dispersal in zygopteran dragonflies. To obtain a detailed and comprehensive picture of the movements of individuals it would be necessary to spend much time tracking individuals for days at a time. Odonata individuals are excellent subjects for ecological and dispersal studies because of their abundance, large size, day activity, ease of capture and their occurrence in open habitats (Moore, 1957). The most useful tools in such studies have been the marking and subsequent observation or recapture of identifiable individuals. The mark-recapture techniques used in Odonata by Corbet et al., (1960). These authors advised the commonly used method of cellulose paint. Odonata can be good organisms for mark-recapture (Mollet et al., 2015).

The mobility In Zygoptera is low in many species (Parr & Parr, 1979; Utzeri et al., 1984; Banks & Thompson, 1985 and Eberhard, 1986). Marking wild animals allows researchers to estimate densities and key demographic parameters, longevity and emigration rates.

Odonates as a model to use in the development of mark-recapture methods because large data sets are relatively easy to obtain. One method to analyze mark-recapture data was developed to deal with the survival rates of age in *Ischnura elegans*. Additionally, in

an extensive study of a community of odonates, Van Noordwijk (1978) evaluated a method to analyze mark-recapture data, again. Anholt et al., (2001) studied mark-recapture to estimate of daily survival rates of *Ischnura elegans*. Conard et al., (2002) studied the characteristics of *Ischnura elegans*: age, sex, size and ectoparasitism. Rassim Khelifa et al., (2021) studied capture-mark-recapture by integrating high-speed videos.

Dispersal is one of the methods and is considered as the key demographic processes in population ecology. Templeton & Rothman (1981) study the mechanism of species moving between habitats. McPeck, (1989) studies the dispersal among *Enallagma* damselflies (Odonata) inhabiting different habitats. He studies the mechanisms of dispersal for *Enallagma* found in southwestern Michigan, U.S.A. The rarity of Odonata dispersal has usually prevented examination of whether some individuals are more likely to disperse than others (Anholt, 1990). Dispersal may be defined as an undirected movement (in contrast to migration) away from the site of habitat (Den Boer, 1990) and a life history trait that has profound consequences for odonates individual population (Dieckmann et al., 1999). Zohreh E. B. et al., (2023) studied population characteristics of *Ischnura elegans* (Odonata: Coenagrionidae) in arid regions: sex and female morphs differences in survival and capture probabilities, space use patterns and spatial density.

Most empirical on odonate dispersal have focused on within-patch movements (Garrison & Hafernik, 1981; Conrad & Herman, 1990; Jenkins, 2001) or have considered movements between different stations (Van Noordwijk, 1978; Koenig & Albano, 1987; Thompson, 1991 and Stettmer, 1996). Schutte et al., (1997) captured *Calopteryx splendens* for two months between the 16th of May and the 30th of August 1993. They were captured with the net on being observed for the first time and individually marked with points on the wings using quickly drying lacquer. In response to factors such as deforestation, development of agriculture and mining areas and global warming, have been observed in odonates (Sternberg *et al.* 1999) and suggest that some species are moving across unsuitable habitats.

Odonates are excellent subjects for dispersal studies for several reasons. First, they are large, conspicuous and easily handled and observed. Second, most events are relatively easily monitored, since the majority of movements appear to occur between populations at water bodies < 1 km apart (Moore, 1953; Stettmer, 1996 and Conrad et al., 1999. Cordero, (2000) study the mobility and fluctuating asymmetry in time mating success of *Ischnura graellsii* (Rambur) (Zygoptera: Coenagrionidae). Mobility is difficult to appreciate for males observed only a few times. Some males showed high site fidelity but others were observed at different locations at every sighting. Some males and also several females were caught by gentle netting and marked by a unique combination of white and/or red paint spots on the outer sides of the wings. After about one minute a marked individual was released at the same place. Conard et al., (2002) studied the dispersing of *Ischnura elegans* and *Coenagrion puella* (Odonata): age, sex, size and morphology

Here, both males and females within and between-patch dispersal are examined directly in *Ischnura elegans*, using data from mark release recapture techniques in four populations of Shoubra village, Aga city, Dakahlyia Governorate (Egypt). Investigation movements are pertinent in this rare species since it occupies four fragmented biotopes in Egypt. We estimated the extent of variation in the dispersal tendency of damselfly *Ischnura* (Odonata: Zygoptera) and considered the reasons for this variation.

To achieve such research, four stations were chosen in Shoubra village, Aga city, Dakahlyia Governorate (Egypt). To survey these above-mentioned insects we used the sweeping net.

MATERIALS AND METHODS

Study Sites:

The study sites are situated in Shoubra village, Aga city, Dakahlyia Governorate (Egypt). The study area contains four populations of *Ischnura elegans*. All stations are large channels. The field study was conducted from April 2020 to the end of July 2020.

Ischnura elegans individuals were collected at four stations in Shoubra village, each station (200 meters) being divided into 20 sections of 10 meters, to determine. The author next examined, if significant dispersal occurred among stations, by following the *Ischnura elegans* composition through the flight season. Dispersal through stations would be expressed as a change in compositions at one or all of the stations through time.

Although fieldwork was carried out between the 26th of April and the 29th of July, this period covered most of the flight season of *Ischnura elegans*. The individuals of each station are distinguished by a different color from the individuals of other stations. Unmarked individuals were each given a number of points on the wings, this means that on the first visit, the author made one point on the wing with an indelible pen and on the second time made two points and so on, and the individual was released at the place of capture.

After marking, the damselflies resumed their normal behavior rapidly. When individuals were recaptured, their sex, the date of marking, the section in which they were recaptured and the number of points were noted.

In order to apply capture-recapture methods to a mobile animal population it is necessary for captured animals to be given marks. Each animal is given an individual mark when it is first captured but not marked again. These individual marks must be such that the times of captures and recaptures can be determined for all the individual animals seen during the sampling. Capture-recapture data were obtained in order to examine changes in the structure of the population over the flying season.

Daily Movement:

Ischnura elegans were observed and captured on one day at four stations: They were captured with a net and marked with consecutive numbers of points on the wings by many colors and then immediately released in the same sector in which they had been captured. Five recapture individuals were carried out by reading the number of points and the color of the wings in each recapture.

RESULTS

The relative frequencies of *Ischnura elegans* at the four stations are given in Tables (1&2). It detected movement of *Ischnura elegans* throughout the sections of each station but no or slight movement among stations (from station 2 to station 3). 969 individuals of *Ischnura elegans* (710 males and 259 females) marked over the period of study, 409 individuals (42.2%) 357 males and 52 females, were recaptured. In some stations, some individuals moved within a stretch of suitable stream and the proportion of individuals not moving at all was also substantial. The number of migrating individuals of *Ischnura elegans* is 5 males from station 1 to station 2, 2 males from station 2 to station 1, 3 males from station 3 to station 4 and 11 males from station 4 to station 3, and the distance of migration is 120 meter, 100 meters, 140 meters and 200 meters, respectively. No females migrating. The distribution of marking dates of individuals who moved between stations was bimodal from April 2020 to July 2020 for *Ischnura elegans*.

Table 1: Total number of marking and re-capture individuals of *Ischnura elegans* at stations 1, 2, 3 and 4 in Dakahliya Governorate.

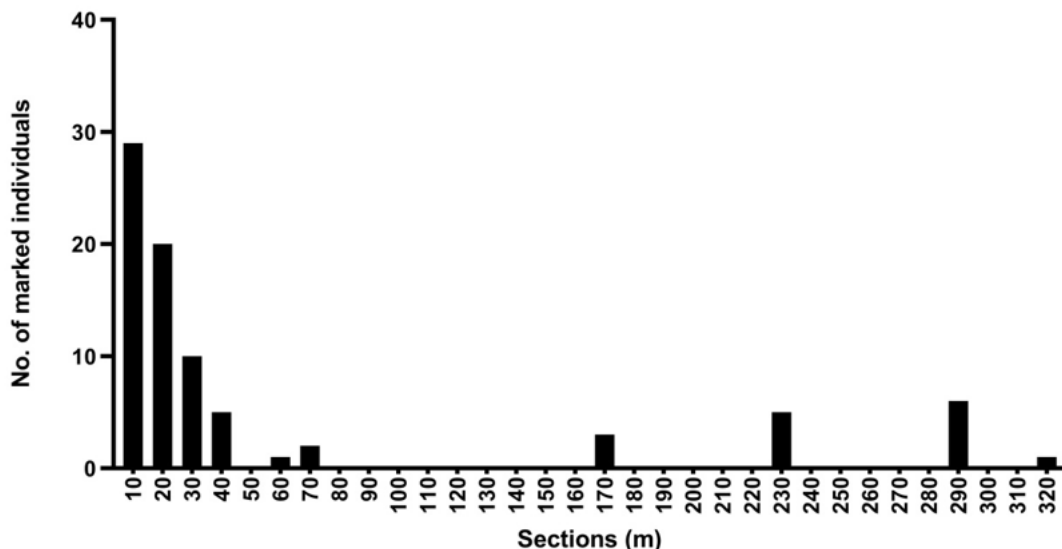
| Station | No. of mark. | Total no. of marked | | No. of recapt. | Total no. of recaptured and percentage | | | | No. and dist. of migration individual | | | | | |
|---------|--------------|---------------------|--------|----------------|--|------|--------|----|---------------------------------------|-----|-----|---|---|---|
| | | Male | Female | | Male | % | Female | % | m | % | D | F | % | D |
| 1 | 8 | 192 | 71 | 12 | 95 | 49.4 | 10 | 14 | 5 | 5.2 | 120 | 0 | 0 | 0 |
| 2 | 8 | 131 | 52 | 12 | 62 | 47.3 | 6 | 11 | 2 | 3.2 | 100 | 0 | 0 | 0 |
| 3 | 8 | 82 | 31 | 12 | 37 | 45.1 | 5 | 16 | 3 | 8.1 | 140 | 0 | 0 | 0 |
| 4 | 8 | 305 | 105 | 12 | 163 | 53.4 | 31 | 29 | 11 | 6.7 | 200 | 0 | 0 | 0 |

Table 2: Sex ratio of marking and re-capture individuals of *Ischnura elegans* at stations 1, 2, 3 and 4 in Dakahliya Governorate.

| Station | Total no. sex ratio of marked individuals | | | | Total no. sex ratio of recaptured individuals | | | |
|---------|---|---------|--------|---------|---|---------|--------|---------|
| | Male | s. r. % | Female | s. r. % | Male | s. r. % | Female | s. r. % |
| 1 | 192 | 73 | 71 | 27 | 95 | 90.4 | 10 | 9.6 |
| 2 | 131 | 71 | 52 | 29 | 62 | 91 | 6 | 9 |
| 3 | 82 | 72.5 | 31 | 27.5 | 37 | 88 | 5 | 12 |
| 4 | 305 | 74.3 | 105 | 25.7 | 163 | 84 | 31 | 16 |

Daily Movement:

Figures (1, 2, 3 & 4) and Table (3) show that, the daily movement of *Ischnura elegans* at four stations. 401 individuals (280 males and 121 females) were marked, 152 individuals (105 males and 47 females), 58 individuals (40 males and 18 females), 43 individuals (32 males and 11 females) and 148 individuals (103 males and 45 females) at stations 1, 2, 3 and 4, respectively. 223 individuals were moved (167 males and 56 females) throughout the sections of each station or among stations. 82 individuals (61 males and 21 females), 34 individuals (25 males and 9 females), 27 individuals (20 males and 7 females) and 80 individuals (61 males and 19 females) at stations 1, 2, 3 and 4 respectively. Most of the marked individuals 29 (35.36%) individuals at Station 1, 15 (44.11%) individuals at Station 2, 11 (40.74%) individuals at Station 3 and 31 (38.75%) individuals at Station 4, the recaptured individuals moved of 10 meters. But 1 (.01%) individuals at station 1 and 1 (.012%) individuals at station 4 moved over a distance of 320 meters.

**Fig. 1:** Daily movement of *Ischnura elegans* at station 1 in Dakahliya Governorate.

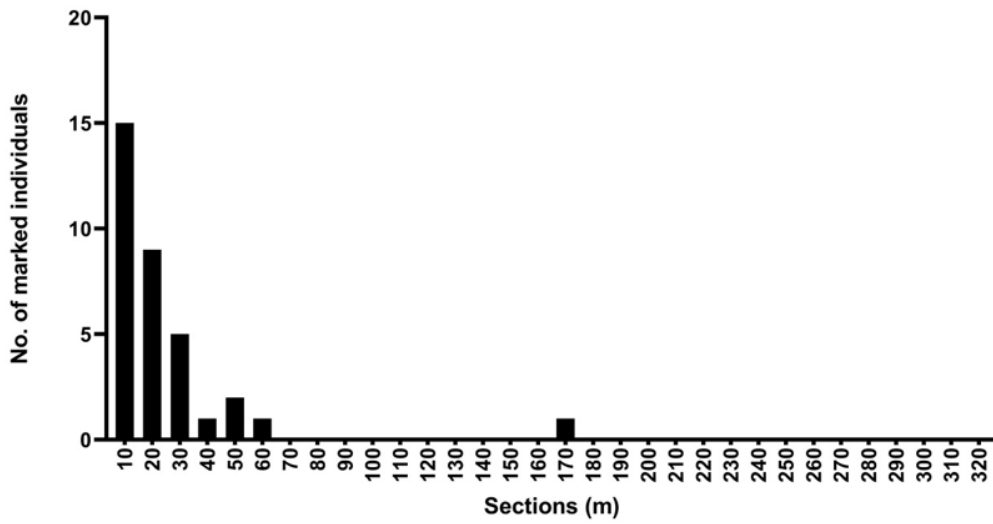


Fig. 2: Daily movement of *Ischnura elegans* at station 2 in Dakahliya Governorate.

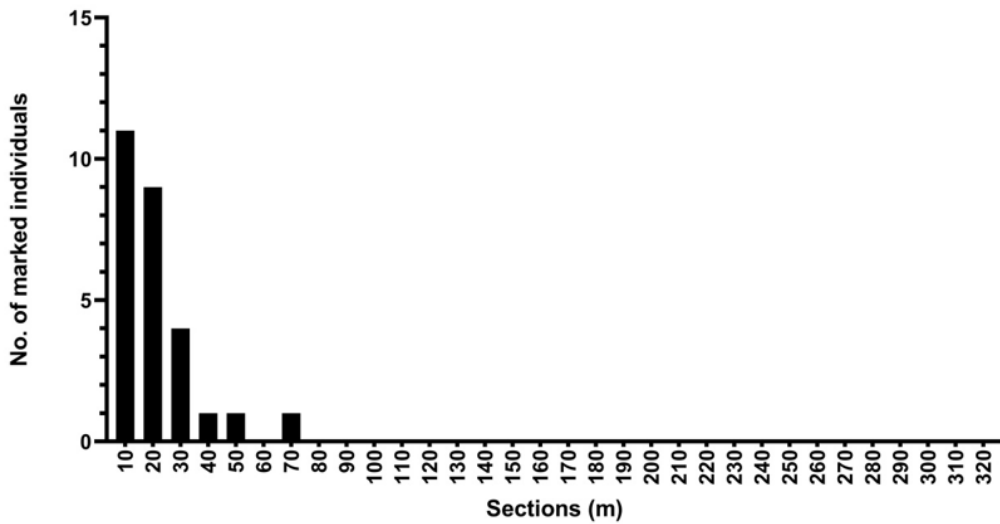


Fig. 3: Daily movement of *Ischnura elegans* at station 3 in Dakahliya Governorate.

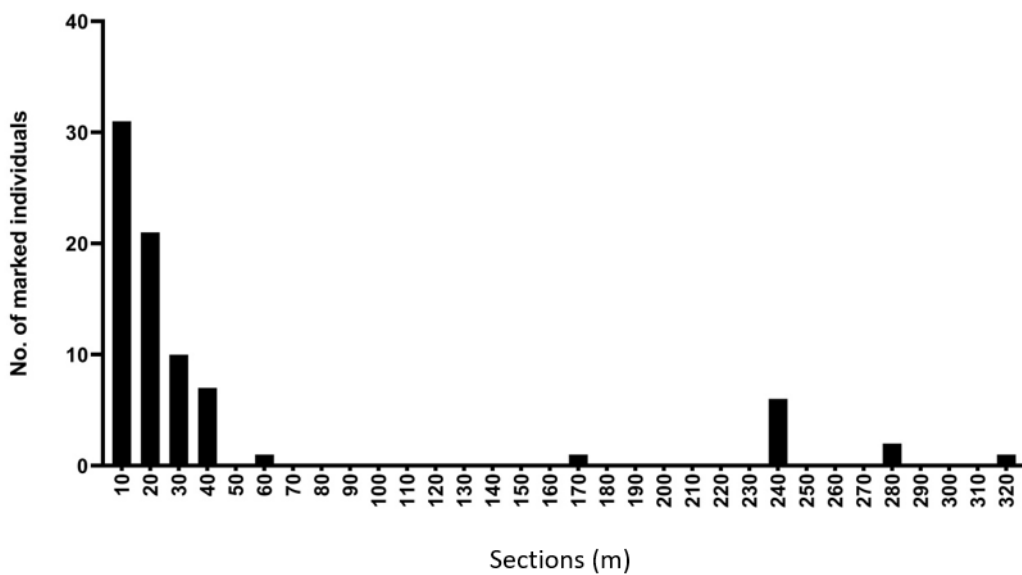


Fig. 4: Daily movement of *Ischnura elegans* at station 4 in Dakahliya Governorate.

Table 3: Daily movement of *Ischnura elegans* at stations 1, 2, 3 and 4 in Dakahliya Governorate.

| Stations/ distance(m.) | Station 1 | Station 2 | Station 3 | Station 4 |
|-----------------------------|-----------|-----------|-----------|-----------|
| 10 | 29 | 15 | 11 | 31 |
| 20 | 20 | 9 | 9 | 21 |
| 30 | 10 | 5 | 4 | 10 |
| 40 | 5 | 1 | 1 | 7 |
| 50 | 0 | 2 | 1 | 0 |
| 60 | 1 | 1 | 0 | 1 |
| 70 | 2 | 0 | 1 | 0 |
| 80 | 0 | 0 | 0 | 0 |
| 90 | 0 | 0 | 0 | 0 |
| 100 | 0 | 0 | 0 | 0 |
| 110 | 0 | 0 | 0 | 0 |
| 120 | 0 | 0 | 0 | 0 |
| 130 | 0 | 0 | 0 | 0 |
| 140 | 0 | 0 | 0 | 0 |
| 150 | 0 | 0 | 0 | 0 |
| 160 | 0 | 0 | 0 | 0 |
| 170 | 3 | 1 | 0 | 1 |
| 180 | 0 | 0 | 0 | 0 |
| 190 | 0 | 0 | 0 | 0 |
| 200 | 0 | 0 | 0 | 0 |
| 210 | 0 | 0 | 0 | 0 |
| 220 | 0 | 0 | 0 | 0 |
| 230 | 5 | 0 | 0 | 0 |
| 240 | 0 | 0 | 0 | 6 |
| 250 | 0 | 0 | 0 | 0 |
| 260 | 0 | 0 | 0 | 0 |
| 270 | 0 | 0 | 0 | 0 |
| 280 | 0 | 0 | 0 | 2 |
| 290 | 6 | 0 | 0 | 0 |
| 300 | 0 | 0 | 0 | 0 |
| 310 | 0 | 0 | 0 | 0 |
| 320 | 1 | 0 | 0 | 1 |
| Total no. of moved indi. | 82 | 34 | 27 | 80 |
| No. of recaptures | 5 | 5 | 5 | 5 |

Survival:

The probability of survival rate of *I. elegans* was 85.0 % / day and occurrence differed between males and females (male 81.0% and female 50.4%).

DISCUSSION

Most of the marked individuals migrated less than one hundred meters, the same

result given by Schutte et al., (1997) and Zohreh et al., (2023), but the smaller distances given by St. Quentin, (1964), this distance might indicate the home range of an individual can not be interpreted as dispersal activity.

McPeck, (1989) found few adults of four *Enallagma* species movement between lakes in observation of pairs of lakes. N.K., Michiels, et al., (1991) reported that about 20% of individuals are considered to have emerged locally, indicating that most matures had immigrated over distances of 1.75 km. or more. Rain can reduce survival Cordoba-Aguilar, (1993).

Mark-recapture experiments are usually carried out over a timescale of years or months and thus have relatively few encounter occasions whilst adult insect mark-recapture is often carried out on a daily basis yielding tens of encounter occasions. Insect studies commonly involve much larger numbers of individuals that are much less likely to be recaptured due to their relatively small size and high mobility making the data sparse. This means that large insect populations will not be amenable to combined analyses of recoveries and resightings which have allowed unbiased estimations of survival and emigration in vertebrates (Frederiksen & Bregnballe, 2000).

The mobility of *I. elegans* was greater in several respects. Hunger & Röske, (2001) found that 96% of individuals in a population in southwestern Germany remained within 25 meters of the site in which they were marked. In this study, the proportion was much lower (20-47%) and some individuals (46-80%) moved within the natal station. The *I. Elegans* movement within stations and between stations was greater in this study, being 610 m and 1060 m respectively, versus 170 m and 300 m observed by Hunger & Roske, 2001. In the present work *I. elegans* movement between stations of up to 320 meters. This agrees with the results by (Hold, 1997; Hopkins & Day, 1997 and Jenkins, 1998). Jenkins, (2001) found a low rate of movements (1/1223 individuals) between two adjacent streams (75-150 m apart) in the New Forest. The distance between sampled patches in the southwest German population was approximately 600 m (Hunger & Röske, 2001).

It is significant that adult *I. elegans* was capable of moving between sections of the same station within one day. Whilst *I. elegans* was found to move around 320 m., larger zygopterans such as *Calopteryx splendens* and *C. virgo* can move around 1 km. in one or two days (Stettmer, 1996).

Zohreh *et al.*, (2023) reported that the survival rate of *I. elegans* females was almost smaller than males. In our study, the daily survival in *I. elegans* was 85.0 % / day and occurrence differed between males and females (male 81.0% and female 50.4%).

Declarations:

Ethical Approval: It is not applicable.

Competing interests: The author declares no conflict of interest.

Funding: No funding was received.

Availability of Data and Materials: All datasets analysed and described during the present study are available from the corresponding author upon reasonable request.

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